TOPICS RELEVANT TO PROFESSIONAL ETHICS, GENDER, HUMAN VALUES, ENVIRONMENT AND SUSTAINABILITY IN CURRICULUM

Sl No:	Subject	Professional Ethics	Environment & Sustainability	Gender Issues	Human Values
1	Political Science	**Part-II** **Paper-III (H)** Role of religion		**Part-II** **Paper-III (H)** Womens Movement. **Part-III** **Paper-VII** Gender and politics: basic issues.	**Part-I (H)** **Paper-I** Liberty, Equality, Rights and Justice Liberty, Equality, Rights **Part-II** **Paper-III (H)** Fundamental Rights **Part-III** **Paper-VI (H)** Movements against caste system and untouchability – Ambedkar's views on Social Justice and Depressed Class.
2	**Education**		Part –III (Honours) Paper- V Group- A (Psychology of Adjustment) Module- I & Module- II Part I (General) Paper- 1 (Principles of Education) Module II		Part-I (Honours) Paper-I (Philosophical Foundation of Education and Contribution of Great Educators) Group- A Module-I Part I (General) Paper 1(Principles of Education) Module- II
3.	**Economics**		Part - I (Hons) Paper IV-A (Development Economics) Unit 6 & Unit 7	Part - I (Gen) Paper IV-A (Development Economics I) Unit 5	

Rajyasri Ghosh

Principal
Vijaygarh Jyotish Ray College
Kolkata-700 032

			Part I (Hons) Paper VI-A (Comparative Development Experience) Unit 1		
4.	**Microbiology**		**PART-II (Honors)** **Paper IV Group A (TH):** Environmental and Food Microbiology (Unit-I and Unit-II) **Paper IV Group B (PR):** Unit-I and Unit-II		
5	**Chemistry**		Part-1(Honors), CHT11a, Unit-1 Radioactivity and atomic structure Part-11(Honors), CHT21b Chemistry of s and P block elements Part-111(chemistry general) Unit-I, CGT31b, Environmental chemistry unit-II , Pesticides		
6	**Zoology**	**Paper 6 Unit 2** Biotechnology and Applied Zoology (i) Modern techniques of fish hybridization and induced breeding in carps. (ii) Application of biotechnology in – (a) Sericulture, (b) Lac culture, (c) Api culture,	**Paper 2 Unit 1** Stem cell: ES and adult stem cell, characteristic features, definition of potency and niche, markers in human stem cell, potential application of stem cells as regenerative medicine **Paper 3 Unit 2 Group A** Brief idea on EI		

		(d) Pearl culture practice, (e) Prawn culture (iii) Integrated pest management and biological control of pests: principles and significance. (iv) Principle of LD50 and LC50 and their application in applied Zoology	nino, La nina and their consequences **Paper 3 Unit 2 Group B** Types of biodiversity, biodiversity and human welfare, mega diversity zones and biodiversity hot spots with special reference to India Concept of wildlife, wildlife heritage of India, reasons for wildlife depletion in Indian context Concept of threatened fauna – IUCN categories. Protected area concept – Sanctuary, National Park, Biosphere reserve, Core Zone, Buffer Zone, Corridor concept. Conservation reserves JFM & Arabari model for conservation – key stone, flagship and umbrella species Special management program with special reference to Tiger project Man–animal conflict (man-tiger and		

			man-elephant) – causes and concern Environmental audit and impact assessment Role of NGO's in wildlife conservation in India **Paper 6 Unit 2** Transgenic animals (i) Production of transgenic animals: cloning (methodology and application) (ii) Contribution of transgenic animals to human welfare (Poultry and Dairy) 3. Animal cell culture (i) Cell culture types (ii) Cell culture technology (suspended and adherent culture) (iii) Cell culture media (RPMI-1640,M-199 and its components) 4. Gene therapy: Principle: Ex-vivo & In-vivo gene therapy. Strategies, Viral and non-viral vectors, antisense therapy		

			Practical Paper 8 Ecosystem and its biodiversity assessment. (Any suitable ecosystem) (various diversity indices with explanation must be presented) Visit a place of wild life interest (Sanctuary, National Park, Biosphere Reserve etc.) {Man-wildlife conflict, eco-tone, edge effect, eco-sensitivity, economics of the native inhabitants, logging and lopping effect, conservation process practiced etc.}		
7	**Botany**		**PaperIII, module VI:** **ECOLOGY** 1. *Preliminary idea on* : 1.1. Habitat and Niche, 1.2. Ecotone and edge–effect, 1.3. Microclimate, 1.4. Ecads, ecotype and ecoclines, 1.5. Carrying capacity. 2. *Community ecology* : 2.1. Community-Characteristics		

			and diversity, 2.2. Ecological succession –Primary and secondary, Seral stages (with reference to Hydrosere), autogenic and allogenic succession. 3. 3.1. Plant indicators (metallophytes); 3.2. Phytoremediation. 4. *Conservation of Biodiversity*: 8 4.1. Level of Biodiversity: genetic, species & ecosystem diversity, 4.2. Biodiversity hot spots- criteria, Indian hotspots, 4.3. *In- situ and ex-situ* conservation, 4.4. Seed-banks, 4.5. Cryopreservation, 4.6. Geographic Information System and Remote Sensing (brief idea) . **PLANT GEOGRAPHY** 5. *Phytogeographical regions* : 5.1. Phytogeographical regions of India (Chatterjee 1960); 5.2. Dominant flora of Eastern Himalaya, Western Himalaya and Sunderban. 6. *Endemism* : 6.1.		

			Endemic types and Factors; 6.2. Age & Area hypothesis and Epibiotic theory; 6.3. Endemism in Indian flora.		

8.	**PHILOSOPHY**	**PART-III** **PAPER-VII Unit-I Indian Ethics A. Introduction:Concerns and Presuppositions Concept of Sthitaprañjna Karmayoga: (Gīta) Puruùārthas and their inter-relations. B. Meaning of Dharma, Concept of èõa and èta. Classification of Dharma: Sāmānya dharma, viśeùadharma, sādhāraõadharma, C. Pancaśīla, Brahmavihārabhāvanā (Bauddha) Anuvrata, Mahāvrata, Ahimsā. (Jaina)** **Unit-II Western Ethics A. Nature and Scope of Ethics Moral and Non-moral actions, Object of Moral Judgement—Motive and Intention B. Standards of Morality: Hedonism—Ethical, Psychological. Unit-III**	**PART-III** **Unit—IV A. Environmental Ethics: Concepts of Anthropocentrism and non-anthropocentrism, Value beyond sentient beings, Reverence for life, Deep Ecology, Concepts of Kinship Ethics. B. Ecological Concern in Indian thoughts: Jaina and Bauddha views. C. Meta-ethics: Nature of meta-ethics, Emotivism as a meta-ethical theory, Prescriptivism.**	**PART-III PAPER-IV (SOCIAL-POLITICAL PHILOSOPHYAND CONTEMPORARY INDIAN THOUGHT) (Social-Political Philosophy) Unit-I A. Primary Concepts: Society, Community, Association, Institution. B. Social Groups: Its Different Forms. Family: Its Different Forms. C. Social class and Caste: Principles of Class and Caste; Marxist conception of class; Class Attitudes and Class consciousness. Unit-II A. Social Codes: Religious and Moral Codes; Custom and Law; Culture and Civilization. B. Political**	**PART-III** **Contemporary Indian Thought: Swami Vivekananda, M.K.Gandhi and B.R.Ambedkar) Unit-III A. Swami Vivekananda: Nature of man, nature of religion. B. The ideal of a universal religion, Practical Vedānta. Unit-IV A. Gandhi: Nature of man, non-violence, satyāgraha, theory of trusteeship. B. Ambedkar: Critique of social evils, Dalit movement.**

		Philosophy of Religion-I A. Nature and scope of Philosophy of Religion. Doctrine of karma and rebirth, doctrine of liberation, (Hindu, Bauddha and Jaina views). B. The Philosophical teachings of the Holy Quoran: God the ultimate Reality, His attributes, His relation to the world and man. C. Some basic tenets of Christianity: The doctrine of Trinity, The theory of Redemption. **PART-ii(GENERAL)** **PAPER—III** **(ETHICS AND PHILOSOPHY OF RELIGION)** **Ethics (Indian and Western)** **Unit-I Ethics (Indian) A. Four Puruùārthas-Dharma, artha, kāma and mokùa and their interrelation Karma (Sakāma & Niùkāma) Cārvāka Ethics B. Buddhist Ethics: The**		**Ideals: Democracy: Its Different Forms. Socialism:**	

		Four Noble Truths and the Eight-fold Path Unit-II Ethics (Western) A. Moral and Non-moral Actions Object of Moral Judgement B. Teleological Ethics: Utilitarianism (Bentham and Mill) Deontological Ethics: Kant's Moral Theory C. Theories of Punishment. **Ethics (Western) A. Moral and Non-moral Actions Object of Moral Judgement B. Teleological Ethics: Utilitarianism (Bentham and Mill) Deontological Ethics: Kant's Moral Theory C. Theories of Punishment Half-II (50 marks) Applied Ethics and Philosophy of Relgion Unit-III A. Concept of Applied Ethics. B. Killing: Suicide, Euthanasia. C. Famine, Affluence and**			

		Morality. D. Environmental Ethics: Value Beyond Sentient Beings, Reverence for life, Deep Ecology Unit-IV A. Nature & Concerns of Philosophy of Religion. Argument for the existence of God: Cosmological argument, Ontological argument and Teleological argument. B. Problem of Evil and Suffering. C. Grounds for disbelief in God: Sociological theory of Durkheim, Freudian Theory,Carvaka View.			
9.	PHYSIOLOGY(GEN)	**PART-III PAPER IVA** **WORK PHYSIOLOGY, BIOSTATISTICS**	**PART-III PAPER IVA** **ENVIRONMENTAL PHYSIOLOGY**		**PART-III PAPER IVA** **SOCIAL PHYSIOLOGY**

10.	Physics		PART-III (3rd Year General) Paper IVA: Application of Thermodynamics, **Energy Sources**, Electronics, Communications		

UNIVERSITY OF CALCUTTA

SYLLABUS

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THREE-YEAR HONOURS
DEGREE COURSE OF STUDIES

MICROBIOLOGY

2010

w.e.f. 2010-11

Syllabus for Microbiology Honours

Part I

Paper I

Group A: Biomolecules

Unit I

1. Stereochemistry
2. Carbohydrates
3. Amino acids

Unit II

1. Protein
2. Nucleic Acids
3. Lipids

Group B: Biophysical Chemistry and Biometry

Unit I

1. Physicochemical properties of water
2. Thermodynamics
3. Microscopy
4. Radioactivity

Unit II

1. Spectroscopy
2. Biometry

Paper II

Group A: General Microbiology

Unit I

1. Development of microbiology
2. position of microbes
3. Staining
4. Morphology and subcellular structures
5. Bacterial cell wall biosynthesis and structure

Unit II

1. **Eukaryotic microbes**
2. **Microbial nutrition**
3. **Microbial growth**
4. **Control of growth of microbes**

Group B: Practical

Unit I

1. **Operation of Light-Microscope; oil-immersion objective**
2. **Preparation of culture,media,Cultivation of Microorganisms, Pure-culture, Staining techniques**
3. **Micrometry**

Unit II

1. **Qualitative tests of carbohydrates**
2. **Separation of aminoacids**
3. **Estimation of amino acid**
4. **Biometry**

Detailed syllabus

Paper I

Group A: Biomolecules (50 marks)

UNIT I

1. Stereochemistry: (15)

General concepts on: Plane of symmetry, centre and axis of symmetry; Concepts of chirality; optical isomerism; geometrical isomerism; DL, RS nomenclature; Projection formula (Fischer & Howarth); Isomers: anomers, epimers.

Stereochemistry of cyclohexane: idea of axial & equatorial bonds (related to chair form conformation), Important chemical reactions relating to configurations, Mutarotation and its mechanism.

2. Carbohydrates: (15)

Definition, classification and structural concept of:

Monosaccharides: Hexoses (only Glucose), Pentoses (Ribose, Ribulose, Xylose)

Disaccharides: Sucrose, Lactose, Maltose

Amino Sugars: Glucosamine, Muramic Acid

Inversion (hydrolysis) of cane sugar.

Chemical reactions of monosaccharides (glucose & fructose i.e., aldose and ketose) with $HN0_3$, Br_2 - water, $HI0_4$, Phenylhydrazine. Principle of chemical estimation of sugar. Anomeric effect (Methylation effect). Polysaccharides: Chemical structure of Starch (α-amylose, amylopectin), glycogen & cellulose. Smith degradation and enzymic hydrolosis of α-amylose & amylopectin.

3. Amino Acids: (10)

Definition, classification, structure, stereochemistry of amino acids; Physico-chemical properties (Ionization & Biuret reaction) of amino acids. Amphoteric molecule, Zwitterion, pK values; Isoelectric point, Electrophoresis, Formol titration of Glycine (only reaction & principle). Reaction with Ninhydrin, FDNB, Dansyl & Dabsyl chloride, Fluorescamine, Van-slykes reaction. Reactions of carboxyl & amino groups. Synthesis of Glycine. Separation of amino acids by-Ion-exchange, Gel filtration, Paper Chromatography and Thin layer Chromatography. Peptides: peptide bond, biologically important peptides (glutathione, oxytocin-important functions).

UNIT II

1.Proteins (15): Classification (Primary, Secondary, Tertiary, Quaternary- definition, examples) Forces that stabilize structure of proteins: H-bonds, hydrophobic interaction, electrostatic attraction, Van der Waal's interaction, dipole-dipole interaction.

Types of proteins:

i) Fibrous (α -helix, β - sheet, e.g. collagen): definition and structure.

ii) Globular (Haemoglobin, Myoglobin): definition & examples.

iii) Simple proteins and conjugated protein: definition & examples—physical denaturation and renaturation

.

2. Nucleic acid: **(15)**

Purine, pyrimidine - definition and structure. Nucleoside, nucleotide: definition and structure. DNA & RNA: Double helical structure. A-DNA, B-DNA & Z-DNA (structure and differences). Chemical Properties: Hydrolysis (acid, alkali), enzymatic hydrolysis of DNA. General structure and types of RNA (tRNA, mRNA, rRNA). Viscosity, Buoyant density. Hyperchromic effect. Cot curve, T_m.

3.Lipids (10)

Definition, nomenclature, classification - (simple, complex, derived lipids - structure & example) phospholipids, glycolipids, - (structure, composition); hydrolysis, saponification, saponification number, I_2 number, acetylation, acetyl number, volatile fatty acid number - definition and related problems, Isomerism - *cis-trans* isomerism.

Fatty acids: Saturated (palmitic acid, stearic acid), unsaturated (oleic acid): Structure of free fatty acids (example only). General chemical reaction of fatty acids - esterification. Hydrogenation and halogenations

Suggested textbooks:

1.Finar, IL. Organic Chemistry, Part I and Part II.

Group B

Biophysical Chemistry and Biometry (50 marks)

UNIT I

1. Physico-chemical properties of water : (10)

Ionic product of water; pH - definition, effect of pH in enzyme catalyzed reaction. Acids, bases and buffers in biological system; Arrhenius, Bronsted-Lowry theories of acid and bases. Polyprotic acids, ampholytes, dissociation of polyprotic acid; titrable and true acidity. Surface tension, viscosity: application to biomolecules.

2. Thermodynamics: (15)

Zero-th law, 1st law & 2nd law of thermodynamics: application in biological systems, Concept of free energy, standard free energy change. Equilibrium constant; enthalpy; entropy. Transport across membrane - passive diffusion, facilitated diffusion & active transport - (definition and examples); gradient of chemical potential as driving force in transport, equilibria and transport across membranes; diffusion, osmosis, sedimentation, osmotic pressure. Donnan equilibrium, diffusion potential, membrane potential. Electrophoresis.

3. Microscopy: (5)

General principles of optics in relation to microscopy; different components of light wave (UV, IR, visible); principles and applications of Compound Microscope; Light Microscope; Dark field Mircroscope; Bright field Microscope; Phase Contrast Microscope; Fluorescent Microscope; Electron Microscope; Resolving power; Numerical aperture:Chromatic Aberration.

4. Fundamentals of radioactivity: (10)

Law of Radioactivity, Decay constant, half life, average life. Properties of α, β, γ radiations, unit of radioactivity, radioactive carbon dating. Applications of radioactive isotopes (^{14}C, ^{3}H, ^{32}P) in biological systems, (in Radioimmunoassay, glucose metabolism, DNA synthesis). Principle of liquid scintillation counter. Radiation absorption- biological effectiveness- Linear energy transfer- radiation protection and safety aspects.

UNIT II

1. Spectrophotometry: (15)

Concept of electromagnetic radiations - UV, visible, IR.

Orbital theory: Bonding and antibonding; simple association of 1t orbital to form TT orbitals. Concept of chromophore - Wit's chromophore theory, auxochorome, red shift, blue shift, Lambert-Beer's law - derivation & deviation; absorptivity, line diagram & working principle of spectophotometer. Extinction co-officient. Instrumentation and application of UV and visible spectrophotometry, Light Scattering, fluorescence spectroscopy, fluorescence energy transfer, infrared spectroscopy.

2. Biometry: (15)

Introduction **:** Types of Biological Data, Population and samples.

Descriptions of Samples and Populations**:** Frequency Distributions, Descriptive statistics (measures of Central tendency and measures of Dispersion, Boxplot)

Probability**:** Introductory concepts, Binomial distribution, Random sampling

Distribution Theory**:** Normal distribution and sampling distributions.

Statistical Inference**:** Statistical estimation, standard error of the mean, confidence interval and hypothesis testing of the population mean – *t* test. Brief discussions on the comparison of two independent population means. The Chi square test and its applications.

Analysis of Variance**:** Multi sample Hypotheses

Linear Regression and Correlation.

Suggested text books:

1. Tinoco, Sauer and Wang, *Physical Chemistry, Principles and Applications in Biological Sciences*, Prentice Hall, 4th Edition (2001).
2. Zar, JH., Biostatistical analysis, Pearson Education.
3. Atkins, *Physical Chemistry for the Life Sciences*, W.H. Freeman (2005).
4. Atkins, *The Elements of Physical Chemistry*, W.H. Freeman, 3rd Edition (2000)
5. Cantor & Schimmel, *Biophysical Chemistry*, Part I, II, III, Freeman Press (1980-1981).

6. Eisenberg & Crothers, *Physical Chemistry with Applications to the Life Sciences*, Benjamin/Cummings Publishing Co. (1979).
7. K. E. van Holde, W. C. Johnson, and P.S. Ho, *Principles of Physical Biochemistry* (1998).
8. P. Atkins and J Paula, *Physical Chemistry for the Life Sciences* (2006).
9. C.R. Cantor and P.R.Schimmel, Biophysical Chemistry (1980), Part I: The Conformation of Biological Macromolecules, Part II: Techniques for the Study of Biological Structure and Function.
10. Forthofer, RN., Lee, ES. (1995) Introduction to Biostatistics: A guide to design, analysis and discovery, Academic Press.

Paper II

Group A : General Microbiology (50 marks)

UNIT I

1. Notable contributions in the development of Microbiology: (3)

i) Spontaneous generation (abiogenesis).
ii) Biogenesis.
iii) Germ Theory of Disease.
iv) Koch's Postulates.
v) Scope of Microbiology.

2. Position of microorganisms in biological world: (4)

Whittaker's Five-kingdom and three-kingdom concept of living organisms (General characteristics of those groups); General features of Eubacteria and Archaebacteria (major difference within Eubacteria).

3. Stains & Staining techniques: (10)

Definition of auxochrome; Chromophores; Acidic and Basic dyes; Classification of stains; Simple and differential staining: theories of staining, mordant and its function; Gram staining; acid fast staining; endospore staining; negative staining; capsule staining; flagella staining; mechanism of gram staining.

4. Bacterial Morphology and subcellular structures: (18)

Morphology of bacteria, Slime layer, Mycelial morphology: Actinomycetes, Capsule, Cell wall, Ribosome, Cytoplasmic membrane (Fluid mosaic model of Singer - Nicholson); Cytoplasmic inclusion bodies - (inorganic, organic); Exospores & Cysts: types & structure; Endospore, Flagella, Pilus, Fimbriae (structure, composition and functions). Plasmids and episomes. Nuclear material, Bacterial Chromosome (Fundamental differences with eukaryotic chromosome).

5. Bacterial cell wall biosynthesis and structure(5)

UNIT II

1. Eukaryotic microbes: (10)

General characteristics, vegetative & reproductive structure of the following groups of microorganisms:

Algae: Cyanophyta, Chlorophyta, Bacillariophyta, Phacophyta, Rhodophyta, Fungi: Phycomycetes, Asocomycetes, Basidiomycetes, Deuteromycetes; Protozoa: Giardia, Plasmodium & Entamoeba.

2. Microbial Nutrition: (10)

Nutritional types (definition and example) - Photoautotrophs, Photoorganotrophs, Chemolithotrophs (ammonia, nitrite, sulfur, hydrogen, iron oxidizing bacteria); Chemoorganotrophs, Effect of oxygen on growth - classification on the basis of oxygen requirement and tolerance.

3. Bacterial Growth: (5)

Growth phases - Generation time. Kinetics of growth, Batch culture. Continuous culture. Synchronous culture (definition and brief description). Physical factors influencing growth - Temperature. pH, osmotic pressure, salt concentration.

4. Control of growth of Microbes: (15)

Sterilization, disinfection, antiseptic, sanitizer, germicide, antimicrobial agent (definition, application & examples); physical method of disinfection and sterilization - dry heat, moist heat, filtration, radiation (mode of action, applications); Chemical control – dye solutions, alcohol, acid, alkali, halogen, heavy metal, phenol, phenol derivatives,

formaldehyde, ethylene oxide, detergents (mode of action, applications). Assessment of chemical disinfectant; phenol coefficient-definition and method of determination.

Chemotherapeutic agents - sulphonamides, antibiotics, (definition types); mechanism of action and antimicrobial spectrum of penicillin, streptomycin, tetracycline, chloramphenicol, Nalidixic acid and metronidazole; drug resistance - phenomena and mechanism.

Suggested textbooks:

1. Stanier, RY., et al., General Microbiology, 5th ed. Macmillan Press.
2. Pelczar. M., et al., Microbiology, 5th ed.,2000, Tata-McGraw Hill
3. Atlas, RM., Principles of Microbiology, 2nd ed.,1997, McGraw-Hill
4. Salle, AJ., Fundamental Principles of Bacteriology, 7th ed.,1999, Tata- McGraw Hill
5. Prescott, LM., Microbiology, 6th ed. 2005, McGraw-Hill.

Group B : Practical (50 marks)

Unit I

1. Operation of Light-Microscope; use of oil-immersion objective. (5)

2. Preparation of culture media: (10)

Complex media (Nutrient Broth; NA slant; Lactose broth); Chemically defined, Synthetic media (Czapekdox broth / agar). YPD / select media which will be used for the experiments specified.

a) **Cultivation of Microorganisms** : on agar-slant/agar-plate streak culture:Bacteria (*Bacillus subtilis, Staphylococcus aureus, Escherichia coli*); Yeast (*Saccharomyces cerivisiae*) Moulds (*Penicillium notatum, Aspergillus niger*).

b**) Pure-culture**: by streak-plate/pour plate methods (12)

c) **Staining techniques** for examination of microorganisms :(15)

i) Bacteria-preparation of heat-fixed smear and (a) Simple straining (*E.coli, Bacillus subtilis, Staphylococcus aureus*) (b) Gram-staining-Gram positive (*B. subtilis, S. aureus, M.lutea*); Gram-negative (*E. coli, K. aerogenes*) (c) Capsule staining (*K. aerogenes, K. pneumoniae*) (d) Endospore st.aining (*B. subtilis*).

ii) Fungi-Lactophenol - Cotton blue staining of Yeast (*Saccharomyces cerevisiae*) :

Molds (*Penicillium notatum, Aspergillus niger*).

3. Micrometry: (5)

Microscopic measurement of bacterial cell (*B.subtilis*) yeast (*Saccharomyces cerevisiae*), fungal spores (*P. notatum, A. niger*).

4. Enumeration of microbes: Yeast by Haemocytometer. (5)

Unit II

1. Qualitative tests of carbohydrates: (6)

Glucose, fructose (Benedict's Test); sucrose (Acid hydrolysis & Benedict's Test); proteins (Biuret method); lipids (TLC & detection by Iodine vapor).

2. Separation of aminoacids (Lysine, glycine, tryptophan, proline) by Thin Layer Chromatography. (6)

3. Estimation of amino acid (glycine) by formol titration. (4)

4. Biometry: (10)

Hypothesis Test: *N*: testing Goodness of Fit and Contingency: t- Test for analysis of experimental samples. Study of Poisson Distribution of Microbes in a given sample (e.g. bacteria in a sample of water collected from a reservoir) - using Hacmocytometer.

PART II

Paper III

Group A: Cellular and Molecular Biology

Unit I

1.DNA Replication

2.Transcription in prokaryotes

3.Mechanism of translation in prokaryotes:

Unit II

1. Eukaryotic cell biology

Group B: Metabolism and Bioenergetics

Unit I

1.Enzymes

2. Amino acid metabolism

Unit II

1.Carbohydrate metabolism:

2. Purine and Pyrimidine metabolism (10)

3. Lipid metabolism

Paper IV

Group A: Environmental and Food Microbiology

Unit I

1. Air Microbiology

2. water Microbiology

3.Food Microbiology

4.Preservation of food

5.Microbiologically Fermented food

Unit II

1. Soil Microbiology

2. Biogeochemical cycles

Group B: Practical

Unit I	**1.Enumeration of microbes**
	2.Growth curve
	3.Assay of antibiotics
	4.MIC
Unit II	**1.Water microbiology**
	2. Milk microbiology
	3.Phenol coefficient

DETAILED SYLLABUS

Paper III

Group A: Cellular and Molecular Biology

Unit I

1. DNA Replication: (10)

DNA-Replication-Meselson-Stahl experiment as evidence for semiconservative replication; Mechanism of replication-Rolling-circle model & Theta (8) structure (bidirectional)

2. Transcription in prokaryotes: (15)

Mechanisms (Initiation, elongation, termination); promoter structures, subunits of bacterial polymerases, functions and domains responsible for activity, elongation process, mechanism of termination, □-dependent and independent termination; *lac, trp, ara* operons.

3. Mechanism of translation in prokaryotes: (15)

Description of ribosomal cycle including phenomena of initiation, elongation, termination; description of factors involved in these processes; genetic code; tRNA: clover-leaf structure & function; rRNA: structure and function; role of aminoacyl tRNA synthetases. Non-ribosomal peptide synthesis: cyclic peptide antibiotics e.g. Gramicidin etc.

Unit II

1.Eukaryotic cell biology: *(35)*

Eukaryotic Cell Membrane, Difference in membrane constituents between eukaryotes and prokaryotes: target of antimicrobial drugs; Elementary idea of intracellular organelles, Transport across membrane - (Active, Passive, Facilitated), Comparison between eukaryotic and prokaryotic flagella and cilia; Microfibrils in protozoan physiology; Mitochondria vs kinetoplasts (found in unicellular protozoan parasite)

Cell Biology of Yeast: Budding and fission yeasts, mating types and its determination (only elementary ideas) Mitosis & Meiosis, Cell cycle; Secretory pathway in yeasts (preliminary ideas about Sec mutants, transport of materials to the bud. Secretion in bacteria (3 types of secretion, Sec proteins, secretory metabolites)

Protein degradation: prokaryotic and eukaryotic-only elementary concepts (GroE, GroEL etc vs proteosomal system)

Suggested textbooks:

Stryer. L. et al. Biochemistry, 5th edition, WH Freeman, 2006.

Voet, D., and Voet JG. Biochemistry, Wiley, 1995.

Alberts, B., et al. Molecular Biology of the Cell, Garland, 4th ed., 2002

Lodish, H., et al. Molecular Cell Biology, WH Freeman, 2003.

Group B: Metabolism and Bioenergetics

Unit I

1.Enzymes: General properties, Nomenclature and classification; Co-factors definition and function with special reference to the representative substances - a) Co-enzymes (NAD+, NADP+, Co-enzyme-A, TPP, Pyridoxal phosphate); b) Prosthetic groups (FAD+ - Succinic dehydrogenase); c) Metal ions: Zn^{2+}, Mg^{2+}, Fe^{2+}, Fe^{3+}, Mn^{2+} - required for enzyme action

Enzyme Kinetics - Michaelis-Menten equation; Enzyme Inhibition - Competitive-cite succinate on Malonate dehydrogenase as example, Non-competitive - Cite Iodoacetamide on triose phospate dehydrogenase and EDTA as example; Suicide inactivation-action of penicillin on bacterial cell wall biosynthesis as an example; Regulatory enzymes-Allosteric - Cite CTP on aspartate transcarbamylase as example; Feedback inhibition - Cite Threonine to Isoleucine as example; Ribozyme (catalytic RNA) and Abzyme (use of antibody as enzyme**)** - definition only

2.Amino acid metabolism (10)

Transamination, deamination, transmethylation and decarboxylation. Glucogenic and ketogenic amino acids, Outline of Urea Cycle; Microbial metabolism of glycine, phenylalanine and lysine

Unit II

1.Carbohydrate metabolism: (25)

Aerobic respiration-Glycolysis (EMP-pathway) with energy production: entry of galactose & fructose in EMP-path; TCA-cycle with energy production: pentose-phosphate pathway: Electron Transport Chain (in brief) & ATP generation sites; ATP & ADP cycle (oxidation-reduction potential and electromotive force). Photophosphorylation, oxidative

phosphorylation (chemiosmotic theory); Anaerobic respiration - Utilizing NO_2, Sulfur (SO_4), CO_2 as electron acceptors; Stickland-reaction; Entner-Doudoroff pathway
Fermentation - Glucose metabolism in anaerobic condition general concept only
Bacterial photosynthesis (Cyanobacteria and Green-sulphur bacteria); Difference with eukaryotic photosynthesis

2.Purine and Pyrimidine metabolism (10*)*

Synthesis of purines: elementary concept, source of the precursors of purines, ribose 5-phosphate; synthesis of AMP and GMP from IMP-only preliminary idea; Importance of folic acid and target of sulfonamides; Microbial reduction of purines to deoxy-purines: thioredoxine; Biosynthesis of pyrimidines: Aspartate transcarbamoylase (ATCase); Origin of Thymine: importance of folic acid (conceptual); Degradation of nucleotides: xanthines, uric acid; catabolites of pyrimidines: NAD and Coenzyme A (only elementary ideas)

3.Lipid metabolism (5)

Detailed account for oxidation of even-and odd-carbon numbered, saturated and unsaturated fatty acids; Brief idea of fatty acid biosynthesis; Metabolism of Triglycerides and phospholipids

Suggested textbooks:

Biochemistry—D.Voet and JG Voet
Biochemistry—L.Stryer
Principles of Enzymology—T.Palmer

Paper IV

Group A: Environmental and Food Microbiology

Unit I

1.Air Microbiology: (5)

Different types of microorganisms in the air, aerosols, sampling techniques, airborne pathogens, techniques of room sterilization.

2. Microbiology of water: (10)

Microbiological analysis of water (total count, indicative organism), B.O.D. & C.O.D. - determination and implication. Coliform test - detection of faecal and non-faecal coliform); IMViC test; determination of MPN microbiological treatment of sewage and industrial waste water. Anaerobic Treatment (safety tank).

3. Food Microbiology: (**15**)

Milk as a growth medium of bacteria, Normal microflora in milk, undesirable microbes in milk and normal microflora of meat, poultry, eggs, fruits and vegetable; Fresh food, Fresh milk, canned food and stored grains; Microscopic examination and Culture, phosphatase test of pasteurized milk.

4.Preservation of food (5)*:* High temperature (Boiling, Pasterurization. Appertization) Low temperature (Freezing) : Dehydration. Osmotic Pressure.

Chemical Preservations. Radiation.

5.Microbiologically Fermented food (5) : Curd. Cheese. Idli. Yogurt. Acidophilic Milk Microorganisms as food-SCP : Food borne diseases - Salmonellosis. shigellosis.

Unit II

1. Soil Microbiology*:* (25)

Physical and chemical characteristics of various soil types-different microbial groups in soil, method of study,. Rhizosphere, Phyllosphere. Brief account of microbial interactions - (symbiosis, neutralism, commensalism, competition, ammensalism, synergism, parasitism, and predation); Biological nitrogen fixation - symbiotic and asymbiotic; Root - nodule formation in legumes; Compost and Biofertilizers, Biological Pest control. Plant disease (brown spot of rice, black stem rust of wheat, stem rot of jute, rice disease by Tungo virus, grey blight of tea,_red rot of sugarcane, TMV, Blast of rice, leaf blight of potato. Powdery mildew of cucurbit) dissemination and control.;

2.Biogeochemical cycles (15)- Carbon, Nitrogen, Phosphorus, and Sulphur Cycles – role of micro organisms in the process;: Microbiology of methane production

Suggested textbooks:

Salle, AJ. Fundamental Principles of Bacteriology, 7th Ed., Tata-McGraw Hill Publishing Co.

Subba Rao, NS. Soil Microbiology, 4th Ed., Oxford & IBH Publishing Co. Pvt. Ltd.

Dubey, R.C., and Maheswari, D.K. Textbook of Microbiology, S. Chand & Co.

Group B: Practical

Unit I

1.Enumeration of microbes- Isolation of pure culture from natural sources

(a) Bacteria from soil-by serial dilution and pour-plate/spread plate method. (b) Yeast from rotten banana or apple-by the method same as (a), (c) Molds from infected citrus fruits-by streak-plate method, (d) Microbes from air-by agar-plate exposure method.

2.Growth curve

3.Assay of antibiotics-. Microbiological assay of antibiotics: Antibiotic sensitivity test by paper disc and by Cup-Plate method

4. MIC- ii) Determination of Minimal Inhibitory Concentration (MIC) by serial dilution method for assaying commonly used antibiotics (using appropriate test bacteria). (36)

Unit II

1.Water microbiology- i) Microbiological examination of water: (Drinking water, Supply water, Pond water)

a) Presumptive test

b) Confirmatory test

c) Completed test: for coliform

ii) IMViC reactions.

2. Milk microbiology

Microbiological examination of milk: By Methylene-blue dye reduction test;

3.Phenol coefficient- Determination of Phenol-coefficient (Dettol), Test organism to be used: E. coli.

PART III

Paper V

Group A: Microbial Genetics

Unit I 1.**Structure: DNA, gene and chromosome**:
2. **Genetic exchange**

Unit II 1. **Mutation and Repair**
2.Recombination

Group B: Industrial Microbiology and Recombinant DNA Technology

Unit I 1.**Industrial microbiology**

2.General method of preservation of industrially important culture strains

Unit II 1.**Recombinant DNA Technology**

Paper VI

Group A: Medical Microbiology and Virology

Unit I 1.**Normal Microbial Flora (normal) of human body**

2.**Mechanism of Bacterial Pathogenicity**

3.Antimicrobial Therapy

4.Common Microbial Diseases

Unit II 1. **Virology**

Group B: Immunology

Unit I. **1.Introduction: overview of the Immune system.**

2.Cells and organs of Immune system

3.Types of Immunity

4.Antigens

Unit II **1. Immunoglobulins**

2. Antigen - Antibody interactions

3. Complement

. 4.**Hypersensitivity: definition, types, examples.**

5. Vaccines

Paper VII

Practical

Unit I

1. **Isolation and characterization** of one industrially important enzyme, immobilization of cells..

2. **Determination of Km, V_{max} and pH optima**, effect of activator, inhibitor of alkaline phosphatase

Unit II

1. **Protein estimation** by Lowry method
2. **Absorption spectra** of DNA and protein, hyperchromic shift f DNA
3. **Phage titration**

Paper VIII

Practical

Unit I

1. **Antigen-Antibody reaction –**
2. **Restriction digestion of plasmid DNA.**

Unit II

1. **Isolation of plasmid-DNA (**E.coli - DH 5α) by using a standard method of any authentic teaching kit: Gel-electrophoresis (Agarose-gel), quantification of DNA and purity.
2. **Transformation of *E. coli*** by using plasmid DNA by $CaCl_2$ method.
3. **Conjugation experiments** using any standard teaching kit.

Detailed Course

Paper V

Group A: Microbial Genetics (50 marks)

UNIT I

1. **Structure: DNA, gene and chromosome**: (20)

Experimental evidence for DNA as genetic material (Experiments of Griffith, Avery and MacLeod; Hershey and Chase); Experimental evidence for RNA as genetic material (TMV).

Nucleic Acid structure: DNA double helix: crystallographic proof, alternative forms of DNA, intercalating agents, secondary and tertiary structure of RNA.

Structure prokaryotics gene; genomic organization in prokaryotes (nucleoid, DNA supercoiling, topoisomerases)**,** Extrachromosomal inheritance: Plasmids (genes found, copy number, compatibility) . Episomes.

Structure of eucakryotic genes (description and experimental proofs), multigene family.

Genome organization (ARS, centromere, telomere, chromatin structure), various forms of repetitive DNA (satellite, LINEs and SINEs), psedogenes. Extrachromosomal inheritance (mitochondria and plastids)

2. **Genetic exchange**: (15)

Transformation, Conjugation, Hfr bacteria and chromosome mapping. Transduction-generalized (P1) and specialized (lambda-phage).

Transposable elements: Bacterial Transposons.

UNIT II

1. **Mutation and Repair** (20)

Spontaenous (Spontaneous mutation Luria - Delbruck's Fluctuation Test) and induced mutations, Mutagenic agents - Physical, Chemical and Biological (Phage-mu). Genetic Techniques to detect mutations in bacteria and fungi (isolation and characterization of nutritional auxotrophic mutation); Different forms of mutations and how they arise (tautomeric shift, base analog, alkylating agent, apurinic lesions, UV radiation and

thymine dimers, replicational error); Ames test is used the assess the mutagenecity of compounds.

Repair: reversal of UV damage in prokaryotes: photoreactivation, base excision and nucleotide excision repair, post replicational repair, mismatch repair, SOS repair, error prone repair.

2. Recombination (10)

Homologous recombination (Holiday structure : RecBCD system); gene conversion; site specific recombination (lambda)

Suggested textbooks:

1. Molecular Biology of the Gene (5th edition): By James D Watson et al
2. Concept of Genetics (6th edition): By Klug and Cummings
3. Genetics: Principles and Analysis (4th edition): By Hartl and Jones
4. Genetics: Analysis and Principles: By Robert J Brooker

Group B: Industrial Microbiology and Recombinant DNA Technology (50 marks)

UNIT I

1.Industrial microbiology: (25)

Microbial culture selection by screening method with reference to the Antibiotic and Enzyme production. Strain improvement, equipment and instrumentation (fermenters-General description of different types - Stirred Tank, Bubble column, Air Lift, Packed-bed Bioreactor)

Fermentation - static, submerged, agitated, solid phase, batch, feed-batch, continuous. Use of Immobilized cells and enzymes (Ca-alginate beads: polyacrylamide, micro-film)-definition and general characteristics. Industrial production of (using most common and low-cost raw materials) Ethyl Alcohol, Acetic Acid, Penicillin, Vitamin B12' Lysine, a. -amylase (inoculum building, fermentation, separation, assay and purification of products-general discussion). Concept of Primary and Secondary metabolites in Microorganisms.

2.General method of preservation of industrially important culture strains: (5)

UNIT II

1.Recombinant DNA Technology: (35)

Isolation & purification of nucleic acids & protein, RFLP, RAPD, Finger printing, Southern blotting, Dot blotting. Northern blotting. Western blotting - techniques.

Cloning vectors (pBR. 322, pUC8I9. YACs). Cloning. pCR techniques. Ti plasmid as transformation vector.

Construction of DNA libraries (Basic ideas and outlines of methods). Restriction and Modification enzymes: Enzymes used in Recombinant DNA techniques: DNA ligase. Polynucleotide Kinase. DNA Polymerase. etc.

Over Expression of Recombinant Proteins in Bacteria: Insulin, Human Growth Hormone, FSH.

Suggested textbooks

Industrial Microbiology—Presscott & Dunn

Industrial Microbiology—H. Patel

Indutrial Microbiology—L.E.J.R.Casida

Cell and Molecular Biology---J E..Darnell, H. Lodish, D.Baltimore,

The Cell --- De.Robertics

Principle of Gene Manipulation—Bob Old and S B Primrose

Paper VI

Group A: Medical Microbiology and Virology (50 marks)

UNIT I

1.**Normal Microbial Flora (normal) of human body: (5)**

Thoracic, Abdominal, Urogenital & Skin.

2.Mechanism of Bacterial Pathogenicity: (15)

Entry, colonization, growth, mechanism of damage of host cell. Production of endo-and exo-toxins - definition and general properties. (a) Neurotoxin: exotoxin & toxoid,

botulinum toxin, tetanus toxin; (b) Enterotoxin: Cholera toxin, Salmonella toxin, Klebsiella toxin. (c) Cytotoxin: Shigella toxin, Diphtheria toxin.

3.Antimicrobial Therapy: (15)

General properties of antibacterial agents (inhibitors of cell wall synthesis, disruptors of cell membranes, inhibitors of protein synthesis, inhibitors of nucleic acid synthesis and antimetabolites), antifungal agents, antiviral agents, antiprotozoan and.antihelminthic agents: selective toxicity, spectrum of activity, modes of action, side effects, resistance of microorganisms. Gene Therapy: Definition and outlines of different methods.

4.Common Microbial Diseases: (15)

(Names of pathogens, disease symptoms, preventive measures and vector control where applicable).

i) Bacterial - Tuberculosis, Leprosy, Tetanus, Cholera, Gonorrhea, Anthrax, Typhoid

ii) Viral – Flu, Polio, AIDS.

iii) Fungal - Candidiasis.

iv) Protozoan -Malaria, Amoebiasis and leishmaniasis

UNIT II

1.Virology: (30)

General characteristics of viruses: What are viruses? Difference between bacteria and viruses, Components of viruses, sizes and shapes of different viruses (describe with at least one example), host range and specificity

Classification of viruses based on the nucleic acid content: DNA (dsDNA, ssDNA) and RNA (ssRNA, dsRNA) viruses with examples

Human cancer viruses (SV40, HTLV - 1 & 2, Epstein-Barr virus only)

Virus like agents: viroids; prions;

Viral replication: General characteristics of replication, Replication of T4 phage, Phage growth and the estimation of phage numbers, Lytic and lysogenic life cycle of bacteriophage lambda; mechanism(s) that determines lytic and lysogenic life cycle, SOS response of *E coli* host;.Replication of an animal virus (ds DNA); Bacteriophage isolation

Suggested textbooks

Medical Microbiology---David Greenwood

Molecular Biology----Padmanabhan and Shastri

A Genetic Switch---Mark Ptashne

Group B: Immunology (50 marks)

UNIT I

1.Introduction: overview of the Immune system. (2)

2.Cells and organs of Immune system: (10) Hematopoietic stem cells, stromal cells, hematopoietic growth factors, Lymphoid organs (primary and secondary) and cells, Mononuclear cells, Granulocytic cells, Mast cells, Dendritic cells- characteristics and functions.

3.Types of Immunity: (14) (i) Innate immunity - mechanism of immune response (anatomic, physiological, phagocytic and inflammatory barriers).

(ii) Adaptive immunity: Humoral and Cell-mediated immunity - mechanism of immune response---antigen processing and presentation, types and structures of Major histocompatibility complex molecules (MHC) and their role in antigen presentation, clonal selection of lymphocytes, definition of cytokine, generation of humoral and cell mediated response by cellular interactions (general concept only).

4.Antigens: .(6) chemical nature, antigenicity, immunogenicity, hapten, epitopes, mitogens (definition, properties, examples); Adjuvant (definition, examples, function)

UNIT II

1. Immunoglobulins : (9) Isotypes- definition, basic and fine structures, general characteristics and functions. Monoclonal and polyclonal antibody (definition and characteristics).

2. Antigen - Antibody interactions: (5) Precipitation reactions-Radial immunodiffusion, double immunodiffusion, immunoelectrophoresis; Agglutination reactions-Hemagglutination, passive agglutination, bacterial agglutination, agglutination inhibition.

3. Complement : (6) The complement components, function, complement activation- (i) Classical, (ii) Alternate and (iii) lectin pathways (characteristics & functions).

4. Hypersensitivity: definition, types, examples. (3)

5. Vaccines : (7) Active and passive immunization (definition, characteristics, examples and functions). Attenuated and inactivated viral or bacterial vaccines (definition, characteristic, functions, examples).

Suggested textbooks

Immunology—Jenis Kuby

Basic Immunology—Abbas

Paper VII (100 marks)

Practical

Unit I

1. Isolation and characterization of one industrially important enzyme, immobilization of cells.
2. Determination of Km, V_{max} and pH optima, effect of activator, inhibitor of alkaline phosphatase

Unit II

1. Protein estimation by Lowry method
2. Absorption spectra of DNA and protein, hyperchromic shift of DNA
3. Phage titration

Paper VIII (100 marks)

Practical

UNIT I

1. Antigen-Antibody reaction –

a) Agglutination (blood typing etc.),

b) Ouchterlony's agar diffusion method,

c) Single radial immunodiffusion (Mancini's method),

d) Immunoelectrophoresis (by standard teaching kits).

2. Restriction digestion of plasmid DNA

UNIT II

1. Isolation of plasmid-DNA (E.coli - DH 5α) by using a standard method of any authentic teaching kit: Gel-electrophoresis (Agarose-gel), quantification of DNA and purity.

2. Transformation of *E. coli* by using plasmid DNA by $CaCl_2$ method.

3. Conjugation experiments using any standard teaching kit.

Existing, Syllabus of B.Sc. General Course in Microbiology effective from the academic session 2003-04 (vide University Notification No. CSR/!86/2002, dt. 8th October, 2002), will remain unchanged.

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UNIVERSITY OF CALCUTTA

SYLLABI

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THREE-YEAR HONOURS & GENERAL DEGREE COURSES OF STUDIES

ECONOMICS
2010

University of Calcutta
Syllabus for BA/BSC (Honours and General)
Effective from the Academic Year 2010-11.

Part I

Structure of the BA/BSC (Honours)
Total Marks = 800

Year	Paper No.	Paper Name	Comments	Marks
1st Year				**200**
	Paper IA	Microeconomic Principles		50
	Paper IB	Macroeconomic Principles		50
	Paper IIA	Statistics for Economics		50
	Paper IIB	Mathematics for Economics		50
2nd Year				**200**
	Paper IIIA	Microeconomics		50
	Paper IIIB	Macroeconomics		50
	Paper IVA	Development Theory		50
	Paper IVB	Indian Economy Since Independence		50
3rd Year				**400**
	Paper VA	International Economics		50
	Paper VB	Public Economics		50
	Paper VIA	Comparative Development Experience		50
	Paper VIB	Contemporary Economic Issues: India and West Bengal	**Group A (30 Marks)**: Contemporary Economic Issues – India. **Group B (20 Marks)**: Contemporary Economic Issues- West Bengal.	50
	Paper VIIA	Statistics & Basic Econometrics		50
	Paper VIIB	Applied Economics	**Students have option to answer from either Group A or Group B.**	

			Group A Applications of Economics to Managerial Issues or **Group B** Mathematical Economics	
	PaperVIIIA	Indian Economic History		50
	PaperVIIIB	Term Paper		50

Guidelines for Term Paper (Paper VIII B) of BA/BSc Economics (Honours)

1. Each student will prepare a term paper not exceeding 5000 words (excluding charts, diagrams, tables etc.).
2. The term paper may be descriptive, exploratory or empirical.
3. The selection of the topic will be from the subjects covered in the undergraduate economics honours syllabus.
4. The term paper will be submitted by the candidates to the respective colleges at least a fortnight before the *viva-voce* examination which will be held at the respective college centres.
5. The board of examiners will consist of one internal and one external examiner.
6. The marks division for the term paper will be as follows: 30 for the written paper and 20 for *viva voce*. The marks of the written paper will be the average given by the internal and external examiners. However, the *viva-voce* will be conducte*d* and the marks awarded by the external examiner only**.**

Part II

Structure of the BA/BSC General

Year	Paper No.	Paper Name	Comments	Marks
1st Year				**100**
	Paper IA	Microeconomics I		50
	Paper IB	Macroeconomics I		50
2nd Year				**200**
	Paper IIA	Microeconomics II		50
	Paper IIB	Macroeconomics II		50
	PaperIIIA	Indian Economy I		50
	PaperIIIB	Indian Economy II		50
3rd Year				**100**
	Paper IVA	Development Economics		50
	Paper IVB	International Economics & Statistics	**Group A (25 Marks): International Economics.** **Group B (25 Marks): Statistics.**	50

Syllabus for BA/BSC (Honours)

	Paper IA: Microeconomic Principles	
	Full Marks 50: Total Lectures 90	
Unit	Topic	Lectures (No)
1	**The Economic Way of Thinking**	**18**
	1.1 Normative Economics and Positive Economics - Methodology 1.2 Wants, Scarcity, Competing Ends and Choice - Defining Economics 1.3 Basic Economic Questions, Microeconomics and Macroeconomics. Lipsey, Chapter 1 and Chapter 4. Mankiw, chapter 2. 1.4 Principles of Microeconomics – principles of individual decision making and principles of economic interactions – Introduce trade Off, Opportunity Cost, Efficiency, Marginal Changes and Cost-Benefit, Trade, Market economy, Market failure, Externality and Market power. Mankiw, Chapter 1, Stockman Chapter 1 1.5 Interdependence and the Gains from Trade – production possibilities frontier and increasing costs, absolute and comparative advantage, comparative advantage and gains from trade. Mankiw, Chapter 3, Stockman Chapter 2.	
2	**Market and Adjustments**	**25**
	2.1 The Evolution of Market Economies. Price System and the Invisible Hand. Lipsey Chapter 5, (page 59-61). 2.2 The Decision-takers – households, firms and central authorities 2.3 The Concepts of Markets – individual market, separation of individual markets, interlinking of individual markets. Difference among markets – competitiveness, goods and factor markets, free and controlled markets. Market and non-market sectors, public and private sectors, economies – free market, command and mixed. 2.4 Different Goods: Public goods, Private goods, Common resources and Natural Monopolies Lipsey Chapter 6, 67-71, Mankiw Chapter 11 (201-203), Lipsey and Chrystal Chapter 13 (278). 2.5 Market and competition; Demand and its determinants; Supply and its determinants; relation of Quantity Demand with Price (using arguments of income and substitution effects); relation of Quantity Supply with Price (using increasing costs argument); Laws of Demand and Supply; Demand and Supply as Planning Curves; movement along and shift of the curve; Demand, Supply and Other factors. 2.6 Equilibrium and Disequilibrium 2.7 Market Adjustment without Government (with illustrations) Mankiw, Chapter 4. Lipsey and Chrystal, Chapter 3. Stockman Chapter 4	
3.	**Market Sensitivity and Elasticity**	**10**
	3.1 Importance of Elasticity in Choice-Decisions 3.2 Method of Calculation – Arc Elasticity. Point Elasticity – definition. 3.3 Demand and Supply Elasticities – types of elasticity and factors effecting elasticity. 3.4 Demand Elasticity and Revenue	

	3.5 Income and Cross Price elasticity 3.6 Long run and Short Run elasticities of Demand and Supply 3.7 Case Studies – OPEC and Oil Price, Illegal Drugs Mankiw, Chapter 5. Stockman, Chapter 5. Lipsey and Chrystal, Chapter 4.	
4	**Government Intervention**	**10**
	4.1 The Economic Role of Government with respect to Market:(i) Price Ceiling, Price Floor and Market Adjustment (with short case studies of agricultural administered price, minimum wage and rent control); (ii) Black Market (iii) Tax and market adjustment; (iv) Elasticity and Tax incidence. Mankiw, Chapter 6. Lipsey, Chapter 10 (115-16). Stockman, chapter 8.	
5	**Utilitarian Approach**	**4**
	The History of Utility Theory – From Cardinal to Ordinal Approach. Samuelson and Nordhaus, Chapter 6 (85-86). 5.2 Utility in Cardinal Approach – Utility and choice, Total Utility and Marginal utility, Utility and choice - maximization, marginal utility theory of demand. Lipsey and Chrystal, Chapter 5 (87-90)	
6	**Markets and Welfare**	**10**
	6.1 Willingness to Pay and Consumer Surplus 6.2 Willingness to Sell and Producer Surplus 6.3 Market Efficiency and Deadweight Loss 6.4 Deadweight Loss of Taxation. Mankiw, Chapters 7 and 8 (152-157). Stockman, Chapter 9	
7	**Market failure, Externalities and Public Goods**	**12**
	7.1 Market Failure (definition) and its causes. Lipsey and Chrystal Chapter 13 (277-278). 7.1 Externalities and market inefficiency: difference between social costs and private costs, Positive and negative externalities, Private Solution to Externalities: Coase theorem, Public Policy towards Externalities: Regulation, Pigovion tax and subsidies, tradable permits. Mankiw Chapter 10, Stockman Chapter 21. 7.2 Public Goods and Common Resources: Pubic Good and the free rider problem. Common Resources and Tragedy of Commons. Examples of Public Goods and Common Resources. Mankiw Chapter 11 (203-211).	
8	**Conflicting and Complementary Roles of Market and Government (Summary)**	**1**
Readings **Texts** 1. R.G. Lipsey. An Introduction to Positive Economics. English Language Book Society. (sixth edition or later edition) 2. Lipsey and Chrystal. 2007. Economics. Oxford University Press. 3. G, Mankiw. 2007. Economics: Principles and Applications. South Western of Cengage Learing. 4. A, Stockman. 1999. Introduction to Economics. Dryden Press. (2nd or later edition). **References** 5. Edwin G Dolan & David E Lindsey. 1994. Microeconomics. The Dryden Press.		

6. J E Stiglitz and C E Walsh. Principles of Economics, W.W. Norton & Company, New York (3rd or later Edition) 7. P Samuelson and W Nordhaus. Economics, Mc GrawHill International Editions. (14th edition or latest one) 8. R. L. Heilbroner. The Worldly Philosophers: The Lives, Times and Ideas of the Great Economic Thinkers. Touchstone: New York. 6th or latest edition. (for students interested in knowing the historical evolution of economy, the lives and contributions of great economists).	

	Paper IB: Macroeconomic Principles	
	Full Marks 50: Total Lectures 90	
Unit	Topic	Lectures (No)
1	**Nature and Scope of Macroeconomics**	**12**
	1.1 Distinction between Macro economics and Microeconomics - Aggregation and Macroeconomics 1.2 Goals and Instruments of Macroeconomics 1.3 Supply and Demand in Macroeconomics Introduce Economic growth, GNP gap, booms, recessions, depressions, business cycles, fiscal policy, monetary policy, international economic policy, macro equilibrium, exchange rate, inflation and deflation, stagflation, supply shock and tight money. 1.4 Brief history and Schools of Macroeconomics – Keynesian, Classical, New Keynesian and New Classical. Samuelson and Nordhaus, Chapter 23. S, Sikdar Introduction (page 6-8).	I
2	**Accounting Output and Income**	**20**
	2.1 The Circular Flow Explication - Measuring Output – Gross National Product - Nominal GNP, Real GNP and GNP Deflator. 2.2 The Two Approaches to measure GNP - The Final Goods Approach and Income Approach. 2.3 Intermediate goods and value added approach 2.4 Flow Statistics and Stock Statistics –Investment –Consumption –Capital stock 2.4 GNP, Gross Domestic product, Net National product, National Income and Disposable Income. 2.5 GNP and Economic Well Being Samuelson and Nordhaus, Chapter 24, Mankiw, Chapter 23.	
3	**Consumption and Investment**	**14**
	Consumption and Savings – Consumption, Income and Saving, Consumption Function, Marginal Propensity to Consume, Marginal Propensity to Save. Determinants of Consumption. Determinants of Investment. Investment Demand Curve and interest rate. Samuelson and Nordhaus, Chapter 25	
4	**Production and Growth**	**10**
	4.1 History of Economic Growth and Why Growth Matters. 4.2 Importance of productivity in growth. Determinants of productivity –	

	physical capital, human capital, natural resources and technological knowledge. 4.3 Economic Growth and Public Policy – importance of saving and investment, diminishing returns and catch-up effect, foreign investment, education, property rights and political stability, free trade, population control and research and development (brief illustration in the context of Indian economic reform) Mankiw, Chapter 25.	
5	**Unemployment**	**12**
	5.1 Defining and Measuring the Unemployment Rate – Counting of Unemployed – Employed, Unemployed, Labour Force, Discouraged Workers. Okun's Law. Economic Costs of High Unemployment. 5.2 Types of Unemployment – Frictional Unemployment and Job Search, Structural Unemployment and Cyclical Unemployment, Voluntary versus Involuntary Unemployment. 5.3 Sources of Inflexibility in wages – minimum wages, unions and collective bargaining and efficiency wages. Samuelson and Nordhaus, Chapter 31 (572-81), Mankiw, Chapter 28	
6	**Money and Monetary Institutions**	**12**
	6.1 The Classical and Modern View 6.2 Definition and functions of Money. 6.3 Origins of Money including Gresham's Law. 6.4. Money Creation, Models of Banking – ratios approach and competitive banking system, money supply and competitive banking. 6.5 Money and Relative Values – money as a veil, neutrality of money, money illusion, real and monetary effects and price level changes. Lipsey and Chrystal, Chapters 20 and 21 (462-464). 6.6 Reserve Bank of India, Targets and instruments of monetary policy. Sikdar. Chapter 6 (79, 82-84), Samuelson and Nordhaus Chapter 29 (529-532).	
7	**Inflation**	**10**
	7.1. Definition and measurement of Inflation rate – CPI and GNP Deflator. 7.2 Index-number problems in measuring the cost of living. 7.3. Types of Inflation – Moderate inflation, Galloping Inflation and hyperinflation. 7.4 Impact of Inflation – redistribution of Income and Wealth and distortions on output and prices. 7.5 Correcting economic variables from inflationary effects. Samuelson and Nordhaus, Chapter 32. G, Mankiw, Chapter 24.	

Readings

Texts

1. P Samuelson and W Nordhaus. Economics, Mc GrawHill International Editions . (14th edition or latest one)
2. G, Mankiw. 2007. Economics: Principles and Applications. South Western of Cengage Learing.
3. Lipsey and Chrystal. Economics. Oxford University Press. (eleventh edition or latest one).

References

4. S, Sikdar. Principles of Macroeconomics. Oxford University Press.

5. R.E. Hall and D.H. Papell. Macroeconomics. WWW Norton. (6th edition or latest one).
6. J E Stiglitz and C E Walsh. Principles of Economics, W.W. Norton & Company, New York (3rd or later Edition).

	Paper II A: Statistics for Economics	
	Full Marks 50: Total Lectures 90	
Unit	Topic	Lectures (no)
1	**Data Presentation**	**5**
	Data - Classification and presentation, Population and Sample, Collection of Data - Variable and Attribute. Frequency distribution - Diagrammatic representation of frequency distribution. Goon,Gupta,Dasgupta – Fundamentals of Statistics, Vol I	
2	**Central Tendency**	**15**
	2.1 Arithmetic Mean, Median and Mode (for both grouped and ungrouped data), Comparison of Mean, Median and Mode, Geometric and Harmonic Mean, Composite Mean. *2.2 Application:* Index Numbers: their concept as weighted averages, Problems in the Construction of Index Numbers, Chain Index, Cost of Living Index Number (different formulae) 2.3 Wholesale Price Index and Cost of Living Index in India, Uses of Index Numbers. Goon,Gupta,Dasgupta – Fundamentals of Statistics, Vol I	
3	**Dispersion**	**6**
	3.1 Range, Mean Deviation Quartile Deviation and Standard Deviation, Measures of Relative Dispersion, Curve of Concentration. 3.2 Measurement of Economic Inequality: Gini Coefficient and Lorenz Curve. Goon,Gupta,Dasgupta – Fundamentals of Statistics, Vol I	
4	**Skewness and Kurtosis**	**3**
	4.1 Central and non central moments, different measures of skewness and kurtosis Goon,Gupta,Dasgupta – Fundamentals of Statistics, Vol I	
5	**Probability Theory**	**15**
	5.1 Elements of Probability Theory - Sample Space, Events Meaning of Probability, Classical Definition of Probability 5.2 The Addition Rule, The Multiplication Rule, Theorems of Total Probability, Conditional Probability and Statistical Independence 5.3 Limitations of the Classical definition, Frequency definition, Axiomatic Approach, Bayes' Rule	

	Mathai & Rathie – Probability and Statistics Goon,Gupta,Dasgupta – Fundamentals of Statistics, Vol I	
6	**Random Variables and Probability Distributions**	
	6.1 Definition of random variable – discrete and continuous random variable, probability mass function and probability density functions, Expectation and Variance of random variables 6.2 Univariate Probability Distributions: Binomial, Poisson, Hypergeometric, Normal and Standard Normal Distribution -Mean Variance, Skewness and Kurtosis.	**6** **15**
	6.3 Moment Generating Functions, Limiting form of Binomial distribution (with proof), Limiting form of Poisson distribution (no proof), Importance of Normal Distribution in Statistics, Central Limit Theorem (statement only). Mathai & Rathie – Probability and Statistics Goon,Gupta,Dasgupta – Fundamentals of Statistics, Vol I	**10**
7	**Bivariate Analysis**	**10**
	7.1 Definition of bivariate data, scatter diagram, covariance - measure of association - Coefficient of Simple Correlation - Properties and the method of calculation. 7.2 Concept of rank correlation -Spearman's Rank Correlation 7.3.Measure of influence - Simple Linear Regression - Least Squares and Normal Equations and determination of regression coefficient Goon,Gupta,Dasgupta – Fundamentals of Statistics, Vol I	
8	**Population Statistics**	**5**
	8.1 Measurements of mortality: Crude Death Rate, Specific death Rate, Standardised death rate, Mortality index, Infant mortality rate. 8.2 Measurements of fertility: Crude birth rate, general fertility rate, age-specific fertility rate, total fertility rate, Gross Reproduction Rate, Net Reproduction Rate. *8.3* Life Table: its uses. Goon,Gupta,Dasgupta – Basic Statistics.	
	Readings	
	Texts 1. Goon, Gupta, Dasgupta – Fundamentals of Statistics, Vol I, World Press Private limited 2. Mathai & Rathie – Probability and Statistics, The Macmillan company of India Limited **References** 3. Earl.K. Bowen and Martin K. Starr. Basic Statistics for Business and Economics. McGraw Hill International Student Edition	

	4. Kenney and Keeping. Mathematics of Statistics, Vol.1 (Chapters, 1, 2 and 5). Affiliated East West Press. 5. Allen Webster. Applied Statistics for Business and Economics, 3rd Edition. McGraw Hill International Edition. 6. P H Karnel and M Polasek. Applied Statistics for Economists, 4th Edition. Pitman: Australia 7. M R Spiegel and L.J. Stephen. Statistics, Schaum Series

	Paper IIB: Mathematics for Economics	
	Full Marks 50: Total Lectures 120	
Unit	Topic	Lectures (No)
1	**Introduction to Functions and Graphs**	**12**
	The concept of sets and their operations Cartesian product, vocabulary of functions, graphs, polynomials, increasing and decreasing functions Local, global maximum, linear and non-linear functions and their slopes Differentiability and continuity of a function Ref: Chiang & Wainwright , Chapter 2 , Archibald & Lipsey, Chapter 2&3	
2	**Derivatives and its uses in single-variable calculus**	**15**
	2.1 Use of first derivatives for graphing, second derivatives and curvature 2.2 Maxima and minima (local and global) 2.3 Concepts of average and marginal change, and elasticity Ref: Archibald & Lipsey, Chapter 4&6	
3	**Functions of several variables:**	**15**
	3.1 Level curves 3.2 Partial derivatives, second order derivatives and use of chain rule, convexity of level curves 3.3 Monotonic transformation, homogeneous function, Euler's theorem Ref: Archibald & Lipsey, Chapter 8	
4	**Linear Algebra, Fundamentals of Matrix Algebra and Linear Programming**:	**18**
	4.1 System of linear equations and its solutions, Cramer's rule 4.2 Comparative Static exercise, matrix operations of linear equation systems, system with multiple or no solutions 4.3 Input-Output Matrices 4.4 Formulation of a linear programming problem, concepts of feasible and basic feasible solution, duality Ref: Chiang & Wainwright: Chapter 4&5, Archibald & Lipsey,Chapter 15	
5	**Optimisation with Equality and Inequality Constraints**	**18**
	5.1 Constrained and unconstrained optimization with first-order and second-order conditions 5.2 Homogeneous and homothetic functions, concave and quasi-concave functions and their programming Ref: Chiang & Wainwright, Chapter 12,13 (Section 13.1) Archibald & Lipsey, Chapter 10	
6	**Difference Equations:**	**12**
	6.1 Linear first-order difference equation and their solution	

	6.2 Linear second-order difference equation and their solution Ref: Chiang& Wainwright, Chapter 16	
7	**Differential Equations:**	**15**
	7.1 Linear first-order differential equation 7.2 Linear second order differential equation with real equal and unequal roots and complex roots Ref: Chiang & Wainwright, Chapter 17, 18 (Section 18.1)	
8	**Game theory:**	**15**
	8.1 Concepts of Game, representation, pure strategy and mixed strategy solutions 8.2 Two person Zero sum game as a linear programming problem, Constant & Non-constant sum game 8.3 Prisonner's Dilemma, Dominance, Pure Stregy, Nash Equilibrium Ref: Baumol, Chapter 18	
	Readings List	
	Texts Archibald, G.C & Lipsey, R (1990) (Third Edition)An Introduction to a Mathematical Treatment of Economics, New, Delhi, All India Traveller Bookseller,Indian Reprint Baumol, W.J (2009)(Fourth Edition): Economic Theory and Operations Analysis, Prentice Hall, Chapters 2,3,5,7,8,18 Chiang, A. C.& Wainwright(2005)(Fourth Edition): Fundamental Methods of Mathematical Economics, McGraw-Hill. Schaum's Easy Outline of Introduction to Mathematical Economics (2005) **References** Aliprantis, D C. and S. K. Chakrabarti (1999) Games and Decision Making, Oxford University Press. Renshaw, G (2009) Second Edition): Maths for Economics, Oxford University Press. Sydstaeter, K & Hammond, P.J (1995): Mathematics for Economic Analysis, Pearson edition	

	Paper IIIA: Microeconomics	
	Full Marks 50: Total Lectures 90	
Unit	Topic	Lectures(No)
1	**Consumer Theory**	**25**
	1.1 Assumptions on preference ordering, indifference curve, marginal rate of substitution and convexity of IC, budget constraint, consumers' equilibrium – interior and corner, Derivation of Demand Curves from ICs, composite good convention. Application: Cash subsidy versus subsidy in kind. 1.2 Income and price consumption curves Price effect - substitution effect (Hicks and Slutsky), inferior goods and Giffen goods, income effect, ordinary and compensated demand curves. Maddala and Miller, Chapters 4 and 5. 1.3 Inter-temporal choice (saving and borrowing). Maddala and Miller, Chapter 5 (page 142-145)	

	1.4 Revealed preference. Pindyck and Rubinfeld, Chapter 3 (section: 3.4) 1.5 Choice under uncertainty- utility function and expected utility, risk aversion and risk preference (concepts only)	
2	**Production and Costs**	**15**
	2.1 Technology, Production Functions and Isoquants, short run and long run, production with one and two variable inputs, total average and marginal products, law of diminishing return, marginal rate of technical substitution, elasticity of substitution, economics of scale. Pindyck and Rubinfeld, Chapter 6 2.2 Types of production functions- Cobb-Douglas, fixed-coefficient and CES functions. 2.3 Cost structure-implicit cost, explicit cost, accounting cost, sunk cost, economic cost, fixed cost, variable cost, total, average and marginal cost. Determinants of Short run cost, Cost Curves, cost minimization and expansion path, Short run versus long run cost curves, economies of scope. Pindyck and Rubinfeld, chapter 7.	
3	**Market Structure**	**30**
	3.1 Organization, Firms and Profit Maximization. 3.2 Marginal Revenue, Marginal Cost and Profit Maximization. 3.3 Perfect competition- short run competitive equilibrium of the firm, short run supply curve of firm and industry, Output choice and competitive equilibrium in long run, Economic rent and profit, long-run industry supply – constant, increasing and decreasing cost. Lipsey and Chrystal Chapter 6 (114-116), Pindyck and Rubinfeld, Chapter 8 3.4 Efficiency of competitive equilibrium, Government intervention and dead weight loss, Application – Minimum prices and price supports. Pindyck and Rubinfeld, Chapter 9 (283-285, 288-290, 292-294). 3.2 Monopoly and barriers to entry – output determination and price rule, measure and sources of monopoly power, social costs of monopoly power – deadweight loss. Pindyck and Rubinfeld, Chapter 10 (319-344). 3.3 Pricing with market power – first, second and third degree price discrimination. Pindyck and Rubinfeld, Chapter 11 (361-375) 3.4 Monopolistic competition – short run and long run equilibrium, excess capacity. Pindyck and Rubinfeld, Chapter 12 (414-419) 3.5 Oligopoly – Oligopoly equilibrium as Nash equilibrium, Cournot and Stackelberg Model, Competition versus collusion – the Prisoners' Dilemma. Pindyck and Rubinfeld, Chapter 12 (419-437)	
4	**Input Markets**	**10**
	4.1 Basic concepts-derived demand, productivity of an input, marginal product of an input, marginal revenue product. 4.2 Marginal productivity theory of distribution. 4.3 Labor market-supply of labor, competitive labor markets, monopsony, collective bargaining. 4.4 Land markets and rent. Pindyck and Rubinfeld, Chapter 14. Lipsey and Chrystal, Chapter 10	

5	**Other issues related to Market**	**10**
	5.1 General Equilibrium and Economic Efficiency - Exchange, production and welfare. 5.2 Reasons for Market Failure Pindyck and Rubinfeld, Chapter 16 5.3 Markets with asymmetric information- adverse selection, moral hazards, agency problems (concepts only). Lipsey and Chrystal, Chapter 11 (241-243).	
	Readings	
	Texts 1. R S. Pindyck and D.L. Rubinfeld, (2000), Microeconomics, 3rd edition, Prentice Hall, India. 2. G.S. Maddala and E. Miller. 1989. Microeconomics. McGraw-Hill International Editions. (or later edition) **References** 3. Lipsey and Chrystal. 2007. Economics. Oxford University Press. 4. R S. Pindyck, D.L. Rubinfeld and Mehta (2007). Microeconomics, 7Th edition, Prentice Hall, India. 5. H R. Varian. Intermediate Microeconomics, a Modern Approach. Affiliated East-West Press. 6. Satya Chakrabarty. Microeconomics. Allied Publishers. 7. B.D. Bernheim and M.D. Whinston. Microeconomics. McGraw-Hill International Editions. 8. H. Gravelle and R Rees. Microeconomics. Addison Wesley Longman Limited. 9. Anindya Sen. Microeconomics, Oxford University Press. 10. Ferguson and Gould. Microeconomic Theory. All India Traveler Book Sellers. (sixth edition).	

	Paper IIIB: Macroeconomics	
	Full Marks 50: Total Lectures 80	
Unit	Topic	Lectures (No)
1	**The Economy in the Long Run**	**15**
	1.1 The classical analysis of the real sector-determination of employment, income and interest rate. Mankiw Chapter 3. 1.2 Job Loss, Job finding and Natural Rate of Unemployment. Mankiw Chapter 6 (page 132-35). Hall and Papell Chapter 3 (61-72) 1.3 Money and Inflation - quantity theory of money, seigniorage and inflation tax, inflation and interest rates, nominal interest rate and demand for money. Mankiw Chapter 7 (161-175).	
2	**Th Economy in the Short Run**	**25**
	2.1 Simple Keynesian analysis of aggregate demand without and with the government sector, multiplier. Mankiw Chapter 10 (256-265). Hall and Papell Chapter 7 (168-180). 2.2 IS-LM, fiscal and monetary policy. Mankiw Chapter 10 (266- 279), Chapter 11 (282-291); Hall and Papell Chapter 8 (189-209)	

	2.3 IS-LM and Aggregate Demand Mankiw Chapter 11 (291-294); Hall and Papell Chapter 8 (209-215) 2.4 Aggregate supply – Sticky Wage Model and Imperfect Information Model, Aggregate Supply and Phillips curve, Inflation and Unemployment trade off without and with rational expectations. G, Mankiw Chapter 13 (350-353, 357-358, 364-373) 2.5 Economy wide equilibrium with fiscal and monetary policy, demand and supply shocks, wage price flexibility and rigidity (only definition), Keynesian aggregate supply and Classical Aggregate Supply. S, Sikdar Chapter 8 (120-126).	
3	**Foreign Trade and Exchange Rate**	**10**
	3.1 Economic Openness with an emphasis on Indian economy, balance of payments, BOP and the Central Bank, Financing Current Account Deficit. 3.2 Exchange Rate Concepts, Determination of Exchange Rate – fixed and flexible, Importance of Foreign Currency Reserves with reference to India, Domestic Adjustment, BOP Crisis and Speculative Attack, Internal and External Balance under Fixed Rate, Advantages of Flexible exchange and Fixed Rates. 3.3 Foreign exchange market reform in India, relation of Devaluation with purchasing power parity and inflation, purchasing power parity principle. 3.4 IS-LM model without capital flows, Open economy with capital flows – the Mundell-Fleming Model. S, Sikdar Chapter 7.	
4	**Theories of Consumption and Investment**	**15**
	4.1 Consumption - Keynes and consumption function, inter-temporal choice, life cycle and permanent income hypothesis. 4.2 Investment—business fixed investment, neo-classical approach, Tobin's q, Residential investment and accelerator model of inventories. G, Mankiw Chapters 16 and 17.	
5	**Demand for Money**	**5**
	5.1 Demand for money: Portfolio theory of money demand, Baumol-Tobin analysis of cash management. G, Mankiw Chapter 18.	
6	**Economic Growth**	**10**
	6.1 Solow model, Golden Rule of capital, impact of changes in saving propensity, population growth and technological progress. Growth accounting and Solow residual. G, Mankiw Chapter 4 and Chapter 5 (105-108, 125-130) 6.2 Endogenous Growth Theory (introduction). G, Mankiw Chapter 5 (118-119)	

Readings

Texts

1. N. Gregory Mankiw, (2000), Macro-Economics, 4th Edition or latest, Macmillan.
2. Soumen Sikdar. Principles of Macroeconomics. Oxford University Press.

References

3. R.E. Hall and D.H. Papell. Macroeconomics. WWW Norton. (6th edition).
4. Rudiger Dornbusch, Stanley Fischer and Richard Startz, Macroeconomics, 7th (or later) edition, McGraw Hill.
5. Richard Froyen. Macroeconomics. Pearson Education. (9th edition or latest).

	Paper IVA: Development Theory	
	Full Marks 50 : Total Lectures 80	
Unit	Topic	Number of Lectures
1	**Concepts and measures of development**	**8**
	1.1 Nature, Questions and Values of Development, Meanings of development – economic growth, redistribution from growth and capabilities approach to development, Objectives of development. Todaro and Smith Chapter 1. 1.2 Measures of development – Purchasing power parity and Per capita income as an index of development, difference between growth and development, human development index. Thirlwall Chapter 2 (page 30-36, 47). Meier and Rausch Chapter 1 (5-14) 1.3 Definition of developing economy. Todaro and Smith Chapter 2 (68-71). 1.4 Characteristics of a developing economy. Todaro and Smith Chapter 2 (80-91). Thirlwall, Chapter 3 (65-77, 80-84).	
2	**Process of Development – theoretical perspectives**	**10**
	2.1 Theories of transition – Clark and Fisher on change in sectoral share; Rostow's stages of growth; Kuznets's characteristics of Growth; Industrialisation, Growth and Kaldor's growth laws; The neo-classical approach of market and growth. Todaro and Smith Chapter 3 (119-125, 158-159, 162-165). Thirlwall, Chapter 3 (105-120)	
3	**Factors in economic development**	**10**

	3.1 Land: Ownership and tenancy system – fixed rent contract and share cropping, role of agriculture in development, barriers to agricultural development and land reforms. Thirlwall Chapter 5 (167-178). Debraj Ray Chapter 12 (415-420, 457-458) 3.2 Labour – Population and Labor force growth, casual and long term labor, permanent labor market. Todaro and Smith 3 (114-116). Debraj Ray 13 (484-86, 504-506). 3.3 Capital: Role of capital accumulation in economic development. Significance of capital-output ratio, role of technology and technological progress, learning, human capital. Todaro and Smith 3 (113-114). Thirlwall Chapter 6 (210-226)	
4	**Population and Development**	**4**
	4.1 Concepts of Population: definitions of fertility, mortality, birthrates, death rates, fertility rate, life expectancy, infant mortality rate, youth dependency ratio. 4.2 Theory of demographic transition Todaro and Smith Chapter 7 (293-308).	
4	**Development strategies**	**14**
	4.1 Complementarity and Coordination Todaro and Smith Chapter 5 (184-187). Debraj Ray Chapter 5 (131-136). 4.2 Poverty Trap of Nurkse and Big Push theory of Rosenstein-Rodan 4.3 Linkages – backward and forward; linkages, policy and big push. Debraj Ray, Chapter 5 (136-143). Todaro and Smith Chapter 5 (184-193) 4.4 Choice of technology and choice of scale (large vs small) and criteria for investment. Thirlwall Chapter 12 4.5 Gains from Trade – static, dynamic and vent for surplus, tariffs versus subsidies. Prebisch doctrine, Prebisch-Singer thesis and Terms of Trade. Thirlwall 16. Todaro and Smith Chapters 12.	
5	**Development in a Labour surplus economy**	**14**
	5.1 The concept of economic dualism. Kausik Basu Chapter 7 (151-153). Thirlwall Chapter 7 (234-236) 5.2 Lewis' model of economic development with unlimited supply of labour, Disguised Unemployment: Types and Measurement. Todaro and Smith Chapter 4 (150-155). Thirlwall Chapter (198-206). The Informal Sector. Todaro and Smith Chapter 8 (358-366). 5.4 Rural-urban migration of labour – Harris-Todaro model Todaro and Smith Chapter 8 (368-381).	
6	**Development, Inequality and poverty**	**14**

	6.1 Meaning of inequality, inequality measures, Lorenz Curve, Range, Coefficient of variation, Gini-coefficient, Kuznet's Inverted U hypothesis. 6.2 Poverty, relative and absolute deprivation with respect to income, Poverty line, Poverty measures – Head count ratio, Poverty gap ratio, Income gap ratio, Human Poverty Index. 6.4 Social dimensions of poverty – rural poverty, women and ethnic minorities and indigenous populations. Todaro and Smith Chapter 6. Debraj Ray Chapters 6, 7 (199-200), 8 (249-256). Thirlwall Chapter 2 (47-54). 6.5 Tackling Poverty – The World Bank Approach Thirlwall Chapter 2 (41-44).	
7	**Environment and development**	**6**
	7.1 Development and Environmental – an overview. Meier and Rauch Chapter 10 (588-89) 7.2 Basic Issues of development and environment - Sustainable development and environment accounting, population and resources, poverty, rural development, urban development, global environment - rain forest destruction and greenhouse gases. Todaro and Smith Chapter 11 (497-507) 7.3 Policies for Environmental Regulation. Lipsey and Chrystal, Chapter 13 (286-89).	
	Readings **Texts** 1. A.P. Thirlwall. Growth and Development. Palgrave McMillan. (8th edition or latest) 2. M.P. Todaro and S.C. Smith, "Economic Development". Pearson Education. 3. Debraj Ray. Development Economics. Oxford University Press. **References** 4. Lipsey and Chrystal. 2007. Economics. Oxford University Press. 5. K. Basu. Analytical Development Economics: The Less Developed Economy Revisited. Oxford University Press. 6. G.M. Meier and J.E. Rauch. Leading Issues in Economic Development. Oxford University Press. (8th edition or latest) 7. Y. Hayami, "Development Economics", (Oxford University Press) 8. S. Fukuda-Parr and A.K. Shiva Kumar. Readings in Human Development. Oxford University Press.	

	Paper IVB: Indian Economy Since Independence	
	Full Marks 50: Total Lectures 80	
Unit	Topic	Lectures (No)
1.	**Indian Economy at the time of Independence**	**2**
	Features of Indian Economy around 1947-1950 and characteristics of economic underdevelopment of India (with reference to colonial rule of India)	

	Bipan Chandra in Jalan (ed). Uma Kapila, Chapter 1.	
2.	**Planning: Evolution of India's Development Goal and Strategy**	**30**
	The background and Structure of Indian Planning. Uma Kapila, Chapters 1 and 2. Chakravarty, Chapter 1.	
	Structural Constraints and India's development strategy – Choice of industrialization strategies – public vs. private sector, capital goods versus consumer goods – Mahalanobis Plan Model (basic argument), import substitution vs. export promotion strategy. Uma Kapila, Chapter 3. Chakravarty Chapters 2 and 5 (page 69-75).	
	Agriculture-industry relationship – demand side and supply side linkages– agriculture-industry terms of trade - food crisis of the 1960s and imperatives for agricultural growth, genesis of green revolution – fourth plan (basic argument). Chakravarty Chapter 3 and 5 (59-64); Uma Kapila Chapter 11.	
	2.4 Poverty Eradication, foreign aid and self-reliance – Fifth Five Year Plan Model (basic argument) Chakravarty, Chapter 3. Wadhwa Chapters 5 and 7,	
	Regional inequality in India – causes; policies for balanced regional development. Chakravarty Chapter 4 (45-52).	
	Planning deficiencies and its abandonment– 7^{th} five year plan and Indian economic crisis. Chakravarty Chapter 4 (39-44). Bardhan in Jalan (ed).	
	New Economic Policy – liberalisation, market and state (introduction) Rangarajan in Uma Kapila, Chapter 5. Uma Kapila, Chapter 20. Bardhan in Jalan (ed).	
3	**Land and Agriculture**	**20**
	2.1 Land and tenancy system- sharecropping- Different dimensions of Land Reform – Productivity Debate – Marketable Surplus. S.K. Ray in Uma Kapila, Chapter 12. Wadhwa Chapters 19, 20, 21, 22, 23 and 31.	
	2.2 Green Revolution – features of green revolution – positive and negative impacts of green revolution. Performance of Indian agriculture. Vaidyanathan. 1994. Chakravarty Chapter 3 (24-27). Wadhwa Chapters 29 and 30.	
	2.3 Agricultural Policies and Pricing – Agricultural Price commission – support price vs. procurement price – Public investment in agriculture - agricultural subsidies and tax. Hanumantha Rao in Jalan (ed). Uma Kapila Chapter 11. Wadhwa Chapters 24, 25, 26 and 27.	
4	**Industrial Development: Evolution, Trade and Policy**	**18**
	4.1. Structure and composition of Industry – issues of concentration, large vs small industry – industrial location. Small scale reservation policy. Trends and patterns of industrial growth. Uma Kapila, Chapter 18. Rakesh Mohan in Jalan (ed).	
	4.2 Foreign trade regime, protection and foreign competition, Productivity; import substitution versus export Competitiveness, effect on export competitiveness. Uma Kapila, Chapter 18. T.N. Srinivasan in Uma Kapila, Chapter 25. Rangarajan in Uma Kapila, Chapter 26.	

	4.3 Industrial Policies – Industrial licensing system. Uma Kapila, Chapter 18. Rakesh Mohan in Jalan (ed). Wadhwa Chapter 16.	
5.	**Employment, Wages and Inflation**	**10**
	5.1 The trends and pattern of employment and wages in India – informalisation and tertiarisation of employment - problems of unemployment and under-employment	
	5.2 Government policies on employment and wages and employment – employment guarantee scheme – minimum wage.	
	Movement of prices in India – –trends and patterns – causes, consequences and policies adopted. Papola in Jalan (ed.), Visaria in Jalan (ed). Zagha in Sachs, Varshney and Bajpai (ed.).	

Readings

Texts

1. Uma Kapila (ed). India's Economic Development Since 1947 (3rd Ed. or latest version). Academic.
2. S Chakraborty. 1987. Development Planning: The Indian Experience. Clarendon Press.
3. Vaidyanathan A.1994. Performance of Indian Agriculture since Independence in Kaushik Basu (ed.) Agrarian Question, Oxford University Press.
4. Bimal Jalan (ed.) The Indian Economy: Problems and Prospects Penguin.

References

5. C D. Wadhwa. Some problems of India's Economic Policy, Tata McGraw Hill.
6. J. Sachs, A Varshney and N Bajpai (ed). India in the Era of Economic Reforms. Oxford University Press.
7. I, Judge Ahluwalia. 1985. Industrial Growth in India since the Mid-sixties. Oxford University Press.
8. PC Joshi. 1975. Land Reforms in India: Trends and Perspectives. Allied Publishers: New Delhi.
9. Pramit Chaudhuri. 1979. Indian Economy: Poverty and Development.George Allen and Unwin, London.

	Paper VA: International Economics	
	Full Marks 50 : Total Lectures 80	
Unit	Topic	**Lectures (No)**
1	**Basic Models of Trade**	**10**
	1.1 Ricardian Model: Comparative advantage. 1.2 One factor economy: production possibility frontier, relative demand and relative supply and autarkic terms of trade. 1.2 Trade in Ricardian world: determination of international terms of trade, complete specialiszation, gains from trade.	
	Readings	

	Texts International Economics: Paul R. Krugman, Maurice Obstfeld, (8th Ed.)Chapter 2, Pearson Education **References** World Trades and Payments: Caves, Frankel, Jones (9th Ed.)Chapter 3, Pearson Education International Economics: Dominick Salvatore (8th Ed.) Chapter 2, Wiley India.	
2	**Resources, Comparative Advantage, and Income Distribution**	**18**
	2.1 Model of two factor economy: Assumptions, Factor prices and commodity prices (Stolper-Samuelson effect)-correspondence, Resources & output, Rybzynski effect. 2.2 Effects of International Trade between two factor economies, Relative prices and and the pattern of Trade, Trade and distribution of Income, Factor Price Equalization. 2.3 Empirical studies - Leontief Paradox.	
	Readings	
	Texts International Economics: Paul R. Krugman, Maurice Obstfeld, Chapter 4(8th Ed.), Pearson Education **References** International Economics: Dominick Salvatore (8th Ed.) Chapter 5, Wiley India World Trades and Payments: Caves, Frankel, Jones (9th Ed.)Chapter 6,Pearson Education	
3	**The Standard Trade Model**	**16**
	3.1 Production Possibilities and relative supply, relative prices and demand, welfare effects of changes in terms of trade, determining relative prices. 3.2 Economic growth: shift of RS curve, growth and production possibility frontier, RS and terms of trade, International effects of growth, International transfers of income: shifting RD curve, Transfer problem, effects of transfer on terms of trade, Tariffs and export subsidies. 2.3 Offer curves: Derivation, International Equilibrium.	
	Readings	
	Texts International Economics: Paul R. Krugman, Maurice Obstfeld, Chapter 5 (8th Ed.), Pearson Education **References** International Economics: Dominick Salvatore (8th Ed.) Chapter 3, Wiley India.	
4	**Trade Policy**	**18**

	4.1 Partial equilibrium analysis: Tariff- cost and benefit, effective rate of protection and intermediate goods, quota, tariff- quota equivalence and non-equivalence, export subsidy, voluntary export restraint. 4.2 General Equilibrium Analysis: Distinction between small and large open economy, welfare effects of tariff in a small country, optimum tariff for large open economy, Metzler's paradox. 4.3 Tariff & Import Quotas in presence of monopoly.	
	Readings	
	Texts International Economics: Paul R. Krugman, Maurice Obstfeld, Chapter 8 (8th Ed.), Pearson Education **References** International Economics: Dominick Salvatore (8th Ed.) Chapter 8, Wiley India World Trades and Payments: Caves, Frankel, Jones (9th Ed.)Chapter 10, Pearson Education.	
5	**Accounting, Income Determination and Exchange Rates**	**18**
	5.1 Balance of payment accounts; national income accounting in an open economy; monetary account; 5.2 Determination of national Income, multiplier analysis, the transfer problem, introduction of foreign country and repercussion effect. 5.3 Fixed and Flexible Exchange rates: Adjustments, Demand & Supply of foreign exchange, Effects of exchange rate changes on domestic prices and terms of trade, Marshall-Lerner condition, J-curve effect.	
	Readings	
	Texts International Economics: Paul R. Krugman, Maurice Obstfeld, Chapter 12(8th Ed.), Pearson Education (for 5.1 & 5.2) International Economics: Dominick Salvatore (8th Ed.) Chapter 16, 17 Wiley India (for 5.3) **References** Open Economy Macroeconomics: R Dornbusch, (International Students Edition), Basic Books, New York. World Trades and Payments: Caves, Frankel, Jones (9th Ed.) Chapter16, Pearson Education.	

	Paper VB: Public Finance	
	Full Marks 50: Total Lectures 70	
Unit	**Topic**	**Lectures (No)**
1.	**Introduction to public economics**	**2**
	1.1 The nature, scope and significance of public economics Musgrave and Musgrave Page 3-6. Bhatia Page 17-25.	
2.	**Forms and Functions of Government**	**8**
	2.1 Different forms of government – unitary and federal. Tiers of government in the federal form- Central, State, Local (Introductory discussion with examples). 2.2 Functions of Government - Economic functions -allocation, distribution and	

	stabilization. 2.3 Regulatory functions of the Government and its economic significance Musgrave and Musgrave Chapter 29, Chapter 1 Page 6-14. Stiglitz in Bagchi (ed.) Chapter 9, page 170-171.	
3	**Federal Finance**	**10**
	3.1 Federal Finance: Different layers of the government, Inter governmental transfer—horizontal vs. vertical equity. Musgrave and Musgrave Chapter 28, Page 457-461, Misra and Puri Chapter 53, page 694-698, 700-701. 3.2 Grants—merits and demerits of various types of grants—unconditional vs. conditional grants, tied grants, matching grants. Musgrave and Musgrave, Chapter 28 Page 461—469, Misra and Puri Chapter 53 page 703-705.	
4	**Public Goods and Public Sector**	**10**
	4.1 Concept of public goods—characteristics of public goods, national vs. local public goods, determination of provision of public good 4.2 Externality, concept of social versus private costs and benefits, merit goods, club goods. Musgrave and Musgrave, Chapter 4. McGuire in Bagchi (ed.) Chapter 5. 4.3 Provision versus production of public goods. Market failure and public provision. Pricing of public goods—vertical summation Musgrave and Musgrave, Chapter 5	
5.	**Government Budget and Policy**	**12**
	5.1 Government budget and its structure – Receipts and expenditure - concepts of current and capital account, balanced, surplus, and deficit budgets, concept of budget deficit vs. fiscal deficit, functional classification of budget. Concept of Revenue Deficit. Bhatia Chapter 4 page 37-39, Chapter 13, page 248-253, Chapter 20 page 460-462; Musgrave and Musgrave Chapter 31, page 534-537, Chapter 12, page 211-216, Chapter 30, page 499-505; Chelliah in Bagchi (ed) Chapter 20. 5.2 Budget, government policy and its impact. Budget multipliers. Stiglitz, Blinder and Solow, Fisher and Easterly in Bagchi (ed), Chapters 9, 16, 17.	
6.	**Revenue Resources**	**10**
	6.1 Concept of tax, types of tax – direct tax and indirect tax, canons of taxation, subsidy, transfer policy. H.L.Bhatia Chapter 4 page 39-49, Chapter 20 page 467-470. 6.2 Principles of taxation -Ability to Pay principle (brief discussion), Benefit Approach (Actual Examples) Musgrave and Musgrave, Chapter 13, page 218-231 6.3 Tax Design - introduction – truth seeking mechanism.	

7.	**Tax Structure**	**8**
	7.1 Effects of income tax on work effort, saving and risk bearing (just brief ideas). Musgrave and Musgrave Chapter 17, page 297-308, 311-312. 7.2 Excess burden of indirect taxes Musgrave and Musgrave Chapter 16, page 293-295. 7.3 VAT, Goods and Services Tax (pros and cons). Misra and Puri, 26th edition, page 662-663, Chelliah, Agarwal, Purohit and Rao in Bagchi (ed) Chapter 15. 7.4 Non-tax revenue resources-earnings from public undertakings, interest on loans.	
8.	**Distribution and Stabilization**	**10**
	8.1 Instruments for stabilization Musgrave and Musgrave, Chapter 30 8.2 Public Debt---internal and external. Musgrave and Musgrave Chapter 32, Misra and Puri, Chapter 51. 8.3 Public Finance and Public Choice: The Role of State. Bagchi (ed), Chapter 24.	
	Readings 1. Musgrave and Musgrave: Public Finance in Theory and Practice (Fifth Edition). 2. H.L. Bhatia. Public Finance. (Fifteenth Revised Edition). 3. Amaresh Bagchi (ed.). Readings in Public Finance. Oxford University Press. 4. Misra and Puri. Indian Economy.	

	Paper VIA: Comparative Development Experience	
	Full Marks 50: Total Lectures 90	
Unit	Topic	Lectures (No.)
1.	**International comparisons of development**	**3**
	1.1 Differences in initial conditions of development of less developed countries and present day developed countries. 1.2 Nature of development gap prevailing at present between developed and less developed countries. Ref: Thirlwall Ch1 pp 13-21, Ch 2 pp 23-30.	
2	**Genesis of capitalism.**	**15**

	2.1 Different types of social organization, feudalism, precapitalist societies other than feudalism, capitalism in the West, development of the Third World Ref: Bagchi, Ch 1 pp 1-18. 2.2 Industrial revolution in Great Britain - Causes – Why Great Britain became the pioneer? – Characteristics - Effects Ref: P Deane, Ch 1.	
3	**Industrialization Experiences in Early Part of 20th Century.**	**12**
	3.1 The Great Debate in Soviet Union on the assignment of priority on development of heavy industry in the process of planned economic development. 3.2. The Great Depression of the 1930's and recovery – Experiences of USA and Great Britain. Ref: Maurice Dobb Chapter 8 or Alec Nove Chapter 5. H.U. Faulkner, Chapters 29 and 30. S.W. Southgate, Chap. 14, 35.	
	Post Second World War Development Scenario	20
	4.1 Global Change, Welfare state and mixed economy. 4.2 Post War global institutions: International Monetary Fund, World Bank, United Nations Conference on Trade and Development. Ref: Todaro and Smith Chapter 14 (660-664). Thirlwall Chapter 15 (479-484), Chapter 16 (556). 4.3 Trade and Strategies of Development: Infant industry, Import substitution versus export promotion in less developed countries. Illustrations from South Asia, Latin America and East Asia. Ref: Meier and Rausch Chapter 3 (144-145), chapter 4(156-162). Todaro & Smith Ch 13 pp 589-601. Thirlwall Chapter 16. 4.4 Foreign Finance, Investment and Development: Private foreign direct investment and Multinational Corporations, private portfolio investment, development assistance debate. Ref: Todaro & Smith Ch 15. Thirlwall Ch 15.	
5	**Development and underdevelopment as historical processes**	**5**
	5.1 Dependency Approach. 5.2 Unequal exchange. Ref: Thirlwall Chapter 7 (252-255). Dos Santos in Goddard, Cronin and Dash (ed.).	
6	**Evolution of New international economic order.**	**24**
	6.1 Neo liberalism, Washington consensus, North-South Divide, Recasting of IMF and World Bank. Ref: Thirlwall Chapter 15 (479-484), Chapter 17 595-607). Sen Chapter 2. Stiglitz Chapters 1, 2 and 3. Stiglitz in Nayyar (ed). 6.2 General Agreements on Tariff and Trade (GATT) and the Dunkel Draft controversy-World Trade Organization (WTO). Ref: Sen Chapter 3. Sikdar Chapters 6 (123-131) and Chapter 7. Shukla in Nayyar (ed). 6.3 Economic Integration and Regional Trading Blocs. Ref: Todaro and Smith Chapter 13 (613-617). Sikdar 6 (146-148, 151-153). 6.4 Global Polarization. Ref: Samir Amin in Goddard, Cronin and Dash (ed.).	
7	**Development policies and role of the state**	**5**

	7.1 Nature of Development planning, Rationale for development planning. Ref: Todaro and Smith: Ch 16 pp 714-718. 7.2 Washington Consensus, New Consensus and the State Ref: Todaro and Smith: Ch 16 pp 736-439.	
8	**Some Recent Development Experiences**	**6**
	(i) China, (ii) Africa (iii) Argentina. Ref: Meier and Rausch Chapter 1 (45-51, 62-72). Todaro and Smith Chapter 5 (223-224). Sen, pp 22-28.	
	Readings **Texts** 1. A.P. Thirlwall. Growth and Development. Palgrave McMillan. (8th edition) 2. M.P. Todaro and S.C. Smith. Economic Development. Pearson Education. 3. G.M. Meier and J.E. Rauch. Leading Issues in Economic Development. Oxford University Press. (8th edition or latest). 4. Sunanda Sen. 2007. Globalisation and Development, National Book Trust, India 5. C. Roe Goddard, Patrick Cronin and Kishore C. Dash. (ed). International Political Economy. Viva Books Private Limited. (articles by Theotonio dos Santos and Samir Amin). (2nd edition). 6. Maurice Dobb. Soviet Economic Development since 1917. Chap. 8. Routledge and Kegan Paul. 7. H.U. Faulkner. American Economic History. Chap. 29 – 30. Harper and Row. 8. G.W. Southgate. English Economic History. Chap. 14, 35 J.M. Dent and Sons Ltd. 9. Phyllis Deane. The First Industrial Revolution. Cambridge University Press 10. A.K. Bagchi. The Political Economy of Underdevelopment. Orient Longman. **References** 11. J. Stiglitz. Globalisation and its Discontents. Penguin. 12. Soumyen Sikdar. Contemporary Issues in Globalisation. An Introduction to Theory and Policy in India. Oxford University Press. 13. D. Nayyar. 2002. Governing Globalisation, Issues and Institutions. Oxford University Press. 14. Alec Nove. An Economic History of the USSR. Penguin Books.	

	Paper VIB: Contemporary Economic Issues: India and West Bengal	
	Full Marks 50: Total Lectures 80	
Unit	Topic	Lectures (No)
Group A	**Contemporary Economic Issues –India.** **Marks: 30**	
1.	**Economic Reform in India Since 1991**	**20**

	1.1. Background of Indian Economic Reforms – New Economic Policy. Redefining India's development strategy. Changing Role of State and Market. Rangarajan in Uma Kapila, Chapter 5. Economic Survey 2009-10, Chapter 2 (21-24). Uma Kapila, Chapter 20. 1.2 Industrial Policy, Disinvestment policy and Privatization. Basu and Maertens (page 141-146, 350-354, 366-371). Rangarajan in Uma Kapila, Chapter 21. Ahluwalia in Sachs, Varshney and Bajpai. 1.3 Financial sector reforms including banking reform. Monetary Policy of RBI. Basu and Maertens (246-251, 219-225, 255-261). Joshi and Little, Chapter 4. Ahluwalia in Sachs, Varshney and Bajpai. 1.4 Fiscal Policy Reform – tax reform, debt management, FRBM act and subsidies. Basu and Maertens (357-366, 141-146), Vijay Joshi in Ahluwalia and Little (ed). Ahluwalia in Sachs, Varshney and Bajpai. 1.5 External sector reforms: Foreign Exchange market, balance of payments, reform, convertibility, export-import policy, foreign direct investment. Basu and Maertens (280-299, 305-307). Uma Kapila Chapter 24. Ahluwalia in Sachs, Varshney and Bajpai.	
2	**Agriculture, Poverty and Social Security**	**13**
	2.1 Post-reform Agricultural Performance and its Crisis. Basu and Maertens (59-65, 83-86). Mahendra Dev, Chapter 2. Rao and Jeromi in Uma Kapila, Chapter 13. Vaidyanathan in Uma Kapila, Chapter 14. 2.2 Poverty and exclusion, NREGA, social security for unorganized workers and forest policy. Basu and Maertens (543-555, 110-113, 428-431, 86-89). Mahendra Dev Chapters 4 and 8. Vaidyanathan in Uma Kapila, Chapter 33.	
3	**Post-reform performance of Indian Economy**	**4**
	3.1 Appraisal of Indian Economic Reform. India's Growth Experience. Uma Kapila Chapter 29. Basu and Maertens (24-32). Ahluwalia 2002. Ahluwalia in Sachs, Varshney and Bajpai.	
4.	**Indian economy: Some Current and Future Issues**	**18**
	4.1 Inclusive development Mahendra Dev, Introduction. Economic Survey 2009-10, Chapter 2 (21-24). 4.2 Growth of the Service Sector. Basu and Maertens (205-215). M Rakshit 2007. 4.3 Food security, Food Procurement and Public Distribution System. Basu and Maertens (484-489, 561-565). Mahendra Dev Chapter 3 (43-46, 62-66), Chapter 5. Hanumantha Rao in Uma Kapila, Chapter15. Economic Survey 2009-10, Chapter 8 (198-204) (or latest issues). 4.4 Migration and Urbanization. Basu and Maertens (443-447). Agarwal, Chapter 7 (86-101) 4.5 Land acquisition, SEZ and Industrialisation. Basu and Maertens (103-109, 164-68), Aradhana Agarwal 2006, Swapna	

	Banerjee-Guha 2008. 4.6 Demographic dividend. Basu and Maertens (415-421). Chandrasekhar, Ghosh and Roy Choudhury (2006). Uma Kapila, Chapter 9.	
Group B	**Contemporary Economic Issues -West Bengal Marks – 20**	
5	**West Bengal Economy: An Overview**	**10**
	5.1 West Bengal Economy Structure and Growth – based on state domestic product (SDP) data and employment data from National Sample Survey and Census of India.	
	5.2 West Bengal Economy in relation to India and major states in recent decades: in terms of indicators on - per capita SDP, per capita consumption (rural and urban), income growth, human development.	
6	**Growth and Development of West Bengal Economy**	**15**
	6.1 Land Reforms, agricultural growth and related current problems- growth of non-farm rural sector	
	6.2 Industrial development – problems and prospects; Tertiary sector growth – Informalisation in manufacturing and tertiary sectors.	
	6.3 Poverty alleviation, Employment generation, self-help-group and social security: Problems and policies	

Readings

For India:

Texts

1. K. Basu and A. Maertens. The Concise Oxford Companion to Economics in India. Oxford University Press.
2. Uma Kapila (ed). India's Economic Development Since 1947 (3rd Ed. or latest version). Academic.
3. S. Mahendra Dev. 2007. Inclusive Growth in India. Oxford University Press.
4. Agarwal, A.N. 2003, Indian Economy: Problems of Development and Planning (29th Edition) Wishwa Prakashani

References

4. M.S. Ahluwalia. 2002. "Economic Reforms in India since 1991: Has Gradualism Worked?" The Journal of Economic Perspectives, Vol. 16, No. 3.
5. I.J. Ahluwalia & I.M.D. Little (ed.). 1999. India's Economic Reforms and Development, Essays in honour of Manmohan Singh, Oxford University Press, New Delhi.
6. V. Joshi and I.M.D. Little. India' Economic Reforms 1991-2001. Oxford University Press.
7. M Rakshit. 2007. "Services-led growth: The Indian Experience" in Money and Finance, February.
8. C.P. Chandrasekhar, J. Ghosh and A Roy Choudhury. 2006. "The Demographic Dividend and Young India's Economic Future," in Economic and Political Weekly, 9 December.
9. G S Bhalla. 2004. Globalisation and Indian Agriculture: State of the Indian Farmer. Academic Publishers: New Delhi.
10. Government of India (annual) Economic Survey of India (Current years), also see Economic Survey 2009-10, Chapter 2.
11. Aradharna Agarwal. 2006. Special Economic Zones: Revisiting the Policy Debates. Economic and Political Weekly. November 4.

12. Swapna Banerjee-Guha. 2008. Space Relations of Capital and Significance of New Economic Enclaves: SEZs in India. Economic and Political Weekly. November 22.
13. J. Bhagwati. India in Transition. Clarendon Press.
14. J. Sachs, A Varshney and N Bajpai (ed). India in the Era of Economic Reforms. Oxford University Press.

For West Bengal:

1.Montek Singh Ahluwalia, 2006,"Economic Performance of States in Post Reform Period", Economic and Political Weekly (May 6).
2.B B Bhatacharyya & S Sakthivel, 2004, "Regional Growth and disparity in India – Comparison of Pre and Post Reform Decades", Economic and Political Weekly (March 6)
3.Ratan Khasnabis, 2008,"The Economy of West Bengal", Economic and Political Weekly (December 27)
4. A. Raychaudhuri & Tuhin Das (ed.).2005. West Bengal Economy: Some Contemporary issues, Allied Publishers
5. Economic and Political Weekly, 1998, 33 (47-48) articles on West Bengal Economy
6. West Bengal Human Development Report, 2004, Oxford University Press
7. B Rogaly, B Barbara Hariss-White and S Bose. 1999. Sonar Bangla? Agricultural Growth and Agrarian Change in West Bengal and Bangladesh. Sage Publications.

	Paper VIIA: Statistics & Basic Econometrics	
	Full Marks 50: Total Lectures 90	
Unit	Topic	Lectures (No)
1	**Joint Probability Distribution**	**10**
	Joint Probability Distribution – Idea of Independence, Marginal and Conditional Distribution. Expectation of the product of two variates.	
2	**Sampling Theory**	**5**
	2.1 Population and Sample, Parameter and Statistic, Random Sampling - Methods of Drawing Random samples –with replacement and without replacement, Random sampling Numbers. 2.2 Sampling Distribution,Standard Error. Mathai & Rathie – Probability and Statistics Goon,Gupta,Dasgupta – Fundamentals of Statistics, Vol I	
3	**Sampling Distribution**	**15**
	3.1 Sampling Distributions associated with Normal Population, Expectation and Standard Error of Sample Mean for with replacement and without replacement random samples, 3.2 Chi-Square Distribution, Student t Distribution, F-Distribution (definition and important properties only-Idea of degrees of freedom. Mathai & Rathie – Probability and Statistics Goon,Gupta,Dasgupta – Fundamentals of Statistics, Vol I	
3	**Classical Statistical Inference**	**25**
	4.1 Estimators-Desirable properties of estimators -Unbiasedness, Minimum Variance, Consistency and Sufficiency 4.2 Point Estimation - Maximum Likelihood Estimators and their properties – 4.3 Maximum Likelihood estimation of the parameters of Binomial, Poisson and Normal Distributions.	
	4.4 Confidence Intervals -Testing of Hypothesis -p-Values -Type-I and Type -II Errors 4.5 Simple applications of tests for the Mean and Variance of a Univariate Normal Population. Mathai & Rathie – Probability and Statistics Goon,Gupta,Dasgupta – Fundamentals of Statistics, Vol I	
5	**Elementary Econometrics**	**25**

	5.1 Classical Linear Regression Model (CLRM): Specification of the Model- Assumptions- Linearity in variables and parameters, Estimation of the Error Variance 5.2. Gauss Markov Theorem, Goodness of fit: R square –Coefficient of Determination 5.3 Inference in the Linear Regression Model- Confidence interval for the parameters and the Testing of Hypotheses -Prediction with the Simple Regression model. 5.4 Concepts of Heteroscadasticity and Autocorrelation problems. G.S. Maddala – Introduction to Econometrics D. Gujarati – Basic Econometrics.	
6	**Time Series Data**	**10**
	6.1 Time Series: Introduction, Components, Measurements: Secular Trend (Free hand curve fitting, Moving averages, fitting mathematical curves), Seasonal fluctuation (monthly averages, ratio to moving averages, ratio to trend) Goon,Gupta,Dasgupta – Fundamentals of Statistics, Vol II	
	Readings	
	Text 1. Goon,Gupta,Dasgupta – Fundamentals of Statistics, Vol I & II, World Press Private Limited 2. Mathai & Rathie – Probability and Statistics, The Macmillan Company of India Limited 3. G.S. Maddala – Introduction to Econometrics. Wiley Publishers (Indian edition). 4. D. Gujarati – Basic Econometrics, Tata McGraw-Hill Publishing Company Limited	
	References	
	5.Earl K. Bowen & Martin K. Starr, Basic Statistics for Business and Economics, McGraw Hill International Student Edition.	

	Paper VIIB: Applied Economics **Group A: Application of Economics to Managerial Issues**	
	Full Marks 50 : Total Lectures 75	
Unit	Topic	Lectures (No)
1	**Nature and Scope of Managerial Economics**	**5**
	1.1 Nature and Scope of Managerial Economics; 1.2 Basic Economic Tools in Managerial Economics: Opportunity Cost Principle,	

	Incremental Principle, Principle of Time Perspective, Discounting Principle and Equi-marginal Principle; 1.3 Managerial Economist- Role and Responsibilities. Ref: Varshney and Maheshwari Ch-1,2,3 (page 1-27).	
2	**Demand, Cost and Profit Analysis**	**15**
	2.1 Demand Analysis: Demand Estimation for major consumer durables, non-durable products; Demand forecasting techniques. Ref: Keat and Young Ch-5,6 (188-288) 2.2 Cost Estimation Ref: Keat and Young Ch-8 (355-417) 2.3 Cost-Volume-Profit Analysis (Break-Even Analysis) : What is C-V-P Analysis? Objectives of C-V-P Analysis, Assumptions of C-V-P Analysis Determination of Break-even point, Profit-Volume Graph, Profit-Volume Ratio, Margin of Safety, Uses and Applications of Break-Even Analysis, Limitations of C-V-P Analysis. Ref: P.L. Mehta Ch-20 p-405 to 450.	
3	**Organizational Design, Principal-Agent Analysis & Incentive Design**	**10**
	The Nature of the Firm, the Breadth of the Firm, Assigning Decision-Making Responsibilities, Monitoring & Rewarding performance, Separation of Ownership & Control in the Modern Corporation. Ref: Samuelson & Marks Ch-15 (641-677). And Anindya Sen Ch-7 (105-112), ch-15 (246-250)	
4	**Pricing Policies and Practices:**	**10**
	Factors Governing Prices, Objectives of Pricing Policy, Price Leadership, Full – Cost Pricing, Mark-up Pricing, Limit Pricing, Marginal Cost Pricing or Variable Cost Pricing, Rate of Return Pricing, Going-Rate Pricing, Peak-Load Pricing, Cyclical Pricing, Pricing over the life-cycle of a product (a) Skimming Price (b) Penetration Price (c) Pricing in Maturity; Product-line pricing, Price Discounts and Differentials, Price Forecasting. Ref: P.L. Mehta Ch-15, 16, 17 (329-378).	
5	**Capital Budgeting**	**10**
	What is Capital Budgeting? Need for Capital Budgeting; Different Steps in the Capital Budgeting Process; Nature of Capital Budgeting Problem; Capital Budgeting Appraisal Methods (a) Payback Method (b) Accounting Rate of Return Method (c) Net Present Value Method (d) Internal Rate of Return Method (e) Benefit-Cost Ratio Method; Comparison between NPV and IRR Methods; Capital Rationing; Alternative Methods of Financing Investments. Ref: P.L. Mehta Ch-21 (451-484).	
6	**Cost of Capital**	**7**
	Cost of Debt Capital, Cost of Preference Share Capital, Cost of Equity Capital, Cost of Retained Earnings, Average Cost of Capital, The Opportunity Cost Concept – Borrowing Rate vs. Lending Rate. Ref: Varshney and Maheshwari Ch-29 (358-368) or P.L. Mehta Ch-22 (485-491)**.**	

7	**Inventory Management**	**10**
	Inventory Costs, Concept of Average Inventory; Various Inventory Models: (a) Economic Order Quantity (EOQ) (b) Optimum number of Orders per year (c) Optimum no. of Days' Supply per Order; Quantity Discounts – Cost Comparison Approach; EOQ Concept and Production Processes. Ref: Varshney and Maheshwari Ch-41 (473-481)or P.L. Mehta Ch-12 (254-269).	
8	**Corporate Governance**	**8**
	Role of Institutional Investors, Mechanisms and Controls – Internal and External Govt Controls, Problems of Corporate Governance, Role of Accountant, Regulation – Rules & Principles, Enforcement, Action beyond obligation, Corporate Governance Models with emphasis on Anglo American Model, Impact of Corporate Governance on Firm Performance. Ref: Anindya Sen Ch-7, (112-119). Thomas Clarke- International Corporate Governance, Routledge	
	Readings	
	<u>Texts</u> 1. Varshney,R.L and Maheshwari, K.L - Managerial Economics , Sultan Chand, New Delhi 2. Keat, Paul G and Young, Philip K.Y - Managerial Economics, Pearson Education, New Delhi 3. Mehta, P.L - Managerial Economics, Sultan Chand, New Delhi 4. William F. Samuelson and Stephen G. Marks – Managerial Economics. Wiley Student Edition. 5. Thomas Clarke – International Corporate Governance Routledge, 2007. 6. Anindya Sen – Microeconomics, Oxford University Press. **<u>References</u>** 7. Debroy, Bibek - Managerial Economics, All India Management Association & Global Business Press 8. James A. Brickley, Clifford W. Smith, Jr., and Jerold L. Zimmereman - Managerial Economics & Organizational Architecture, Tata McGraw Hill. 9. Colley, J, Doyle, J, Logan, G & Stettinius, W – What Is Corporate Governance, McGraw Hill, New York 10. Monks, Robert A G & Minow, Nell - Corporate Governance, Blackwell. 11. Bhattacharya, Harasankar and Sarkhel, Jaydeb – Managerial Economics, Book Syndicate Pvt Ltd, Kolkata	

	Paper VIIB: Applied Economics **Group B: Mathematical Economics** **Full Marks 50: Total Lectures 75**	
Unit	Topic	Lectures (No)
1	**Theory of the Consumer**	**10**
	Utility maximization, Lagrangian multiplier, Indirect Utility function, Roy's Identity, Derivation of Slutsky's equation, Slutsky's Equation in elasticity form, Compensated demand curve	

	Different forms of Utility Function—Separable, quasi-linear, homogeneous and homothetic Labour-leisure choice Ref: Simon & Blum, Chapter22 Section 22.1, Chiang & Wainwright,Chapter 12, Silberberg & Suen, Chapter 10	
2	**Theory of the Firm**	**15**
	2.1 Output maximization, Cost minimization, Homogeneous and homothetic production functions, Elasticity of substitution, CES production function, Relationship between average cost and marginal cost 2.2 Factor demand curves, output elasticity, Analysis of firms in competitive equilibrium and monopoly, imposition of taxes 2.3 Analysis of factor demands in the long run 2.4 Fixed coefficient production functions, Leontief Input-Output system. Ref: Simon & Blum, Chapter22 Section 22.2, Chiang .& Wainwright,Chapter 12, Silberberg & Suen, Chapter 4	
3	**Games and Decisions**	**10**
	Two person matrix games, solving matrix games with mixed strategies Sequential Games and Decisions Ref: Aliprantis & Chakrabarti, Chapter 2,3,4	
4	**Inter-temporal Choice Theory**	**5**
	4.1 n-period utility maximization, Time preference, Stocks and flows Ref: Silberberg & Suen, Chapter 12	
5	**Behaviour under uncertainty**	**5**
	5.1 Uncertainty and Probability, State preference approach for preferences 5.2 Expected Utility Hypothesis, Risk aversion and its measures. Ref: Silberberg & Suen, Chapter 13	
6	**Comparative Statics**	**10**
	6.1 Generalisation to n variables: First and Second order conditions 6.2 Profit maximisation: n factors and Utility Maximisation 6.3 National Income Model, IS-LM Model 6.2 Simple Trade Models Ref: Silberberg & Suen,Chapter 6 , Chiang & Wainwright, Chapter 8.	
7	**Application of Difference and Differential Equations**	**20**
	7.1 Cobweb Model 7.2 Multiplier-Accelerator Interaction Model 7.3 Linear Systems via Eigen values 7.4 Solution of linear systems by substitution 7.5 Phase diagrams of linear systems 7.6 Solow model. Ref: Chiang & Wainwright, Chapter 17, 18	
	Readings:	
	Aliprantis, D C. and S. K. Chakrabarti (1999) Games and Decision Making, Oxford University Press. Chiang, A. C. and Wainwright(2005)(Fourth Edition): Fundamental Methods of Mathematical Economics, McGraw-Hill. Silberberg, E and W. Suen (2001)(Third Edition): The Structure of Economics, A Mathematical Approach, McGraw-Hill.	

	Simon, C.P and L. Blume (1994): Mathematics for Economists, Norton & Company Schaum's Easy Outline of Introduction to Mathematical Economics (2005)	

	Paper VIIIA: Indian Economic History	
	Full Marks 50 : Total Lectures 55	
Unit	Topic	Lectures (No)
1	**Economic condition in India on the eve of British rule**	**3**
2	**Aspects of Economic Policies under in British India**	**25**
	2.1 Land policy	
	2.2 Policy of Discriminating Protection	
	2.3 Early Industrial Development and Managing Agency System	
	2.4 Currency and monetary policy	
	2.5 Infrastructure and Transport	
3	**Impact of British rule on India**	**25**
	3.1 Deindustrialisation	
	3.2 Commercialisation of agriculture	
	3.4 Economic Drain	
4	**Early Economic planning initiatives during British rule**	**2**
	Readings 1. Dharma Kumar (ed). Cambridge Economic History, Vol II. 2. V B Singh (ed.). Economic History of India (1857-1956). 3. Dhires Bhattacharyya. Concise Economic History of India. 4. D R Gadgil. Industrial Evolution of India in Recent Times. 5. A K Bagchi. Private Investment in India (1900-1939). 6. Bipan Chandra. Rise of Economic Nationalism. 7. Rothermund, Dietmar. 1988. An Economic History of India, From Pre-colonial times to 1986, Croom Helm, London. 8. Tirthankar Roy. The Economic History of India 1857-1947. Oxford University Press. (2nd edition).	

	Paper VIIIB : Term Paper	
	Full Marks 50 : Total Lectures: 15	
Unit	Topic	Lectures (No)
	The college should arrange for 10 to 15 lectures to inform the students on the method of preparing for and writing the term paper.	

Syllabus for BA/BSC (General)

	Paper IA: Microeconomics I	
	Full Marks 50: Total Lectures 45	
Unit	**Topic**	**Lectures (No)**
1	**Economics and Microeconomics**	**8**
	1.1 What is economics? Branches of Economics. What is microeconomics? 1.2 Economic agents and their activities as consumer, producer, investor. Concepts of demand and supply, and markets.	
2	**Demand and Consumer Behaviour**	**19**
	2.1 What is demand? Law of Demand - Demand curve and its foundation in consumer behaviour 2.2 Utility Approach: Total and Marginal Utility-Law of Diminishing Marginal Utility -. Relation between Law of Demand and Law of Diminishing Marginal Utility. 2.3 Indifference Curve Approach: Definition and Characteristics-Consumer's,-Equilibrium- income Effect and Substitution Effect-Price Effect. 2.4 Elasticity of Demand: Price Elasticity and Income Elasticity of Demand, Measurement of Price Elasticity.	
3	**Producer's Behaviour**	**18**
	3.1 Concept of production –raw material and factors of production-technology – organization of production – large scale vs. small scale production. 3.2 Production technology and production Function – total product, average product, marginal product (with numerical example) - Returns to Factor and Returns to Scale. 3.3 Cost of Production: Real Cost and Opportunity Cost-Fixed and Variable cost; Cost curves -Shape of Cost Curves (Short-run and Long run)-Relation between Average Cost and Marginal Cost. 3.4 Revenue - Total Revenue, Average revenue, Marginal Revenue - Relation between Average Revenue, Marginal Revenue and Price Elasticity of Demand.	
	Readings	
	1. Stonier, A. W. and D.C. Hague: A Text Book of Economic Theory, Longman Group, London. 2. Samuelson, P.A. and William D: Economics, McGraw Hill Book Co., Nordhaus, Singapore. 3. Lipsey, R.G.: An Introduction to Positive Economics, Weidenfeld and Nicholson, London.	

	Paper IB: Macroeconomics I	
	Full Marks 50: Total Lectures 45	
Unit	**Topic**	**Lectures (No)**
1	**National Income Accounting**	**7**
	1.1. National Income Concepts: Distinction between Goss Domestic Product, Net Domestic Product and Net National Product 1.2. Different Methods of Measuring National Income.	
2	**Money and Banking**	**14**
	2.1 Concept and Functions of Money- Value of Money-Money supply – components of money supply (M1, M2, etc) 2.2 Quantity Theory of Money: Fisher's Version and Cambridge Version 2.3 Banking: Functions of Commercial Banks: Credit Creation –role in money supply –Functions of Central Banks: Credit Control Methods.	
3	**Consumption and Investment**	**14**
	3.1 Concept of aggregate consumption – private vs public consumption - Keynesian Consumption Function -Relation between Average and Marginal Propensity to Consumer-Multiplier Theory 3.2 Concept of aggregate investment – components of investment – aggregate investment function and determinants of investment	
4	**Government sector**	**10**
	4.1 Transactions of the Government sector -Budget – receipts and expenditures –revenue account and capital account 4.2 Principles of Taxation: Direct and Indirect Taxation –Regressive, Progressive and Proportional Taxation 4.3 Public Debt- Internal & external –purpose and implications	
	Readings	
	1. Stonier, A.W. and D.C. Hague. : A Text Book of Economic Theory,Longman Group, London	
	2. Lipsey & Chrystal : An Introduction to Positive Economics	
	3. Gupta, S.B. : Monetary Economics, S.Chand & Co;New Delhi.	

	Paper IIA: Microeconomics II	
	Full Marks 50: Total Lectures 45	
Unit	**Topic**	**Lectures (No)**
1	**Theory of Markets**	
	1.2 Concepts of Perfect Competition, Monopoly, Monopolistic Competition, Oligopoly. 1.3 Short-run and Long-run Equilibrium under perfect Competition at the Firm level, as well as industry level. Idea of price discrimination. 1.4 Price and Output Determination under Monopoly.	**20**
2	**Theory of Distribution**	**25**
	2.1 Marginal Productivity Theory of Distribution-Factor Price	

	Determination. 2.2 Rent: (a) Ricardian Theory, (b) Modern Theory. 2.3 Wage: Distinction between Money Wage and Real Wage-Factors Determining Real Wage-Role of Trade Union in Wage Determination under competitive set up. 2.4 Interest: Real and Money Interest Loanable fund and liquidity preference theory of interest. 2.5 Profit: Alternative theories of profit.	
	Readings	
	1. Stonier, A. W. and D.C. Hague: A Text Book of Economic Theory, Longman Group, London. 2. Samuelson, P.A. and William D: Economics, McGraw Hill Book Co., Nordhaus, Singapore. 3. Lipsey, R.G.: An Introduction to Positive Economics, Weidenfeld and Nicholson, London.	

	Paper IIB: Macroeconomics II	
	Full Marks 50: Total Lectures 45	
Unit	**Topic**	**Lectures (No)**
5	**Theories of Income and Employment**	**15**
	4.1 Concept of Classical Theory of Employment and output-Say's Law of markets. 4.2 Simple Keynesian theory of Income and Employment: Concept of Effective Demand.	
6	**Prices and Inflation**	**15**
	6.1 Concept of price index –alternative price indices and measurements of inflation rate 6.2 Concept of Inflation, Deflation and Stagflation: Inflationary Gap - Distinction between Demand-pull and Cost-Push Inflation 6.3 Anti-Inflationary Monetary and Fiscal Policies -Effects of Inflation	
7	**External Sector**	**15**
	7.1 International Trade: Distinction between Internal and International Trade –exports and imports in goods and services. 7.2 Basis of Trade: Concepts of absolute advantage and comparative Advantage -Arguments for Free Trade – Argument for Protection.	
	Readings	
	1. Stonier, A.W. and D.C. Hague. : A Text Book of Economic Theory,Longman Group, London	
	2. Lipsey & Chrystal : An Introduction to Positive Economics	
	3. Gupta, S.B.: Monetary Economics, S.Chand & Co;New Delhi.	

	Paper IIIA: Indian Economy I	
	Full Marks 50 : Total Lectures 45	
Unit	**Topic**	**Lectures**

		(No)
1	**Indian Economy –An Overview**	**9**
	1.1 The structure of Indian Economy – its sectoral composition, rural-urban dimension –India's per capita income – relative position relation to developed and underdeveloped economies 1.2 Features and Causes of Underdevelopment of the Indian Economy	
2	**NI Trends**	**8**
	National Income of India: Trend, Estimation and Distribution.	
3	**Demography**	**10**
	3.1 The trends and pattern of population growth –age distribution – demographic rates and population projection 3.2 The nature of population problem in India and government policies related to population	
4	**Dualism**	**8**
	Dualism, in the Indian Economy: Poverty Line-Poverty Eradication Programmes in India.	
5	**Indian Planning**	**10**
	5.1. Background for Indian Planning and Planning process and institutions 5.2 Objectives, achievements and failures of India's Five-year Plans (broad outline)	
	Readings	
	1.Dutta, R. & K.P.M. Sundaram : Indian Economy, S. Chand & Co. New Delhi.	
	2.Misra, S.K. & V.K. Puri : Indian Economy, Himalayas Publishing Co. Mumbai	
	3.Agarwal, A.N.: Indian Economy, Vikash Publishing Co. Delhi.	
	4.Gupta, S.B.: Monetary Planning in India Oxford University Press, Delhi.	
	5.Dhar, P.N. : Indian Economy.	

	Paper IIIB: Indian Economy II	
	Full Marks 50: Total Lectures 45	
Unit	**Topic**	**Lectures (No)**
1	**Indian Agriculture**	**10**
	1.1 Characteristics of Indian Agriculture: Causes of Low Productivity. 1.2 Land Reforms: Meaning, importance. Evaluation of the Programmes. 1.3 New technology and Green Revolution and its effects 1.4 Effects of Economic Reforms on Indian Agriculture.	
2	**Indian Industry**	**10**
	2.1 Structure of Indian industry -Role of Cottage, Small-scale and Large-scale Industries in India's development. 2.2 Problems and strategies of industrial development Economic Development -Problems and Solutions. I	

	2.3 Industrial Labour, Industrial Finance, Industrial Policy.	
3	**Finance in India**	**8**
	3.1 Financial Markets and Financial system in India 3.2 Banking: Role of Indian Commercial Banks - Credit Control Policy of Reserve Bank of India	
4	**Indian Public Finance**	**10**
	4.1 Central and state budgets – revenue account and capital account - Sources of Revenue of Union and State Governments –direct and indirect tax – major heads of expenditures – plan vs. non-plan expenditures 4.2 Union-State Financial Relation – Role of Finance Commission of India.	
5	**India's Foreign Trade**	**7**
	5.1 Importance of foreign trade for Indian Economy 5.2 India's Foreign Trade: Change in volume and direction of trade in the post liberalisation period.	
	Readings	
	1. Dutta, R. & K.P.M. Sundaram: Indian Economy, S. Chand & Co. New Delhi.	
	2. Misra, S.K. & V.K. Puri: Indian Economy, Himalayas Publishing Co. Mumbai	
	3. Agarwal, A.N: Indian Economy, Vikash Publishing Co. Delhi.	
	4. Gupta, S.B: Monetary Planning in India Oxford University Press, Delhi.	
	5. Dhar, P.N: Indian Economy.	

	Paper IVA: Development Economics I	
	Full Marks 50: Total Lectures 45	
Unit	**Topic**	**Lectures (No)**
1	Distinction between Economic Growth and Economic Development: Net National Income and Per Capita Income as Growth Indicators- Concept Of HDI.	**10**
2	Development Planning & its necessity -balanced vs. unbalanced growth. Complementary Roles of Agriculture and Industry -Role of Technology in Agriculture and Industry.	**10**
3	Population and Economic Development: The Two Way Relation. Domestic Capital Formation in an Underdeveloped Country: The Problems -Incentives for Savings and Investment.	**10**
4	Foreign Investment: Different forms -Their roles in Economic Development. Role of IMF & World Bank in economic development of the LDCS.	**10**
5	Gender Related Issues.	**5**

	Readings	
	1. Todaro, M.P.: Economic Development in the Third World, Longman, New York.	
	2. Salvatore, D. and E. Dowling: Development Economics, Schaum's, Outline Series in Economics, McGraw Hill, New York.	
	3. Agarwala, A.N. and S.P. Singh: Economics of Underdevelopment, (eds.) Oxford University Press, London.	
	4. Meier, G.M. (ed.): Leading Issues in Economic Development, Oxford University Press, New York.	
	5. United Nations Development Programme, Human Development Report (Recent Years)	
	6. Todaro, M.P. : Economic Development in the Third World, Longman, New York. 7. Salvatore, D. and E. Dowling : Development Economics, 8. Schaum's Outline Series in Economics, McGraw Hill, New York. 9. Agarwala, A.N. and S.P. Singh : Economics of Underdevelopment, (eds.) Oxford University Press, London. 10. Meier, G.M. (ed.) : Leading Issues in Economic Development, Oxford University Press, New York. 11. United Nations Development Programme, Human Development Report (Recent Years)	

	Paper IVB: International Economics & Statistics	
	Full Marks 50: Total Lectures 45	
Unit	**Topic**	**Lectures (No.)**
Group A	**International Economics.** **Full Marks: 25**	
1.	Comparative Advantage and Protectionism: Principle of Comparative advantage, Ricardo's analysis, Economic Gains from trade, Graphical Analysis of comparative advantage, Equilibrium Price ratio, Extensions to many commodities and countries, Protectionism: Supply and demand analysis of trade and tariffs, Free Trade, Trade barriers, Prohibitive Tariff, Non-prohibitive Tariff, Quotas, Economic costs of tariff. Arguments for protection	**12**
	Readings:	
	Economics: Samuelson & Nordhaus, Tata McGraw_Hill,Chapter 35	
2.	Balance of Payments: Debits and Credits, Balance on Current Account and Capital Account, Exchange rates and Balance of Payments	**7**
	Readings:	

	Economics: Samuelson & Nordhaus, Tata McGraw_Hill,Chapter 34, pp 682 - 685	
Group B	**Statistics.** **Full Marks: 25**	
1.	Data – Classification and presentation, Population and Sample, Collection of Data - Variable and Attribute, Frequency Distribution – Diagrammatic representation of frequency distribution – Cumulative frequency - Ogive.	**10**
2.	Central Tendency- Arithmetic Mean, Median and Mode (for both grouped and ungrouped data)	**9**
3.	Dispersion: Range and Standard Deviation, Measures of Relative Dispersion – Curve of Concentration, Concepts of Measurement of Economic Inequality: Lorenz Curve.	**7**
	Readings: 1. Basic Statistics: Goon,Gupta, DasGupta, The World Press Pvt. Ltd., 2. Statistical Methods: N.G. Das, Vol. I, Paperback 1st Edition, Tata McGraw-Hill, 3. Basic Statistics: Basic Statistics (s) 2nd Edition. R. K Das, A I Nagar Oxford University, Paperback.	

C.U. B.Sc. BOTANY (HONOURS) SYLLABUS, 2010

PART I : 200 MARKS

(THEORETICAL -150 and PRACTICAL – 50)

PAPER I (THEORETICAL) 100 MARKS 4 Hours

Algae	25 Marks (20 Periods)
Microbiology	25 Marks (20 Periods)
Fungi & Lichen	25 Marks (20 Periods)
Plant Pathology	25 Marks (20 Periods)

PAPER IIA (THEORETICAL) 50 MARKS 2 HOURS

Bryophytes	20 Marks (16 Periods)
Palaeobotany & Palynology	20 Marks (16 Periods)
Embryology	10 Marks (8 Periods)

PAPER IIB (PRACTICAL) 50 MARKS 4 HOURS

1. Work out on Algae	12 Marks
2. Work out on Fungi	12 Marks
3. Identification with reasons 3x5 = (Algae-1,Fungi-1, Lichen-1& Bryophytes-2)	15 Marks
4. Laboratory Records (Laboratory note books– 4, Slides-2)	6 Marks
5. Viva	5 Marks

Module I: Algae + Microbiology

Module II: Fungi & Lichen + Plant Pathology

Module III: Bryophyte+ Palaeobotany & Palynology+ Embryology

Module IV: Work out on Algae & Fungi + Identification of Algae, Fungi, Lichen, Bryophytes + Laboratory Records + Viva.

PART II : 200 MARKS
(THEORETICAL -150 and PRACTICAL – 50)

PAPER III (THEORETICAL) 100 MARKS 4 HOURS

Pteridophytes	25 Marks (20 Periods)
Gymnosperms	25 Marks (20Periods)
[redacted]	25 Marks (20 Periods)
Anatomy	25 Marks (20 Periods)

PAPER IVA (THEORETICAL) :50 MARKS 2 HOURS

Morphology of Angiosperms	10 Marks (8 Periods)
Taxonomy of Angiosperms	40 Marks (32 Periods)

PAPER IVB (PRACTICAL): 50 MARKS 4 HOURS

1. Workout on Pteridophytes	8 Marks
2. Workout on Angiosperms	12 Marks
3. Spot Identification [1.5 x4]	6 Marks
4. Identification with reasons (2 x 4) = (Pteridophyte – 1, Gymnosperms – 2, Palaeobotany/Palynology–1,)	8 Marks
5. Laboratory Records	5 Marks
6. Field Records (Field note book–3, Herbarium specimens–3)	6 Marks
7. Viva	5 Marks

Module V: Pteridophytes + Gymnosperms

Module VI: [redacted] + Anatomy

Module VII: Morphology of Angiosperms + Taxonomy of Angiosperms

Module VIII: Work out on Pteridophytes & Angiosperms + Spot Identification of Angiosperms + Identification (Pteridophytes + Gymnosperms + Palaeobotany/Palynology) + Laboratory Records + Field Records (Field note book + Herbarium Specimens) + Viva.

PART III : 400 MARKS

(THEORETICAL -200 and PRACTICAL – 200)

PAPER V (THEORETICAL): 100 MARKS 4 HOURS

Biochemistry	35 Marks (28 Periods)
Pharmacognosy	15 Marks (12 Periods)
Plant Physiology	50 Marks (40 Periods)

PAPER VI (THEORETICAL) : 100 MARKS 4 HOURS

Cell Biology	20 Marks (16 Periods)
Plant Breeding & Biometry	15 Marks (12 Periods)
Plant Biotechnology	15 Marks (12 Periods)
Genetics & Molecular Biology	50 Marks (40 Periods)

Module IX: Biochemistry + Pharmacognosy

Module X: Plant Physiology

Module XI: Cell Biology + Plant Breeding & Biometry + Plant Biotechnology

Module XII: Genetics & Molecular Biology

PAPER VII (PRACTICAL):100 MARKS 6 HOURS

1. Plant Biochemistry (Quantitative & Qualitative)(20+10)= 30 Marks
2. Plant Physiology 25 Marks
3. Anatomy 10 Marks
4. Pharmacognosy 10 Marks
5. Identification (Anatomy-2.5 x 2) 5 Marks
7. Laboratory Records (Laboratory note books-8 & Slides-2) 10 Marks
8. Viva 10 Marks

PAPER VIII (PRACTICAL)

1. Cell Biology and Genetics (20+10) = 30 Marks
2. Biometry 13 Marks
3. Microbiology 12 Marks
4. Plant Pathology 10 Marks
5. Identification (Cell Biology 4,Pathology - 2) (2.5X6)= 15 Marks
6. Laboratory Records (Laboratory note books-8 & Slides-2) 10 Marks
7. Viva 10 Marks

Module XIII: Biochemistry + Pharmacognosy + Laboratory Records + Viva

Module XIV: Plant Physiology + Anatomy (work out + Identification) + Laboratory Records + Viva

Module XV: Cell Biology & Genetics + Identification + Laboratory Records + Viva

Module XVI: Biometry + Microbiology + Plant pathology + Identification + Laboratory Records + Viva

PAPER I (THEORETICAL): 100 MARKS : 4 HOURS

Algae	**25 Marks (20 Periods)**
Microbiology	**25 Marks (20 Periods)**
Fungi & Lichen	**25 Marks (20 Periods)**
Plant Pathology	**25 Marks (20 Periods)**

PAPER I (THEORETICAL)

ALGAE 25 Marks (20 Periods)

1. *General account* :
   1.1. Thallus organization, 1.2. Ultrastructure of Plastids and Flagella, 1.3. Origin and evolution of sex, 1.4. Life cycle patterns.
2. *Classification* :
   2.1. Classification by Lee (1999) upto division (phylum) with examples, 2.2. Salient features of Cyanophyceae, Chlorophyceae , Charophyceae, Bacillariophyceae, Xanthophyceae, Phaeophyceae, Rhodophyceae .
3. *Blue Green Algae* :
   3.1. Ultrastructure of cell , 3.2. Heterocyst - structure and function, 3.3. Renaming as Cyanobacteria.
4. *Diatom* :
   4.1. Cell structure, 4.2. Cell division, 4.3. Auxospore formation in Centrales and Pennales.
5. *Life History* :
   5.1. *Oedogonium* , 5.2. *Chara* , 5.3. *Ectocarpus* , 5.4. *Polysiphonia* .
6. *Economic Importance* :
   6.1. Food , 6.2. Phycocolloid (Agar-agar, Algin, Carrageenan), 6.3. Diatomite, 6.4. Algal Biotechnology – potential of microalgae for SCP, β-carotene, Biofertilizer, Biodiesel; Principles of mass cultivation of microalgae; 6.5. Algal toxins.

MICROBIOLOGY 25 Marks (20 Periods)

1. *Virus* :
   1.1. Plant virus- types, 1.2. Transmission and translocation of Plant virus, 1.3. TMV- Physicochemical characteristics and Multiplication, 1.4. One step growth curve, 1.5. Lytic cycle (T4 phage) and Lysogenic cycle (Lambda phage), Significance of lysogeny, 1.6.Viroids and Prions.
2. *Bacteria* :
   2.1. Distinguishing features of Archaea and Bacteria , 2.2. Characteristics of some major groups: Proteobacteria (Enterobacteria), Firmicutes, Mollicutes, Actinobacteria, Spirochaetes, Chlamydiae, 2.3. Glycocalyx- nature and function, 2.4.Flagella (ultrastructure) & Pilli, 2.5. Cell wall – chemical structure and differences between Gram +ve & Gram – ve bacteria, 2.6. Bacterial genome and plasmid, 2.7. Endospore - formation , structure and function, 2.8.Genetic Recombination (a) Transformation – with special emphasis on Natural and Induced competence and DNA uptake, (b) Conjugation– F- factor, F^+ X F^-, Hfr X F^-, concept of F', chromosome mobilization, (c) Transduction– Generalised and specialized.
3. *Applied Microbiology* :
   3.1. Industrial Production of Vinegar and Streptomycin (brief outline), 3.2. Microbial sources and uses of Enzyme (Amylase, Protease), Amino acid (Glutamic acid, Lysine), Polysaccharides (Dextran), 3.3. Use of microbes as Biofertilizer and Biopesticides.

FUNGI & LICHEN 25 Marks (20 Periods)

1. *General Account* :
   1.1. Hyphal forms , 1.2. Fungal spore forms and mode of liberation, 1.3. Sexual reproduction and degeneration of sex, 1.4. Homothallism and heterothallism, 1.5. Life cycle patterns, 1.6. Anamorphic fungi and parasexuality, 1.7. Mycotoxins with emphasis on aflatoxin.
2. *Classification* :
   Classification of Fungi (Ainsworth, 1973) upto sub-division with diagnostic characters and examples.
3. *Life history* :
   3.1. *Synchytrium*, 3.2. *Rhizopus* , 3.3. *Ascobolus* , 3.4. *Agaricus* .
4. *Mycorrhiza* :
   4.1. Types with salient features , 4.2. Role in Agriculture & Forestry .

5. *Fungal Biotechnology* :
5.1. Mushroom – Food value and cultivation of *Pleurotus* , 5.2. Cheese and Ethanol- Industrial production (brief outline), 5.3. Fungal sources and uses of Mycoprotein, Enzyme (Cellulase),Amino acid (Tryptophan), Vitamin (Riboflavin), Antibiotic(Griseofulvin), Pharmaceuticals (Cyclosporin-A).
6. *Lichen* :
6.1. Types , 6.2. Reproduction , 6.3. Economic and ecological importance

PLANT PATHOLOGY 25 Marks (20 Periods)

1. *Terms and Definitions* :
1.1. Disease concept, 1.2. Symptoms, 1.3. Etiology & causal complex, 1.4. Primary and secondary inocula, 1.5. Infection, 1.6. Pathogenecity and pathogenesis, 1.7. Necrotroph and Biotroph, 1.8. Koch's Postulates, 1.9. Endemic, Epidemic, Pandemic and Sporadic disease, 1.10. Disease triangle, 1.11. Disease cycle (monocyclic, polycyclic and polyetic).
2. *Host – Parasite Interaction* :
2.1. Mechanism of infection (Brief idea about Pre-penetration ,Penetration and Post-penetration), 2.2. Pathotoxin (Definition,criteria and example), 2.3. Defence mechanism with special reference to Phytoalexin, 2.4.Resistance-Systemic acquired and Induced systemic.
3. *Plant Disease Management* :
3.1. Quarantine, 3.2. Chemical, 3.3. Biological, 3.4. Integrated.
4. *Symptoms , Causal organism ,, Disease cycle and Control measures of* :
4.1. Late blight of Potato, 4.2. Bacterial blight of rice, 4.3. Black stem rust of wheat, 4.4. Stem rot of jute.

PAPER IIA (THEORETICAL) : 50 MARKS : 2 HOURS

Bryophytes	20 Marks (16 Periods)
Palaeobotany & Palynology	20 Marks (16 Periods)
Embryology	10 Marks (8 Periods)

PAPER IIA (THEORETICAL)

BRYPOPHYTES 20 Marks (16 Periods)

1. *General Account* :
1.1. Origin of bryophytes, 1.2. Amphibian nature, 1.3. Classification (Proskauer, 1957) upto class with diagnostic characters and examples .
2. *Life History:* Gametophyte structure and Reproduction, Development and Structure of sporophyte, Spore dispersal in:
2.1. *Marchantia* , 2.2. *Anthoceros* , 2.3. *Funaria* .
3. *Phylogeny* :
3.1. Origin of Alternation of Generations (Homologous and Antithetic theory), 3.2. Evolution of Sporophytes (Progressive and Regressive concept).
4. *Importance :*
Role of bryophytes in : 4.1. Plant succession , 4.2. Pollution Monitoring.

PALAEOBOTANY & PALYNOLOGY 20 Marks (16 Periods)

1. *Plant Fossil* :
1.1. Types: Body fossil (Micro- and Megafossils), Trace fossil, Chemical fossil, Index fossil, 1.2. Different modes of preservation (Schopf, 1975), 1.3. Conditions favouring fossilization, 1.4. Nomenclature and Reconstruction, 1.5 Importance of fossil study
2. *Geological time scale* with dominant plant groups through ages.
3. *Indian Gondwana System* - Three fold division with major megafossil assembledges .
4. *Palynology* :

4.1. Spore and Pollen, 4.2. Pollen aperture types, 4.3. NPC classification (Erdtman). 4.4. Pollen wall- Sporopollenin, Stratification and Ornamentation (sculpturing),

5. *Applied Palynology*:-

Basic concepts of : 5.1.Palaeopalynology, 5.2.Aeropalynology ,5.3.Forensic palynology, 5.4.Melissopalynology.

EMBRYOLOGY 10 Marks (8 Periods)

1. *Pre-fertilisation changes* :

1.1. Microsporogenesis and Microgametogenesis, 1.2. Megasporogenesis and Megagametogenesis (monosporic, bisporic and tetrasporic).

2. *Fertilisation:*

2.1.Pollen-ovule ratio and its significance, 2.2.Pollen germination, Pollen tube– growth, entry into ovule and discharge, 2.3. Double fertilization.

3. *Post-fertilization changes :*

3.1. Embryogenesis in *Capsella*, 3.2. Development of Endosperm (3 types).

4. *Apomixis & Polyembryony:*

4.1. Apomixis- Apospory and Apogamy , 4.2.Polyembryony- different types.

PAPER IIB (PRACTICAL) : 50 MARKS : 4 HOURS

1. Work out on Algae		**12 Marks**
2. Work out on Fungi		**12 Marks**
3. Identification with reasons	**(3 x 5) =**	**15 Marks**
(Algae-1, Fungi-1, Lichen-1 & Bryophyte- 2)		
5. Laboratory Records (Laboratory note books– 4, Slides-2)		**6 Marks**
6. Viva		**5 Marks**

PAPER IIB (PRACTICAL)

ALGAE

1. Work out of the following algae with reproductive structure (Free hand drawing and drawing under drawing prism with magnification): *Oedogonium* , *Chara*, *Ectocarpus.*
2. Study of (a) Permanent slides : *Gloeoitrichia*, *Volvox, Vaucheria, Coleochaete, Polysiphonia,* Centric and Pennate diatom*;* (b) Macroscopic specimens : *Laminaria*, *Sargassum.*

FUNGI AND LICHEN

1. Work out of the following fungi with reproductive structures (including microscopic measurement of Reproductive structures): *Rhizopus* (asexual) , *Ascobolus* , *Agaricus* .
2. Study from permanent slides : Zygospore of *Rhizopus* , Conidia of *Fusarium*,Conidiophore of *Penicillium.*
3. Morphological study of Fungi (fruit body of *Polyporus, Cyathus*), Lichens (fruticose and foliose) .

BRYOPHYTES

1. Morphological study of the plant body : Genera as mentioned in theoretical syllabus and *Riccia* , *Porella*.
2. Study from permenant slides : *Riccia* (V.S. of thallus with sporophyte), *Marchantia* (L.S.through gemma cup, antheridiophore , archegoniophore) , *Anthoceros* (L.S. of sporophyte) , *Funaria* (L.S. of capsule) .

LABORATORY RECORDS

1. Laboratory Note Book of each section must be signed by the respective teacher with date during practical classes .
2. Slides (permanent) prepared during practical classes.

PART II : 200 MARKS
(THEORETICAL -150 and PRACTICAL – 50)

PAPER III (THEORETICAL) 100 MARKS : 4 HOURS

Pteridophytes	25 Marks (20 Periods)
Gymnosperms	25 Marks (20Periods)
Ecology and Plant Geography	25 Marks (20 Periods)
Anatomy	25 Marks (20 Periods)

PAPER III (THEORETICAL)

PTERIDOPHYTES 25 Marks (20 Periods)

1. *General Account* :
   1.1. Colonisation and rise of early land plants , 1.2. Classification of vascular plants by Gifford & Foster (1989) upto division (Rhyniophyta to Filicophyta) with diagnostic characters and examples.
2. *Life History* :
   Sporophyte structure, Reproduction and Structure of gametophyte in 2.1. *Psilotum*, 2.2. *Selaginella*, 2.3. *Equisetum*, 2.4. *Dryopteris.*
3. *Fossil Pteridophytes* :
   Structural features, Geological distribution and Evolutionary significance of 3.1. *Rhynia*, 3.2. *Lepidodendron* (Reconstructed), 3.3. *Calamites* (Reconstructed).
4. *Telome concept* and its significance in the origin of different groups of Pteridophytes.
5. *Heterospory and Origin of Seed habit.*
6. *Economic importance* as food, medicine and Agriculture.

GYMNOSPERMS 25 Marks (20 Periods)

1. *Classification* of vascular plants by Gifford & Foster (1989) upto division (Progymnospermophyta to Gnetophyta) with diagnostic characters and examples.
2. *Progymnosperms* :
   2.1. Diagnostic characters of the group, 2.2. Vegetative and reproductive features of *Archeopteris*, 2.3. Phylogenetic importance.
3. *Life History* :
   Distribution in India; Vegetative and Reproductive structure of sporophyte, Development of gametophyte and Embryogeny in : 3.1. *Cycas* , 3.2. *Pinus* and 3.3. *Gnetum* .
4. *Fossil gymnosperms* :
   Structural features and Geological distribution of reconstructed genera: 4.1. *Lyginopteris*, 4.2. *Williamsonia*, 4.3. *Cordaites.*
5. *Economic Importance* with reference to Wood, Resins, Essential oils, and Drugs.

1. *Preliminary idea on* :
   1.1. Habitat and Niche, 1.2. Ecotone and edge–effect, 1.3. Microclimate, 1.4. Ecads, ecotype and ecoclines, 1.5. Carrying capacity.
2. *Community ecology* :
   2.1. Community- Characteristics and diversity, 2.2. Ecological succession –Primary and secondary, Seral stages (with reference to Hydrosere), autogenic and allogenic succession.
3. 3.1. Plant indicators (metallophytes); 3.2. Phytoremediation.
4. *Conservation of Biodiversity*:

4.1. Level of Biodiversity: genetic, species & ecosystem diversity, 4.2. Biodiversity hot spots- criteria, Indian hotspots, 4.3. *In- situ and ex-situ* conservation, 4.4. Seed-banks, 4.5. Cryopreservation, 4.6. Geographic Information System and Remote Sensing (brief idea).

5. *Phytogeographical regions* :

5.1. Phytogeographical regions of India (Chatterjee 1960); 5.2. Dominant flora of Eastern Himalaya, Western Himalaya and Sunderban.

6. *Endemism* :

6.1. Endemic types and Factors; 6.2. Age & Area hypothesis and Epibiotic theory; 6.3. Endemism in Indian flora.

ANATOMY 25 Marks (20 Periods)

1. *Cell wall:*

1.1. Ultrastructure & Chemical constituents, 1.2. Plasmodesmata- ultrastructure, 1.3. Concept of Apoplast and Symplast, 1.4. Growth and Thickening of cell wall.

2. *Stomata* :

2.1. Types (Metcalfe and Chalk, Stebbins and Khush) , 2.2. Ontogeny.

3. *Ontogeny of* 3.1. Trachea and 3.2. Sieve-tube.

4. *Stele* :

4.1 Leaf-trace and leaf-gap, 4.2. Stelar types & evolution

5. *Secondary growth:*

5.1. Normal (intra- & extra-stelar), 5.2. Anomalous (stem of *Bignonia*, *Boerhavia*, *Tecoma*, *Dracaena* and root of *Tinospora*).

6. *Mechanical tissues* and the Pinciples governing their distribution in plants.

7. *Developmental Anatomy* :

7.1. Organisation of shoot apex (Tunica–Corpus) and Root apex (Korper-Kappe), 7.2. Plastochrone.

8. *Ecological Anatomy*:

Adaptive anatomical features of 8.1. Hydrophytes , 8.2. Xerophytes .

PAPER IVA (THEORETICAL): 50 MARKS : 2 HOURS

Morphology of Angiosperms	10 Marks (8 Periods)
Taxonomy of Angiosperms	40 Marks (32 Periods)

PAPER IVA (THEORETICAL)

MORPHOLOGY OF ANGIOSPERMS 10 Marks (8 Periods)

1. *Inflorescence* types with examples.
2. *Flower* : Corolla- forms, aestivation; Stamen- types; Placentation-types; Ovule - structure and forms.
3. *Fruit* - types with examples.

TAXONOMY OF ANGIOSPERMS 40 Marks (32 Periods)

1. *Introduction* :

1.1. Components of Systematics: Nomenclature, Identification, Classification; 1.2. Taxonomy and its phases - Pioneer, Consolidation , Biosystematic and Encyclopaedic ; alpha- and omega- taxomony .

2. *Nomenclature* :

Elementary knowledge of ICBN: Principles; Rank of taxa, Retention and rejection of names; Type method; Principle of priority; Effective and valid publication; Author Citation.

3. *Systems of classification :*

Broad outline of Bentham & Hooker (1862-1883), Cronquist's (1988) system of classification with merits and demerits

4. *Systematics in Practice* :

4.1. Herbaria and Botanical Gardens – their role; important Indian Herbaria and Botanical Gardens; 4.2. Dichotomous keys – indented and bracketed.

5. *Phenetics and Cladistics* :
Brief idea on Phenetics, Numerical taxonomy; Cladistics; Monophyletic, polyphyletic and paraphyletic groups; Plesiomorphy and apomorphy.

6. *Data sources in Taxonomy:*
Supportive evidences from : 6.1. Phytochemistry, 6.2. Cytology, 6.3. Anatomy.

7. Diagnostic features, Systematic position (Bentham & Hooker and Cronquist), Economically important plants (parts used and uses) of the following families:

7.1. **Dicotyledons** : Magnoliaceae, Malvaceae, Leguminosae (subfamilies), Euphorbiaceae, Umbelliferae (Apiaceae), Solanaceae, Scrophulariaceae, Acanthaceae, Labiatae (Lamiaceae), Cucurbitaceae, Rubiaceae, Compositae (Asteraceae).

7.2. **Monocotyledons**: Alismataceae, Palmae (Arecaceae), Gramineae (Poaceae), Liliaceae, Zingiberaceae, Orchidaceae.

PAPER IVB (PRACTICAL) : 50 MARKS : 4 HOURS

1. Workout on Pteridophytes	8 Marks
2. Workout on Angiosperms	12 Marks
3. Spot Identification [4x 1.5]	6 Marks
4. Identification with reasons (4 x 2) = (Pteridophyte - 1, Gymnosperms - 2, Palaeobotany/Palynology–1,)	8 Marks
5. Laboratory Records	5 Marks
6. Field Records (Field note book–3, Herbarium specimens–3)	6 Marks
7. Viva	5 Marks

PAPER IVB (PRACTICAL)

PTERIDOPHYTES

1. Morphological study of the sporophytic plant body: Genera as mentioned in the theoretical syllabus and *Lycopodium, Ophioglossum, Marsilea* and *Pteris.*
2. Workout of the reproductive structures : *Selaginella* , *Equisetum* , *Pteris*.
3. Study from permanent slides : *Psilotum* (T.S. of synangium), *Lycopodium* (L.S. of strobilus),*Ophioglossum* (L.S. of spike), *Dryopteris* (gametophyte), *Marsilea* (L.S. of sporocarp)

ANGIOSPERMS

1. Study of types of inflorescence, flower and fruit with labeled skectches.
2. Work out, description, preparation of floral formula and floral diagram, identification up to genus with the help of suitable literature of wild plants from the following families: Malvaceae, Fabaceae (Papilionaceae), Solanaceae, Scrophulariaceae, Acanthaceae, Labiatae (Lamiaceae), Rubiaceae.
3. Spot identification (Binomial, Family) of plants from families included in the theoretical syllabus.

FIELD WORK

1. At least four excursions including one long excursion to a specialized phytogeographical zone of India and one to Acharya Jagadish Chandra Bose Indian Botanic Garden (Shibpur, Howrah) and Central National Herbarium (CNH).
2. Study of community structure by quadrat method and determination of (i) Minimal size of the quadrat, (ii) Frequency, density and abundance of components (to be done during excursion).

FIELD RECORDS

1. Field Note Book (authenticated) with ecological notes on the plants of the area of excursion and voucher specimen book.
2. Herbarium specimen: Preparation of 25 angiospermic specimens (identified with author citation, voucher number and arranged following Bentham & Hooker's system of classification) to be submitted in the University Examination.

GYMNOSPERMS

1. Morphological study: *Cycas* (microsporophyll and megasporophyll), *Pinus* (female and male cone), *Gnetum* (female and male cone).
2. Study from permanent slides: *Cycas* (L.S. of ovule), *Pinus* (L.S. of male and female cone), *Ginkgo* (L.S.of female strobilus), *Gnetum* (L.S. of male cone and ovule).

PALAEOBOTANY AND PALYNOLOGY

1. Morphological study : *Ptilophyllum* and *Glossopteris* leaf fossils.
2. Study from permanent slides : T.S. of stem of *Rhynia,Lepidodendron, Calamites, Lyginopteris, Cordaites.*
3. Study of Pollen types (colpate,porate and colporate) from permanent slides. Slides may be prepared from specimens: Colpate (*Leonurus sibiricus/ Brassica* sp.), Porate (*Hibiscus rosa-sinensis*), Colporate (*Cassia sophera/ C.tora*).

LABORATORY RECORDS

1. Laboratory Note Book of each section must be signed by the respective teacher with date during practical classes.
2. Slides (prepared during practical classes).

PART III : 400 MARKS

(THEORETICAL -200 and PRACTICAL – 200)

PAPER V (THEORETICAL): 100 MARKS : 4 HOURS

Biochemistry	35 Marks (28 Periods)
Pharmacognosy	15 Marks (12 Periods)
Plant Physiology	50 Marks (40 Periods)

PAPER V (THEORETICAL)

BIOCHEMISTRY 35 Marks (28 Periods)

1. *Biochemical Foundations* :
   1.1. Covalent and non-covalent bonds ; hydrogen bond ; Van der Waal's forces ; 1.2. Structure and properties of water ; 1.3. pH and buffer (inorganic and organic); 1.4. Handerson-Hasselbalch equation; 1.5. Isoelectric point.
2. *Molecules of life :*
   2.1. Nucleic Acids – structure of nucleosides and nucleotides ; oligo- and poly nucleotides , B & Z form of DNA, RNA- different forms; nucleotide derivatives (ATP, NADP), 2.2. Proteins – structure and classification of amino acids; primary, secondary, tertiary and quaternary structure of proteins; 2.3. Carbohydrates - structure of mono-, di- and polysaccharide; stereoisomers, enantiomers and epimers; 2.4. Lipids - structure of simple lipid and compound lipid (phospholipids and glycolipids), fatty acids- saturated and unsaturated.
3. *Energy flow and enzymology* :
   3.1. Bioenergetics-Thermodynamic principles; free energy; energy rich bonds- phosphoryl group transfer and ATP; redox potentials and Biological redox reactions, 3.2. Enzymes – classification and nomenclature (IUBMB); Co-factors and co-enzymes; isozymes, 3.3. Mechanism of enzyme action; enzyme inhibition; 3.4. Enzyme kinetics (Michaelis-Menten equation) and simple problems.
4. *Cell membrane and Biosignalling* :
   4.1. Membrane chemistry, 4.2. Membrane transport (uniport, symport, antiport), mechanism of ion uptake 4.3. Signal transduction pathway and second messenger concept - G-protein and Ca^{2+} as messenger.
5. *Phosphorylation :* ATP Synthesis- Chemiosmotic model, Oxidative and Photophosphorylation- Mechanism and differences.

PHARMACOGNOSY 15 Marks (12 Periods)

1. *General account* :
   1.1 Pharmacognosy and its importance in modern medicine , 1.2 Crude drugs, 1.3 Classification of drugs- chemical and pharmacological , 1.4 Drug evaluation – organoleptic , microscopic, chemical, physical and biological.
2. *Secondary metabolites* :
   2.1 Definition of secondary metabolites and difference with primary metabolites , 2.2 Interrelationship of basic metabolic pathways with secondary metabolite biosynthesis (outlines only), 2.3 Major types–terpenoids, phenolics, flavonoids, alkaloids and their protective action against pathogenic microbes and herbivores.
3. *Pharmacologically active constituents :*
   Source plants (one example) parts used and uses of : 3.1 Steroids (Diosgenin, Digitoxin), 3.2 Tannin (Catechin), 3.3 Resins (Gingerol, Curcuminoids), 3.4 Alkaloids (Quinine, Strychnine, Reserpine, Vinblastine).

PLANT PHYSIOLOGY 50 Marks (40 Periods)

1. *Plant-water relations*:
   1.1 Concept of water potential , components of water potential in plant system , 1.2 Soil-plant-Atmosphere continuum concept, Cavitation in xylem and embolism, 1.3 Stomatal physiology-mechanism of opening and closing, Role of carbon di-oxide, potassium ion, abscisic acid and blue light in stomatal movement, Antitranspirants.
2. *Organic Translocation* :
   2.1 Phloem sap, P-protein, 2.2 Phloem loading and unloading, 2.3 Mass-flow (pressure flow) hypothesis and its critical evaluation.
3. *Photosynthesis* :
   3.1 Chemical structure of chlorophyll a and b , absorption and action spectra, biological significance of carotenoid pigments, 3.2 Red drop and Emerson effect, Components of photosystems (light harvesting complex), Photochemical

reaction centres, Cyclic and noncyclic electron transport, Water splitting mechanism, 3.3 Calvin cycle – Biochemical reactions & stoichiometry, 3.4 HSK Pathway– three variants of the pathway, 3.5. Photosynthetic efficiency of C_3 and C_4 plants and crop productivity, 3.6. Photorespiration – mechanism and significance, 3.7 Crassulacean acid metabolism – mechanism and ecological significance.

4. *Respiration* :
   4.1 EMP pathway, regulation and its anabolic role , 4.2 Conversion of Pyruvic acid to Acetyl CoA, 4.3 TCA-cycle and its amphibolic role ,4.4. Oxidative pentose phosphate pathway and its significance, 4.5 ß-oxidation of fatty acids and significance, 4.6 Mitochondrial electron transport system, uncouplers, 4.7 Oxidation of cytosolic $NADH+H^+$ 4.8 Stoichiometry of glucose oxidation (aerobic).
5. *Nitrogen Metabolism* :
   5.1 Assimilation of nitrate by plants, 5.2 Biochemistry of dinitrogen fixation in *Rhizobium,* 5.3. General principle of amino acid biosynthesis (including GS and GOGAT enzyme system).
6. *Plant Growth Regulators* :
   6.1. Physiological roles of Auxin, Gibberellin, Cytokinin, Abscisic acid, Ethylene, 6.2 Chemical nature –IAA, GA_3, Kinetin, 6.3. Biosynthesis and bioassay of IAA, 6.4 Mode of action of IAA, 6.5 Brassinosteroids and Polyamines as PGRs (brief idea).
7. *Photomorphogenesis* :
   7.1 Concept of photomorphogenesis, 7.2 Photoperiodism and plant types, 7.3 Perception of photoperiodic stimulus, 7.4 Critical day length, concept of light monitoring, 7.5 Phytochrome – chemical nature, interconversion, function in flowering, 7.6 Role of GA in flowering, 7.7 Vernalisation – role of low temperature in flowering, 7.8 Concept of biological clock and biorhythm .
8. *Seed dormancy* : 8.1 Types; Causes and Methods of breaking seed dormancy, 8.2 Biochemistry of seed germination.
9. Physiology of Senescence and Ageing.
10. *Stress Physiology*: Plant responses to: 9.1 Water stress, 9.2 Temperature stress, 9.3 Salt stress

PAPER VI (THEORETICAL) : 100 MARKS : 4 HOURS

Cell Biology	20 Marks (16 Periods)
Plant Breeding & Biometry	15 Marks (12 Periods)
Plant Biotechnology	15 Marks (12 Periods)
Genetics & Molecular Biology	50 Marks (40 Periods)

PAPER VI (THEORETICAL)

CELL BIOLOGY — 20 Marks (16 Periods)

1. *Origin and Evolution of Cells :*
   1.1. Concept of RNA world, Ribozymes, First cell, 1.2. Origin of eukaryotic cell, 1.3. Organellar DNA (cp-and mt-DNA).
2. *Nucleus and Chromosome :*
   2.1. Nuclear envelope, Nuclear lamina and Nuclear pore complex, 3.2. Nucleolus-ultrastructure and ribosome biogenesis, 3.3. Chromatin ultrastructure and DNA packaging in eukaryotic chromosome, 3.4. Karyotype concept and its parameters.
3. *Cell cycle and its regulation :*
   3.1. Centromere, kinetochore, spindle apparatus & telomere–structural organization and functions, 3.2. Dynamics of chromosome movement in anaphase, 3.3. Mechanism of cell cycle control in Yeast (checkpoints and role of MPF), Apoptosis (Brief idea).

PLANT BREEDING & BIOMETRY — 15 Marks (12 Periods)

1. *Plant Breeding:*

1.1 Maintenance of germplasm, 1.2 Mass selection and Pure line selection, 1.3 Back cross method,1.4. Heterosis and hybrid seed production, 1.5. Male sterility and its use in plant breeding, 1.6 Molecular Breeding (use of DNA markers in plant breeding).

2. *Biometry:*
   2.1 Random sampling, Feqeuency distribution, 2.2. Central tendency– Arithmetic Mean, Mode and Median, 2.3.Measurement of dispersion – Standard Deviation, Standard error of Mean, 2.4. Test of significance: ‘t’- test; chi-square test for goodness of fit, 2.5 Probability (Addition and Multiplication rules),2.6 Measurement of gene frequency (Hardy-Weinberg equilibrium).

PLANT BIOTECHNOLOGY 15 Marks (12 Periods)

1. *Plant tissue culture –Introduction:*
   1.1. Cellular totipotency, 1.2. Tissue culture media, 1.3. Aseptic manipulation.
2. *Callus culture* :
   2.1. Callus initiation, growth and maintenance, 2.2. Applications.
3. *Micropropagation* :
   3.1. Organogenesis (direct and indirect), 3.2. Somatic embryogenesis, Artificial seed, 3.3. Significance.
4. *Haploid Culture* :
   4.1. Anther and Pollen culture methods, 4.2. Significance .
5. *Protoplast Culture* :
   5.1. Protoplast isolation and culture, 5.2. Protoplast fusion (somatic hybridization), 5.3. Significance.
6. *Plant Genetic Engineering* :
   6.1. Brief concept of different gene transfer methods, special emphasis on *Agrobacterium* mediated gene transfer, Role of Reporter gene, 6.2. Achievements in crop biotechnology (suitable examples of transgenic plants).

GENETICS & MOLECULAR BIOLOGY **5**0 Marks (40 Periods)

1. *Linkage, Crossing over and Gene Mapping :*
   1.1. Complete and incomplete linkage, linkage group, 1.2 Detection of crossing over (McClintock’s experiment), 1.3 Molecular mechanism of crossing over (Holliday model), 1.4 Gene mapping (three point test cross), 1.5 Co-efficient of coincidence and interference, Mapping function, 1.6 Problems on gene mapping, 1.7 Molecular mapping – ISH, FISH (brief idea).
2. *Epistasis and Polygenic inheritance* in plants.
3. *Aneuploidy and Polyploidy*: Types, examples, meiotic behaviour and importance of: 3.1 Aneuploidy, 3.2 Polyploidy.
4. *Chromosomal aberration*: Types and meiotic behaviour of: 4.1 Deletion, 4.2 Duplication, 4.3 Translocation, 4.4 Inversion.
5. *Mutation :*
   5.1 Point mutation-Transition, Transversion and Frame shift mutation, 5.2 Molecular mechanism (tautomerisation, alkylation, deamination, base analogue incorporation, dimerisation), 5.3 DNA repair (brief idea).
6. *Structural organisation of Gene* :
   6.1 One Gene–one polypeptide concept, 6.2 Complementation test (rII locus), 6.3 Split gene, 6.4 Overlapping gene, 6.5 Repetitive DNA-tandem and interspersed, 6.6 Transposon (*Ac-Ds* system), 6.7 Homoeotic gene in plants (ABC model in *Arabidopsis*).
7. *DNA Replication, Transcription and Translation (Prokaryotes & Eukaryotes):*
   7.1 Central Dogma, 7.2 Semiconservative replication – mechanism, 7.3 Transcription, 7.4 RNA processing, 7.5 Aminoacylation of tRNA, 7.6 Translation.
8. *Gene Regulation* :
   8.1 Concept of *Lac*-operon, 8.2 Positive and negative control.
9. *Genetic Code* :
   9.1 Properties-evidences & exceptions, 9.2 Decipherence of codon (Binding technique) .
10. *Recombinant DNA Technology:* 10.1 Enzyme (Restriction endonuclease, ligase), 10.2 Vector (plasmid pBR 322) 10.3 Marker gene, 10.4. Steps of cloning technique, 10.5 PCR and its application 10.6 Genomic DNA and cDNA library.
11. *Bioinformatics* : Brief concept on 11.1 Genomics, 11.2 Proteomics.

PAPER VII **(PRACTICAL):100 MARKS : 6 HOURS**

1. Plant Biochemistry (Quantitative & Qualitative)(20+10)= 30 Marks

2. Plant Physiology	25 Marks
3. Anatomy	10 Marks
4. Pharmacognosy	10 Marks
5. Identification (Anatomy-2x2.5)	5 Marks
7. Laboratory Records (Laboratory note books-8 & Slides-2)	10 Marks
8. Viva	10 Marks

PAPER VII (PRACTICAL)

PLANT BIOCHEMISTRY

Qualitative :

1. Detection of organic acids: citric , tartaric, oxalic and malic from laboratory samples.
2. Detection of carbohydrate and protein from plant samples.
3. Detection of the nature of carbohydrate – glucose, fructose , sucrose and starch from laboratory samples.
4. Detection of Ca, Mg, Fe, S from plant ash sample.

Quantitative :

1.Estimation of amino-nitrogen by formol titration method (glycine) .
2. Estimation of glucose by Benedicts quantitative reagent.
3. Estimation of titratable acidity from lemon.
4. Estimation of catalase activity in plant samples.
5. Estimation of urease activity in plant samples.
6. Colorimetric estimation of protein by Folin phenol reagent.

PLANT PHYSIOLOGY

1. Determination of loss of water per stoma per hour.
2. Relationship between transpiration and evaporation.
3. Rate of photosynthesis under varying HCO^-_3 concentration in an aquatic plant using bicarbonate and to find out the optimum and toxic concentration .
4. Separation of plastidial pigments.
5. Measurement of oxygen uptake by respiring tissue (per g/hr.)
6. Determination of the RQ of germinating seeds.
7. Measurement of osmotic pressure of storage tissue by weighing method.
8. Measurement of osmotic pressure of *Rhoeo* leaf by plasmolytic method.
9. Effect of temperature on absorption of water by storage tissue and determination of Q_{10}.
10. Comparison of imbibitions of water by starchy, proteinaceous and fatty seeds.

ANATOMY

1. Microscopic studies on: Types of stomata, sclereids, raphides (*Colocasia*), cystolith (*Ficus* leaf) starch grains, aleurone grains, laticiferous ducts, oil glands.
2. Study of anomalous secondary structure in stem of *Bignonia, Boerhaavia, Tecoma, Dracaena* and root of *Tinospora*
3. Study of adaptive anatomical features : Hydrophytes (*Nymphaea* – petiole) and Xerophytes (*Nerium* – leaf).

PHARMACOGNOSY

1. Chemical tests for (a) Tannin (*Camellia sinensis / Terminalia chebula*), (b) Alkaloid (*Catharanthus roseus)* .
2. Powder microscopy – *Zingiber* and *Holarrhena* .
3. Histochemical tests of (a) Curcumin (C*urcuma longa*) , (b) Starch in non-lignified vessel (*Zingiber*), (c) Alkaloid (stem of *Catharanthus* and bark of *Holarrhena*).

LABORATORY RECORDS

1. Laboratory Note Book of each section must be signed by the respective teacher with date during practical classes.
2. Slides (permanent) prepared during practical classes.

PAPER VIII (PRACTICAL) : 100 MARKS : 6 HOURS

1. Cell Biology and Genetics	**(20+10) =**	**30 Marks**
2. Biometry		**13 Marks**
3. Microbiology		**12 Marks**
4. Plant Pathology		**10 Marks**
5. Identification (Cell Biology - 4, Pathology - 2)	**(2.5X6) =**	**15 Marks**
6. Laboratory Records (Laboratory note books-8, Slides-3)		**10 Marks**
7. Viva		**10 Marks**

PAPER VIII (PRACTICAL)

CELL BIOLOGY AND GENETICS

1. *Introduction to chromosome preparation:* Pre-treatment, Fixation, Staining, Squash and Smear preparation, Preparation of permanent slides.
2. *Determination of mitotic index* and frequency of different mitotic stages in pre-fixed root tips of *Allium cepa*.
3. *Study of mitotic chromosome* : Metaphase chromosome preparation , free hand drawing under high power objective, drawing with drawing prism under oil immersion lens, determination of 2n number, comment on chromosome morphology of the following specimens from root tips: *Allium cepa , Aloe vera , Lens esculenta.*
4. *Study of meiotic chromosome:* Smear preparation of meiotic cells, identification of different stages and free hand drawing of the following specimens from flower buds: *Allium cepa* and *Setcreasea* sp.
5. *Identification from permanent slides* : Meiosis – (i) normal stages (ii) abnormal stages – laggard, anaphase bridge, ring chromosome (*Rhoeo discolor*); Mitosis –(i) normal stages, (ii) abnormal stages- early separation, late separation, multipolarity , sticky bridge, fragmentation, (ii) pollen mitosis.

BIOMETRY

1. Determination of goodness of fit in normal and modified mono-and dihybrid ratios (3:1, 1:1, 9:7, 13:3, 15:1, 9:3:3:1, 1:1:1:1) by Chi-square analysis and comment on the nature of inheritance .
2. Univeriate analysis of statistical data : Statistical tables , mean , mode , median , standard deviation and standard error (using seedling population / leaflet size).

MICROBIOLOGY

1. Preparation of bacterial media – (a) Nutrient agar and nutrient broth, (b) Preparation of slants and pouring Petri-plates.
2. Sub-culturing of bacterial culture.
3. Gram staining from bacterial culture.
4. Microscopic examination of bacteria from natural habitat(curd) by simple staining.

PLANT PATHOLOGY

1. Preparation of fungal media (PDA).
2. Sterilization process.
3. Isolation of pathogen from diseased leaf.
4. Inoculation of fruit and subculturing.
5. Identification : Pathological specimens of Brown spot of rice, Bacterial blight of rice ,Loose smut of wheat, Stem rot of jute, Late blight of potato; Slides of uredial, telial, pycnial & aecial stages of *Puccinia graminis.*

LABORATORY RECORDS

1. Laboratory Note Book of each section must be signed by the respective teacher with date during practical classes.
2. Slides (permanent) prepared during practical classes.

QUESTION PATTERN OF BOTANY (Honours), C.U.

A-Type-Objective type question each of 1 or 2 marks, no optional question.
B-Type-Short note/ short answer type question each of 5 marks; no part marking.
C-Type-Long answer type question each of 15 marks may be split into 2 to 4 relevant parts, avoiding the pattern of A and B type questions.

Paper-I

Module I (50 Marks).

Q.1. 'A' Type Questions- 10 marks
Algae-(2x2) + (1x1) = 5
Microbiology-(2x2) + (1x1) = 5

Q.2.'B' Type Questions-10 marks
(a). Algae- (one out of two) - 5x1= 5
(b). Microbiology – (one out of two) - 5x1= 5

Q.3. 'C' Type Questions-30 marks
(a). Algae- (one out of two) - 15x1= 15
(b). Microbiology – (one out of two) - 15x1= 15

Module II (50 Marks)

Q.1. 'A' Type Questions- 10 marks
Fungi & Lichen-(2x2) + (1x1) = 5
Plant Pathology-(2x2) + (1x1) = 5

Q.2.'B' Type Questions-10 marks
(a). Fungi & Lichen - (one out of two) - 5x1= 5
(b). Plant Pathology – (one out of two) - 5x1= 5

Q.3. 'C' Type Questions-30 marks
(a). Fungi & Lichen - (one out of two) - 15x1= 15
(b). Plant Pathology – (one out of two) - 15x1= 15

Paper-IIA

Module III (50 Marks)

Q.1. 'A' Type Questions- 10 marks
Bryophyte-(2x2) + (1x1) = 5
Paleobotany & Palynology-(2x2) + (1x1) = 5

Q.2. Bryophyte- C Type-15 Marks
Or
B Type-5x3= 15 Marks

Q.3. Paleobotany & Palynology - C Type-15 Marks
Or
B Type-5x3=15 Marks

Q.4. Embryology - B Type (Two to be answered out of 4) 5x2=10 Marks

Paper-IIB

Module IV (Practical)

Paper-III

Module V (50 Marks)

Q.1. 'A' Type Questions- 10 marks
Pteridophytes-(2x2) + (1x1) = 5
Gymnosperms-(2x2) + (1x1) = 5

Q.2.'B' Type Questions-10 marks
(a). Pteridophytes- (one out of two) - 5x1= 5
(b). Gymnosperms- – (one out of two) - 5x1= 5

Q.3. 'C' Type Questions-30 marks
(a).Pteridophytes - (one out of two) - 15x1= 15
(b). Gymnosperms – (one out of two) - 15x1= 15

Module VI (50 Marks)

Q.1. 'A' Type Questions- 10 marks
Ecology & Plant Geography-(2x2) + (1x1) = 5
Anatomy-(2x2) + (1x1) = 5

Q.2.'B' Type Questions-10 marks
(a). Ecology & Plant Geography - (one out of two) - 5x1= 5
(b). Anatomy - (one out of two) - 5x1= 5

Q.3. 'C' Type Questions-30 marks
(a). Ecology & Plant Geography - (one out of two) - 15x1= 15
(b). Anatomy – (one out of two) - 15x1= 15

Paper-IVA

Module VII

Q.1. 'A' Type Questions- 10 marks
Angiosperms-(2x4)+(1x2)=10

Q.2. Morphology of Angiosperms
Type B-(Two to be answered out of four) =5x2=10 marks

Q.3. Taxonomy of Angiosperms
Type C--(One to be answered out of two) =15 marks

Q.4. Angiosperms
Type C--(15 marks)
Or
Type B--(5x3=15 marks)

Paper-IVB

Module VIII (Practical)

Paper-V

Module IX (50 Marks)

1. 'A' Type
Biochemistry-(2x4) +(1x2) =10 marks

2. Biochemistry-'B' Type
(Two to be answered out of four)-5x2=10 marks

3. Biochemistry-'C' Type
(One to be answered out of two)-15x1=15 marks

4. Pharmacognosy
C Type-15 marks
Or
B Type-5x3=15 marks

Module X (50 Marks)

1. 'A' Type
Physiology-(2x4) +(1x2)=10 marks

2. 'B' Type (Physiology)
(Two to be answered out of four)-5x2=10 marks

3. 'C' Type (Physiology)
(Two to be answered out of four)-15x2=30 marks

Paper-VI

Module XI (50 Marks)

1.'A' Type Questions- 10 marks
Cell Biology-(2x2) + (1x1) = 5.
Plant Breeding & Biometry-(2x2) + (1x1) = 5.

2. Cell Biology
'C' Type-15 x 1=15 marks
Or
'B' Type-5x3=15 marks

3. Plant Breeding & Biometry
'B' Type (Two out of four)-5x2=10 marks

4. Plant Biotechnology
'C' Type-15 x 1=15 marks
Or
'B' Type-5x3=15 marks

Module XII (50 Marks)

1. 'A' Type Questions- 10 marks
Genetics & Molecular Biology (2x4)+(1x2)=10
2. 'B' Type -10 Marks
(Two out of four)-5x2=10
3. 'C' Type-30 Marks
(Two out of four)-15x2=30

Suggested Readings

Same as 2006

UNIVERSITY OF CALCUTTA

SYLLABUS

FOR

THREE-YEAR B.Sc. GENERAL COURSE

UNDER 1+1+1 SYSTEM

OF EXAMINATION

BOTANY 2010

Syllabus for three-year B.Sc. Botany General Course
(With effect from 2010-2011)

PART-I : Full Marks-100

Paper-I (Theoretical) **Marks-100**

Module I: [50 marks]

Microbiology, Algae, Fungi, Plant Pathology, Bryophytes.

Module II: [50 marks]

Pteridophytes, Gymnosperms, Palaeobotany & Palynology, Angiosperms (Morphology & Embryology), Taxonomy.

PART II : Full Marks-200
(Theoretical-100 & Practical-100)

Paper-II (Theoretical) **Marks-100**

Module III: 50 Marks

Anatomy, Cell Biology and Genetics.

Module IV: 50 marks

Biochemistry and Plant Physiology, Economic Botany, Ecology.

PAPER-III (Practical) **Full Marks-100**

(Each module to be conducted on separate days)

Module V **4 Hours: Marks 50**

1. Work out on Algae/Fungi (anyone) 9
2. Work out on Angiosperms 12
3. Identification: (2 x 7) 14
   Algae/Fungi-1, Bryophyte-1, Pteridophyte-1, Gymnosperm-1, Morphology-1, Taxonomy-2 (species and family).
4. Submission: Laboratory records (laboratory note-book, slides) and Field records (field note book, herbarium sheets). (5+5) = 10
5. Viva-voce 5

Module VI **4 Hours: Marks 50**

1. Plant Physiology Experiment	12
2. Anatomy	12
3. Cell Biology	10
4. Identification: (3x2) Anatomy-1, Cytology-1	6
5. Submission: Laboratory records	5
5. Viva-voce	5

PART III : Full Marks-100
(Theoretical-70 & Practical-30)

Paper-IVA (Theoretical) **3 Hours: Marks 70**

Module VII **Marks- 70**

Biofertilizer, Mushroom, Plant Disease Control, Plant Breeding, Biometry, Plant Tissue Culture, Recombinant DNA Technology, Pharmacognosy

PAPER – IVB (Practical) **Marks-30**

Module VIII **3 Hours: Marks-30**

1. Microbiology	5
2. Biometry	8
3. Demonstration of a laboratory instrument	4
4. Identification of medicinal plants (2 x 2)	4
5. Submission (Laboratory note book & Field report)	4
6. Viva-voce	5

Syllabus for three-year B.Sc. Botany General Course
(With effect from 2010-2011)

PART-I

Full Marks-100

Paper-I (Theoretical) **Marks-100**

Module I: [50 marks]

Microbiology, Algae, Fungi, Plant Pathology, Bryophytes.

Module II: [50 marks]

Pteridophytes, Gymnosperms, Palaeobotany & Palynology, Angiosperms (Morphology & Embryology), Taxonomy.

Module I: 50 Marks

1. **Domains of life:** Archaea, Bacteria and Eukarya.
2. **Microbiology:**
   2.1 Plant virus - general characteristics, 2.2 Transmission and Translocation of plant virus, 2.3 Lytic cycle (T4 phase) and Lysogenic cycle (Lambda phage), 2.4 Chemical nature of cell wall of Gram positive and Gram negative bacteria, 2.5 Genetic recombination in bacteria (Conjugation, Transformation, Transduction), 2.6 Industrial uses of bacteria.
3. **Algae:**
   3.1. Diagnostic characters and examples of Cyanophyceae, Rhodophyceae, Chlorophyceae, Charophyceae and Phaeophyceae (Lee 1999), 3.2 Life histories of *Chara* and *Ectocarpus*, 3.3 Economic importance.
4. **Fungi:**
   4.1 Diagnostic characters and examples of Oomycotina, Mastigomycotina, Zygomycotina, Ascomycotina Basidiomycotina, Deuteromycotina (Ainsworth, 1973). 4.2 Life histories of *Rhizopus* and *Ascobolus*: 4.3. Economic importance of fungi, 4.4 Fungal symbioses: Mycorrhiza, Lichen and their importance.
5. **Plant Pathology** :
   5.1 Symptoms - necrotic, hypoplastic and hyperplastic, 5.2 Koch's postulates, 5.3 Biotrophs and Necrotrophs, 5.4 Disease triangle, 5.5 Pathotoxins and phytoalexins (brief concept), 5.6 Symptoms, causal organism, disease cycle and control measures of plant diseases (Late blight of potato, Black steam rust of wheat).
6. **Bryophytes:**
   6.1 Amphibian nature, 6.2 Diagnostic characters and examples of Hepaticopsida, Anthocerotopsida and Bryopsida (Proskauer 1957), 6.3 Life histories of *Marchantia* and *Funaria*. 6.4 Ecological importance.

Module II: 50 Marks

7. **Pteridophytes:**
   7.1 Diagnostic characters and examples of Psilophyta, Lycophyta, Sphenophyta & Filicophyta (Gifford & Foster 1989), 7.2 Life histories of *Selaginella* and *Dryopteris. 7*.3 Economic importance.
8. **Gymnosperms:**
   8.1 Progymnosperms (brief idea), 8.2 Diagnostic characters and examples of Cycadophyta, Coniferophyta and Gnetophyta (Gifford & Foster 1989), 8.3 Life histories of *Cycas* and *Pinus.* 8.4 Economic importance of Gymnosperms.
9. **Paleobotany & Palynology:**
   9.1 Importance of fossil study, 9.2 Modes of Preservation. 9.3 Geological time scale. 9.4 *Williamsonia* (Reconstructed), 9.5 Palynology - Definition, spore & pollen (brief idea), Applications.

10. **Angiosperm Morphology & Embryology:**
    10.1 Inflorescence types with examples, 10.2 Corolla forms, Aestivation, 10.3 Placentation types, 10.4 Sporogenesis & Gametogenesis, 10.5 Embryo development in *Capsella*, 10.6 Endosperm development.
11. **Taxonomy of Angiosperms :**
    11.1 Artificial, Natural and Phylogenetic systems of c1assificaiton, 11.2 Principles of ICBN, 11.3 Bentham and Hooker's system of classificaiton, 11.4 Phenetics- Brief concept. 11.5 Diagnostic features of following families- Malvaceae, Leguminosae (Fabaceae), Cucurbitaceae, Solanaceae, Labiatae (Lamiaceae), Acanthaceae, Rubiaceae, Compositae (Asteraceae), Gramineae (Poaceae), Orchidaceae.

PART II
Full Marks-200
(Theoretical-100 & Practical-100)

Paper-II (Theoretical) Marks-100

Module III: 50 Marks
Anatomy, Cell Biology and Genetics.

Module IV: 50 marks
Biochemistry and Plant Physiology, Economic Botany, Ecology.

Module III: 50 Marks

1. **Anatomy:**
   1.1 Stomata - Types (Metcalfe & Chalk), 1.2 Mechanical Tissues - Principle and distribution, 1.3 Stelar types and evolution, 1.4 Shoot apex (Tunica-Corpus) and Root apex

(Korper-Kappe), 1.5 Secondary growth – normal in dicot stem and anomaly in stem of *Tecoma* & *Dracaena.*

2. Cell Biology and Genetics:

2.1 Ultrastructure of nuclear envelope, nucleolus and their functions, 2.2 Molecular organisation of metaphase chromosome (Nucleosome concept), 2.3 Chromosomal aberrations-deletion, duplication, inversion & translocation, 2.4 Aneuploidy & Polyploidy-types, importance and role in evolution, 2.5 Central Dogma, 2.6 DNA replication -mechanism in prokaryote, 2.7 Transcription, Processing of mRNA and Translation, 2.8 Genetic Code-properties, 2.9 Epistasis, 2.10 Linkage group and Genetic map (three-point test cross), 2.11 Mutation - Point mutation (tautomerisation; transition, transversion and frame shift), Mutagen-physical and chemical, 2.12 Brief concept of Split gene, Transposons.

Module IV

Marks: 50

3. Biochemistry and Plant Physiology:

3.1 Proteins - Primary, secondary and tertiary structure, 3.2 Nucleic acid- DNA structure, RNA types, 3.3 Enzyme- Classifications with examples (IUBMB), Mechanism of action. 3.4 Transport in plants - ascent of sap and Xylem cavitation , Phloem transport and source-sink relation, 3.5 Transpiration- Mechanism of stomatal movement, significance 3.6 Photosynthesis-Pigments, Action spectra and Enhancement effect, Electron transport system and Photophosphorylation, C_3 and C_4 photosynthesis, CAM- Reaction and Significance 3.7 Respiration- Glycolysis & Krebs cycle— Reactions and Significance, ETS and oxidative phosphorylation 3.8 Nitrogen metabolism –Biological dinitrogen fixation, Amino acid synthesis (reductive amination and transamination) 3.9 Plant Growth regulators – Physiological roles of Auxin, Gibberellin, Cytokinin, Ethylene, ABA 3.10 Photoperiodism (Plant types, Role of phytochrome and GA in flowering) and Vernalization 3.11 Senescence (brief idea).

4. Economic Botany:

Study of the following economically important plants (scientific names, families, parts used and importance) : 4.1 Cereals-rice, wheat, 4.2 Pulses- mung, gram, 4.3 Spices - ginger, cumin, 4.4 Beverages - tea, coffee, 4.5 Medicinal Plants - cinchona, neem, ipecac, vasaka, 4.6 Oil yielding plants- mustard, groundnut, coconut, 4.7 Vegetables-potato, radish, bottlegourd, cabbage, 4.8 Fibre yielding plants-cotton, jute, 4.9 Timber yielding plants-teak, sal 4.10 Fruits- mango, apple, 4.11 Sugar yielding plant- sugarcane.

5. Ecology:

5.1 Ecotypes and microclimate, 5.2 Plant succession - stages of succession (hydrosere) 5.3 Ecological adaptation of hydrophytes, halophytes and xerophytes, 5.4 Biodiversity - Definition, levels of biodiversity (genetic, species and ecosystem), methods of *in-situ* & *ex-situ* conservation, 5.5 Phytoremediation (brief idea).

Paper-III (Practical)

Marks-100

Module V

50 Marks

1. **Cryptogams:** Work out, microscopic preparation, drawing and labeling, description and identification of the following cryptogams: *Chara*, *Ectocarpus*, *Rhizopus*, *Ascobolus.*
2. **Angiosperms:** Dissection, drawing and labeling, description of angiospermic plants and floral parts, floral formula and floral diagram, identificaiton (family) from the following families: Leguminosae (Fabaceae), Malvaceae, Solanaceae, Labiatae (Lamiaceae), Acanthaceae.
3. **Identificaiton with reasons:**
   Cryptogamic specimens (macroscopic/microscopic) as prescribed in the theoretical syllabus.
   Gymnosperms: Macroscopic - male and female strobilus of *Cycas*, and *Pinus*
   Anatomical slides (stelar types, transfusion tissue, sieve tube, sunken stomata, lenticel**).**
   Morphology: Inflorescence types.
4. **Spot identification (Scientific names and families) of the following Angiospermic plants:** *Sida rhombifolia* (Malvaceae), *Abutilon indicum* (Malvaceae), *Thespesia populnea* (Malvaceae), *Cassia sophera* (Fabaceae), *Tephrosia hamiltonii* (Fabaceae), *Crotalaria pallida* (Fabaceae), *Leucaena leucocephala* (Fabaceae), *Coccinia grandis* (Cucurbitaceae), *Solanum sisymbriifolium* (Solanaceae),. *Nicotiana plumbaginifolia* (Solanaceae), *Physalis minima* (Solanaceae), *Leucas aspera* (Lamiaceae), *Leonurus sibiricus* (Lamiaceae), *Anisomeles indica* (Lamiaceae), *Parthenium hysterophorus* (Asteraceae), *Tridax procumbens* (Asteraceae), *Mikania scandens* (Asteraceae), *Eclipta prostrata* (Asteraceae), *Eragrostis tenella* (Poaceae), *Chrysopogon aciculatus* (Poaceae), *Eleusine indica* (Poaceae), *Vanda tasellata* (Orchidaceae).
5. **Laboratory Records:** Laboratory note books (regularly signed) and slides (prepared in class) are to be submitted at the time of Practical Examination.
6. **Field Excursion:** Local Excursions (at least two including one to Acharya Jagadish Chandra Bose Indian Botanic Garden, Shibpur, Howrah).
7. **Field Records:** Field note-book and 15 herbarium sheets of common angiospermic weeds are to be prepared and submitted at the time of Practical Examination.

Module VI

50 Marks

1. **Plant Physiology:**
   i) Experiment on Plasmolysis.
   ii) Measurement of leaf area (graphical method) and determination of transpiration rate per unit area by weighing method.
   iii) Imbibition of water by dry seeds - proteinaceous and fatty seeds.
   iv) Evolution of O_2 during photosynthesis (using graduated tube).
   v) Evolution of CO_2 during aerobic respiration and measurement of volume.
2. **Anatomy:** Anatomical studies (following double-staining method) of:
   i) Stem: *Cucurbita*, Maize.
   ii) Root: Gram, Orchid.
   iii) Leaf: *Nerium*, Tuberose.
3. **Cell Biology:**
   i) Staining (Aceto-orcein) and squash preparation of onion root tip: study of mitotic stages.
   ii) Determination of mitotic index (from onion root tip).
4. **Identificaiton with reasons:**
   i) Cytological slides of different mitotic and meiotic stages.
5. **Laboratory Records:** Laboratory note books (regularly signed) and slides (prepared in class) are to be submitted at the time of Practical Examination.

DISTRIBUTION OF MARKS (PAPER-III)

Time : 6 Hours **Full Marks-l00**

Module V — 50 Marks

6.Work out on Algae/Fungi (anyone)	9
7. Work out on Angiosperms	12
8. Identification: (2 x 7) Algae/Fungi-1, Bryophyte-1, Pteridophyte-1, Gymnosperm-1, Morphology-1, Angiosperms-2 (species and family).	14
9. Submission: Laboratory records (laboratory note-book, slides) and Field records (field note book, herbarium sheets). (5+5) =	10
10.Viva-voce	5

Module VI — 50 Marks

6. Plant Physiology Experiment	12
7. Anatomy	12
8. Cell Biology	10
9. Identification: (3x2) Anatomy-1, Cytology-1	6
10.Submission: Laboratory records	5
5. Viva-voce	5

PART III
Full Marks-100
(Theoretical-70 & Practical-30)

Paper-IVA (Theoretical) — Marks-70

Module VII

1. **Biofertilizer:**
   1.1 Sources 1.2 Production, 1.3 Application.
2. **Mushroom:**
   2.1 Food value, 2.2 Cultivation technique of *Pleurotus*.
3. **Plant disease control:**
   3.1 Quarantine, 3.2 Biological control, 3.3 Chemical Control.
4. **Plant Breeding:**
   4.1 Mass and Pure line selection, 4.2 Heterosis and hybrid seed production.

5. **Biometry:**
   5.1 Measures of Central Tendency (Mean, Mode and Median), 5.2 Goodness of fit (Chi-square test).
6. **Plant tissue culture:**
   6.1 Callus culture and plant regeneration, 6.2 Micropropagation, 6.3 Somatic embryogenesis and Artificial seed, 6.4 Protoplast culture and applications.
7. **Recombinant DNA Technology:**
   7.1 Recombinant DNA, restriction enzymes, plasmids as vector, 7.2 Gene cloning (basic steps), 7.3 Transgenic plants.
8. **Pharmacognosy:**
   8.1 Scope and importance, 8.2 Secondary metabolites- alkaloids, terpenoids, phenolics and their functions, 8.3 Organoleptic evaluation of crude drugs.

Paper-IVB (Practical) 30 Marks

Module VIII

1. Acquaintance with laboratory instruments - Autoclave, Incubator, Clinical centrifuge, Analytical balance, pH Meter, Colorimeter, Water bath, Distillation plant.
2. Sterilization technique by autoclaving.
3. Preparation of PDA medium (slants, pouring of plates).
4. Bacteria staining by simple staining method (methylene blue/crystal violet) from curd.
5. Acquaintance with common medicinal plants and their useful parts : *Terminalia arjuna, Centella asiatica, Saraca asoca, Adhatoda vasica, Andrographis paniculata, Asteracantha longifolia, Eclipta alba, Aloe barbadensis, Rauvolfia serpentina, Vitex negundo, Herpestis monieria, Holarrhena antidysenterica, Boerhaavia repens.*
6. Determination of Goodness of fit of normal monohybrid ratios (3: I and I: 1) by Chi-square analysis.
7. Visit to a Medicinal Plant Garden.

DISTRIBUTION OF MARKS (PAPER - IVB)

Module VIII

Time : **3 Hours** **Full Marks-30**

7.	Microbiology	5
8.	Biometry	8
9.	Demonstration of a laboratory instrument	4
10.	Identification of medicinal plants (2 x 2)	4
11.	Submission (Laboratory note book & Field report)	4
12.	Viva-voce	5

QUESTION PATTERN OF BOTANY (GENERAL), C.U.

Type ('A', 'B', 'C') of questions of 1, 5, 10 marks each, respectively.

Paper-I

Module I (50)

Q.1. 'A' Type Questions- 10 marks
(10 to be answered out of 15) 1x10=10
(3 questions to be set from each group)

Q.2. 'B' Type Questions-10 marks
(2 to be answered out of 5) 5x2=10
(1 question to be set from each group)

Q.3. 'C' Type Questions-30 marks
(3 to be answered out of 5) 10x3=30
(1 question to be set from each group)

Module II (50)

Q.1. 'A' Type Questions- 10 marks
(10 to be answered out of 15) 1x10=10
(3 questions to be set from each group)

Q.2. 'B' Type Questions-10 marks
(2 to be answered out of 5) 5x2=10
(1 question to be set from each group)

Q.3. 'C' Type Questions-30 marks
(3 to be answered out of 5) 10x3=30
(1 question to be set from each group)

Paper-II

Module III (50)

Q.1. 'A' Type Questions- 10 marks
(10 to be answered out of 15) 1x10=10
(5 questions to be set from Anatomy &

10 questions to be set from Cell Biology & Genetics)

Q.2. 'B' Type Questions-10 marks
(2 to be answered out of 5) 5x2=10
(1 question to be set from Anatomy &
4 questions to be set from Cell Biology & Genetics).

Q.3. 'C' Type Questions-30 marks.
a. Anatomy-1 question to be answered out of two……10x1=10
b. Cell Biology & Genetics -2 question to be answered out of three..10x2=20

Module IV (50)

Q.1. 'A' Type Questions- 10 marks.
(10 to be answered out of 15. 1x10=10,
(10 questions to be set from Plant Physiology & Biochemistry and
5 questions to be set from Ecology+ Economic Botany)

Q.2. 'B' Type Questions-10 marks.
(2 to be answered out of 5) 5x2=10,
(1 question to be set from Ecology,
1 question to be set from Economic Botany and
3 questions to be set from Plant Physiology & Biochemistry)

Q.3. 'C' Type Questions-30 marks.
a. Ecology + Economic Botany-1 question to be answered out of two……10x1=10
b. Plant Physiology & Biochemistry -2 questions to be answered out of three..10x2=20

Paper-III (Practical)

Module V & VI

Paper-IVA

Module VII (70 Marks)

Q.1. 'A' Type Questions- 1x15=15 marks
(15 to be answered out of 20)
Q.2. 'B' Type Questions-5x3=15 marks
(3 to be answered out of 5)
Q.3. 'C' Type Questions-10x4=40 marks
(4 to be answered out of 6)

Paper-IVB

Module VIII (30 Marks) - Practical

Suggested Readings

Like 2007

UNIVERSITY OF CALCUTTA

SYLLABUS

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THREE-YEAR HONOURS
DEGREE COURSE OF STUDIES

POLITICAL SCIENCE

2010

Syllabus for Three-Year B.A. (Honours) Course in

POLITICAL SCIENCE

Part I F.M. 200

Paper I: POLITICAL THEORY: 100-Marks

Unit I

1. What is Politics – Approaches to the study of Politics: Normative, Behavioural and Post-behavioural. Feminist views to Politics.
2. Theories of the State (a) Origin: Social Contract Theory; (b) Nature: Idealist, Liberal and Neo-liberal theories.
3. Concept of State Sovereignty: Monistic and Pluralistic theories – Changing concepts of Sovereignty in the context of Globalization.

Unit II

1. Democratic Theories: David Held's Classification: Protective (Bentham), Developmental (J.S. Mill), Participatory.
2. Liberty, Equality, Rights and Law: concepts and their interrelations – Justice: concept – theory of Rawls.
3. Empirical political theories: Systems Analysis, Structural-Functionalism.

Unit III

1. Marxist approach to the study of Politics.
2. Dialectical Materialism and Historical Materialism with special reference to relationship between base and superstructure – Concepts of Class and Class Struggle.
3. Marxist theory of the State – the question of relative autonomy.

Unit IV

1. Marxist Concepts of Freedom and Democracy.
2. Marxian theory of Revolution: contributions of Lenin and Mao.
3. Marxian theory of the Party: Lenin's contribution – Lenin – Rosa Luxemburg Debate on Party.

PAPER II: COMPARATIVE POLITICS & GOVERNMENT 100 Marks

Unit I

1. Distinction between Comparative Politics and Comparative Government – Development of Comparative Politics.
2. Scope, purposes and methods of comparison – Approaches to the study of Comparative Politics.
3. Federal systems: federalism in USA and Russia

Unit II

1. Nature of liberal and socialist political systems – their distinguishing features, with special reference to conventions, rule of law, parliamentary sovereignty (UK), separation of powers, checks and balances, judicial review (USA), ideology, democratic centralism (PRC), referendum, initiative (Switzerland).
2. Political Parties: features and role of party system/parties in UK, USA and PRC. Interest groups: their roles and performance in UK and USA

Unit III

1. Legislature in UK and PRC: composition and functions of the legislative chambers – the NPC in PRC – role of second chambers in UK and USA – Committee system in UK and USA – role of speakers in parliamentary and presidential systems (UK and USA).
2. Executive in UK, USA, France and Russia: A comparative study of (i) Russian, French and American Presidency; (ii) British and French cabinet systems.

Unit IV

1. Relation between executive and legislature in UK, USA and PRC: A comparative study.
2. Judiciary in UK, USA and PRC (with special reference to the procuratorate): A comparative study.
3. Rights of the citizens of UK, USA and PRC: A comparative study – Duties of the citizens of PRC.

Part II **F.M. 200**

PAPER – III: GOVERNMENT AND POLITICS IN INDIA **100** Marks

Unit I

1. Framing of the Indian Constitution: Role of the Constituent Assembly – the Preamble.
2. Fundamental Rights and Duties – Directive Principles.
3. Nature of Indian Federalism: Union-State Relations.
4. Union Executive: President, Vice-President: election, position, functions (with reference to Emergency Powers), Prime Minister, Council of Ministers, relationship of Prime Minister and President.

Unit II

1. Union Legislature: Rajya Sabha, Lok Sabha: Organisation, Functions – Law-making procedure, Privileges, Committee system – Speaker.
2. Government in the states: Governor, Chief Minister and Council of Ministers: position and functions – State Legislature: composition and functions.
3. The Judiciary: Supreme Court and the High Courts: composition and functions – Judicial activism.

4. Constitutional amendment: Procedure – main recommendations of the Constitutional Review Commission (Venkatachalliah Commission).

Unit III

1. Party system: features and trends – major national political parties in India: ideologies and programmes – coalition politics in India: nature and trends – political parties in West Bengal: An overview.
2. Electoral process: Election Commission: composition, functions, role.
3. Role of business, working class, peasants in Indian politics.

Unit IV

1. Role of (a) religion (b) language (c) caste (d) tribe and (e) regionalism in Indian politics.
2. New Social Movements since the 1970s: (a) environmental movements, (b) women's movements, (c) human rights movements.

PAPER IV: INTERNATIONAL RELATIONS 100 Marks

Unit I

1. International Relations: a brief outline of its evolution as an academic discipline.
2. Some representative theories of International Relations: (a) Realism (b) Pluralism (c) World Systems theory.
3. Emergent issues in International Relations: (a) Development (b) Regionalism and Integration (c) Terrorism

Unit II

1. Some basic concepts in International Relations: (a) Balance of Power (b) Bi-polarity and Unipolarity (c) Neo-colonialism (d) Globalization.
2. Foreign Policy: concept and techniques: diplomacy, propaganda, military

Unit III

1. Cold war and its evolution: an outline – understanding the post-cold war world: an overview.
2. Europe in transition: (a) European Union (b) Ethnicity and nationalism in Eastern Europe since 1990s.
3. Problems of developing countries: NAM – contemporary relevance, Regionalism: ASEAN, AU (African Union), OPEC, SAFTA and SAARC – West Asia and the Palestine question after the cold war.

Unit IV

1. Indian Foreign Policy: basic principles and evolution.
2. Foreign policies of USA and China: Evolution and basic issues after the cold war.
3. UNO: Background; Organs with special reference to Security Council, General Assembly and Secretariat – role of the UNO in peace-keeping and human rights.

Part – III **F.M. 400**

PAPER – V: WESTERN POLITICAL THOUGHT **100** Marks

Unit I

1. Greek political thought: main features – Plato: justice, communism – Aristotle: state, classifications of constitutions.
2. Roman political thought: theories of Law and Citizenship – contributions of Roman thought.
3. Medieval Political Thought in Europe: Main features.

Unit II

1. Medieval political thought in Europe: main features.
2. Political thought of Reformation.
3. Bodin: contributions to the theory of Sovereignty.

Unit III

1. Hobbes: founder of the science of materialist politics.
2. Locke: founder of Liberalism: views on natural rights, property and consent.
3. Rousseau's views on Freedom and Democracy.
4. Bentham: Utilitarianism.

Unit IV

1. John Stuart Mill's views on liberty and representative government.
2. Hegel: Civil Society and State.
3. Utopian and Scientific socialism: basic characteristics – Anarchism: an outline.
4. Varieties of non-Marxist socialism: Fabianism, Syndicalism, Guild Socialism, German Revisionism.

PAPER VI: INDIAN POLITICAL THOUGHT AND MOVEMENT **100 Marks**

Unit I

1. Features of ancient Indian political ideas: an overview – Kautilya: Saptanga theory, Dandaniti, Diplomacy.
2. Medieval political thought in India: legitimacy of kingship – duties and responsibilities of a Muslim ruler.
3. Modern Indian thought: Rammohan Roy as pioneer of Indian liberalism – his views on Rule of Law, Freedom of thought and Social Justice.
4. Bankimchandra, Vivekananda and Rabindranath: views on nationalism.

Unit II

1. Gandhi: State and Trusteeship.
2. M.N. Roy: Radical Humanism.
3. Narendra Deva: contributions to socialism.
4. Syed Ahmed Khan: views on colonial rule and modernization.

Unit III

1. Foundation of the Indian National Congress.
2. Bengal Partition and Swadeshi movement.
3. Khilafat and Non-Cooperation Movement – Civil Disobedience movement
4. Alternatives to Congress politics: (a) Subhas Chandra Bose and Forward Bloc (b) Congress Socialist Party (c) the Communists.

Unit IV

1. Movements against caste system and untouchability – Ambedkar's views on Social Justice and Depressed Class.
2. Class and the nationalist movement under colonial rule: working class movement and peasant movement.
3. Roots of communal politics: Savarkar and Hindu nationalism, Jinnah and two-nation theory.
4. August 1942 movement – the INA – Naval uprisings.

PAPER VII: POLITICAL SOCIOLOGY 100 Marks

Unit I

1. Social bases of politics.
2. Process of State formation and nationalism in West Europe and third world.
3. Social stratification and politics: caste, class, elite.

Unit II

1. Gender and politics: basic issues.
2. Power, Authority and Legitimacy.
3. Religion, Society and Politics – religion in society: different views.

Unit III

1. Classification and types of political systems.
2. Political culture and Political socialization: nature, types and agencies.
3. Political participation: concept and types.
4. Groups in politics: Parties and Pressure groups.

Unit IV

1. Political communication: concept and features.
2. Electorate and electoral behaviour (with reference to India)
3. Military and politics: conditions and modes of intervention.
4. Political development and social change – role of tradition and modernity.

PAPER VIII: PUBLIC ADMINISTRATION **100** Marks

Unit I

1. Nature, Scope and Evolution of Public Administration – Private and Public Administration – Principles of Socialist Management.
2. Challenges to the discipline of Public Administration and responses: New Public Administration, Comparative Public Administration and Development Administration (with special reference to India).
3. Major concepts of administration: (a) Hierarchy (b) Unity of command (c) Span of control (d) Authority (e) Centralization, Decentralization and Delegation (f) Line and Staff.
4. Bureaucracy: Views of Marx and Max Weber.

Unit II

1. Ecological approach to Public Administration: Riggsian Model.
2. Administrative Processes: (a) Decision making (b) Communication and Control (c) Leadership (d) Co-ordination.
3. Policy-making: Models of policy making – policies and implementation.

Unit III

1. Continuity and change in Indian administration: a brief historical outline.
2. The Civil Service in India (Bureaucracy): recruitment (role of UPSC, SPSC), training.
3. Organization of the Union Government: Secretariat Administration: PMO, Cabinet Secretariat.
4. Organization of the State Government: Chief Secretary – relationship between Secretariat and Directorate.
5. District Administration: changing role of District Magistrate.

Unit IV

1. Local Self Government: Corporations, Municipalities and Panchayats in West Bengal: structure and functions – 73rd and 74th Amendment: an overview.
2. Planning and plan administration: Planning Commission, National Development Council, District Planning.
3. Financial Administration: Public Accounts Committee, Estimates Committee – role of CAG.
4. Citizen and administration: functions of Lokpal Lokayukt.

Question Pattern

The present system should continue. Students will have to write (i) two short notes – each carrying 5 marks – out of four, and (ii) one broad question of 15 marks out of two from each Unit.

Number of Lectures

There should be 64 classes per week for 8 honours papers, i.e. 8 classes a week for each paper.

NOTE: **The syllabus of General Course remain unchanged.**

UNIVERSITY OF CALCUTTA

SYLLABI

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THREE-YEAR HONOURS AND GENERAL
DEGREE COURSES OF STUDIES

PHILOSOPHY

2010

Syllabus for Three-Year B.A. (Honours) Course in Philosophy

Minimum number of classes per paper of 100 marks: 100

Part I

Paper I: INDIAN PHILOSOPHY 100 marks

Paper II: PSYCHOLOGY & SOCIAL-POLITICAL PHILOSOPHY 100 marks

Part II

Paper III: HISTORY OF WESTERN PHILOSOPHY 100 marks

Paper IV: LOGIC 100 marks

Part III

Paper V: INDIAN LOGIC AND EPISTEMOLOGY 100 marks

Paper VI: PHILOSOPHY OF LANGUAGE, EPISTEMOLOGY AND METAPHYSICS (WESTERN) 100 marks

Paper VII: ETHICS AND PHILOSOPHY OF RELIGION 100 marks

Paper VIII: OPTIONAL PAPER (ANY OF THE FOLLOWING) 100 marks

A: Vedāntasāra - Sadānandayogīndra—(Entire Text).

B: An Enquiry Concerning Human Understanding: David Hume

C: The Problems of Philosophy: Bertrand Russell

D: Western Logic

E: Ethics

F: Contemporary Indian Philosophy

Syllabus for Three-Year B.A. (Honours) Course in Philosophy

Minimum number of classes per paper of 100 marks: 100

Part-I
PAPER-I

(INDIAN PHILOSOPHY) 100 marks

Half-I **(50 marks)**

Unit-I

A. Introduction: Division of Indian Philosophical Schools:Āstika and Nāstika
B. Cārvāka School—Epistemology, Metaphysics, Ethics.
C. Jainism—Concept of Sat, Dravya, Paryāya, Guṇa. Anekāntavāda, Syādvāda and Saptabhanginaya.
D. Buddhism— Four noble Truths, Theory of Dependent Origination (Pratītyasamutpādavāda), Definition of Reality (Arthakriyākāritvamsattvam), Doctrine of Momentariness, (Ksanabhangavāda), Theory of no-soul (Nairātmyavāda), Four Schools of Buddhism (Basic tenets).

Unit-II

A. Nyāya –Pramā and Pramāṇa, Pratyakṣa (Definition), Sannikarṣa, Classification of Pratyakṣa: Nirvikalpaka, Savikalpaka, Laukika, Alaukika;

B.Anumiti,Anumāna (Definition), vyāpti, parāmarśa, Classification of Anumāna: pūrvavat, śeṣavat, smānyatodṛṣta, kevalānvayī, kevalavyātirekī, anvayavyātirekī, svārthānumāna, parārthānumāna, Upamāna (definition), Śabda (definition)
C.Vaiśeṣika—Seven Padārthas, dravya, guṇa, karma, sāmānya, viśeṣa, samavāya, abhāva,
D. Asatkāryavāda.

Half-II **(50 marks)**

Unit-III

A. Sāmkhya—Satkāryavāda, Nature of Prakṛti , its constituents and proofs for its existence. Nature of Puruṣa and proofs for its existence, plurality of puruṣas, theory of evolution.
B. Yoga—Citta, Cittavṛtti, Cittabhūmi. Eight fold path of Yoga, God.
C. Mīmāṃsā (Prābhakara and Bhātta) : Arthāpatti and Anupalabdhi as sources of knowledge.

Unit-IV

A. Advaita Vedānta—Sankara's view of Brahman, Saguṇa and Nirguṇa Brahman, Three grades of Sattā: prātibhāsika, vyavahārika and pāramārthika, Jīva, Jagat and Māyā.
B. Viśiṣṭādvaita—Ramanuja's view of Brahman, Jīva, Jagat. Refutation of the doctrine of Māyā.

Suggested Readings :

English:

- Outlines of Indian Philosophy: M. Hiriyanna
- A Critical Survey of Indian Philosophy: C.D. Sharma
- An Introduction to Indian Philosophy: D. M. Dutta & S.C. Chatterjee
- Classical Indian Philosophy: J.N. Mohanty
- History of Indian Philosophy: S.N. Dasgupta
- Indian Philosophy (Vol. I & II): S. Radhakrishnan
- Indian Philosophy (Vol. I & II): J.N. Sinha
- Studies on the Carvaka/Lokayata: Ramakrishna Bhattacharya
- The Central Philosophy of Buddhism: T.R.V. Murti
- Yogacara Idealism: A.K.Chatterjee
- An Introduction to Maddhyamika Philosophy: Jaydev Singh
- Reflections on Indian Philosophy: K.P. Sinha
- Philosophy of Jainism: K.P. Sinha
- Nyaya Theory of Knowledge: S.C. Chatterjee
- Six Ways of Knowing: D.M. Dutta
- Nyaya-Vaisesika Metaphysics: Sadananda Bhaduri
- The Doctrine of Maya: A.K. Roychoudhuri
- Self and Falsity in Advaita Vedanta: A.K. Roychoudhuri

Bengali:

- Bharatiya Darshan: Debabrata Sen
- Bharatiya Darshan: Nirodbaran Chakraborty
- Sayan Madhaviya Sarva Darshan Samgraha: Satyajyoti Chakraborti
- Lokayata Darshan: Debiprasad Chatoopadhyay
- Carvakacarca: Ramakrisna Bhattacharya
- Carvaka Darshan: Panchanan Sastri
- Carvaka Darshan: Amit Kumar Bhattacharya
- Bauddha Dharma O Darshan: Swami Vidyaranya
- Bauddha Darshan: Panchanan Sastri
- Gautama Buddher Darshan o Dharma: Sukomol Choudhury
- Bauddha Darshan: Amit Kumar Bhattacharya
- Ksanabhangavada: Bidhubhusan Bhattacharya
- Jainadarshaner Digdarshan: Satindra Chandra Bhattacharya
- Nyaya Darshan: Phanibhushan Tarkavagisha
- Nyaya Paricaya: Phanibhushan Tarkavagisha

- Nyaya-Vaisesika Darshan: Karuna Bhattacharya
- Nyaya Tattva Parikrama: Kalikrishna Bandyopadhyaya
- Samkhya Darshan: Bhupendranath Bhattacharya
- Samkhya Darshaner Vivarana: Bidhubhushan Bhattacharya
- Samkhyamata Samiksa: Yogendranath Bagchi
- Samkhya Tattva Kaumudi: Narayan Chandra Goswami
- Samkhya-Patanjal Darshan: Kanakprabha Bandyopadhyaya
- Patanjal Darshan: Purnachandra Veadantachanchu
- Puva Mimasa Darshan: Sukhamaya Bhattacharya
- Vedanta Darshan: Roma Choudhury
- Vedanta Darshan: Advaitavada: Ashutosh Sastri
- Mayavada: Pramatha Nath Tarkabhushan
- Vedanta Darshan: Swami Vidyaranya

PAPER—II

(PSYCHOLOGY & SOCIAL-POLITICAL PHILOSOPHY) 100 marks

Half-I (50 marks)

Unit-I

A. Methods of Psychology: Introspection, Extrospection, Experimental Methods—variables—dependent & independent, controls in experiment, limitations of experimental method.
B. Sensation and perception: Nature of sensation, nature of perception, relation between sensation and perception, Gestalt theory of perception.
C. Learning: Theories of Learning—Trial and error theory, Thorndike's laws of learning, Gestalt Theory, Pavlov's theory of conditioned response, B.F. Skinner's theory of Operant Conditioning (reinforcement, extinction, punishment).

Unit-II

A. Interactionism, Double-aspect theory, Philosophical Behaviorism, Identity theory ,The Person theory (Strawson).
B. Consciousness: Levels of mind—Conscious, Sub-conscious, Unconscious, proofs for the existence of Unconscious, Freud's theory of Dream.
C. Intelligence: Measurement of Intelligence, I.Q.,Test of Intelligence, Binet-Simon test, Terman-Merril and Wecshler test.

Half-II (50 marks)

Unit-III

A. Nature and Scope of i) Social Philosophy ii) Political Philosophy. Relation between social and political Philosophy.
B. Basic concepts: Society, community, association, institution, family: nature, different forms of family, role of family in the society.
C. Marxist conception of class.
D. Theories regarding the relation between individual and society
   i) Individualistic theory
   ii) Organic theory
   iii) Idealistic theory

Unit-IV

A. Secularism—its nature, Secularism in India.
B. Social Change: Nature, Relation to Social progress, Marx-Engles on social change, Gandhi on social change.
C. Political Ideals: Nature of Democracy and its different forms, direct and indirect democracy, liberal democracy, democracy as a political ideal, Socialism: Utopian and Scientific, Anarchism.

Suggested Readings:

English:

- A Textbook of Psychology: Pareshnath Bhattacharya
- Introduction to Psychology: G.T. Morgan, R. A. King Jr.
- A Modern Introduction to Psychology: Rex Knight & M. Knight
- A Manual of Psychology: G.F. Stout
- Psychology: Woodworth & Marquis
- Science and Human Behaviour: B.F. Skinner
- About Behaviorism: B.F. Skinner
- General Psychology: G.D. Boaz
- General Psychology: G. Murphy
- Psychology: W. James
- A Textbook of Psychology: E.B. Titchener
- Principles of Psychology: W. James
- Introduction to Psychology: N.L. Muna
- A Materialist Theory of Mind: D.M. Armstrong (Ch.s 1,5,& 6)
- Philosophy of Mind: J. Heil
- Philosophy of Mind: J. Shaffer (Ch.s 2,3 &4)
- An Introduction to Philosophy of Mind: C.J. Lowe (Ch.s 2&3)
- Individuals: An Essay in Descriptive Metaphysics: P.F. Strawson
- The Concept of Person and Other Essays: A.J.Ayer
- Fundamentals of Sociology: P. Gisbert
- Outlines of Social Philosophy: J.S. Mackenzie
- Problems of Polical Philosophy: D.D. Raphael
- Society: R.M. MacIver & C.H. Page
- Sociology: M. Ginsberg
- Sociology: Tom Bottomore
- Sociology: S.N. Shankar Rao
- Sociology: D.C. Bhattacharya
- Sociology: P.B. Kar
- Guide to Modern Thought: C.E.M. Joad
- Introduction to Modern political Theory: C.E.M. Joad
- The Evolution of Political Philosophy of Gandhi: Buddhadeb Bhattacharya
- Social and Political Thought of Gandhi: Jayantanuja Bandyopadhyay
- The Philosophy of Mahatma Gandhi: D.M. Dutta
- The Philosophy of Sarvodaya: K.S. Bharathi
- Communist Manifesto: Karl Marx & Frederick Engels
- Socialism: Utopian and Scientific: F. Engels

- Open Society and Its Enemies: Karl Popper
- The Open Philosophy and The Open Society: M. Cornforth
- Religion in India: T.N. Madan(ed.)
- Religion and Society: S. Radhakrishnan
- Secularism in the Present Indian Society, Amal Kumar Mukhopadhyay in Bulletin of the Ramakrishna Mission Institute of Culture, Vol.LVII, No. 11
- Secularism and Its Critics: Rajeev Bhargava (ed.)
- Civil Society and Its Institutions: Andre Beteille
- Unravelling the Nation:Sectarian Conflict and India's Secular Identity: Kaushik Basu & Sanjay Subramaniyam (eds.)
- India as A Secular State: D.E. Smith
- Political Thought: C.L. Wayper
- Political Philosophy:An Introduction: W.T. Blackstone
- Political Philosophy:East and West: Krishna Roy
- Political Philosophy: V.P. Verma
- Essays in Social and Political Philosophy: Krishna Roy & Chhanda Gupta (eds.)
- Western Political Thought: Brian R. Nelson
- Western Political Thought: From Plato to Marx: Shefali Jha

Bengali:

- Monovidya: Priti Bhushan Chattopadhyay
- Monovidya: Pareshnath Bhattacharya
- Monovidya: Ira Sengupta
- Monovidya: Samarendra Bhattacharya
- Monosamikksha: M. N. Mitra o Pushpa Mishra
- Monodarshan-Sarirvada o Tar Vikalap: M. N. Mitra o P. Sarkar (Sampadito)
- Monovijana Prasanga: Saradindu Bandyopadhyay
- Adhunik Monovijana: Ira Sengupta
- Shikshashrayi Monovidya: Sushil Roy
- Monodarshan: Arabinda Basu o Nibedita Chakraborty

Bengali:

- Samaj Darshan Dipika: Pritibhushan Chattopadhyay
- Samaj Tattva: Parimal Bhushan Kar
- Samaj Tattva: T. Bottomore
- Bisay Samaj Tattva: Anadi Kumar Mahapatra
- Samajdarshan o Rashtradarshaner Parichoy: A.K. Mahapatra o P. Mukherjee
- Rashtradarshaner Dhara: Amal kumar Mukhopadhyay
- Samajdarshan o Rashtradarshan: Samarendra Bhattacharya
- Samaj o Rajnaitikdarshan: Sandip Das
- Samyabader Itihas: Marx o Engels

- Samajtantra: Kalpanik o Baijnanik: F. Engels
- Marxiya Rashtrachinta: Shovan Lal Dutta Gupta
- Sarvodaya Andoloner Itihas: Gurudas Bandyopadhyay
- Gandhi Rachanasambhar: M.K. Gandhi
- Bharater Dharmanirapekshatar Sankat, Bholanath Bandyopadhyay in Essays on Science and Society: Biplab Chakraborti
- Dharmanirapekshata Birodhi Istahar: Ashis Nandy

PAPER—III

(HISTORY OF WESTERN PHILOSOPHY) 100 marks

Half-I (50 marks)

Unit-I

A. Plato**:** Theory of Knowledge , Theory of Forms.
B. Aristotle **:** Critique of Plato's theory of Forms, theory of Causation.

Unit—II

A. Descartes **:** Cartesian method of doubt, cogito ergo sum, criterion of truth, types of ideas, Proofs for the existence of God, Proofs for the existence of the external world.
B. Spinoza **:** Doctrine of substance, attributes and modes, existence of God, Pantheism, three orders of knowing.
C. Leibniz **:** Monads, truths of reason, truths of facts, innateness of ideas, Some metaphysical principles : Law of Identity of indiscernibles, Law of sufficient reason, Law of continuity, Doctrine of Pre-established harmony.

Half-II (50 marks)

Unit—III

A. Locke **:** Refutation of innate ideas, the origin and formation of ideas, simple and complex ideas, substance, modes and relations, nature of knowledge and its degrees, limits of knowledge, primary and secondary qualities, representative realism.
B. Berkeley **:** Refutation of abstract ideas. Criticism of Locke's distinction between primary and secondary qualities, Immaterialism, esse-est-percipi, role of God.
C. Hume **:** Impression and ideas, association of ideas, distinction between judgements concerning relations of ideas and judgements concerning matters of fact, theory of causality, theory of self and personal identity, Scepticism.

Unit—IV

A. Kant **:** Conception of critical Philosophy, distinction between a priori and a posteriori judgements, distinction between analytic and synthetic judgements. Possibility of Synthetic a priori judgements, General problem of the Critique.
Transcendental Aesthetic **:** Space & time—Metaphysical & Transcendental expositions of the ideas of space & time.

Suggested Readings:

English:

- A Critical History of Greek Philosophy: W.T. Stace
- Encyclopedia of Philosophy: P. Edwards (ed.)
- A History of Philosophy: F. Copleston, vols. I,IV,V,VI
- History of Western Philosophy: B. Russell
- History of Modern Philosophy: R. Falckenberg
- A Critical History of Modern Philosophy: Y.H. Masih
- A History of Philosophy: F. Thilly
- A History of Modern Philosophy: W.K. Wright
- A Critical History of Western Philosophy: D.J. O'Connor
- A History of Philosophy from Descartes to Wittgenstein: R. Scruton
- The Fundamental Questions of Philosophy: A.C. Ewing
- A Brief History of Western Philosophy: A. Kenny
- The Works of Descartes: Haldane & Ross (eds.)
- Descartes: B. Williams
- Descartes: A. Kenny
- Spinoza: S. Hampshire
- Spinoza: Leon Roth
- Leibniz:An Introduction to His Philosophy: N. Rescher
- The Rationalists: J. Cottingham
- An Essay Concerning Human Understanding: J. Locke
- John Locke: R. Aron
- Berkeley: G. Pitcher
- The Works of George Berkeley: T.E. Jessop & A.R. Luce(eds.) 8 vols
- An Enquiry Concerning Human Understanding-D. Hume: J. N. Mohanty (ed)
- A Treatise on Human Nature: D. Hume
- Locke, Berkeley, Hume: J. Bennett
- Locke, Berkeley, and Hume: C.R. Morris
- A Critique of Pure Reason-Immanuel Kant: N.K. Smith(tr. & ed.)
- Kant's Metaphysics of Experience: H.J. Paton vols I & II
- The Philosophy of Kant: J. Kemp
- Kant: Guyer
- A Handbook to Kant's Critique of Pure Reason: Rasvihari Das
- Kant: S. Körner

Bengali:

- Paschatya Darshaner Itihas: Tarak Candra Roy (pratham o dwitiya khanda)
- Paschatya Darshaner Itihas: Kalyan Chandra Gupta
- Paschatya Darshaner Itihas: Susanta Chakraborty
- Paschatya Darshaner Itihas: Samarendra Bhattacharya (pratham o dwitiya khanda)
- Paschatya Darshaner Itihas(Plato o Aristotle): N.B. Chakraborty
- Paschatya Darshaner Itihas(Plato o Aristotle): Debabrata Sen
- Paschatya Darshaner Itihas(Adhunik Yuga-Yuktivada (Descartes), Spinoza,Leibniz:): Chandrodaya Bhattacharya
- Paschatya Darshaner Itihas:Ikshanvada(Locke,Berkeley,Hume): Chandrodaya Bhattacharya
- Paschatya Darshaner Itihas:(Locke,Berkeley,Hume): N.B. Chakraborty
- Hume-er Enquiry-Ekti Upasthapana: Ramaprasad Das
- Kanter Drashan-Tattva o Prayog: Prahlad Kumar Sarkar (ed.)
- Kanter Drashan:Rasvihari Das
- Kanter Shuddha Prajnar Bichar: Mrinal Kanti Bhadra

PAPER-IV

(WESTERN LOGIC) 1OO marks

Half-I **(50 marks)**

Unit—I

A. Logic and Arguments, Deductive and Inductive Arguments, Truth and Validity. Categorical propositions and classes: quality, quantity and distribution of terms, Translating categorical propositions into standard form.

B. Immediate inferences: Conversion, Obversion and Contrapositon, Traditional square of opposition and Immediate Inferences based there on; Existential Import, symbolism and Diagrams for categorical propositions.

C. Categorical Syllogism: Standard Form categorical Syllogism; The Formal nature of Syllogistic Argument, Rules and Fallacies, General Rules; To test Syllogistic Arguments for validity (by applying general rules for syllogism); To solve problems and prove theorems concerning syllogism.

D. Boolean Interpretation of categorical propositions; Review of the Traditional Laws of Logic concerning immediate inference and syllogism; Venn Diagram Technique for Testing Syllogisms, Hypothetical and Disjunctive Syllogisms, Enthymeme, The Dilemma.

Unit—II

A. Induction: Argument by Analogy, Appraising Analogical Arguments, Refutation by Logical Analogy.

B. Causal Connections: Cause and Effect, the meaning of "Cause"; Induction by Simple Enumeration; Mill's Method of Experimental Inquiry; Mill's Method of Agreement, Method of Difference, Joint Method of Agreement and Difference, Method of Residues, Method of Concomitant Variations; Criticism of Mills Methods, Vindication of Mill's Methods.

C. Science and Hypothesis: Explanations; Scientific and Unscientific, Evaluating Scientific Explanations; The pattern of Scientific Investigation; Crucial Experiments and Ad Hoc Hypotheses.

D.Probability: Alternative Conception of Probability; The Probability Calculus; Joint Occurrences; Alternative Occurrences.

Half-II **(50 marks)**

Unit—III

A. Symbolic Logic**:** The value of special symbols; Truth-Functions; Symbols for Negation, Conjunction, Disjunction, Conditional Statements and Material Implication; Argument Forms and Arguments, Statement Forms and Statements; Material Equivalence and Logical Equivalence;

B. Tautologous, Contradictory and Contingent Statement-Forms; The Paradoxes of Material Implication; The Three Laws of Thought.

C. Testing Argument Form and Argument; Statement-Form and Statement for Validity by
   a) The Method of Truth-table.
   b) The Method of Resolution (Fellswoop & Full Sweep)[dot notation excluded];
D. The Method of Deduction: Formal Proof of Validity: Difference between Implicational Rules and the Rules of Replacement; Construction of Formal Proof of Validity by using nineteen rules; Proof of invalidity by assignment of truth-values.

Unit-IV

A. Quantification Theory**:** Need for Quantification Theory, Singular Propositions; Quantification; Translating Traditional subject predicate proposition into the logical notation of propositional function and quantifiers;
B. Quantification Rules and Proving Validity; Proving Invalidity for arguments involving quantifiers.

Suggested Readings:

English:

- Introduction to Logic (13th Edn.): I.M. Copi & C. Cohen
- Symbolic Logic: I.M. Copi
- Methods of Logic (Part I,Ch.s 5,7,9): W.V.O. Quine
- Introduction to Logic and Scientific Method: Cohen & Nagel
- Logic: Informal, Symbolic and Inductive: Chhanda Chakraborty
- Logic: Stan Baronett & Madhuchhanda Sen

Additional Suggested Readings:

- The Elements of Logic: Stephen Barkar
- Understanding Symbolic Logic: Virginia Klenk
- Logic- A Comprehensive Introduction; S.D. Guttenplan & M. Tamney
- Logic & Philosophy- A Modern Introduction: Howard Kahne
- Logic- A First Course: A.E. Blumberg

Bengali:

- Nabya Yuktibijnana(Pratham theke caturtha khanda): Ramaprasad Das
- Sanketik Yuktibijnana:Ramaprasad Das
- Samsad Yuktibijnana Abhidhan: Ramaprasad Das o Subirranjan Bhattacharya

PAPER-V

(INDIAN LOGIC AND EPISTEMOLOGY) 100 marks

Recommended Text: Tarkasaṃgraha with Dīpikā by Annambhatta.
(Buddhikhanda- from the definition of cognition to the division of memory into two kinds)

Half-I (50 marks)

Unit-I

A. Definition of buddhi or jñāna (cognition), its two kinds;
Definition of smṛti; Two kinds of smṛti (memory);
Definition of anubhava, its division into veridical(yathārtha) and non-veridical(ayathārtha);Three kinds of non-veridical anubhava;
Definitions clarified in Tarkasaṃgraha Dīpikā.
B. Four-fold division of pramā and pramāṇa.
Definition of "Karaṇa" (special causal condition) and "kāraṇa" (general causal condition).
The concept of anyathāsiddhi (irrelevance) and its varieties.
The definition of kārya (effect). Kinds of cause: smavāyi, a-samavāyi and nimiṭṭa kāraṇa (definitions and analysis).

Unit-II

A. Definition of pratyakṣa and its two-fold division : nirvikalpaka and savikalpaka jñāna. Evidence for the actuality of nirvikalpaka.
B. Sannikarṣa and its six varieties. Problem of transmission of sound; the claim of "anupalabdhi" as a distinctive pramāṇa examined.

Half-II (50 marks)

Unit-III

A. Definiton of anumāna, anumiti and parāmarśa. Analysis of paksatā. Definition of vyāpti; Vyāptigraha.
B. Definition of pakṣadharmatā—svārthānumiti and parārthānumiti; Analysis of pañcāvayavi Nyāya. Necessity of parāmarśa. Three kinds of linga or hetu: kevalānvayi, kevalayatirekī and anvayavyatirekī. Definiton of pakṣa, Sa-pakṣa and vipaksa with illustrations. Marks of sadhetu.
C. Hetvābhāsa-two types of definition. Five kinds of hetvābhāsa: (1) "Savyabhicāra and its three kinds-defined and illustrated; (2) "Viruddha" defined and illustrated: (3) "Sat-pratipakṣa" defined and illustrated; (4) Three kinds of "Asiddha" enumerated; (a)

āśrayāsiddhi (b) svarūpāsiddhi and (c) vyāpyatvāsiddhi. Vyāpyatvāsiddhi defined as"sopādhika hetu". Upādhi and its four kinds (definition and illustration) (5) "Bādhita" (definition and illustration).

Unit-IV

A. "Upamāna pramāṇa" :Definition and analysis.
"Śabda pramāna" : Definition and analysis. "Śakti" (the direct signifying power), the pada-padārtha-sambandha considered as Īśvara-samketa, Controversy between the Mīmāṃsakas and the Naiyāyikas regarding the nature of Śakti as universal or particular,
B. "Śaktigraha" (ascertainment of the meaning-relation), laksana, varieties of laksana, Analysis of "Gauṇī vṛtti" (the secondary signifying power of a term), "Vyānjanā-vṛtti" (the suggestive power of a term) analysed as a kind of śakti or lakṣaṇā,
C. The question of lakṣanā-bīja tātparya, The concept of "yoga-rūdhi". The three conditions of "śābda-bodha"—ākānkṣā, yogyatā and sannidhi. Two kinds of statements distinguished—Vaidika and Laukika.
D. "Arthāpatti" as a distinctive pramāṇa: Controversy between the Mīmāṃsakas and the Naiyāyikas.

E. The theory of prāmānya:the issue between svataḥ-prāmānyavada and parataḥ-prāmānyavada regarding utpatti and jñapti;the Prābhākara theory of akhyāti.

Suggested Readings:

English:

- Tarkasamgraha with Dipika: Gopinath Bhattacharya
- Tarkasamgraha: M.R. Bodas & Y.V. Athalye (tr. & ed.)
- The Elements of Indian Logic and Epistemology: Chanrodaya Bhattacharya
- A Primer of Indian Logic: Kuppuswami Shastri
- Fundamental Questions of Indian Metaphysics & Logic: S.K. Maitra
- The Nyaya Theory of Knowledge: S.C. Chatterjee

Bengali:

- Tarkasamgraha with Dipika: Narayan Chandra Goswami
- Tarkasamgraha with Dipika: Indira Mukhopadhyay
- Tarkasamgraha with Dipika: Panchanan Shastri
- Tarkasamgraha with Dipika: Kanailal Poddar
- Tarkasamgraha with Dipika: Anamika Roy Chowdhury
- Tarkasamgraha with Dipika: Bipadbhanjan Pal

PAPER--VI

(PHILOSOPHY OF LANGUAGE, EPISTEMOLOGY AND METAPHYSICS [WESTERN])

100 marks

Recommended Text: An Introduction to Philosophical Analysis—John Hospers

Half-I (50 marks)

Unit-I

Meaning and Definition:

A. Word-meaning, Definitions,
B. Vagueness,
C. Sentence-meaning.

Unit-II

Knowledge

A. Concepts, Truth,
B. Sources of Knowledge,
C. Some Principal uses of the verb "To know", Conditions of Propositional Knowledge, Strong and weak senses of "know".

Necessary Truth

A. Analytic truth and logical possibility,
B. The apriori,
C. The Principles of Logic.

Half-II (50 marks)

Unit-III

Empirical Knowledge:

A. Law, Theory and Explanation,
B. The Problem of Induction,
C. Testability and Meaning.

Cause, Determinism and Freedom:

A. What is Cause?
B. The Causal Principles,
C. Determinism and Freedom.

Unit-IV

Our Knowledge of the Physical World:

A. Realism, Idealism,
B. Phenomenalism

Some Metaphysical Problems

C. Substance and Universal

Suggested Readings:

English:

- The Problem of Knowledge: A.J. Ayer
- Language, Truth and Logic: A.J. Ayer
- Readings in Philosophical Analysis: J. Hospers
- The Central Questions of Philosophy: A.J. Ayer
- Theory of Knowledge: A.J. Woozley
- An Introduction to Philosophy: Shibapada Chakraborty

Bengali:

- Darshanik Jijnasa (Bagarthatattva): Ramaprasad Das
- Darshanik Jijnasa (Jnanatattva-Jnaner Svarup): Ramaprasad Das
- Darshanik Jijnasa (Jnanatattva): Ramaprasad Das
- Darshanik Jijnasa (Paratattva o Bhauto Jagater Jnana): Ramaprasad Das
- Darshanik Bishlesaner Ruparekha (Pratham O dvitiya khanda): Samarikanta Samanta
- Paschatya darshaner Ruparekha: Ramaprasad Das o Shibapada Chakraborty

PAPER—VII

(ETHICS AND PHILOSOPHY OF RELIGION) 100 marks

Half-I (50 marks)

Unit-I

Indian Ethics

A. Introduction:Concerns and Presuppositions
Concept of Sthitaprañjna
Karmayoga: (Gīta)
Puruṣārthas and their inter-relations.

B. Meaning of Dharma, Concept of Ṛṇa and Ṛta.
Classification of Dharma: Sāmānya dharma, viśeṣadharma, sādhāraṇadharma,
C. Pancaśīla, Brahmavihārabhāvanā (Bauddha)
Anuvrata, Mahāvrata, Ahimsā. (Jaina)

Unit-II

Western Ethics

A. Nature and Scope of Ethics
Moral and Non-moral actions, Object of Moral Judgement—Motive and Intention
B. Standards of Morality: Hedonism—Ethical, Psychological.
Utilitarianism: Act—utilitarianism, Rule-utilitarianism.
Deontological Theories: Act-Deontological Theories, Rule-Deontological Theories—Kant's Theory.
C. Theories of punishment.

Half-II (50 marks)

Unit-III

Philosophy of Religion-I

A. Nature and scope of Philosophy of Religion.
Doctrine of karma and rebirth, doctrine of liberation, (Hindu, Bauddha and Jaina views).
B. The Philosophical teachings of the Holy Quoran: God the ultimate Reality, His attributes, His relation to the world and man.
C. Some basic tenets of Christianity: The doctrine of Trinity, The theory of Redemption

Unit-IV

A. Arguments for the existence of God: Cosmological, Telelogical and Ontological arguments, Nyāya arguments
B. Grounds for Disbelief in God: Sociological theory (Durkheim), Freudian theory, Cārvāka, Bauddha and Jaina views
C. The Peculiarity of Religious Language: The doctrine of analogy, Religious statements as Symbolic, Religious language as Non-Cognitive (Randal's view), the language game theory (D.Z. Phillip).

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Suggested Readings:

English:

- The Fundamentals of Hinduism-A Philosophical Study: S.C. Chatterjee
- The Ethics of the Hindus: S.K. Maitra
- An Outline of Hinduism: T.M.P. Mahadevan
- Classical Indian Ethical Thought: K.N. Tewari
- Ethics in the Gita-An Analytical Study (pp-119-145): Rajendra Prasad
- Ethics in the Vedas, Satya prakash Singh in Historical-Developmental Study of Classical Indian Philosophy,[History of Science, Philosophy and Culture in Indian Civilisation(Vol. XII, Part 2)]: Rajendra Prasad (ed.)
- Rta, Satya, Tattva, Tathya, Samiran Chandra Chakraborty in Philosophical Concepts Relevant to Sciences in Indian Tradition,[History of Science, Philosophy and Culture in Indian Civilisation(Vol. VIII, Part 4)]: P.K. Sen (ed.)
- Development of Moral Philosophy in India; Surama Dasgupta
- Ethical Philosophies of India: I.C. Sharma
- Studies on the Purusarthas: P.K. Mahapatra (ed.)
- A Critical Survey of Indian Philosophy: C.D. Sharma
- Indian Philosophy (Vo. I): J.N. Sinha
- Philosophy of Hindu Sadhana: N.K. Brahma
- History of Philosophy-Eastern and Western:(Vol. I & II): S. Radhakrishnan
- Principles of Ethics: P.B. Chatterjee
- A Manual of Ethics: J.S. Mackenzie
- Ethics: W. Frankena
- An Introduction to Ethics: W. Lillie
- Ethics-Theory and Practice: J. Thiroux (Chs II & III)
- Ethics-Theory and Practice: Y.V. Satyanaryana
- Moral Reasons: J. Nuttal
- Human Conduct: J. Hospers

- Ethics-The Fundamentals: Julia Driver
- An Introduction to Kant's Ethics: R. Sullivan
- Nicomachean Ethics: Aristotle
- Philosophical Ethics-An Introduction to Moral Philosophy: T.L. Beauchamp (ed.)
- Virtue Ethics: Rosalind Hursthorne (Ch. III)
- Karma,Causation and Retributive Morality: Rajendra Prasad
- Philosophy of Religion: J. Hick
- An Introduction to the Philosophy of Religion: Brian Davies
- Indian Philosophy of Religion: A. Sharma
- Comparative Religion: P.B. Chatterjee
- Comparative Religion: Eric J. Sharpe
- Patterns in Comparative Religion: M. Eliade (Ch I, Sec. I)
- Atheism in Indian Philosophy: D.P. Chattopadhyay
- Essays in Indian Philosophy (pp-145-169): P. K. Sen (ed.)
- Studies in Nyaya-Vaisesika Theism (pp-102-137,139-159): Gopika Mohon Bhattacharya
- The Religions of the World: R.K.M. Institute of Culture
- Encyclopedia Britannica, Vol. I
- Encyclopedia of Islam,Vols. I & II
- Indian Religions: S. Radhakrishnan
- Foundations of Living Faith: H.D. Bhattacharya
- Aspects of Hindu Morality: Saral Jhingram
- A History of Muslim Philosophy (Vols.I &II): M.M. Sharif
- Islam and Secularism: Sayed Muhammad Al-Naquib Al-Attas
- The History of Philosophy in Islam-T.J. de Boer: E. Jones (tr.)
- The Holy Quoran: Mohammad Yusuf Ali (tr.)
- History of Saracenf: Syed Amir Ali
- The Spirit of Islam: Syed Amir Ali
- The Meaning of the Glorious Koran: M. Pickthall
- A History of Islamic Philosophy: M. Fakhry
- The Spirit of Islam's Message, Muhammad Qamaruddin in Religions of the People of India: S.R. Saha (ed.)
- Cultural Heritage of Islam: Osman Ghani
- Old Testament: R. Kittel (ed.)
- New Testament: Kilpatrick
- The Doctrine of the Trinity: R.S. Franks
- The Doctrine of the Trinity: Loenard Hodgson
- The Idea of the Holy: R. Otto
- A Brief Account of the Religion of the Hindus: Srilekha Dutta in Religions of the People of India: S.R. Saha (ed.)
- Dharma in Hinduism: An Ideal Religion: Tapan Kumar Chakraborty in Religions of the People of India: S.R. Saha (ed.)

- Jainism-A Religion of Non-Theistic Humanism: Tushar Sarkar in Religions of the People of India: S.R. Saha (ed.)
- Essays in Analytical Philosophy (Ch.VII): Gopinath Bhattacharya
- Buddhism in India and Abroad: Anukul Badyopadhyay

Bengali:

- Nitividya: Mrinal Kanti Bhadra
- Nitividyar Tattvakatha: Somnath Chakraborty
- Nitishastra: Dikshit Gupta
- Nitividya: Samarendra Bhattacharya
- Nitividya: Sibapada Chakraborty
- Pashchatya Darshaner Itihas (Pratham o dwitiya khanda): S. Radhakrishnan
- Dharma Darshan: A. Bandyopadhyay o K.C. Gupta
- Dharma Darshan: Rabindranath Das
- Dharmadarshanser Katipoy Samasya: Dilip Kumar Mohanto
- Dharma Darshan: Sushil Kumar Chakraborty
- Bharatiya Dharmaniti: Amita Chattopadhyay (Sampadita)
- Bharatiya Darshane Nirishvarvada: B.B. Purakayastha (pp-39-50,56-66)
- Bharatiya Darshaner Drishtite Muktir Swarup: Chandana Das
- Sarvadarshanasamgraha: Satyajyoti Chakraborty (Pratham Khanda)
- Islami Darshan: Hasan Ayub
- Quoran Sharif: Maulana Mobarak Qarim Zahar (Anudita)
- Quoran Sharif: Osman Ghani (Anubad O bhasya)
- Islamer Chinta o Chetanar Kramabikash (dasham Khanda): Osman Gani
- Pabitra Bible (Puratn o Natun Niyam): Bharater Bible Society
- Bauddhadharmer Itihas: Mani Kuntala Halder
- Bauddhadharma o Darshan: Sukomal Chowdhury

Paper—VIII (OPTIONAL PAPER)

Any **one** of the following:

- **A.** Vedāntasāra. (Text)
- **B.** An Enquiry Concerning Human Understanding. (Text)
- **C.** The Problems of Philosophy. (Text)
- **D.** Western Logic. (Texts)
- **E.** Ethics: Theory and Practice
- **F.** Contemporary Indian Philosophy.

A: Vedāntasāra - Sadānandayogīndra—(Entire Text).

Half-I **(50 marks)**

Unit—I

Mangalācarana
Vedānter Paricaya
From Anubandha Catuṣtaya to relation between Iśvara and Prājña

Unit—II

From Tūriyachaitanya to relation between Taijasa and Hiraṇyagarbha.

Half-II **(50 marks)**

Unit—III

Origin of Sthūla Bhūta to Brahma-sākṣātkār.

Unit—IV

Śravaṇa O Ṣaḍbidhalinganirupaṇ to Jīvanmuktir śeṣ phal.

Suggested Readings:

- Vedantasara: Upendranath Mukhopadhyay
- Vedantasara: Medha Chaitanya
- Vedantasara: Kalibar Vedantavagish
- Vedantasara: Bipadbhanjan Pal
- Vedantasara-Advaitavada: Ashutos Shastri
- Vedantasara: Swami Nikhilananda (Eng. Version)
- A History of Indian Philosophy: S.N. Dasgupta

B: An Enquiry Concerning Human Understanding: David Hume

	Half-I	**(50 marks)**
Chapter 1—3	**Unit-I**	
Chapter 4—6	**Unit-II**	
	Half-II	**(50 marks)**
Chapter 7—9	**Unit-III**	
Chapter 10—12	**Unit-IV**	

Suggested Readings:

B. (An Enquiry Concerning Human Understanding: D. Hume)

- An Enquiry Concerning Human Understanding-D. Hume: J.N. Mohanty(ed.)
- The Philosophy of David Hume: Pabitra Kumar Roy
- The Philosophy of David Hume: N.K. Smith
- Hume's Theory of Causality: Tapan Kumar Chakraborty
- Hume: V.C. Chappell (ed.)
- Hume-er Enquiry-Ekti Upasthapana: Ramaprasad Das

C: The Problems of Philosophy: Bertrand Russell

	Half-I	**(50 marks)**
Chapter 1—3	**Unit-I**	
Chapter 4—6	**Unit-II**	
	Half-II	**(50 marks)**
Chapter 7—9	**Unit-III**	
Chapter 10—12	**Unit-IV**	

Suggested Readings:

- Russell and Moore-An Analytical Heritage: A.J. Ayer
- Russell: A.J. Ayer
- Russell: Mark Sanisbury
- Philosophy of B.Russell: Schlipp (ed.)
- Russell-A Short Introduction: A.C. Grayling
- Darshaner Samasya: Debika Saha
- Darshan Samasya: Sushil Kumar Chakraborty

D: Western Logic

Half-I (50 marks)

Unit—I

1. I.M. Copi: Symbolic Logic (fifth edn.) [Sections 3.4, 3.5, 3.6 and 3.7]
2. R.Jeffery: Formal Logic—Its scope and Limits (first edn.) [Ch IV]

Unit—II

3. W.V.O. Quine: Methods of Logic (third edn.) [Ch.s 18, 19]
4. P. Suppes: Introduction to Logic (Indian edn.) [Ch.9,Section 9.1 to 9.7].

Half-II (50 marks)

Unit—III

H.W.B. Joseph: An Introduction to Logic [Ch.s II & IV]
[Terms and their principal distinctions, The Predicables]

Unit—IV

H.W.B. Joseph: An Introduction to Logic [Ch. V]
[The Rules of Definition and Division:Classification and Dichotomy]

Suggested Readings:

- Sanktetik Yuktivijnan (Vakyakalan O Vidheyakalan): Ramaprasad Das
- Sabdajijnasa-Sabder Prakar o Prkriti: Ramaprasad Das
- Yukhtivaijnanik Paddhati: Ramaprasad Das
- Samsad Yuktivijnan Abhidhan: Ramaprasad Das o Subirranjan Bhattacharya

E: Ethics

Half-I **(50 marks)**

Unit—I

A. Postulates of morality.
B. Plato's moral theory.
C. Virtue Ethics (Aristotle).
D. Hume on Virtue.

Unit—II

A. Nature and scope of applied ethics.
B. Killing: Suicide, Euthanasia, Animal killing.
C. Poverty, Affluence and Morality.
D. War and Violence: Terrorism.

Half-II **(50 marks)**

Unit—III

A. Right: Nature and Value of Human Rights—Discrimination on the basis of race, caste and religion.
B. Concept of Justice and Equality.
C. Feminist Ethics: Some basic concepts of Feminism: Sexism, Patriarchy and Androcentrism, Liberal and Radical Feminism, The Ethics of Care.

Unit—IV

A. Environmental Ethics: Concepts of Anthropocentrism and non-anthropocentrism, Value beyond sentient beings, Reverence for life, Deep Ecology, Concepts of Kinship Ethics.
B. Ecological Concern in Indian thoughts: Jaina and Bauddha views.
C. Meta-ethics: Nature of meta-ethics, Emotivism as a meta-ethical theory, Prescriptivism.

Suggested Readings:

- Ethics-The Fundamentals: Julia Driver
- Ethics-Theory and Practice: J. Thiroux (Chs II & III)
- Ethics-Theory and Practice: Y.V. Satyanaryana
- Moral Reasons: J. Nuttal
- Moral Reasons: James Rachels
- Philosophical Ethics-An Introduction to Moral Philosophy: T.L. Beauchamp (ed.)
- Plato's Moral Theory: Terrance Irwine

- Virtue Ethics: R. Crisp & M. Stole (eds.)
- The Nicomachean Ethics: Aristotle trans. David Ross; revised by J.L. Ackrill and J. Urmson
- The Ethics of Aristotle: J.A.K. Thomson
- Aristotles Ethics: Devid Bostock
- Aristotles Ethics: J.O. Urmson
- Virtue Ethics: Rosalind Hursthorne (Ch. III)
- An Enquiry Concerning the Principles of Morals: D. Hume
- Elements of Moral Philosophy: James Rachels
- Theories of Rights: J. Waldron (ed.)
- Human Rights: Alan Gewirth
- Modern Moral Philosophy: W.D. Hudson
- Ethics Since 1900: Mary Warnock
- Introductory Ethics: Fred Feldman
- Ethics: W. Frankena
- Identity and Violence: Amartya Sen
- Twentieth Century Ethics: Roger Hancock
- Aspects of Hindu Morality: Saral Jhingram
- Practical Ethics: Peter Singer (Chs V,VII,VIII,X)
- Applied Ethics: Peter Singer (ed.)
- A Companion to Ethics: Peter Singer (Chs 14,19,22)
- A Companion to Bio-Ethics: Peter Singer & H. Kuhse (eds.)
- Human Rights-An Introduction: D.J. O'Byrne
- Man and Nature: G.F. MacLean (ed.)
- Human Rights, Gender and the Environment: Manisha Preya, Krishna Menon, Madhulika Banerjee
- Gender: G. Geetha
- A Short Introduction to Feminist Theory: Rinita Mazumdar
- Feminist Thought: Shefali Moitra
- Justice and Care: Essential Readings in Feminist Ethics: Virginia Held (ed.)
- Language, Truth and Logic: A.J. Ayer
- The language of Morals: R.M. Hare
- Nitishastra: Dikshit Gupta
- Vyavaharik Nitivijnan: N. Nandy & M. Bal
- Nitividya: Sanjib Ghosh
- Nitividyar Tattvakatha: Somnath Chakraborty
- Tattvagata Nitividya o Vyavaharik Nitividya: Samarendra Bhattacharya
- Vyavaharik Nitividya-Peter Singer: Pardip Kumar Roy (tr.)
- Prayogik Nitividya: A.S.M. Abdul Khalek

F. Contemporary Indian Philosophy

Swami Vivekananda, Rabindranath Tagore, Sri Aurobindo and M.K. Gandhi.

Half-I

Unit-I

Swami Vivekananda:

A. Real nature of man.
B. Nature of Religion.
C. Ideal of Universal Religion.
D. Concept of Practical Vedanta.

Unit-II

Rabindranath Tagore:

A. Reality and God.
B. Nature of Man.
C. Surplus in man.
D. Nature of Religion.
E. Tagore's Humanism.

Half-II (50 marks)

Unit—III

Sri Aurobindo:

A. Reality as Sat-Cit-Ānanda
B. Nature of Creation, the World process: Descent or involution, Maya and Lila, Ascent or evolution.
C. Integral Yoga.

Unit-IV

M.K.Gandhi:

A. God and Truth.
B. Nature of Man.
C. Non-Violence
   Satyāgraha.
D. Swaraj
E. Theory of Trusteeship

Suggested Readings:

- Contemporary Indian Philosophy: T.M.P. Mahadevan & G.V. Saroja
- Contemporary Indian Philosophy: Basant Kumar Lal
- Contemporary Indian Philosophy: Binoy Gopal Roy
- Practical Vedanta (Vol.II,pp-291-358): Swami Vivekananda
- Swami Vivekananda as a Philosopher: J.L. Shaw
- The Philosophy of Swami Vivekananda: Pradip Kumar Sengupta
- The Complete Works of Swami Vivekananda (Vol.I,pp-333-343 & II,pp-70-87,375-396): Mayavati Memorial Edition
- The Philosophy of Vivekananda: Govinda Dev
- Life Divine: Sri Aurobinda
- Synthesis of Yoga: Sri Aurobinda
- Integral Yoga: Sri Aurobinda
- Among the Great: Dilip Kumar Roy (Chapter on Sri Auribinda)
- Towards Supermanhood-The Philosophy of Sri Aurobinda: P.B. Chatterjee
- The Philosophy of Sri Aurobinda: Ramnath Sharma
- An Introduction to the Philosophy of Sri Aurobinda: S.K. Maitra
- Guide to Sri Aurobinda's Philosophy: K.D. Acharya
- Future Evolution of Man-The Divine Life Upon Earth: Sri Aurobinda
- Sri Aurobinda-The Prophet of Life Divine: Haridas Choudhuri
- Sri Aurobinda's Concept of the Superman: Chittaranjan Goswami
- Religion Of Man: Rabindranath Tagore
- Philosophy of Rabindranath Tagore: S. Radhakrishnan
- The Philosophy of Rabindranath Tagore : Binoy Gopal Roy
- Hind Swaraj: M.K. Gandhi
- Trusteeship; M.K. Gandhi
- Selections from Gandhi: N.K. Bose
- Contemporary Indian Philosophy: S,Radhakrishnan & J.H. Murihead (eds.)
- The Evolution of Political Philosophy of Gandhi: Buddhadeb Bhattacharya
- Social and Political Thought of Gandhi: Jayantanuja Bandyopadhyay
- The Philosophy of Mahatma Gandhi: D.M. Dutta
- The Philosophy of Sarvodaya: K.S. Bharathi
- Gandhi's Political Philosophy: Bhikhu Parekh
- Sarvodaya Andoloner Itihas: Gurudas Bandyopadhyay
- Gandhi Parikrama: Sailesh Kumar Bandyopadhyay
- Gandhi Rachanasambhar: M.K. Gandhi
- Chintanayak Vivekananda: Swami Lokeshwarananda (ed.)
- Swami Vivekanander Bani-o-Rachana (Khanda 2,pp-21-64;Khanda 3,pp-105-117,149-173): Janma Shatabarshiki Samskaran,Udbodhan

- Karmajibane Vedanta (Khanda 2,pp-219-290): Swami Vivekananda
- Visva-vivek: Asit Kr Bandyopadhyay, Shankari Prasad Basu, Shankar
- Manabjatir Bhavisyat Vivartan: Sri Aurobinda Ghosh
- Sri Aurobinda Katha: Manmatha Mukhopadhyay
- Divya Jiban: Srimat Anirban
- Yoga-Samannay: Srimat Anirban
- Sri Aurobinda Janma Shatabarshiki Smarak Grantha: Sri Aurobinda Patha Mandir
- Rabindra Rachanabali (Khanda 12,pp-532-545,567-614): Janmashatbarshiki Samskaran

General instructions regarding question pattern and distribution of marks:

Each paper will consist of two halves (50 marks each). The pattern of distribution of marks of each unit of each half of a paper will be as follows:

Compulsory:

- *Two* short type questions out of four questions, each carrying 5 marks (2X 5) =10.
- *One* question out of two questions each carrying 15 marks (1X 15) = 15

Total Marks of each unit of each half : (10+15)= 25

Total Marks of a paper: (25 X 4)= 100

Until the introduction of the semester system each paper will be of 100 marks. The pattern of distribution of marks will be as follows:

Q.1 is compulsory.

- Q1:Candidates will be required to answer *four* short type questions, each carrying 5 marks, out of *eight* questions covering the entire syllabus.
- Candidates will be required to answer *five* questions each carrying 16 marks out of *ten* questions taking at least *one* from **each unit.**

Syllabus for Three-Year B.A. (General) Course in Philosophy

Minimum number of classes per paper of 100 marks: 100

Part I

Paper I: METAPHYSICS AND EPISTEMOLGY-INDIAN & WESTERN 100 marks

Part II

Paper II: WESTERN LOGIC & PSYCHOLOGY 100 marks
Paper III: ETHICS AND PHILOSOPHY OF RELIGION 100 marks

Part III

Paper IV: SOCIAL-POLITICAL PHILOSOPHY AND CONTEMPORARY INDIAN THOUGHT

100 marks

PHILOSOPHY (GENERAL COURSE) (3 YEAR, B.A.)

PART-I

PAPER-I

(EPISTEMOLOGY AND METAPHYSICS—INDIAN AND WESTERN) 100 marks

Half-I **(50 marks)**

Indian Epistemology and Metaphysics

Unit-I

A. Cārvāka Epistemology: Perception as the only source of Knowledge; Refutation of Inference and Testimony as source of Knowledge.
B. Nyāya Epistemology: The Nature of Perception; Laukika Śannikarṣa; Determinate (Savikalpaka) and Indeterminate (Nirvikalpaka) Perception; Anumāna; Sādhya; Pakṣa, Hetu, Vyāpti, Paramarsa and Vyāptigraha; Svārthānumiti and Parārthānumiti; Pañcāvayavi Nyāya.

Unit-II

A. Vaiśeṣika Metaphysics: Categories—Dravya, Guṇa, Karma, Sāmanya, Viśeṣa , Samavāya, and Abhāva.
B. Advaita Metaphysics: Brahman, Māyā, The relation between Jīva and Brahman.

Half-II **(50 marks)**

Western Epistemology and Metaphysics

Unit-III

A. Different senses of 'Know', Conditions of Propositional Knowledge,Origin of Concepts: Concept Rationalism-Views of Descartes and Leibniz, Concept Empiricism-Views of Locke,Berkeley and Hume.
B. Theories of the origin of Knowledge: Rationalism, Empiricism, Kant's Critical Theory.
C. Realism: Naïve Realism, Locke's Representationalism.
Idealism: Subjective Idealism (Berkeley)

Unit-IV

A. Causality: Entailment Theory, Regularity Theory
B. Mind-Body Problem: Interactionism, Parallelism and the Identity Theory.

Suggested Readings:

- A Critical Survey of Indian Philosophy: C.D. Sharma
- An Introduction to Indian Philosophy: D. M. Dutta & S.C. Chatterjee
- Nyaya-Vaisesika Darshan: Karuna Bhattacharya
- Bharatiya Darshan: Nirodbaran Chakraborty
- Bharatiya Darshan: Samarendra Bhattacharya
- An Intruduction to Philosophical Analysis: J. Hospers
- An Introduction to Philosophy: Shibapada Chakraborty
- Paschatya Darshan O Yuktivijnan: Ramaprasad Das
- Paschatya Darshaner Ruparekha: Ramaprasad Das o Shibapada Chakraborty
- Paschatya Darshan O Yuktivijnan: Samir Kumar Chakraborty
- Paschatya Darshan: Samarendra Bhattacharya

PART-II

PAPER—II

(WESTERN LOGIC AND PSYCHOLOGY) 100 marks

Half-I (50 marks)

Western Logic

Unit-I

A. Introductory topics: Sentence, Proposition, argument, truth and validity.
B. Aristotelian classification of categorical propositions, distribution of terms, Existential Import Boolean interpretation of categorical propositions.
Immediate inference. Immediate inference based on the square of opposition, conversion, obversion and contraposition.
C. Categorical syllogism: Figure, mood, rules for validity, Venn Diagram method of testing validity, fallacies.

Unit-II

A. Symbolic Logic: Use of symbols
Truth-functions: Negation, Conjunction, disjunction, implication, equivalence.
B. Tautology, Contradiction, Contingent statement forms.
Construction of truth-table, using truth-tables for testing the validity of arguments and statement forms.
C. Mill's methods of experimental inquiry.

Half-II (50 marks)

Psychology

Unit-III

A. Sensation: What is sensation? Attributes of sensation.
Perception: What is perception? Relation between sensation and perception, Gestalt theory of perception, illusion and hallucination.
B. Consciousness: Conscious, Subconscious, Unconscious, Evidence for the existence of the Unconscious, Freud's theory of dream.

Unit-IV

A. Memory: Factors of memory, Laws of association, Forgetfulness.
   Learning: The Trial and Error theory, Pavlov's Conditioned-Response theory, Gestalt theory.
B. Intelligence: Measurement of Intelligence, I.Q., Test of Intelligence, Binnet-Simon test.

Suggested Readings:

- Introduction to Logic (13th Edn.): I.M. Copi & C. Cohen
- Paschatya Darshan O Yuktivijnan: Ramaprasad Das
- Paschatya Darshan O Yuktivijnan: Samir Kumar Chakraborty
- A Textbook of Psychology: Pareshnath Bhattacharya
- Introduction to Psychology: G.T. Morgan
- A Modern Introduction to Psychology: Rex Knight & M. Knight
- Monovidya: Priti Bhushan Chattopadhyay
- Monovidya: Pareshnath Bhattacharya
- Monovidya: Ira Sengupta
- Monovidya: Samarendra Bhattacharya

PAPER—III

(ETHICS AND PHILOSOPHY OF RELIGION) 100 marks

Half-I (50 marks)

Ethics (Indian and Western)

Unit-I

Ethics (Indian)

A. Four Puruṣārthas- Dharma, artha, kāma and mokṣa and their interrelation
   Karma (Sakāma & Niṣkāma)
   Cārvāka Ethics
B. Buddhist Ethics: The Four Noble Truths and the Eight-fold Path

Unit-II

Ethics (Western)

A. Moral and Non-moral Actions
   Object of Moral Judgement
B. Teleological Ethics: Utilitarianism (Bentham and Mill)
   Deontological Ethics: Kant's Moral Theory
C. Theories of Punishment

Half-II **(50 marks)**

Applied Ethics and Philosophy of Relgion

Unit-III

A. Concept of Applied Ethics.
B. Killing: Suicide, Euthanasia.
C. Famine, Affluence and Morality.
D. Environmental Ethics: Value Beyond Sentient Beings, Reverence for life, Deep Ecology

Unit-IV

A. Nature & Concerns of Philosophy of Religion.
   Argument for the existence of God: Cosmological argument, Ontological argument and Teleological argument.
B. Problem of Evil and Suffering.
C. Grounds for disbelief in God: Sociological theory of Durkheim, Freudian Theory,Carvaka View.

Suggested Readings:

- The Fundamentals of Hinduism-A Philosophical Study: S.C. Chatterjee
- The Ethics of the Hindus: S.K. Maitra
- Principles of Ethics: P.B. Chatterjee
- A Manual of Ethics: J.S. Mackenzie
- Ethics: W. Frankena
- An Introduction to Ethics: W. Lillie
- Practical Ethics: Peter Singer
- Applied Ethics: Peter Singer (ed.)
- Nitividya: Samarendra Bhattacharya
- Nitividya: Somnath Chakraborty
- Nitividyar Tattvakatha: Somnath Chakraborty
- Nitishastra: Dikshit Gupta
- Vyavaharik Nitivijnan: N. Nandy & M. Bal

- Nitividya: Sanjib Ghosh
- Philosophy of Religion: J. Hick
- The Philosophy of Religion: M.Edwards
- The Idea of God: Pringle Pattison
- Atheism in Indian Philosophy: D.P. Chattopadhyay
- Dharma Darshan: A. Bandyopadhyay o K.C. Gupta
- Dharma Darshan: Rabindranath Das
- Dharma Darshan: Sushil Kumar Chakraborty
- Bharatiya Dharmaniti: Amita Chattopadhyay (Sampadita)
- Bharatiya Darshane Nirishvarvada: B.B. Purakayastha (pp-39-50,56-66)

PART-III

PAPER-IV

(SOCIAL-POLITICAL PHILOSOPHYAND CONTEMPORARY INDIAN THOUGHT)

100 mraks

Half-I **(50 marks)**

(Social-Political Philosophy)

Unit-I

A. Primary Concepts: Society, Community, Association, Institution.
B. Social Groups: Its Different Forms. Family: Its Different Forms.
C. Social class and Caste: Principles of Class and Caste; Marxist conception of class; Class Attitudes and Class consciousness.

Unit-II

A. Social Codes: Religious and Moral Codes; Custom and Law; Culture and Civilization.
B. Political Ideals: Democracy: Its Different Forms.
Socialism: Utopian and Scientific Socialism.

Half-II **(50 marks)**

(Contemporary Indian Thought: Swami Vivekananda, M.K.Gandhi and B.R.Ambedkar)

Unit-III

A. Swami Vivekananda: Nature of man, nature of religion.
B. The ideal of a universal religion, Practical Vedānta.

Unit-IV

A. Gandhi: Nature of man, non-violence, satyāgraha, theory of trusteeship.
B. Ambedkar: Critique of social evils, Dalit movement.

Suggested Readings:

- Society: R.M. MacIver & C.H. Page
- Sociology: M. Ginsberg
- Sociology: Tom Bottomore
- Sociology: S.N. Shankar Rao
- Sociology: D.C. Bhattacharya
- Sociology: P.B. Kar
- Introduction to Modern Political Theory: C.E.M. Joad
- Samaj Tattva: Parimal Bhushan Kar
- Samaj Tattva: T. Bottomore
- Bisay Samaj Tattva: Anadi Kumar Mahapatra
- Samajdarshan o Rashtradarshan: Samarendra Bhattacharya
- Contemporary Indian Philosophy: T.M.P. Mahadevan & G.V. Saroja
- Contemporary Indian Philosophy: Basant Kumar Lal
- The Philosophy of Swami Vivekananda: Pradip Kumar Sengupta
- The Philosophy of Mahatma Gandhi: D.M. Dutta
- The Philosophy of Sarvodaya: K.S. Bharathi
- Gandhi's Political Philosophy: Bhikhu Parekh
- Dr. Ambedkar-Life & Mission: Dhananjoy Keer
- Social Philosophy of B.R. Ambedkar: D.R. Jatava
- The Essential Writings of B.R. Ambedkar: Valerian Rodrigues (ed.)
- Chintanayak Vivekananda: Swami Lokeshwarananda (ed.)
- Visva-vivek: Asit Kr Bandyopadhyay, Shankari Prasad Basu, Shankar
- Sarvodaya Andoloner Itihas: Gurudas Bandyopadhyay
- Gandhi Parikrama: Sailesh Kumar Bandyopadhyay
- Gandhi Rachanasambhar: M.K. Gandhi

General instructions regarding question pattern and distribution of marks:

Each paper will consist of two halves (50 marks each). The pattern of distribution of marks of each unit of each half of a paper will be as follows:

Compulsory:

- *Two* short type questions out of four questions, each carrying 5marks (2X 5)=10.
- *One* question (out of two questions) carrying 15 marks (1X 15) = 15.

Total Marks of <u>each unit</u> of <u>each half</u> : (10+15)=25.

Total Marks of a paper: (25+25+25+25)=100.

Until the introduction of the semester system each paper will be of 100 marks. Each paper is divided into **two** halves (50 marks each). The pattern of distribution of marks for <u>each half</u> will be as follows:

- Compulsory:

  Q.no.1:Candidates will be required to answer *four* short type questions out of eight questions, each carrying 5 marks. (4X5)=20

- Candidates will be required to answer *two* questions out of *four* questions taking <u>one</u> from <u>each unit.</u> Each questions carries 15 marks. (2X15)=30

  Total marks of each half of a paper (20+30)=50
  Total marks of a paper (50+50)=100

UNIVERSITY OF CALCUTTA

SYLLABI

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THREE-YEAR HONOURS AND GENERAL
DEGREE COURSES OF STUDIES

PHYSICS

2010

Honours

Part – I

1st year : **Paper I (100 Marks)**
Unit-01: 50 Marks- Mathematical Methods I & Mathematical Methods II
Unit-02: 50 Marks- Waves and Optics I & Electronics I
Paper IIA (50 Marks)
Unit-03: 50 Marks- Classical Mech.I & Thermal Physics I
Paper IIB (50 Marks)
Unit-04: 50 Marks- Laboratory

Part – II

2nd year : **Paper III (100 Marks)**
Unit-05: 50 Marks- Electronics II & Electricity and Magnetism
Unit-06: 50 Marks- Electrostatics & Waves and Optics II
Paper IVA (50 Marks)
Unit-07: 50 Marks- Quantum Mech.I & Thermal Physics II
Paper IVB (50 Marks)
Unit-08: 50 Marks- Laboratory

Part – III

3rd year : **Paper V (100 Marks)**
Unit-09: 50 Marks- Classical Mechanics II & Special Theory of Relativity
Unit-10: 50 Marks- Quantum Mech.II & Atomic Physics
Paper VI (100 Marks)
Unit- 11: 50 Marks- Nuclear and Particle Physics I & Nuclear and Particle Physics II
Unit- 12: 50 Marks- Solid State Physics I & Solid State Physics II
Paper VIIA (50 Marks)
Unit- 13: 50 Marks- Statistical Mechanics & Electromagnetic Theory
Paper VIIB (50 Marks)
Unit- 14: 50 Marks- Laboratory
Paper VIIIA (50 Marks)
Unit- 15: 50 Marks- Laboratory
Paper VIIIB (50 Marks)
Unit- 16: 50 Marks- Computer laboratory

Paper I

Unit - I

MATHEMATICAL METHODS I (25 Marks) **LECTURES: 25 + 5 Tutorial**

1. Preliminary Topics

Infinite sequences and series - convergence and divergence, conditional and absolute convergence, ratio test for convergence. Functions of several real variables - partial differentiation, Taylor's series, multiple integrals. Random variables and probabilities - statistical expectation value, variance; Analysis of random errors: Probability distribution functions (Binomial, Gaussian, and Poisson) (10)

2. Vector Analysis

Transformation properties of vectors; Differentiation and integration of vectors; Line integral, volume integral and surface integral involving vector fields; Gradient, divergence and curl of a vector field; Gauss' divergence theorem, Stokes' theorem, Green's theorem - application to simple problems; Orthogonal curvilinear co-ordinate systems, unit vectors in such systems, illustration by plane, spherical and cylindrical co-ordinate systems only. (10)

3. Matrices

Hermitian adjoint and inverse of a matrix; Hermitian, orthogonal, and unitary matrices; Eigenvalue and eigenvector (for both degenerate and non-degenerate cases); Similarity transformation; diagonalisation of real symmetric matrices. (5)

MATHEMATICAL METHODS II (25 Marks) **LECTURES 25 + 5 Tutorial**

1.Ordinary Differential Equations

Solution of second order linear differential equations with constant coefficients and variable coefficients by Frobenius' method (singularity analysis not required); Solution of Legendre and Hermite equations about x=0; Legendre and Hermite polynomials - orthonormality properties. (7)

2. *Partial Differential Equations*

Solution by the method of separation of variables; Laplace's equation and its solution in Cartesian, spherical polar (axially symmetric problems), and cylindrical polar (`infinite cylinder' problems) coordinate systems. (11)

3. Fourier Series

Fourier expansion – statement of Dirichlet's condition, analysis of simple waveforms with Fourier series. Introduction to Fourier transforms; the Dirac-delta function and its Fourier transform; other simple examples. Vibration of stretched strings- plucked and struck cases. (7)

Paper I

Unit-II

WAVES & OPTICS I (25 Marks) **LECTURES 25 + 5 Tutorial**

1. Linear Harmonic Oscillator

LHO. Free and forced vibrations. Damping. Resonance. Sharpness of resonance. Acoustic, optical, and electrical resonances: LCR circuit as an example of the resonance condition. A pair of linearly coupled harmonic oscillators --- eigenfrequencies and normal modes. (7)

2. Waves

Plane progressive wave in 1-d and 3-d. Plane wave and spherical wave solutions. Dispersion: phase velocity and group velocity. (5)

3. Fermat's principle

Fermat's principle and its application on plane and curved surfaces. (3)

4. *Cardinal points of an optical system*

Two thin lenses separated by a distance, equivalent lens, different types of magnification : Helmholtz and Lagrange's equations, paraxial approximation, introduction to matrix methods in paraxial optics – simple application. (5)

5. *Wave theory of light*

Huygen's principle; deduction of law of reflection and refraction. (5)

ELECTRONICS I (25 Marks) **LECTURES 25 + 5 Tutorial**

1. *Network*
Thevenin Theorem, Norton theorem, Maximum power transfer theorem, Superposition principle, T and Π networks. (3)

2. *Semiconductor diodes*:
p-n junction diode, I-V characteristics, Zener diode and its applications, optoelectronic diodes: LED, photo diodes. (2)

3. *Bipolar junction transistors (BJT)*
pnp and npn structures; active and saturation regions, characteristics of BJT, common emitter configuration, input and output characteristics, α and β of a transistor and their interrelation, common base configuration, output characteristics. Two port analysis of a transistor, definition of h-parameters, loadline concept, emitter follower, biasing methods, stability factor, low frequency model. Comparison of CB, CC and CE amplifiers. (6)

4. *Field effect transistors (FET)*
Classification of various types of FETs, construction of junction FET, drain characteristics, biasing, operating region, pinch-off voltage. MOSFET: construction of enhancement and depletion type, principle of operation and characteristics. Elementary ideas of CMOS and NMOS. (7)

5. *Digital electronics*
Boolean theorem, Boolean identities, OR, AND, NOT, NAND, NOR gates, Ex-OR, Ex-NOR gates, universal gate, de-Morgan's theorem, 1's and 2's complement, binary number addition, subtraction and multiplication, functional completeness, S-O-P and P-O-S representation, Karnaugh map.

(7)

Paper IIA
Unit-I

CLASSICAL MECHANICS I (25 Marks) **LECTURES: 25 + 5 Tutorial**

1. *Mechanics of a Single Particle*

Velocity and acceleration of a particle in (i) plane polar coordinates - radial and cross-radial components (ii) spherical polar and (iii) cylindrical polar co-ordinate system; Time and path integral of force; work and energy; Conservative force and concept of potential; Dissipative forces; Conservation of linear and angular momentum.

(7)

2. *Mechanics of a System of Particles*

Linear momentum, angular momentum and energy - centre of mass decompositon; Equations of motion, conservation of linear and angular momenta. (6)

3. *Rotational Motion*

Moment of inertia, radius of gyration; Energy and angular momentum of rotating systems of particles; Parallel and perpendicular axes theorems of moment of inertia; Calculation of moment of inertia for simple symmetric systems; Ellipsoid of inertia and inertia tensor; Setting up of principal axes in simple symmetric cases. Rotating frames of reference - Coriolis and centrifugal forces, simple examples. Force-free motion of rigid bodies - free spherical top and free symmetric top. (12)

THERMAL PHYSICS I (25 Marks) **LECTURES 25 + 5 Tutorial**

1.Kinetic Theory of Gases

Basic assumptions of kinetic theory, Ideal gas approximation, deduction of perfect gas laws. Maxwell's distribution law (both in terms of velocity and energy), root mean square and most probable speeds. Finite size of molecules : Collision probability, Distribution of free paths and mean free path from Maxwell's distribution. Degrees of freedom, equipartition of energy (detailed derivation not required). (8)

2.Transport Phenomena

Viscosity, thermal conduction and diffusion in gases. Brownian Motion: Einstein's theory, Perrin's work, determination of Avogardo number. (4)

3.Real Gases

Nature of intermolecular interaction : isotherms of real gases. van der-Waals equation of state, Other equations of state (mention only), critical constants of a gas, law of corresponding states; Virial Coefficients, Boyle temperature. (4)

4.Conduction of Heat

Thermal conductivity, diffusivity. Fourier's equation for heat conduction – its solution for rectilinear and radial (spherical and cylindrical) flow of heat. (3)

Radiation :

Spectral emissive and absorptive powers, Kirchoff's law, blackbody radiation, energy density, radiation pressure. Stefan-Boltzmann law, Newton's law of cooling, Planck's law (no detailed derivation). (6)

Paper III

Unit-I

ELECTRONICS II (25 Marks) **LECTURES 25 + 5 Tutorial**

1. *Amplifier*
   Voltage and current gain, principle of feedback, positive and negative feedback, advantages of negative feedback, multistage amplifier, frequency response of a two stage R-C coupled amplifier, gain and band width and their product, operating point of class A, amplifier, analysis of single tuned voltage amplifier, requirement of power amplifiers (4)

2. *Oscillators*
   Barkhausen criterion for sustained oscillation, L-C, Weinbridge and crystal oscillators, relaxation oscillators- monostable, bistable and astable multivibrators. (4)

3. *Operational amplifier*
   Properties of ideal OP-AMP, differential amplifiers, CMRR, inverting and non-inverting amplifiers, mathematical operations. (4)

4. *Combinational logic*
   Half adder, full adder, digital comparator, decoder, encoder (ROM), multiplexure (5)

5. *Sequential logic*
   Flip-flops- RS, D, JK, JKMS flip-flops, edge triggering. Shift register, ripple counter(binary and decade). (5)

6. *Communication principles*
   Modulation and demodulation – elementary theory of AM, FM and PM, demodulation of AM (diode detector) and FM (slope detector) waves. (3)

ELECTRICITY AND MAGNETISM (25 Marks) **LECTURES 25 + 5 Tutorial**

1. *Magnetic effect of steady current*
   Lorentz force and concept of magnetic induction; force on linear current element; Biot-Savart's law. $\nabla . \mathbf{B}=0$; magnetic vector potential; calculation of vector potential and magnetic induction in simple cases – straight wire, magnetic field due to small current loop; magnetic dipole; field due to a dipole; magnetic shell; Ampere's theorem; Ampere's circuital law – simple illustrations; force between long parallel current carrying conductors; $\nabla \times \mathbf{B} = \mu \mathbf{J}$; comparison between static electric and magnetic fields. (8)

2. *Field and magnetic materials*
   Free current and bound current; surface and volume density of current distribution; magnetisation; nonuniform magnetisation of matter; $\mathbf{J}_b = \nabla \times \mathbf{M}$; Ampere's law in terms of free current density and introduction of **H**; line integral of **H** in terms of free current; boundary conditions for **B** and **H**; permanently magnetized body; magnetic scalar potential; application of Laplace's equation to the problem of a magnetic sphere in uniform magnetic field; hysteresis and energy loss in ferromagnetic material; magnetic circuit; energy stored in magnetic field. (9)

3. *Electromagnetic induction*
   Faraday's and Lenz's law; motional e.m.f.-simple problems; inductances in series and parallel; reciprocity theorem LR, CR and LCR circuits- transient and sinusoidal emf cases, calculation of self and mutual inductance in simple cases. (8)

Unit-II

ELECTROSTATICS (25 Marks) **LECTURES 25 + 5 Tutorial**

1. *Units and dimensions*

CGS, Gaussian and SI units; conversion between Gaussian and SI units; dimension of various quantities. **(SI system to be followed for the rest of the syllabus)** (2)

2. *Gauss' law*

Coulomb's law of electrostatics, intensity and potential; Gauss' theorem – its application; Poisson and Laplace's equations; Superposition theorem (statement only). Application of Laplace's equation to simple cases of symmetric spherical charge distribution. (7)

3.Multipole expansion

Multipole expansion of scalar potential – monopole, dipole and quadrupole terms; potential and field due to a dipole; work done in deflecting a dipole; dipole-dipole interaction (for both electric and magnetic dipoles); force on dipole in a non-homogeneous field. (6)

4. Dielectrics

Polarisation, electric displacement vector (**D**); Gauss's theorem in dielectric media; boundary conditions; electrostatic field energy; computation of capacitance in simple cases (parallel plates); spherical and cylindrical capacitors containing dielectrics – uniform and non-uniform. (6)

5. Electrical Images

Solution of field problems in case of a point charge near a grounded conducting infinite plane. Boundary value problem : in uniform external field for (i) conducting spherical shell and (ii) dielectric sphere. (4)

WAVES & OPTICS II (25 Marks) **LECTURES 25 + 5 Tutorial**

1. *Interference of light waves*

Young's experiment; spatial and temporal coherence; intensity distribution; Fresnel's biprism, interference in thin film; fringes of equal inclination and equal thickness; Newton's ring. Michelson's interferometer. Multiple beam interference – reflected and transmitted pattern. Fabry-Perot interferometer. (9)

2. *Diffraction of light waves*

Fresnel and Fraunhofer class, Fresnel's half period zones; explanation of rectilinear propagation of light; zone plate. Fraunhofer diffraction due to a single slit, double slit and circular aperture (qualitative). Plane diffraction grating (transmission). Rayleigh criterion of resolution; resolving power of prism, telescope, microscope and transmission grating. (10)

3. *Polarisation*

Different states of polarisation; double refraction, Huygen's construction for uniaxial crystals; polaroids and their uses.

Production and analysis of plane, circularly and elliptically polarised light by retardation plates and rotatory polarisation and optical activity; Fresnel's explanation of optical activity; Biquartz and half shade polarimeter. (6)

Paper IVA

Unit-I

QUANTUM MECHANICS I (25 Marks) **LECTURES 25 + 5 Tutorial**

1. *Old quantum theory*

Planck's formula of black-body radiation. Photoelectric effect. Bohr atom and quantization of energy levels. (5)

2. *Basic quantum mechanics*

de Broglie hypothesis. Electron double-slit experiment. Compton effect, Davisson-Germer experiment, Heisenberg's uncertainty principle (statement) with illustrations. Concept of wave function as describing the dynamical state of a single particle. Group and phase velocities, classical velocity of a particle and the group velocity of the wave representing the particle. Principle of superposition. Schrodinger equation. Probabilistic interpretation; equation of continuity, probability current density. Boundary conditions on the wave function. (10)

3. Basic postulates of quantum mechanics

Dynamical variables as linear hermitian operators and eigenvalue equations, Momentum, energy and angular momentum operators. Measurement of observables, expectation values. Commutation relations between operators. Compatible observables and simultaneous measurements, Ehrenfest theorem. (10)

THERMAL PHYSICS II (25 Marks) **LECTURES 25 + 5 Tutorial**

1. *Basic Concepts*

Microscopic and macroscopic points of view : thermodynamic variables of a system, State function, exact and inexact differentials. (2)

2. *First Law of Thermodynamics*

Thermal equilibrium, Zeroth law and the concept of temperature. Thermodynamic equilibrium, internal energy, external work, quasistatic process, first law of thermodynamics and applications including magnetic systems, specific heats and their ratio, isothermal and adiabatic changes in perfect and real gases. (5)

3. *Second Law of Thermodynamics*

Reversible and irreversible processes, indicator diagram. Carnot's cycles-efficiency, Carnot's theorem. Kelvin's scale of temperature, relation to perfect gas scale, second law of thermodynamics – different formulations and their equivalence, Clausius inequality, entropy, change of entropy in simple reversible and irreversible processes, entropy and disorder; equilibrium and entropy principle, principle of degradation of energy. (9)

4. *Thermodynamic Functions*

Enthalpy, Helmholtz and Gibbs' free energies; Legendre transformations, Maxwell's relations and simple deductions using these relations; thermodynamic equilibrium and free energies. (4)

5. *Change of State*

Equilibrium between phases, triple point : Gibbs' phase rule (statement only) and simple applications. First and higher order phase transitions, Ehrenfest criterion. Clausius-Clapeyron's equation. Joule-Thomson effect. (5)

Paper V

Unit-I

CLASSICAL MECHANICS II (25 Marks) **LECTURES 25 + 5 Tutorial**

1. Central force problem

Motion under central force; Nature of orbits in an attractive inverse square field; Kepler's laws of planetary motion. Rutherford scattering as an example of repulsive potential. (7)

2. *Mechanics of Ideal Fluids*

Streamlines and flowlines; Equation of continuity; Euler's equation of motion; Streamline motion - Bernoulli's equation and its applications. Definition of Newtonian and non-Newtonian fluids. (6)

3. Lagrangian and Hamiltonian formulation of Classical Mechanics

Generalised coordinates, constraints and degrees of freedom; D'Alembart's principle; Lagrange's equation for conservative systems (from D'Alembert's principle; variational principle not required) and its application to simple cases; Generalised momentum; Idea of cyclic coordinates, its relation with conservation principles; Definition of Hamiltonian, Hamilton's equation (derivation by Legendre transformation) and its application to simple cases. (12)

SPECIAL THEORY OF RELATIVITY (25 Marks) **LECTURES 25 + 5 Tutorial**

1. Introduction

Galilean transformation and invariance of Newton's laws of motion, non-invariance of Maxwell's equations. Michelson-Morley experiment and explanation of the null result. (4)

2. Special Theory of Relativity

Concept of inertial frame. Postulates of special theory; simultaneity; Lorentz transformation along one of the axes – length contraction, time dilatation and velocity addition theorem, Fizeau's experiment. Four vectors. Relativistic dynamics : variation of mass with velocity; energy momentum relationship. (10)

3. Vectors and Tensors

Covariant and contravariant vectors. Contraction. Covariant, contravariant, and mixed tensors of rank-2, transformation properties. The metric tensor (flat space-time only). Raising and lowering of indices with metric tensors. (Consistent use of any one convention --- diag(-1,1,1,1) or diag(1,-1,-1,-1).) Example of common four-vectors: position, momentum, derivative, current density, four-velocity. (6)

4. Invariant intervals

Concept of space-time: Euclidean and Minkowski. Invariant intervals in 1+1 and 3+1 dimensions (use Minkowski space-time). Space like, time-like and light like four vectors. Light cone. Causality and simultaneity in different frames. (5)

Unit-II

QUANTUM MECHANICS II (25 Marks) **LECTURES 25 + 5 Tutorial**

1. Time dependent and time independent Schrodinger equation

Eigenstates, normalization and orthonormality.
(4)

2. Simple applications of Quantum Mechanics

One dimensional potential well and barrier, boundary conditions, bound and unbound states. Reflection and transmission coefficients for a rectangular barrier in one dimension – explanation of alpha decay. Free particle in one dimensional box, box normalization, momentum eigenfunctions of a free particle. Linear harmonic oscillator, energy eigenvalues from Hermite differential equation, wave function for ground state, parity of wave function. (11)

3. Schrodinger equation in spherical polar coordinates

Angular momentum operators and their commutation relations; eigenvalues and eigenfunctions of L^2 and L_z; theorem of addition of angular momenta [statement with examples]. The hydrogen atom problem – stationary state wavefunctions as simultaneous eigenfunctions of H, L^2, and L_z; radial Schrodinger equation and energy eigenvalues [Laguerre polynomial solutions to be assumed]; degeneracy of the energy eigenvalues. (10)

ATOMIC PHYSICS (25 Marks) **LECTURES 25 + 5 Tutorial**

1. Atomic Spectrum

Good quantum numbers, and selection rules. Stern-Gerlach experiment and spin as an intrinsic quantum number. Incompatibility of spin with classical ideas. Bohr-Sommerfeld model. Fine structure. Study of fine structure by Michelson interferometer. (11)

2. Vector atom model

Magnetic moment of the electron, Lande g factor. Vector model – space quantization. Zeeman effect. Explanation from vector atom model.
(4)

3. Many electron model

Pauli exclusion principle, shell structure. Hund's rule, spectroscopic terms of many electron atoms in the ground state.
(2)

4. Molecular spectroscopy

Diatomic molecules – rotational and vibrational energy levels. Basic ideas about molecular spectra. Raman effect and its application to molecular spectroscopy (qualitative discussion only). (3)

5. Laser Physics

Population inversion, Einstein's A and B coefficients; feedback of energy on a resonator; 3-level and 4-level systems. (5)

Paper VI

Unit-I

NUCLEAR & PARTICLE PHYSICS I (25 Marks) **LECTURES 25 + 5 Tutorial**

1.Bulk properties of nuclei

Nuclear mass, charge, size, binding energy, spin and magnetic moment. Isobars, isotopes and isotones; mass spectrometer (Bainbridge). (5)

2. Nuclear structure

Nature of forces between nucleons, nuclear stability and nuclear binding, the liquid drop model

(descriptive) and the Bethe-Weizsacker mass formula, application to stability considerations, extreme single particle shell model (qualitative discussion with emphasis on phenomenology with examples). (9)

3. Unstable nuclei

(a) Alpha decay : alpha particle spectra – velocity and energy of alpha particles. Geiger-Nuttal law. (3)

(b) Beta decay : nature of beta ray spectra, the neutrino, energy levels and decay schemes, positron emission and electron capture, selection rules, beta absorption and range of beta particles, Kurie plot. (4)
(c)Gamma decay : gamma ray spectra and nuclear energy levels, isomeric states. Gamma absorption in matter – photoelectric process, Compton scattering, pair production (qualitative).
(4)

NUCLEAR & PARTICLE PHYSICS II (25 Marks) LECTURES 25 + 5 Tutorial

1. Nuclear reactions

Conservation principles in nuclear reactions. Q-values and thresholds, nuclear reaction cross-sections, examples of different types of reactions and their characteristics. Bohr's postulate of compound nuclear reaction, Ghoshal's experiment. (4)

2. Nuclear fission and fusion

Discovery and characteristics, explanation in terms of liquid drop model, fission products and energy release, spontaneous and induced fission, transuranic elements. Chain reaction and basic principle of nuclear reactors. Nuclear fusion: energetics in terms of liquid drop model. (5)

3. Elementary particles

(a) Four basic interactions in nature and their relative strengths, examples of different types of interactions. Quantum numbers – mass, charge, spin, isotopic spin, intrinsic parity, hypercharge. Charge conjugation. Conservation laws. (3)

(b) Classifications of elementary particles – hadrons and leptons, baryons and mesons, elementary ideas about quark structure of hadrons – octet and decuplet families. (4)

4. Particle Accelerator and Detector

Cyclotron – basic theory, synchrotron, GM counter (3)

5. Nuclear Astrophysics

Primordial nucleosynthesis, energy production in stars, pp chain, CNO cycle. Production of elements (qualitative discussion) (6)

Unit-II

SOLID STATE PHYSICS I (25 Marks) LECTURES 25 + 5 Tutorial

1. Crystal Structure

Crystalline and amorphous solids, translational symmetry. Elementary ideas about crystal structure, lattice and bases, unit cell, reciprocal lattice, fundamental types of lattices, Miller indices, lattice planes, simple cubic, f.c.c. and b.c.c. lattices. Laue and Bragg equations. Determination of crystal structure with X-rays. (10)

2. Structure of solids

Different types of bonding- ionic, covalent, metallic, van der Waals and hydrogen. Band theory of solids, Periodic potential and Bloch theorem, Kronig-Penny model, energy band structure. Band structure in conductors, direct and indirect semiconductors and insulators (qualitative discussions); free electron theory of metals, effective mass, drift current, mobility and conductivity, Wiedemann-Franz law. Hall effect in metals : Phenomenology and implication. (15)

SOLID STATE PHYSICS II (25 Marks) **LECTURES 25 + 5 Tutorial**

1. *Dielectric properties of materials*

Electronic, ionic and dipolar polarizability, local fields, induced and oriented polarization – molecular field in a dielectric; Clausius-Mosotti relation. (4)

2. *Magnetic properties of materials*

Dia, para and ferro-magnetic properties of solids. Langevin's theory of diamagnetism and paramagnetism. Quantum theory of paramagnetism, Curie's law. Ferromagnetism : spontaneous magnetization and domain structure; temperature dependence of spontaneous magnetisation; Curie-Weiss law, explanation of hysteresis. (11)

3 *Lattice vibrations*

Elastic and atomic force constants; Dynamics of a chain of similar atoms and chain of two types of atoms; optical and acoustic modes; interaction of light with ionic crystals. Einstein's and Debye's theories of specific heats of solids. (5)

4. *Superconductivity*

Introduction (Kamerlingh-Onnes experiment), effect of magnetic field, Type-I and type-II superconductors, Isotope effect. Meissner effect. Heat capacity. Energy gap. Ideas about High-Tc superconductors. (5)

Paper VIIA

Unit-I (5)

STATISTICAL MECHANICS (25 Marks) **LECTURES 25 + 5 Tutorial**

1.Microstates and macrostates

Classical description in terms of phase space and quantum description in terms of wave functions. Hypothesis of equal *a priori* probability for microstates of an isolated system in equilibrium. Interactions between two systems – thermal, mechanical and diffusive. Statistical definition of temperature, pressure, entropy and chemical potential. Partition function of a system in thermal equilibrium with a heat bath. (6)

2. *Classical statistical mechanics*

Maxwell-Boltzmann distribution law. Calculation of thermodynamic quantities for ideal monoatomic gases. (2)

3. *Motivations for quantum statistics*

Gibbs' paradox. Identical particle and symmetry requirement. Derivation of MB, FD and BE statistics as the most probable distributions (micro-canonical ensemble). Classical limit of quantum statistics. (5)

4. *Quantum statistical mechanics*

Bose-Einstein statistics: Application to radiation – Planck's law. Rayleigh Jeans and Wien laws as limiting cases, Stefan's law. Fermi-Dirac statistics: Fermi distribution at zero and non-zero temperatures. Fermi energy and its expression in terms of particle density. Degenerate and non-degenerate Fermi gas. Electron specific heat of metals at low temperature. Saha equation for thermal ionization and its application to astrophysics. (12)

ELECTROMAGNETIC THEORY (25 Marks) **LECTURES 25 + 5 Tutorial**

1. *Generalization of Ampere's Law*

   Displacement Current, Maxwell's Field Equations, Wave equation for electromagnetic (EM) field and its solution – plane wave and spherical wave solutions, transverse nature of field, relation between **E** and **B**; energy density of field, Poynting vector and Poynting's theorem, boundary conditions. (8)

2. *EM Waves in an isotropic dielectric*

   Wave equation, reflection and refraction at plane boundary, reflection and transmission coefficients, Fresnel's formula, change of phase on reflection, polarization on reflection and Brewster's law, total internal reflection. (6)

3. *EM waves in conducting medium*

   Wave equation in conducting medium, reflection and transmission at metallic surface – skin effect and skin depth, propagation of E-M waves between parallel and conducting plates – wave guides (rectangular only). (5)

4. *Dispersion*

   Equation of motion of an electron in a radiation field : Lorentz theory of dispersion – normal and anomalous; Sellmeier's and Cauchy's formulae, absorptive and dispersive mode, half power frequency, band width. (3)

5. *Scattering*

   Scattering of radiation by a bound charge, Rayleigh's scattering (qualitative ideas), blue of the sky, absorption. (3)

PRACTICAL PAPERS

Marks Distribution

Part I	Paper IIB UNIT- 1	Full marks- 20
	UNIT- 2	Full marks- 30
Part II	Paper IVB	Full marks- 50
Part III	Paper VIIB	Full marks- 50
	Paper VIIIA	Full marks- 50
	Paper VIIIB	Full marks- 50

Laboratory Teaching Classes

One laboratory class (of 3 periods duration) per week should be devoted to teach the following topics during the first year. These lectures should be taken in laboratory and should be of interactive type so that students also participate in the learning process.

As the course on computer will be taught in early months of first year, students will get sufficient time to use computer in practical classes. During the three year period each student has to write a number of computer programmes and execute them on a computer. The programmes and the results should be collected in the form of a note book and that is to be submitted at the time of practical examination of Paper 16. This Computer Note Book [CNB] must be signed by the class teacher. During the practical examination of Paper 16, the examiners will check the CNB and ask questions on the report presented by the students in their CNB. The students will have to solve two problems during the examination of paper 16.

Laboratory Teaching

1. Demonstration lectures on use of vernier, micrometer, spherometer, barometer, common balance ,etc.; graph plotting -1 Lab-class
2.(i) Basic ideas of Probability & Statistics
(ii) Error analysis, significant figures, limits of accuracy of an Experiment-associated choice of equipments. -3 Lab-class
3. Measuring instruments (e.g. Galvanometer, Multimeter & CRO) to be used in the laboratory -2 Lab-class
4. Computer-Fundamentals and Programing in C or Fortran -6 Lab-class

Total = 12 Lab-class

In practical classes all data should be recorded directly in the Laboratory Note Book and signed regularly by the attending teachers. This Note Book should be submitted at the time of final practical examination. No separate fair L.N.B. need be maintained. The evaluation of the L.N.B. will be done by the external examiner.

PRACTICAL

PAPER – IIB
UNIT - I

Total Marks 20 **Time – 2 hours**

Distribution of Marks : LNB-5, VIVA-5, Experiment-10; Total = 20.

1. Determination of moment of inertia of metallic cylinder / rectangular bar about an axis passing through its C.G. and to determine the rigidity modulus of the material of the suspension wire.
2. Determination of refractive index of a liquid by using travelling microscope.
3. To estimate the temperature of a torch bulb filament from resistance measurement and to verify Stefan's law.
4. To convert a given ammeter into a voltmeter and a given voltmeter into an ammeter and hence to calibrate the device and measure the internal resistance in each case.
5. To measure the resistance per unit length of the wire of a bridge and to determine an unknown resistance by Carey Fosters bridge.
6. To measure the current flowing in a circuit by measuring the drop of potential across a known resistance in the circuit using a potentiometer (by measuring the resistance of the potentiometer with a P.O. Box).
7. To verify truth tables of different gates using discrete components abd I.C's

UNIT - II

Total Marks 30 **Time – 4 hours**

Distribution of Marks : LNB-5, VIVA-5, Experiment-20; Total = 30.

1. Adjustment of the Spectrometer for parallel rays by Schusters method and to determine the refractive index of the material of a prism by spectrometer from (i-δ) curve.
2. To study the variation of refractive index (μ) of the material of a prism with wave length and to verify Cauchy's dispersion formula and to find the dispersive power of the material of the prism by spectrometer.
3. To determine the specific heat capacity of a liquid by continuous flow (Callender and Barnes) method.
4. Determination of thermal conductivity of a bad conductor of heat by Lee's and Chorlton's method.
5. To study the nature of dependence of dipolar field of a short bar magnet on distance with the help of a deflection magnetometer and to determine the horizontal component of the Earth's magnetic field.
6. To draw the forward and reverse characteristics of a zener diode and to study its regulation characteristics. Estimate the a.c. resistances of the diode for different diode currents in both forward and reverse bias conditions.
7. To draw the regulation characteristics of a bridge rectifier (i) without using any filter and (ii) using a filter. Determine the ripple factor in both cases by measuring the ripple voltage with the help of an ac meter.
8. To execute half adders and full adders with basic gates and hence to verify addition of binary numbers.

PAPER – IVB

Total Marks 50 **Time – 6 hours**

Distribution of Marks : LNB-10, VIVA-10, Experiment-30; Total = 50

1. To determine the wavelength of a monochromatic light by Newton's ring method.
2. Measurement of the slit width and the separation between the slits of a double slit by observing the diffraction and interference fringes.
3. To calibrate a polarimeter and hence to determine the concentration of sugar solution.
4. To determine the boiling opoint of a liquid using a platinum resistance thermometer.
5. To calibrate a thermocouple with the help of potentiometer and hence (i) to measure the thermoelectric power

at a particular temperature , (ii) to measure an unknown temperature.
6. To study the variation of mutual inductance of a given pair of co-axial coils by using a ballistic galvanometer.
7. To calibrate a Hall probe with the help of a Ballistic Galvanometer and use the probe to study the variation of magnetic field of an electromagnet with (i) the magnetizing current and (ii) position in a transverse direction.
8. To measure the voltage across the inductance (L), capacitance (C) and resistance(R) of a series LCR circuit for different frequencies of the input voltage with the help of an A.C millivoltmeter. Hence (i) to study the variation of impedance of L and C with frequency of the impressed voltage, (ii) to draw the resonance curve of the series LCR circuit and to determine the Q-factor of the circuit.
9. Verification of Thevenin, Norton and Maximum power transfer theorems using a resistive Wheatstone bridge, d.c. source and d.c. meters.
10.To determine the band gap energy of a given semiconductor by four-probe method.
11. To draw the characteristics of a transistor in C-E mode and hence to determine the hybrid parameters using dc and ac sources .
12. a)To draw the characteristics of a JFET and hence to determine the relevant parameters and b) to design an amplifier using JFET.

PAPER – VIIB

Total Marks 50 **Time 6 hours**

Distribution of Marks : LNB-10, VIVA-10, Experiment-30;Total=50.

1. To determine the wavelength of a monochromatic light by Fresnel's biprism
2. Verification of Fresnel's equation of reflection of electromagnetic waves with the help of prism and two polaroids.
3. To find the number of lines per centimeter of the transmission grating and hence to measure the wavelength of an unknown spectral line and to measure the wavelength difference between D1 and D2 lines of sodium using a slit of adjustable width
4. To draw the B-H loop for the material of an anchor ring by ballistic galvanometer and to estimate the energy loss per cycle of magnetisation.
5. (a) To measure the self inductance of two coils by Anderson bridge .To find the total inductance of the above two coils connected in series and hence estimate the coefficient of coupling between the coils.
(b)To study the variation of inductance of two coils in series with angle between their planes by Anderson bridge.
6. To determine Fourier spectrum of (i) square, (ii) triangular and (iii) half sinusoidal waveform by C.R.O.
7. To study the diffraction pattern of a crossed grating with the help of a LASER source.

PAPER – VIIIA

Total Marks 50 **Time 6 hours**

Part-B. Electronics Experiment : LNB-10, VIVA-10, Expt-30; Total = 50

1. To construct a regulated power supply on a bread board, using
   (i) a power transistor as pass element,
   (ii) a second transistor as a feedback amplifier and
   (iii) a zener diode as a reference voltage source and to study its operational characteristics.
2. To design and draw the output waveform of an astable multivibrator and hence to verify the time period of oscillation.
3. To construct and study the frequency response of a voltage amplifier using a transistor in CE mode and to find its bandwidth.
4. To design and test the following circuits using an OPAMP
   (i) Inverting and non inverting amplifier
   (ii) Differential amplifier
   (iii) Schmitt trigger
   (iv) Integrator
   (v) Differentiator.
5. To construct Wein Bridge oscillator on a bread board using OPAMP and to study the wave form of the oscillator and calibrate it using CRO.

6. To design and fabricate a temperature controller and to study its performance characteristics.
7. To design and verify the following digital circuits using basic gates:
   i) S-R flip-flops , ii) J-K flip-flops, iii) 4 input multiplexer iv) 7-segment demultiplexer
   v) Mod-5 and decade counters.

USE OF PREFABRICATED CIRCUIT PROHIBITED

PAPER –VIIIB

Total Marks 50 **Time 3 hours**

Distribution of Marks : CNB-10, Viva-10; Experiment : 30 TOTAL = 50.

Apart from executing the programmes prescribed in the syllabus, students should be encouraged to execute other problems of Physics particularly associated with practical with the help of computer, using available software packages (e.g. graph plotting etc.).

1. Language (FORTRAN or C)

Constants and variables. Assignment and arithmetic expressions. Logical expressions and control statements, loops, array, input and output statements (with I, F and E formats), function subprogram, subroutine.

2. Numerical analysis

Computer arithmetic and errors in floating point representation of numbers, different numerical methods for the following problems:

Group A
(i) Sorting.
(ii) Read N numbers, find their mean, median, mode
(iii) Find whether a number is prime, factorize a number
(iv) Sum of different types of series term by term with a specified accuracy
(v) Matrix operations (addition, subtraction, multiplication,transpose)

Group B
(vi) Solution of simultaneous linear equations by Gauss-Siedel method
(vii) Least square fit of a given set of data to a straight line, application to exponential ($y=ae^{bx}$) and power ($y=ax^{b}$) laws.
(viii) Finding zeroes of a given function by the method of bisection and Newton-Raphson
(ix) Interpolation by Lagrange's method
(x) Integration by trapezoidal and Simpson's rule.

The above basic types of programs should be explained in practical classes before performing the experiments. **Each student will have to solve one problem each from Group A and Group B (each of 15 marks) during the examinations.**

B.Sc. (Physics) General Syllabus

PART-I (1st Year)

Paper IA: (50 Marks): Classical Mechanics and Gravitation, Heat and Thermodynamics
Paper IB: (50 Marks): General Properties of Matter, Waves and Vibrations, Geometrical Optics

PART-II (2nd Year)

Paper IIA:(50 Marks): Laboratory
Paper IIB:(50 Marks): Electricity and Magnetism
Paper IIIA:(50 Marks): Physical Optics, Electronics, Modern Physics
Paper IIIB:(50 Marks): Laboratory

PART-III (3rd Year)

Paper IVA:(50 Marks): Application of Thermodynamics, Energy Sources, Electronics, Communications
Paper IVB:(50 Marks): Laboratory, Computer Laboratory

(*Only SI Units to be used*)

Paper IA
Unit I: Classical Mechanics and Gravitation (25)

1. Dimensions of Physical Quantities : Principle of dimensional homogeneity

2. Vectors : Axial and polar vectors, dot product and cross product, scalar triple product and vector triple product. Scalar and vector fields --- gradient, divergence and curl, statement of divergence theorem, statement of Stokes' theorem.

3. Mechanics of a Particle : (a) Newton's laws of motion, principle of conservation of linear momentum, time and path integral of force, conservative force field, concept of potential, conservation of total energy, equation of motion of a system with variable mass.
(b) Rotational motion, angular velocity, angular acceleration, angular momentum, torque, fundamental equation of rotational motion, principle of conservation of angular momentum, radial and cross-radial acceleration.

4. Dynamics of Rigid Bodies : Moment of inertia and radius of gyration - their physical significance, theorems of parallel and perpendicular axes, rotational kinetic energy, calculation of moment of inertia for some simple symmetric systems. Physical significance of MI.

5. Gravitation : Gravitational potential and intensity due to thin uniform spherical shell and solid sphere of uniform density, escape velocity.

Unit II : Heat and Thermodynamics (25)

1. Kinetic Theory of Gases : Perfect gas, pressure exerted by it, Maxwell's law of distribution of molecular velocities (statement only) - rms, mean and most probable velocities, degrees of freedom, principle of equipartition of energy - application in simple cases. Equation of state - defects of ideal gas equation, van der Waals equation (qualitative study), critical constants.

2. Thermal Conductivity : Steady state and variable state, thermal and thermometric conductivity, Fourier equation for one-dimensional heat flow and its solution, Ingen Hausz's experiment, cylindrical flow of heat.

3. Thermodynamics : Basic concepts (equilibrium state, state function, exact and inexact differential), internal energy as state function. First law of thermodynamics and its application. Isothermal and adiabatic changes - relations, indicator diagrams. Reversible and irreversible processes, second law of thermodynamics, Carnot cycle and its efficiency, entropy and its physical interpretation.

4. Radiation : Nature of radiant heat, emissive and absorptive power, Kirchhoff's law, black body radiation, Stefan's law, Newton's law of cooling, Planck's distribution law (only statement), Wien's displacement law, pyrometer - principle.

Paper IB

Unit I : General Properties of Matter (20)

1. Elasticity : Elastic moduli and their interrelations, torsion of a cylinder, bending moment, cantilever, simply supported beam with concentrated load at the centre, strain energy.

2. Viscosity : Streamline and turbulent motion, Poiseuille's formula, critical velocity, Reynolds number, Bernoulli's theorem, Stokes' law (statement only).

3. Surface Tension : Surface tension and surface energy, molecular theory, angle of contact, elevation and depression of liquid columns in a capillary tube, excess pressure in a spherical bubble and spherical drop.

Unit II : Waves and Vibrations (15)

1. Simple Harmonic Motion : Differential equation and its solution.

2. Superposition of Simple Harmonic Motion : Analytical treatment, Lissajous figures, natural, damped and forced vibration, resonance, sharpness of resonance.

3. Differential Equation of Wave Motion : Plane progressive wave - energy and intensity. Bel, decibel and phon. Superposition of waves, beats. Velocity of longitudinal wave in solid and in gas, velocity of transverse wave in string, Doppler effect.

Unit III : Geometrical Optics (15)

1. *Reflection and refraction :* Fermat's Principle, laws of reflection and refraction at a plane surface, refraction at a spherical surface, lens formula. Combination of thin lenses - equivalent focal length.

2. Optical instruments : Dispersion and dispersive power, chromatic aberration and its remedy, different types of Siedel aberration (qualitative) and their remedy. Eye-piece : Ramsden and Huygen's type. Astronomical telescope and compound microscope - their magnifying power.

Paper IIB
Electricity and Magnetism (50)

1. Electrostatics : Quantisation of charge and Millikan's oil-drop experiment, Coulomb's law, intensity and potential --- example of point charge, Gauss' theorem --- simple applications, potential and field due to an electric dipole, mechanical force on the surface of a charged conductor. Dielectric medium, polarization, electric displacement.

2. Capacitor : Parallel-plates and cylindrical, energy stored in parallel plate capacitor.

3. Steady Current : Network analysis --- Kirchoff's laws, Thevnin and Norton's theorem, Wheatstone bridge, potentiometer.

4. Thermoelectricity : Seebeck, Peltier, and Thomson effects, laws of thermoelectricity, thermoelectric curve --- neutral and inversion temperature, thermoelectric power.

5. Magnetic effect of current : Biot and Savart's law, ampere's circuital law (statement only), magnetic field due to a straight conductor, circular coil, solenoid, endless solenoid, Magnetic field due to a small current loop --- concept of magnetic dipole, Ampere's equivalence theorem.

6. Lorentz force : Force on a moving charge in simultaneous electric and magnetic fields, force on a current carrying conductor in a magnetic field.

7. Magnetic materials : Intensity of magnetization, relation between **B**, **H**, and **M** --- illustration in the case of bar magnet, magnetic susceptibility --- dia, para and ferromagnetic materials, statement of Curie's law. Hysteresis in a ferromagnetic material, hysteresis loss.

8. Electromagnetic induction : Self and mutual inductances in simple cases, energy stored in inductance.

9. Varying currents : growth and decay of currents in L-R circuit; charging and discharging of capacitor in C-R circuit.

10. Alternating current : Mean and r.m.s. values of current and emf with sinusoidal wave form; LR, CR and series LCR circuits, reactance, impedance, phase-angle, power dissipation in AC circuit --- power factor, vector diagram, resonance in a series LCR circuit, Q-factor, principle of ideal transformer.

Paper IIIA

Unit I: Physical Optics (15)

1. Light as an electromagnetic wave : Full electromagnetic spectrum, properties of electromagnetic waves, Huygens' principle --- explanation of the laws of reflection and refraction.

2. Interference of light : Young's experiment, intensity distribution, conditions of interference, interference in thin films, Newton's ring.

3. Diffraction : Fresnel and Fraunhofer class, Fresnel's half-period zones, zone plate. Fraunhofer diffraction due to a single slit and plane transmission grating (elementary theory), resolving power.

4. Polarisation : Different states of polarisation, Brewster's law, double refraction, retardation plate, polaroid, optical activity.

Unit II: Electronics (15)

1. Diodes and Transistors : P-N junction diode, bridge rectifier, capacitance input filter, Zener diode, voltage regulator, Transistors --- α and β and their interrelations; output characteristics in CE mode, single stage CE amplifier --- approximate expressions of current and voltage gain with the help of 'Load Line'.

2. Digital circuits : binary systems, binary numbers. Decimal to binary and reverse conversions; binary addition and subtraction.

3. Logic gates : OR, AND, NOT gates --- truth tables. Statement of de Morgan's theorem, NOR and NAND universal gates.

Unit III: Modern Physics (20)

1. Special Theory of Relativity : Postulates of STR, formulae of (i) Length contraction; (ii) Time dilation; (iii) Velocity addition; (iv) Mass variation, and (v) Mass-energy equivalence.

2. Quantum theory of radiation : Planck's concept --- radiation formula (statement only) --- qualitative discussion of photo-electric effect and Compton effect in support of quantum theory; Raman effect.

3. Basic Quantum Mechanics : Wave nature of material particles, wave-particle duality, wavelength of de Broglie waves, Heisenberg uncertainty principle, Schroedinger equation, particle in a one-dimensional infinite well --- energy eigenvalues, wavefunction and its probabilistic interpretation. Bohr's theory of hydrogen spectra --- concept of quantum number, Pauli exclusion principle.

4. Solid State Physics : Crystalline nature of solid, diffraction of X-ray, Bragg's law; Moseley's law --- explanation from Bohr's theory.

5. Nuclear Physics : Binding energy of nucleus, binding energy curve and stability; Radioactivity, successive disintegration, radioactive equilibrium, radioactive dating, radioisotopes and their uses, nuclear transmutation, fission and fusion, nuclear reactor.

Paper IVA

Unit I: Pumps, gauges and engine (10)

1. Production and measurement of high vacuum : Rotary and diffusion pump, Mcleod, Pirani, and Penning gauges.

2. Engines : Heat engines, thermal efficiency, indicated Horse-power and brake Horse-power, Otto

cycle and Diesel cycle, four-stroke petrol and diesel engines, calculation of efficiency and comparison.

Unit II: Energy Sources (15)

1. Conventional energy sources : thermal power plant, relevance of Rankine cycle (qualitative discussion), steam turbine, hydro-electric power plant --- basic principle.

2. Non-conventional energy sources : solar, wind, tidal, geothermal, and biogas sources, elementary idea of production and uses.

Unit III: Electronics (15)

1. Feedback : Basic principle, positive and negative feedback, Barkhausen criterion, oscillator, OPAMP : characteristics, uses of OPAMP as amplifier, oscillator, and filter; light-emitting diodes, 7-segment display, SCR, diac and triac.

2. Digital electronics : combinational circuits --- adder and subtractor, multiplexer, demultiplexer, encoder, decoder, sequential circuits --- flip-flop, D and J-K, registers and counters.

3. Instruments : cathode-ray oscilloscope, digital multimeter, L and C measurements.

Unit IV: Communications (10)

1. Propagation of electromagnetic waves in atmosphere, various layers of atmosphere, ground and sky waves.

2. Transmission of electromagnetic waves : Amplitude and frequency modulation, calculation of power in amplitude modulation, sideband generation in frequency modulated wave; demodulation, linear diode detector, detection of FM waves, signal-to-noise ratio.

3. Transmission through media : coaxial cables, optical fibre --- cladding, energy loss, band width and channel capacity, information carrying capacity of lightwaves (qualitative); satellite communication, microwave link --- modem and internet.

Practical Papers

In practical classes all data should be recorded directly in the Laboratory Note Book and signed regularly by the attending teachers. This Note Book should be submitted at the time of final practical examination. No separate fair L.N.B. need be maintained. The evaluation of the L.N.B. will be done by the external examiner.

Paper IIA

Full Marks: 50 Time: 4Hours
(L.N.B. -10, Viva Voce- 10, Experiment-30)

1. Determination of modulus of rigidity of the material of a wire by dynamical method
2. Determination of moment of inertia of a metallic cylinder / rectangular bar about an axis passing through its c.g.
3. Determination of the coefficient of linear expansion of a metallic rod using an optical lever.
4. Determination of the pressure coefficient of air.
5. Determination of the refractive index of the material of a lens and that of a liquid using a convex lens and a plane mirror.
6. Determination of the focal length of a concave lens by auxiliary lens method or by combination method.
7. Determination of the frequency of a tuning fork with the help of a sonometer (Either by using the relevant formula or by using the n-l curve).
8. Determination of the horizontal component of earth's magnetic field using a deflection and an oscillation magnetometer.
9. Determination of the resistance of a suspended coil galvanometer by the method of half deflection and to calculate the figure of merit of the galvanometer (using the same data)
10. To draw the I-V characteristic of i) resistor and ii) a P-N junction diode in forward bias condition. (Plot both the characteristic curves on the same graph paper.) Estimate from the graphs i) the resistance of the resistor and ii) the dynamic resistance of the diode for three different currents. One current should correspond to the intersecting point of the two curves.
11. Determination of (i) an unknown resistance and (ii) resistance per unit length of an wire by Carey Foster method.
12. Determination of the reduction factor of a tangent galvanometer using a copper voltameter.
13. Measurement of current flowing through a resistor by using a potentiometer. Verify the result with the help of a milliammeter.

Paper IIB

Full Marks: 50 Time: 4Hours
(L.N.B. -10, Viva Voce- 10, Experiment-30)

1. Determination of Young's modulus of the material of a beam by the method of flexure (single length only).
2. Determination of the coefficient of viscosity of water by Poiseuille's method (The diameter of the capillary tube to be measured by travelling vernier microscope).
3. Determination of the surface tension of water by capillary rise method.
4. Determination of the refractive index of the material of a prism by drawing the i-δ curve using spectrometer.

5. To determine the wavelength of a monochromatic light by Newton's ring method.
6. To calibrate a polarimeter and hence to determine the concentration of sugar solution.
7. Determination of the temperature coefficient of the material of a coil using a Carey-Foster bridge (3 sets of readings for both temperatures to be taken, also the resistance per unit length of the wire to be measured).
8. To draw the I-V characteristics of a bridge rectifier (4-diode) (i) without using any filter and (ii) using a capacitive filter. (Percentage voltage regulation to be calculated for each case at a specified load current.)
9. To draw the reverse characteristics of a Zener diode & to study its voltage regulation characteristics using a variable load. (Breakdown region to be identified on the graph and Percentage voltage regulation to be calculated for two load currents.)
10. To draw the output characteristics of a transistor in C-E configuration (for at least 5 base currents) and hence to determine the A.C. current gain from the active region of the characteristics.
11. To verify the truth tables of OR and AND logic gates using diodes and construction of AND, OR and NOT gates using NOR / NAND IC gates on breadboard.
12. To draw the resonance curve of a series LCR circuit and hence to determine the Quality-factor of the circuit.

Paper IV

Module I (Computer lab)

Full Marks: 25
(Experiment - 15, Project Report - 5, Viva -5) Time: 3 hours

1. To familiarise with the hardware and the operating system and to solve simple problems by programming in C or Fortran as per the syllabus.

(i) Computer hardware: basic building blocks, central processing units, memory, hard disc, RAM. ROM, CD-ROM, DVD, pen drive, memory units: bits and bytes, input-output devices,
(ii) Computer software: Operating system, Windows, Unix/Linux

(iii) Programmingin C: basic structure, character set, keywords, identifiers, constants, variables, type declaration, operators --- arithmetic, rational, logical, assignment, increment, increment
and decrement, operator precedence and associativity, arithmetic expression, evaluation and type conversion character I/O, escape sequence and formatted I/O, branching and looping, if, if-else, while, do-while, for, arrays (one and two dimensional).

OR

(iii) Programming in Fortran : constants, variables, arrays, dimension-type statements, arithmetic expressions, input and output statements, control statements -- jumping, branching, and looping.

Problems

(i) Sorting: arranging in ascending/descending order
(ii) Read N numbers ,find their mean, median, mode
(iii) Sum of a G.P. series term by term
(iv) Solution of a quadratic equation with real / complex roots
(v) Simple matrix operations (addition, subtraction, multiplication)

2. To use database package and word processor.

Module II

(All experiments are of project type)

Full Marks: 25 Time: 3Hours
(Experiment – 15, Project report – 5, Viva – 5)

1. To convert a given ammeter into a voltmeter and a given voltmeter into an ammeter. To calibrate the instrument and to measure the internal resistance of it in each case.
2. To construct an adjustable voltage power supply using appropriate IC and to study its regulation.
3. To measure the internal resistance of an analog voltmeter and to increase its internal resistance by using an OP AMP.
4. To use OP AMP as inverting, non-inverting, differential amplifier and as an adder.
5. To calibrate a given temperature sensor and to use the sensor to control the temperature of a heat bath.
6. To develop a photo-sensor using a phototransistor followed by an amplifier and to use the same to control the switching of a bulb.

RECOMMENDED BOOKS (B.SC. HONOURS CURRICULUM)

Paper I: Mathematical Methods I, II

1. Introduction to Mathematical Physics - C. Harper (Prentice-Hall of India).
2. Mathematical Methods - M. C. Potter and J. Goldberg (Prentice-Hall of India).
3. Vector Analysis - M. R. Spiegel, (Schaum's Outline Series) (Tata McGraw-Hill).
4. Tatwiya Padartha Bidyar Bhumika – S. Sengupta, Asok Ghosh and D. P. Roychaudhuri (W.B. State Book Board (WBSBB)).
5. Mathematical Physics – P.K. Chattopadhyay (Wiley Eastern)

Papers I and III: Waves and Optics I, II

1. Advanced Acoustics - D. P. Ray Chaudhuri (Chayan – Kolkata).
2. Waves and Oscillations - Rathin N. Chaudhury (New Age Publ.).
3. Waves- J R Crawford (Tata McGraw Hill)
4. Fundamentals of Optics - F. A. Jenkins and H. E. White (Mc Graw Hill, Kogakusha).
5. Geometrical and Physical Optics - B. S. Longhurst (Orient Longmans).
6. Optics – A. K. Ghatak (Tata Mc Graw Hill).
7. Optics – Hecht and Zajac (Addison-Wesley)
8. Optics – B. K. Mathur.
9. Bhauta Alok Bigyan – B. S. Basak (WBSBB).

Papers I and III: Electronics I, II

1. Integrated Electronics – J. Millman and C. C. Halkias (Mc Graw Hill).
2. Electronic Fundamentals and Applications – D. Chattopadhyay and P. C. Rakshit (New Age International)
3. Electronics Fundamentals and Applications – J. D. Ryder (PHI Pvt. Ltd).
4. Electronic Device and Circuit Theory – R. Boylestad and L. Nashelsky (Prentice – Hall).
5. Integrated Electronics – J. Millman and C. C. Halkias (Mc Graw Hill).
6. Digital Logic and Computer Design – M. Moris Mano, (PHI (Pvt.) Ltd.).
7. Electronics – R.K. Kar (**Books and Allied (P) Ltd.**).
8. Digital Electronics – D. Ray Chaudhuri (Platinum Publishers)
9. Basic Electronics – K. K. Ghosh (Platinum Publishers)

Papers II and V: Classical Mechanics I, II

1. Theoretical Mechanics - M. R. Spiegel, (Schaum's Outline Series) (McGraw-Hill).
2. Mechanics - K. R. Symon (Addison-Wesley).
3. Introduction to Classical Mechanics - R. G. Takwale and P. S. Puranik (Tata McGraw-Hill).
4. Classical Mechanics – N. C. Rana and P. S. Joag (Tata McGraw-Hill).
5. Mechanics and General Properties of Matter – D. P. Roychaudhuri and S. N. Maiti (Book Syndicate).
6. Padarther Dharma - D. P. Ray Chaudhuri (West Bengal State Book Board).
7. The Feynman Lectures on Physics – Vol I (Addison-Wesley).
8. An Introduction to Mechanics – D. Keppner and R.J. Kolenkow (Tata McGraw-Hill).
9. Mechanics – H. S. Hans and S. P. Puri (Tata McGraw-Hill).
10. Classical Mechanics – J. Goldstein (Narosa Publ. House).
11. Classical Mechanics – A. K. Roychaudhuri (O. U. P., Calcutta).

12. Berkeley Physics Course, Vol – I (Mechanics) (Mc Graw Hill).

Papers II and IVA: Thermal Physics I, II

1. Heat and thermodynamics - Zemansky and Ditman (Mc Graw Hill, Kugakusha).
2. Kinetic theory of gases - Loeb (Radha Publ. House).
3. Thermodynamics – F. Fermi (Dover)
4. Tapgatividya – Asoke Ghosh (W.B.S.B.B).
5. A Treatise on Heat - Saha and Sribastava (The Indian Press Ltd).
6. Gaser Anabik Tattwa- Pratip Kumar Chaudhuri (W. B. S. B. B).
7.Thermal Physics – S. Garg, R. M. Bansal, C. K. Ghosh (Tata Mc Graw Hill).
8.Heat and Thermodynamics – H. P. Roy and A. B. Gupta (New Central Book Agency).

Paper III: Electricity and Magnetism
Paper III: Electrostatics
Paper VIIA: Electromagnetic Theory

1. Introduction to Electrodynamics – D. J. Griffith, (Prentice Hall, India Pvt. Ltd).
2. Berkeley Series Vol II (Electricity and Magnetism) E.M. Purcell (Tata McGraw-Hill).
3. The Feynman Lectures on Physics – Vol. II (Addison – Wesley).
4. Electricity and Magnetism - J. H. Fewkes and J. Yarwood (Oxford Univ. Press, Calcutta).
5. Electricity and Magnetism – Chatterjee and Rakshit.
6. Electricity and Magnetism – A. S. Mahajan and A. A. Rangwala (Tata McGraw-Hill).
7. Classical Electrodynamics – J.D> Jackson (Wiley India)

Papers IVA and V: Quantum Mechanics I, II

1. Quantum Mechanics – J. L. Powell and B. Crasemonn, (Oxford, Delhi).
2. Quantum Mechanics – F. Schwabl (Narosa).
3. Quantum Mechanics – A. K. Ghatak and S. Lokenathan (Macmillan, Delhi).
4. Introductory Quantum Mechanics - S. N. Ghoshal (Calcutta Book House).
5. A Textbook of Quantum Mechanics – P. M. Mathews and K. Venkatesan (Tata Mc Graw Hill).
6. Modern Quantum Mechanics – Sakurai (Persian Education)

Paper V: Atomic Physics

1. Laser Principles and Applications – A. K. Ghatak and K. Tyagrajan (Tata – Mc Graw Hill).
2. Optics and Atomic Physics – B. P. Khandelwal (Siblal Agarwala).
3. Physics of Atoms and Molecules – B. H. Bransden and C. J. Joachain(Pearson Education)
4. Atomic and Nuclear Physics – S. K. Sharma (Pearson Education).

Paper VI: Nuclear and Particle Physics I, II

1. Nuclear Physics – Cottingham and Greenwood (Cambridge University Press).
2. Concepts of Nuclear Physcics – R. Cohen (Tata-Mc Graw Hill).
3. Paramanu o Kendrak Gathan Parichay – S. N. Ghoshal (WBSBB).
4. Atomic and Nuclear Physics – S. N. Ghoshal (S. Chand).
5. Nuclear Physics – S. B. Patel (New Age).
6. Nuclei and Particles – E. Segre (Benjamin).
7.Nuclear Physics: Principles and applications – J.S. Lilley (Willey Eastern).
8. Fundamentals in Nuclear Physics: from Nuclear Structure to Cosmology – J. Basdevant, J. Rich and M. Spiro (Springer).
9. Particle Physics – Seiden (Persian Education)

Paper VI: Solid State Physics I, II

1. Introduction to Solid State Physics, C. Kittel (Wiley Eastern).
2. Elementary Solid State Physics – M. Ali Omar (Pearson Education)
4. Solid State Physics – A. J. Dekker (Mc. Millan)
4. Solid State Physics – S. O. Pillai (New Age International)
5. Elements of Solid State Physics – J. P. Srivastava (Prentice Hall)
6. An Introduction to Solid State Physics and Application – R.J. Elliot and A.F. Gibson (McMillan)
7. Solid State Physics – D.W. Snoke (Person Education)

Paper VIIA: Statistical Mechanics

1. Statistical Physics, F. Mandle (ELBS).
2. Fundamentals of Statistical and Thermal Physics, F. Reif, (Mc Graw Hill).

Paper VIIA: Special Theory of Relativity

1. Introduction to Special Theory of Relativity - R. Resnick (Wiley Eastern).
2. Special Theory of Relativity - A. P. French (ELBS).
3. Apekshikata Tattwa - Sriranjan Bandyopadhyay (W. B. S. B. B).
4. The Feynman Lectures on Physics, Vol I (Addison – Wesley).
5. Theory of Relativity – Nikhilendu Bandyopadhyay (Academic Publishers)

UNIVERSITY OF CALCUTTA

SYLLABI

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THREE-YEAR HONOURS AND GENERAL
DEGREE COURSES OF STUDIES

PHYSIOLOGY

2010

w.e.f. 2010-11

HONOURS

PART –I
Theoretical

Paper – I (F.M. 100)

Unit -01 : 50 Marks	**Lectures required** (Each period of 45 minutes duration)
1. Cell Biology I	08
2. Cell Biology II	12
3. Biophysics	16
4. Enzyme	10
5. Digestive System	14

Unit- 02 : 50 Marks

1. Biochemistry-I	10
2. Biochemistry-II	12
3. Vitamins and Minerals	14
4. Muscle Physiology	12
5. Nerve Physiology	12

Paper – II A: (F.M. 50)

Unit – 03 : 50 Marks	**Lectures required** (Each period of 45 minutes duration)
1. Blood	14
2. Cardiovascular System I	14
3. Cardiovascular System II	10
4. Body Fluids and Regional Circulation	08
5. Respiratory System	14

Paper – II B Practical (F.M. 50)
(One practical class is of 3 periods) **Classes required 50**
(Each period of 45 minutes duration)
Unit – 04 : 50 Marks

1. Histology	
Haematological Experiments	15 marks
Permanent slide identification	15 marks
2. Biochemistry	
Qualitative Experiments	10 marks
3. *Viva – Voce*	5 marks
4. Laboratory Note Books	5 marks

PART – II

Theoretical

Paper – III (F.M. 100)

Unit -05 : 50 Marks **Lectures required**

(Each period of 45 minutes duration)

1.	Nervous System I	10
2.	Nervous System II	14
3.	Nervous System III	14
4.	Nervous System IV	14
5.	Molecular neurobiology	08

Unit – 06 : 50 Marks

1.	Instrumentation	12
2.	Renal Physiology	14
3.	Sensory Receptors, Olfaction & Gustation	10
4	Audition	10
5.	Vision	14

Paper – IV A (F.M. 50)

Unit – 07 50 Marks **Lectures required**

(Each period of 45 minutes duration)

1.	Biological Oxidation and Carbohydrate Metabolism	12
2.	Amino acids and Purine & Pyrimidine Metabolism	10
3.	Lipid Metabolism and Reactive Oxygen Species	12
4.	Methodologies	10
5.	Molecular Biology	16

Practical

Paper – IVB (F.M. 50)

(One Practical class is of 3 periods) **Classes required 50**

(Each period of 45 minutes duration)

Unit – 08 : 50 Marks

1.	Histology Fresh Tissue Experiments	10 marks
2.	Biochemistry Quantitative Estimations	15 marks
3.	Experimental Physiology Amphibian skeletal muscle experiments Amphibian unperfused heart experiments	15 marks
4.	*Viva – Voce*	5 marks
5.	Laboratory Note Books	5 marks

PART –III
Theoretical

Paper –V (F.M. 100)

Unit – 09 : 50 Marks

	Lectures required (Each period of 45 minutes duration)
1. General Endocrinolgy I	14
2. General Endocrinolgy II	12
3. General Endocrinolgy III	12
4. General Endocrinolgy IV	14
5. Chronobiology	08

Unit – 10 : 50 Marks

	Lectures required (Each period of 45 minutes duration)
1. Reproductive Physiology I	14
2. Reproductive Physiology II	14
3. Developmental Biology	12
4. Nutrition and Dietetics	12
5. Social Physiology	08

Paper VI (F.M. 100)

Unit- 11 : 50 Marks

	Lectures required (Each period of 45 minutes duration)
1. Work Physiology and Ergonomics	15
2. Sports Physiology	15
3. Skin and Body Temperature Regulation	10
4. Human and Environment I	10
5. Human and Environment II	10

Unit - 12 : 50 Marks

1. Microbiology I	12
2. Microbiology II	10
3. Immunology	14
4. Pharmacology	12
5. Biostatistics	12

Practical

Paper – VII (F.M.100)
(One Practical class is of 3 periods) **Classes Required 70**
(Each period of 45 minutes duration)

Unit - 13

1.	Biochemistry	40 Marks
2.	Experimental Physiology	25 Marks
3.	Microbiology & Biochemical Technique	10 Marks
4.	*Viva – Voce*	15 Marks
5.	Laboratory Note Books	10 marks

Paper VIII (F.M. 100)
(One Practical class is of 3 periods) **Classes Required 70**
(Each period of 45 minutes duration)
Unit - 14

1.	Histology	15 Marks
2.	Experimental Physiology	20 Marks
3.	Experiments on Work Physiology and Ergonomics using human subjects	15 Marks
4.	Biostatistics	10 Marks
5.	Social Physiology	
	Diet Survey	08 Marks
	Field Study Record	07 Marks
6.	*Viva – Voce*	15 Marks
7.	Laboratory Note Books	10 Marks

PART-I

Theoretical

PAPER – I (F.M. 100)

UNIT : 01 (50 Marks)

1. Cell Biology I :

Electron microscopic structure and functions of eukaryotic endoplasmic reticuli, ribosome, golgi bodies, mitochondria, lysosomes, peroxisomes cytoskeletal elements, centrosomes and plasma membrane and subcellular membrane. Ion pores, ion pumps, ion channels, ionophores, passive transport – facilitated diffusion, uniport, symport, antiport. Active transport.Artificial membrane –liposome and erythrocyte ghost. Basic idea of tight junctions, gap junctions and cell adhesion molecules.

(08 lectures)

2. Cell Biology II :

(a) Genetics :

Chromosome structure – morphology. Chromosomal DNA packaging – nucleosomes and higher levels of organization of chromatin. Euchromatin and heterochromatin. Human genome and its characteristics. Nuclear and mitochondrial DNA. Cell cycle – events and regulatory role of cyclin. Elementary idea of apoptosis.

(b) Cell Signalling :

Cell surface receptor proteins – ion channel coupled, G-protein coupled and enzyme-coupled. Intracellular messengers – cAMP, cGMP, IP3, DAG, Protein kinases, Ca^{2+}, CO, NO. Signal transduction pathways – Phosphatidylinositides, MAP kinase, JAK-STAT, SMAD. **(12 lectures)**

3. Biophysics :

Diffusion, surface tension and viscosity – their characteristics, factors influencing and biological applications. Osmosis: osmotic pressure – laws, determination – freezing point depression method and biological applications. Protolysis of water, pH, acid-base neutralization curves, Buffer action: Henderson-Hasselbalch equation. Regulation of pH by blood buffers. Determination of pH – Basic concept of indicators, principle of pH meter- hydrogen electrode and glass electrode. Colloids : Classification, properties – optical, electrical, electrokinetic. Biological importance of colloids. Dialysis and ultrafiltration. Gibbs-Donnan membrane equilibrium. Thermodynamics : Type of surroundings and systems. First Law– Internal energy, enthalpy. Second Law – Entropy, Free energy change, Endergonic and Exergonic reactions, Reversible and Irreversible processes, Equilibrium constant. Physiological steady-state, Living body as a thermodynamic system. **(16 lectures)**

4. Enzymes :

Classification- EC nomenclature, Concept of apoenzyme, holoenzyme, coenzyme, cofactors and prosthetic group. Mechanism of enzyme action : Activation energy, Enzyme-substrate complex, Transition state and Products. Models of enzyme-substrate interactions. Specificity of enzymes. Concept of initial rate, maximum velocity and steady-state kinetics. Michaelis constant, Michaelis-Menten equation, Graphical representation of hyperbolic kinetics– Lineweaver-Burk plot. Significance of K_m and V_{max}. Factors influencing enzyme-catalyzed reactions : substrate concentration, enzyme concentration, pH, temperature. Competitive, non-competitive and uncompetitive inhibitions. Regulation of enzyme activities – covalent modifications, allosteric modifications – Sigmoid kinetics and Hill equation : K- and M- series, Feed-back inhibition. Rate-limiting enzymes. Isozymes, Ribozymes and Abzymes.

(10 Lectures)

5. Digestive System :

Anatomy and histology of alimentary canal. Digestive glands – histological structures of salivary glands, pancreas, liver. Deglutition. Movements of alimentary canal and their regulations. Composition, functions and regulation of the secretion of salivary, gastric, pancreatic and intestinal juices and bile. Synthesis of Bile acids. Enterohepatic circulation. Digestion and absorption of carbohydrates, lipids, proteins and nucleic acids. Defecation. Feces. GALT. Basic concepts of Peptic Ulcer, Jaundice and Gall-stones. **(14 Lectures)**

UNIT :02 (50 MARKS)

1. Biochemistry I :

Carbohydrates : Definition and classification.

Monosaccharides – Classification, structure, stereoisomerism, optical isomerism, optical activity, epimerism. Cyclic structures- Pyranose and furanose forms, anomerism, mutarotation and its mechanism. Chemical reactions of monosaccharides (Glucose & Fructose) — Reactions with concentrated mineral acids, alkali, phenylhydrazine and their biochemical importance. Derivatives of monosaccharides ——Amino sugars, deoxy sugars, sugar alcohols, sugar acids, sugar esters, their biochemical and physiological importance.

Disaccharides – Maltose, Lactose and Sucrose : Structure, Occurrence and Physiological importance.

Polysaccharides – Starch, Glycogen, Dextrin, Cellulose, Glycosaminoglycans, Glycoproteins, Sialic acids, Lectins, Blood group polysaccharides.

Lipids : Definition and classification. Fatty acids —— Classification, systemic nomenclature and structure.Mono-, Di- and Triglycerides. Properties of Fat and Fatty acids —Hydrolysis, Saponification, Saponification number, Iodine number, Acetylation - Acetyl number. Hydrogenation, Rancidity-Acid number, Reichert-Meissl number. Cis-trans isomerism. Eicosanoids, Phospholipids, Glycolipids, Sphingolipids, Cholesterol & its ester — their structure and physiological importance. Lipoproteins —Structure and classification. **(10 Lectures)**

2. Biochemistry II :

Amino acids : Classification, Structure, Nomenclature and Optical properties. Protonic equilibria of amino acids – Zwitterions, Isoelectric point, titration curve of amino acids. Reactions with ninhydrin and formaldehyde.

Peptides and Proteins : Structure and properties of peptide bonds – Phi and Psi angles. Reactions with Sanger's and Edman's reagent. Biuret reaction. Different levels of protein structure – Primary, Secondary (α-helix and β-pleated sheet), Tertiary and Quarternary. Forces stabilizing the structures. Denaturation and Renaturation.

Purine and Pyrimidine : Structure, nomenclature and tautomerism.

Nucleic acids : Nucleosides and Nucleotides —— structure. Polynucleotides. DNA double helix —— Primary, Secondary and Tertiary structure. A-DNA, B-DNA and Z-DNA. RNA —— Structure and types. Denaturation and annealing of DNA. Hyperchromicity, melting temperature and half $C_o t$ value.

(12 Lectures)

3. Vitamins and Minerals :

Vitamins: Thiamin, Riboflavin, Niacin, Pyridoxine, Pantothenic Acid, Biotin, Cyanocobalamin, Folic Acid, Ascorbic Acid, Inositol. Vitamins A, D, E and K. Chemistry, dietary sources, daily requirements, biochemical roles and functions, deficiency symptoms, hypervitaminosis, antivitamins. Minerals: Sources, biological functions, metabolism and regulation of sodium, potassium, calcium, phosphorus, iron, zinc, iodine and fluoride. **(14 Lectures)**

4. Muscle Physiology :

Microscopic and electron microscopic structure of skeletal, smooth and cardiac muscles. The sarcotubular system. Red and white striated muscle fibers. Single-unit and multi-unit smooth muscle. Muscle groups : antagonists and agonists. Properties of skeletal muscle: excitability, contractility, all or none law, summation of stimuli, summation of contractions, effects of repeated stimuli, genesis of tetanus, onset of fatigue, refractory period, tonicity, conductivity, extensibility and elasticity. Optimal load, optimal length of fibers. Muscle proteins. Mechanism of skeletal and smooth muscle contraction and relaxation : Excitation-contraction coupling. Dihydropyridine receptors & Ryanodine receptors. Mechanical components of muscle. Isometric and isotonic contractions – muscle length, tension and velocity relationships. Chemical, thermal and electrical changes in skeletal muscle during contraction and relaxation. Electromyography. **(12 Lectures)**

5. Nerve Physiology:

Structure, classification and functions of neurons and neuroglias. Cytoskeletal elements and axoplasmic flow. Myelinogenesis. The resting membrane potential. The action potential. Electrotonic potentials. Current of injury. Propagation of nerve impulse in different types of nerve fibers. Compound action potentials. Properties of nerve fibers : excitability, conductivity, all or none law, accommodation, adaptation, summation, refractory period, indefatigability. Chronaxie, rheobase and utilization time. Synapses : types, structure, synaptic transmission of the impulse, synaptic potentials, neurotransmitters, cotransmitters, neuromodulators. The neuromuscular junction : structure, transmission, end-plate potential, MEPP, post-tetanic potentiation. Motor unit. Motor point. Injury to peripheral nerves – degeneration and regeneration in nerve fiber, changes in the nerve cell body, transneuronal degeneration, changes in receptors and motor end-plates, denervation hypersensitivity. Thermal changes of nerve during activity. Nerve growth factors. **(12 Lectures)**

DISTRIBUTION OF QUESTIONS IN THEORETICAL PAPERS

1. From each unit, **five** questions of 10 marks each with one alternative are to be set from the same sub-unit . The 10 marks question may be subdivided.
2. Candidates have to **attempt all five** questions from each unit amongst the alternatives.

PAPER – II A (F.M. 50)

UNIT : 03 (50 MARKS)

1. Blood :

Bone marrow. Formed elements of blood–origin, formation, functions and fate Plasma proteins–normal values, origin and functions. Haemoglobin – Structure, reactions, biosynthesis and catabolism. Foetal haemoglobin. Abnormal haemoglobins- Sickle-cell anemia and Thalassemia. Different types of anaemia and their causes. Blood volume – normal values, regulation and determination by dye and radioisotope methods. Hemostasis – factors, mechanism, anticoagulants, procoagulants. Disorders of hemostasis-Hemophilia, Thrombosis and Embolism. Blood group – ABO and Rh. Erythroblastosis foetalis. Blood transfusion and its hazards. **(14 Lectures)**

2. Cardiovascular System – I :

Anatomy of the heart. Properties of cardiac muscle. Origin and propagation of cardiac impulse. Stannius ligature. The cardiac cycle- pressure and volume changes. Heart sounds. Murmurs.Cardiac output – measurement by application of Fick's principle and dye dilution method, factors affecting. Starling's law of heart. Electrocardiography – the normal electrocardiogram, electrocardiographic leads, vectorial analysis, the vectorcardiogram, the mean electrical axis of heart. The His bundle electrogram. Principles of Echocardiography. Cardiac Arrhythmias – Normal cardiac rate. Myocardial Infarctions. **(14 Lectures)**

3. Cardiovascular System – II :

Functional morphology of arteries, arterioles, capillaries, venules and veins, sinusoids. General pattern of circulation and significance of branching of blood vessels. The pulse – arterial and venous. Hemodynamics of blood flow. Blood pressure – its measurement and factors affecting. Cardiovascular homeostasis – neural and chemical control of cardiac functions and blood vessels. Cardiac and vasomotor centers, baroreceptors and chemoreceptors, innervation of the heart and blood vessels, cardiac and vasomotor reflexes. Cardiovascular adjustment after haemorrhage.

(10 Lectures)

4. Body Fluids and Regional Circulation :

Lymph and tissue fluids – formation, circulation, functions and fate. Lymphatic organs-Histological structures and functions of lymph gland and spleen. Regional circulations – cerebral, coronary, pulmonary and hepatic, skeletal muscle. **(08 Lectures)**

5. Respiratory System :

Anatomy and histology of the lung and airways. Mechanics of breathing **–** role of respiratory muscles, glottis. Lung volumes and capacity. Compliance of lungs and chest wall, pressure-volume relationships, alveolar surface tension and surfactant, work of breathing. Ventilation- perfusion ratio. Dead space and uneven ventilation. Spirometry. Transport of gases in body - Partial pressure and composition of normal atmospheric gases in inspired, expired, alveolar airs and blood. Oxygen dissociation curve of hemoglobin and myoglobin – factors affecting. Carbon dioxide dissociation curve. Regulation of respiration **–** neural and chemical, respiratory centers, chemoreceptors, baroreceptors, pulmonary receptors. Hypoxia – types, effects. Asphyxia, Voluntary hyperpnoea, Apnoea, Cyanosis, Periodic breathing, Asthma, Emphysema. Lung function tests. Artificial respiration. Concept of non-respiratory functions of lung. **(14 Lectures)**

DISTRIBUTION OF QUESTIONS IN THEORETICAL PAPER

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Practical

PAPER – IIB (F.M. 50)

Unit – 04 : 50 Marks

1. Histology : 30 Marks

(a) Haematological experiments : Preparation and staining of blood film with Leishman's stain. Identification of blood corpuscles.Differential count of WBC. Total count of RBC and WBC. Haemoglobin estimation. Preparation of haemin crystals. Preparation and staining of bone marrow smear. Measurement of diameter of megakaryocyte. Reticulocyte staining. Blood group determination.

Demonstration: Haematocrit, MCV, MCH and MCHC. Bleeding time, Clotting time, ESR. 15 Marks

(b) Study and identification of stained section of different mammalian tissues and organs : Bone, Hyaline cartilage, Trachea, Lung, Spleen, Lymph gland, Parotid gland, Submaxillary gland, Sublingual gland, Tongue, Oesophagus, Stomach, Duodenum, Jejunum, Ileum, Large intestine, Liver, Kidney, Ureter, Pancreas, Adrenal gland, Thyroid gland, Testis, Ovary, Spinal cord, Cerebral cortex, Cerebellum, Skin, Cardiac muscle, Skeletal muscle, Smooth muscle, Artery, Vein, Uterus**.** 10 Slides-15 Marks

2. Biochemistry Qualitative : 10 Marks

Tests for identification of physiologically important substances : hydrochloric acid, lactic acid, uric acid, albumin, gelatin, peptone, starch, dextrin, glucose, fructose, lactose, sucrose, urea, acetone, glycerol, bile salts.

3. ***Viva – Voce*** : **5 Marks**

4. Laboratory Note -Books : 5 Marks

PART – II

Theoretical

PAPER – III (F.M. 100)

UNIT : 05 (50 Marks)

1. Nervous System I :

A brief outline of organization and basic functions (sensory, motor and association) of the nervous system (central and peripheral). Structural organization of different parts of brain and spinal cord. Reflex action – definition, reflex arc, classification and properties. Autonomic nervous system : organization, outflow, ganglia, centers and functions. Chemical transmission in autonomic nervous systems. Central control of autonomic nervous system. CSF: formation, circulation and functions. Blood-CSF and Blood-Brain barrier. **(10 Lectures)**

2. Nervous System II :

Ascending and descending tracts : origin, courses, termination and functions. Lower and upper motor neurones. Functions of the spinal cord with special reference to functional changes following hemisection and complete section of spinal cord – Brown-Sequard syndrome. Spinal animal. Pain production, perception and regulation. Referred pain. **(14 Lectures)**

3. Nervous System III :

Decerebrate rigidity, decorticate rigidity. Postural reflexes. Muscle spindle and golgi tendon organ: their structure, innervations and functions, regulation of muscle tone. Structure, connections and functions of cerebellum. Structure and functions of vestibular apparatus. Nuclei, connections and functions of thalamus and hypothalamus. Basal nuclei : structure, connections and functions. Cerebral cortex : histological structure, localization of functions. **(14 Lectures)**

4. Nervous System IV :

Limbic system: structure, connections and functions. Physiology of emotion. Electrophysiology of brain: spontaneous electrical activity of brain, EEG and ECoG, evoked potential, DC potential. Isolated cortex. Higher functions of nervous system: conditioning, learning and short-term and long-term memory. Speech. Aphasia. Asymmetrical organization of certain cognitive functions-split brain. Reticular formation: organization, connection and functions of ascending and descending reticular formation. Physiological basis of sleep and wakefulness. **(14 Lectures)**

5. Molecular neurobiology :

General concept of ionotropic and metabotropic receptors. Structure, sub-types, and functions of nicotinic and muscarinic acetylcholine receptors, adrenoceptors, glutamate receptors (NMDA and AMPA receptors), GABA, opiate, serotonin, dopamine and histamine receptors. **(08 Lecturers)**

UNIT : 06 (50 MARKS)

1. Instruments :

Principles of construction and uses of compound microscope, phase contrast microscope, fluorescence microscope, polarizing microscope, confocal microscopy, transmission and scanning electron microscope, photoelectric colorimeter. Brief idea of CRO, CT scan, fMRI and PET. **(12 Lectures)**

2. Renal Physiology :

Anatomy of kidney. Histology of nephron. Renal circulation – peculiarities and autoregulation. Formation of urine – glomerular function and tubular functions. Counter-current multiplier and exchanger. Renal regulation of osmolarity and volume of blood fluids. Diabetes insipidus. Formation of hypertonic urine. Renal regulation of acid-base balance, acidification of urine. Renal function tests – creatinine, inulin, urea, and PAH clearance tests. Physiology of urinary bladder and micturition. Composition of urine. Abnormal constituents of urine, their detection and significance. Renal dialysis. Non-excretory functions of kidney. **(14 Lectures)**

3. Sensory Receptors, Olfaction & Gustation :

Classification of general and special senses. Receptors as biological transducers. Muller's law of specific nerve energies. Weber-Fechner law, Steven's power law. Sensory transduction in Pacinian corpuscle. Adaptation of receptors – phasic and tonic adaptations.
Olfaction and Gustation : Structure and functions of the receptor organs , nerve pathways, centers. Properties of olfactory and gustatory sensation and their transduction & coding.Electro-olfactogram. Abnormalities of olfactory and taste sensation. **(10 Lectures)**

4. Audition :

Audition : Sound waves, decibel. Structure and functional significance of auditory apparatus – external, middle and internal ears. Organ of Corti .Auditory transduction. Auditory pathways and centers. Mechanism of hearing and its modern theories. Different electrical potentials of internal ear. Discrimination of sound frequency and loudness.Localization of sound source. Audiometry. Deafness. **(10 Lectures)**

5. Vision :

Structure of the eyeball. Structure of lens. Cataract .Formation, circulation and functions of aqueous humour, glaucoma. Mechanism of accommodation. Pupillary reflexes light reflex, near response. Argyll-Robertson pupil. Errors of refraction and their corrections. Histological details of retina, peripheral retina, fovea and blind spot. Retinal detachment. Visual pathway and centers. Effects of lesion in visual pathway. Photopic and scotopic vision. Chemical and electrical changes in retina on exposure to light. Visual processing in the retina. Electroretinogram. Positive and negative after- images. Contrast phenonmenon. Light and dark adaptation. Colour vision and its modern concept. Colour blindness.Visual field– perimetry. Visual acuity – measurement, mechanism and factors affecting. Critical fusion frequency. **(14 Lectures)**

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PAPER – IV A (F.M. 50)

UNIT : 07 (50 MARKS)

1. Biological Oxidation and Carbohydrate Metabolism :

Biological oxidation – Redox Potential, Mitochondrial Electron Transport Chain, Oxidative Phosphorylation – Inhibitors and uncouplers.
Carbohydrate - Glycolysis, R-L cycle, TCA cycle, Gluconeogenesis - Cori cycle, Glucose-Alanine cycle.Anaplerotic reactions and Amphibolic nature of TCA cycle. Pentose Phosphate Pathway. Glycogenesis and Glycogenolysis.
*Hormonal regulation of the above mentioned biochemical pathways/cycle not require.***(12 Lectures)**

2. Amino acids and Purine & Pyrimidine Metabolism :

Amino acids - Amino acid pool. Deamination, transamination, amination and decarboxylation. Synthesis of Urea and Nitric oxide. Basic idea of glucogenic and ketogenic amino acids. Metabolism of glycine, sulfur-containing amino acids, tryptophan and phenylalanine.
Purines and Pyrimidines – Biosynthesis : *de novo* and salvage pathways. Catabolism.
Regulation of the above mentioned biochemical pathways/cycle not required. **(10 Lectures)**

3. Lipid Metabolism and Reactive Oxygen Species :

Lipid – β-oxidation and biosynthesis of saturated and monounsaturated fatty acids. Metabolism of Triglycerides. Biosythesis of Lecithin, Cephalin and Cholesterol. Metabolism of Adipose Tissue.Role of lipoproteins in transport and storage of lipids.
Formation of Reactive Oxygen Species and the role of Catalase, Superoxide Dismutase, Glutathione Peroxidase and Glutathione Reductase in combating oxidative stress – role of vitamins.
Hormonal regulation of the above mentioned biochemical pathways/cycle not required.
(12 Lectures)

4. Methodologies :

Chromatography: Principles and uses of : TLC, Gel filtration, Affinity chromatography ion-exchange chromatography. Electrophoresis: Principles and method, uses of Agarose gel electrophoresis, SDS – PAGE. Ultracentrifugation: moving boundary and density gradient ultracentrifugation. Radioactivity – Classification and properties. Their use – radiolabelling of biomolecules and its detection by autoradiography. Principles of radioimmunoassay (RIA), ELISA. Immunoblotting. **(10 Lectures)**

5. Molecular Biology :

DNA replication—Meselson and Stahl Experiment, DNA Polymerases, Ligases and other regulatory proteins. Transcription – RNA Polymerase and other regulatory mechanism in prokaryotes. Genetic code – properties and wobble hypothesis. Translation – codon-anticodon interaction and mechanism in prokaryotes. Regulation of gene expression : operon concept – the lac operon. Gene mutation – agents and types. DNA repairing processes. Concept of oncogenes and properties of cancer cells. Elementary idea of recombinant DNA technology and its applications – gene therapy, transgenic animal. Northern and Southern blotting. **(16 Lectures)**

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Practical
PAPER – IV B (F.M. 50)

UNIT : 08

1. Histology : 10 Marks

Fresh tissue experiments : Suitable staining and examination of fresh tissues – epithelial, areolar, adipose(Sudan III or IV) and muscle tissues. Silver nitrate preparation of cornea and urinary bladder for cell spaces and sciatic nerve for nodes of Ranvier.

2. Biochemistry Quantitative : 15 Marks

Quantitative estimation of glucose and sucrose by Benedict's method. Quantitative estimation of amino nitrogen (Sorensen's formol titration method).*Percentage and total quantity to be done.* Estimation of percentage quantity of lactose in milk by Benedict's method.

3. Experimental Physiology: 15 Marks

a) Study and use of kymograph, induction coil, key and tuning fork.
b) Gastrocnemius-sciatic preparation and kymographic recording of isotonic muscle twitch.
c) Effect of temperature on muscle twitch.
d) Effect of two successive stimuli on muscle twitch.
e) Effect of load (after-load) on muscle twitch. Calculation of work done by the muscle.
f) Normal tracing of unperfused heart beat of toad.
g) Effects of temperature on unperfused heart beat toad.

Demonstration : 1. Gastrocnemius-sciatic preparation and its use in recording effects of make and break shocks of progressively rising intensity.
2. Effect of load (free-load) on muscle twitch.
3. Determination of nerve conduction velocity by kymographic recording of simple twitches.

3. *Viva-Voce* : 5 Marks

4. Laboratory Note-Books : 5 Marks

PART – III

Theoretical

PAPER – V (F.M. 100)

UNIT : 09 (50 MARKS)

1. General Endocrinology I :

Classification of endocrine glands and hormones. Methods of study of endocrine functions. Hypothalamus as a neuroendocrine organ. Anterior and posterior pituitary – histological structure of the gland. Chemical nature, mode of action, functions and regulation of secretion of their hormones. Hypo- and hyperactive states of the gland. Pineal gland – histological structure. Chemical nature, biosynthesis, mode of actions, functions and regulation of secretion of melatonin. (**14 Lectures**)

2. General Endocrinology II :

Thyroid and parathyroid – histological structure of the glands. Chemical nature, mode of action, functions and regulation of secretion of the hormones. Hypo- and hyperactive states of the glands. Thymus – histological structure of the gland. Chemical nature, mode of action and functions of thymic hormones. **(12 Lectures)**

3. General Endocrinology III :

Adrenal cortex and medulla – histological structure of the gland. Chemical nature, mode of action, functions and regulation of secretion of the hormones. Biosynthesis and catabolism of catecholamines. Hypo- and hyperactive states of the gland. Heart as an endocrine organ. Prostaglandins and Kinins. (**12 Lectures**)

4. General Endocrinology IV :

Pancreatic islets – histological structure. Chemical nature, mode of action, functions and regulation of secretion of the hormones. Hormonal control of blood sugar. Hyperinsulinism and diabetes mellitus. Growth factors –EGF, TGF, PDGF, IGF and FGF. Chemical nature, mode of action, functions. Gastro-intestinal hormones – Chemical nature, mode of action, functions and regulation of secretion of the hormones. (**14 Lectures**)

5. Chronobiology :

Different types of physiological rhythms – ultradian, circadian, infradian. Different zeitgebers and their relation with circadian clock. Hormonal biorhythms and their significance: adrenocortical, pineal and prolactin. Body temperature rhythm. Neural basis of biological clock and role of suprachiasmatic nuclei. Sleep-wakefulness cycle.Time keeping genes. Jet-lag and shift work. (**08 Lectures**)

UNIT : 10 (50 MARKS)

1.Reproductive Physiology I :

Primary and accessory sex organs and secondary sex characters. Histology of testis. Endocrine functions of testis. Spermatogenesis. Hypothalamic control of testicular functions. Histology of ovary. Ovarian hormones and their functions. Oogenesis and ovulation. Formation and functions of corpus luteum. Hypothalamic control of ovarian functions. Physiology of puberty. **(14 Lectures)**

2. Reproductive Physiology II :

Estrous cycle. Menstrual cycle and its regulation. Abnormalities in menstrual cycle. Onset of menopause and post-menopausal changes. Structure and functions of placenta. Maintenance of pregnancy and the bodily changes during pregnancy. Parturition. Pregnancy tests. Development of mammary glands, lactation and their hormonal control. **(14 Lectures)**

3. Developmental Biology :

Basic concepts of stem cells : Totipotency, Differentiation - Committed stem cell. Fertilization, Blastulation, Implantation,Gastrulation, Placentation. Development of alimentary canal, heart, urinary system and genital system. Foetal circulation. Ossification of bone.
(12 Lectures)

4. Nutrition and Dietetics :

Constituents of food and their significance. Basal metabolic rate -factors, determination by Benedict-Roth apparatus. Respiratory quotient. Specific dynamic action. Calorific value of foods. Body calorie requirements – adult consumption unit. Dietary requirements of carbohydrate, protein, lipid and other nutrients. Balanced diet and principles of formulation of balanced diets for growing child, adult man and woman, pregnant woman and lactating woman. Nitrogen balance, essential amino acids, biological value of proteins – measurement and factors affecting. Proteins sparers. Supplementary value of protein. Protein efficiency ratio and net protein utilization of dietary proteins. Dietary fibres. Principle of diet survey. Composition and nutritional value of common food stuffs. Physiology of starvation and obesity. **(12 Lectures)**

5. Social Physiology :

Population problem – principles and methods of family planning,. Problem of infertility and Assisted Reproductive Technologies. Malnutrition – PCM, marasmus, kwashiorkor, marasmic kwashiorkor, endemic goiter, nutritional anemias, rickets, osteomalacia, xeropthalmia, beriberi and their social implications. Principles and social importance of immunization against diseases. Epidemiology and prevention of cholera, malaria, hepatitis and AIDS. **(08 Lectures)**

DISTRIBUTION OF QUESTIONS IN THEORETICAL PAPERS

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2. Candidates have to **attempt all five** questions from each unit amongst the alternatives.

PAPER –VI (F.M. 100)

UNIT :11 (50 MARKS)

1. **Work Physiology and Ergonomics :**

Physical work—its definition and nature—isotonic, isometric and isokinetic, positive and negative work. Concept of physiological work. Power and capacity relation. Work-load – light, moderate(submaximal) and heavy (maximal) depending on intensity and duration of work. Exercise inducing equipment – bicycle ergometer, treadmill and stepping stool. Energetics of work – sources of energy and energy demand for different activities. Assessment of energy cost of various physical work – direct and indirect methods with their limitations. Physiological responses to work – cardiovascular, respiratory, metabolic and muscular – short-term and long-term. Work-rest cycle and importance of rest pause. Ergogenics aids. Basic concept of ergonomics and its application in industry to improve efficiency and industrial safety as well as to restrict occupational health hazards. Anthropometry and its implication in ergonomics in general. **(15 Lectures**)

2. **Sports Physiology:**

Concept of endurance, strength and speed in sports activities. Physical training – principles and their impact on performance level in sports with reference to cardiovascular, respiratory and muscular changes. Overtraining and detraining. Warm up and cool down. Brief general idea about nutritional aspects of sports. Aerobic and anaerobic power—concept, factors affecting, methods of measurement and significance of maximal oxygen consumption and excess post exercise oxygen consumption. Lactate threshold, lactate tolerance and their usefulness. Concept of recovery processes and occurrence of fatigue in physical work. Concept of physical fitness and its assessment by Harvard and modified Harvard Step Tests. **(15 Lectures)**

3. **Skin and Body Temperature Regulation** :

Structure and functions of skin. Cutaneous circulation. Sweat glands –structure and composition of sweat. Sweat formation, secretion and its regulation. Insensible perspiration. Regulation of body temperature in homeotherms – its physical and physiological processes, roles of neural and hormonal processes. Pyrexia, hyperthermia and hypothermia.

(10 Lectures)

4. **Human and Environment I :**

Environment – Physical and biological aspects. Effects of exposure to hot and cold environment. Acclimatization to hot and cold environment. Heat disorders and its preventive measures. Effects of hypobaric and hyperbaric environment. Caisson disease. Preventive measure for hypobaric and hyperbaric effects. Acclimatization to high altitudes. **(10 Lectures)**

5. **Human and Environment II :**

G force, ionizing and non-ionizing radiations - physiological effects and preventive measures. Air, noise and water pollutions – causes, effects, prevention measures and control. Brief idea of the hazards of pesticides, carcinogens, mutagens, neurotoxins and war gases. Impact of green house effects on life. **(10 Lectures)**

UNIT : 12 (50 MARKS)

1. Microbiology I:

Classification of microorganisms. Techniques employed for the identification of microorganisms -- microscopic and biochemical methods. Control of microbial growth : Physical and Chemical methods used in sterilization, disinfection and pasteurization. Bacteriology : Bacterial classification based on staining techniques (Gram stain and Acid-fast stain) and morphological aspect. Bacterial structure : cell-wall, LPS layer, pili, flagella, chromosome, plasmid spores and cysts. Culture of bacteria : nutritional requirement – complex and synthetic media, preparation of media ; physical factors required for growth (temperature, pH and gaseous requirement) ; bacterial growth curve : different phases and their significance ; quantitative estimation of bacterial growth ; continuous growth culture and its utility.

Food microbiology : beneficial and harmful microorganisms in food, causative organisms of food-borne infections- mode of transmission and methods of prevention. **(12 Lectures)**

2. Microbiology II :

Bacterial metabolism: fermentation, glyoxalate cycle and Entner-Doudoroff pathway. Bacterial genetics : transformation, conjugation and transduction. Treatment of bacterial infection : chemotherapeutic agents, antibiotics- definition, bactericidal and bacteriostatic and their mechanism of action.

Virology : Viral structure – virion, prion and bacteriophages ; classification of viruses based on nucleic acid composition and host system, replication of bacteriophages – lytic and lysogenic cycles. **(10 Lectures)**

3. Immunology :

Overview of innate and acquired immunity. Elements of acquired immunity : characteristics of immune response, cells and organs involved in immune response. Immunogens and antigens : requirements of immunogenicity, epitopes recognized by B- & T- cells, haptens, adjuvants, cross-reactivity. Antibody structure, classification and functions. Kinetics of antibody responses : primary & secondary. Antigen - antibody interactions - Primary interaction : association constant, affinity & avidity. Secondary interaction : precipitation & agglutination. B-cell receptor. MHC molecules : structure of class I and II molecules, brief idea of peptide binding by MHC molecules, cellular distribution. Antigen processing and presentation. T-cell receptor. T-cell maturation and differentiation - thymic selection in brief. B-cell activation & differentiation : thymus dependent and independent antibodies, T-B co-operation, the carrier effect. Cytokines : produced by T_{H1} & T_{H2} cells, regulating specific immune response only. Complement : Activation components – classical, alternative and lectin. Biological consequence of complement activation. Cell-mediated effector responses : CTLS, NK cells, K cells. Immune responses in allergy. Brief idea of autoimmunity and AIDS. Vaccination : Passive and active immunization, types and uses of vaccine. Toxins and toxoids. Hybridoma technology. **(14 Lectures)**

4. Pharmacology :

The importance of pharmacology in the study of physiological processes. Definition of drug, agonist and antagonist. Drug delivery Drug reactivity. Pharmacokinetics : Drug-receptor interaction, Desensitization of receptors, Absorption, Distribution, Permeation, Elimination, Clearance,Half-life.Pharmacodynamics:dose-response curves.Beneficial versus toxic effects of drugs. Drug biotransformation. Bioavailability. Drug accumulation. Drug toxicity – LD50, ED50, therapeutic index.

Anaesthetics : types and mechanism of action of general anaesthetics.

Sedatives - hypnotics: benzodiazepine, zolpidem.

Diuretics - Carbonic anhydrase inhibitor, loop diuretic, potassium sparing and osmotic diuretics.

Neuromuscular blockers : Tubocurarine and succinyl choline.

Organ system effects and mechanism of action of adrenoceptor agonists and antagonists:

Adrenergic stimulants : Amphetamine and ephedrine. α- adrenergic stimulants – Methaxomine and clonidine. β- adrenergic stimulants – Metaproterenol and salbutamol.

Adrenergic antagonists : Labetelol. α- adrenergic blockers – Phenoxybenzamine and phentolamine. β- adrenergic blockers – Propranolol and atenolol.

Antianginal drugs : Nitroglycerine and calcium-channel blocker – Nifedipine and verapamil. **(12 Lectures**)

5. Biostatistics :

Scope of statistics – utility and misuse.Principles of statistical analysis of biological data. Basic concepts – variable, parameter, statistics. Sampling. Presentation of data-frequency distribution, frequency polygon, histogram, bar diagram and pie diagram. Parameters. Different classes of statistics- mean, median, mode, mean deviation, variance, standard deviation, standard error of the mean. Standard score. Degrees of freedom. Probability. Normal distribution. Student's t-distribution. Testing of hypothesis - Null hypothesis, errors of inference, levels of significance, t-test and z score for significance of difference. Distribution-free test - Chi-square test. Linear correlation and linear regression.

(12 Lectures)

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Practical

PAPER – VII (F.M. 100)

UNIT : 13

1. Biochemical Estimation : 40 Marks

i) Blood Sugar by Folin-Wu Method ; ii) Serum Protein by Biuret Method ; iii) Serum Albumin using Bromocresyl Green ; iv) Estimation of RNA by orcinol method ; v) Blood Uric Acid by cyanide-free method ; vi) Serum urea by DAM method.

2. Experimental Physiology : 25 Marks

Preparation of amphibian Ringer solution. Kymographic recording of perfused heart beat of toad. Study of the effects of changes in perfusion fluid pressure, excess calcium and potassium ion concentration, acetylcholine, adrenaline.

3. Microbiology & Biochemical Technique : 10 Marks

(a) Gram staining of bacteria and identification of Gram positive and Gram negative bacteria.
Demonstration: Spore Staining, Immuno-diffusion.
(b) Isolation of amino acids from an artificial mixture using paper chromatography.

4. *Viva - Voce* : 15 Marks

5. Laboratory Note - Books : 10 Marks

PAPER –VIII (F.M. 100)

UNIT : 14

1. Histology : 15 Marks

Staining of sections by haematoxylin-eosin and iron-haematoxylin.
Demonstration : Preparation of permanent slides – fixation, dehydration, paraffin embedding, block preparation, cutting and staining.

2. Experimental Physiology: 20 Marks

Kymographic recording of normal movements of rat's intestine in Dale's apparatus. Effects of hypoxia, acetylcholine and adrenaline on normal intestinal movements.

3. Experiments on Work Physiology and Ergonomics using human subjects : 15 Marks

a) Sphygmomanometric measurement of arterial blood pressure at rest and after exercise.
b) Modified Harvard step test and determination of physical fitness. Recording of recovery heart-rate after standard exercise and graphical plotting.
c) Pneumographic recording of effects of talking, drinking, laughing, coughing, exercise, hyperventilation and breath - holding.
d) Spirometric measurement of vital capacity.
e) Measurement of some common anthropometric parameters- stature, weight, eye height, shoulder height, eye height (sitting), elbow height, sitting height, elbow rest height (sitting), knee height (sitting), shoulder elbow length, arm reach from wall, elbow-to-elbow breadth, knee-to-knee breadth (sitting), shoulder breadth, head length, head breadth, head circumference and neck circumference, mid-arm circumference, waist circumference, hip circumference, chest circumference.
f) Calculation of Body Surface Area (using nomogram), Body Mass Index and Ponderal Index from anthropometric measurements.

2. Biostatistics : 10 Marks

Computation of mean, median, mode, standard deviation and standard error of the mean with physiological data like body temperature, pulse rate, respiratory rate, height and weight of human subjects. Graphical representation of data in frequency polygon and histogram. Student's t test for significance of difference between means.

Demonstration: Statistical analysis and graphical representation of biological data with computer application program (Microsoft Excel).

3. Social Physiology : Diet survey and Field Study record : 15 Marks

a) Diet survey report (hand-written) of a family (as per ICMR specification) : Each student has to submit a report on his/her own family. 8 Marks
b) A report (hand-written) on the basis of field survey from ONE of the followings: 7 Marks
   1. Physiological parameters of human (at least three parameters).
   2. Anthropometric measurements on human (at least three parameters).
   3. Epidemiological studies on human.
   4. Project work on animals involving physiological parameters (at least three parameters).
c) Optional : Visit to Institute of national importance engaged in physiological, biomedical, biochemical and nutritional research.

4. *Viva Voce* : 15 Marks

5. Laboratory Note - Books : 10 Marks

RECOMMENDED BOOKS FOR PHYSIOLOGY (HONOURS) Parts I, II & III Courses

(The latest edition available should be used for all books)

1. Text book of Medical Physiology, by A.C. Guyton. W.B. Saunders Co.
2. Best & Taylor's Physiological Basis of Medical Practices, edited by B.K. Brobeck. The William and Wilkins Co.
3. Review of Medical Physiology. By W.F. Ganong, Lange Medical Book. Prentice-Hall International.
4. Harper's Biochemistry, by R.K. Murry and others. Lange Medical Book. Prentice-Hall International.
5. Lehninger's Principles of Biochemistry. By D.L. Nelson and M. M. Cox, Worth Publishers Inc.
6. Text Book of Biochemistry, by E.S. West. W.R. Todd. H.S. Mason. J.T. Van Bruggen. The Macmillan Company.
7. Biochemistry. By D.Das, Academic Publishers.
8. Biophysics and Biophysical Chemistry, by D.Das. Academic Publishers.
9. Samson Wright's Applied Physiology. Edited by C.A. Keele. E Neil & N. Toels. Oxford University Press.
10. Physiology, by R.M. Berne & M.N. Levy, C.V. Mosby Co.
11. Basic Histology, by L.C. Junqueira & J Carneiro, McGraw- Hill .
12. Histology- A Text and Atlas, by M.H. Ross & E.J. Reith. The Williams and Wilkins Company.
13. Bailey's Text Book of Histology, revised by W.M. Copenhaver; The Williams and Wilkins Company.
14. The Cell – A Molecular Approach, G.M. Cooper & R.E.Hausman, ASM Press SINAUER.
15. Core Text Book of Neuro-Anatomy, by M.B. Carpenter; the Williams and Wilkins Company.
16. The Human Nervous System, by Charles Nobach, Mc Graw Hill Book Co.
17. Biomedical Instrumentation & Measurements, by L. Cromwell, F.J. Weibell & E.A. Pfeiffer; Prentice-Hall of India Pvt Ltd.
18. The Human Nervous System. By M.L. Barr & J.A. Kierman, Harper & Row.
19. Essential Food and Nutrition, by M. Swaminathan. The Bangalore Printing & Publishing Co. Ltd.
20. Essential Immunology, by I.M. Roitt, Blackwell Scientific Publications.
21. Kuby Immunology, by R.A. Goldsby. T.J. Kindt and B.A. Osborne, W.H. Freeman and Co.
22. Microbiology, by M.J. Pelczer & Others; Tata McGraw Hill Publishing Co Ltd.
23. Cellular & Molecular Biology,by EDP De Robertis & EMF De Robertis; Lea & Febiger.
24. Molecular Biology of the Gene, by J.D. Watson, H.H. Nancy & others; Benjamin-Cummings.
25. Molecular Biology of the Cell, by B. Alberts and others, Garland.
26. Textbook of Medical Physiology, Indu Khurana, Elsevier.
27. Carleton's Histological Techniques, by R.A.B. Drury & E.A. Wellignton, Oxford University Press.
28. Handbook of Experimental Physiology and Biochemistry, by P.V. Chadha; Jaypee Brothers Medical publishers.
29. Neurobiology, by G.M. Shepherd, Oxford University Press
30. Biochemistry, by L. Stryer, W.H. Freeman and Co.
31. Molecular Cell Biology, by H. Lodish, D. Baltimore & others. Scientific American Book.

32. Genetics: Analysis of Genes and Genomes, by DL Hartl and EW Jones & Burtlet Publishers.
33. William's Text Book of Endocrinology Larsen *et al*.,: An Imprint of Elsevier.
34. Endocrinology, Mac E. Hadley, Pearson Education.
35. The Kidney-An outline of Normal and Abnormal Functions, by H.E. Dewardener, ELBS.
36. Physiology of Respiration by J.H. Comroe. Year Book Medical Publihsers.
37. Text Book of Physiology. Vols. I & II by H.D. Patton. A.F. Ruchs. B.Hille. A.M. Scher and R. Sleiner. W.B. Saunders of Co.
38. The Physiological Basis of Physical Education and Athletics by E.L. Fox and D.K. Mathews. Saunders College Publishing.
39. Statistics in Biology and Psychology by D.Das Academic Publishers.
40. An Introduction to Biostatistics, N. Gurumani, M.J.P. Publishers, Chennai.
41. Pesticides by P.K. Gupta, Interprint.
42. Environmental Chemistry by P.V. De. Wiley Eastern Ltd.
43. Exercise Physiology – Energy, Nutrition and Human Performance by W.D. McArdle, F.Katch and V.L. Katch. Lippincott,Williams and Wilkins.
44. Essentials of Exercise Physiology by L.G. Shaver, Surjeet Publications.
45. Text Book of Environmental Physiology by C. Edger Folk Jr. Lea and Febiger.
46. Goodman & Gilman's The Pharmacological Basis of Therapeutics, McGraw-Hill.
47. Quintessence of Medical Pharmacology, S.K. Chaudhuri, New Central Book Agency.
48. Essentials of Medical Pharmacology, KD Tripathi, Jaypee.
49. Text book of Work Physiology by P.O. Astrand and K. Rodahl. Mc Graw- Hill Book Co.
50. Human Factors in Engineering and Design by E.O. McCormick and M. Sanders. Tata McGraw Hill.
51. Energy,Work and Leisure J.V.G.A.Durin and R.Passmore,Heinemann Educational Books.
52. Sports Physiology by E.L. Fox, Saunders College Publishing. Holt-Saunders.
53. Vander's Human Physiology, E.P. Widmaier *et al*., McGraw-Hill, Higher Education.
54. Concise Medical Physiology by S.K. Chaudhuri, New Central Book Agency.
55. Medical Physiology by A.B. Mahapatra, Current Books International.
56. Endocrinology. Vols.I , II and III by L.O. DeGroot. W.B. Saunders Co.
57. The Physiology of Reproduction, Vols.I & II, by E. Knobil and J.D. Neil. Raven Press.
58. Park's Text Book of Preventive and Social Medicine by K. Park, M/s. Banarsidas Bhanot Publishers.
59. Langman's Medical Embryology by J.W. Sadler, Lippincott,Williams and Wilkins.
60. Essentials of Human Embryology by A.K. Datta. Current Books International.
61. Human Embryology by I. Singh & G.P.Pal, McMillan.
62. The Circadian System of Man by R.A. Wever, Spinger-Verlag.
63. The Clocks That Time Us, by M.C. Moore- Ede and others, Harvard University Press.
64. Circadian Rhythms and the Human, by D.S. Minors and J.M. Waterhouse. Wright. PSG.
65. The Physiological Clock: Circadian Rhythms and Biological Chronometry, E. Bunning, Springer-Verlag.
66. Textbook of Pharmacology, SD Seth, B.I. Churchill Livingstone.
67. Basic and Clinical Pharmacology by E.G. Katzung. Appleton and Lange.
68. An Introduction to Biological Rhythms, by D. Palmer, Academic Press
69. Medical Statistics by B.K. Mahajan. Jaypee Brothers, Medical Publishers Pvt. Ltd.
70. Statistical Methods by G.W. Snecedor and W.G. Cochran, Oxford & IBH Publishing Co. Pvt. Ltd.
71. Theory and Practice of Histological Techniques by J.D. Bancroft & A. Stevens, Churchill Livingstone.

72. Practical Biochemistry in Medicine by Srinivas Rao., Academic Publishers.
73. Practical Physiology, by M.K. Manna, Sritara Prakashani, Kolkata

Note Books of Practical Biochemistry, Experimental Physiology and Histology
(Published by the Physiological Society of India, Kolkata)

Note : In order to maintain the uniformity of practical knowledge among the students of different Colleges, Physiological Society of India has published Practical Note Books in Physiology comprising syllabi of different Universities including Calcutta University with the help of experienced teachers including dignitaries of both Honours and General teaching degree colleges. Hence, members of the Undergraduate Board of Studies in Physiology recommend the aforesaid Note Books (Experimental, Biochemistry and Histology) for use by the students in undergraduate degree course (Honours practical) in Physiology.

GENERAL

PART - I

THEORETICAL

Paper I (F.M. 100)

Unit - 01: 50 Marks	Lectures required (Each period of 45 minutes duration)
1. Units of human system	06
2. Biophysical and Biochemical Principles	10
3. Digestive System	12
4. Biochemistry and Metabolism	14
5. Nutrition and Dietetics	08

Unit – 02 : 50 Marks

1. Blood and Body Fluids	10
2. Heart	10
3. Circulation	10
4. Respiratory system	10
5. Renal Physiology	10

PART - II

THEORETICAL

Paper – II (F.M. 100)	Lectures required (Each period of 45 minutes duration)
Unit - 03: 50 Marks	
1. Muscle Physiology	08
2. Nerve Physiology	10
3. Nervous system I	10
4. Nervous system II	10
5. Sensory Physiology	12

Unit – 04 : 50 Marks

1. Skin and Regulation of Body Temperature	08
2. Endocrine system I	12
3. Endocrine system II	12
4. Reproductive Physiology I	09
5. Reproductive Physiology II	09

PRACTICAL

Paper – III (F.M.100)

(One practical class is of 3 periods) Classes required 70
(Each period of 45 minutes duration)

Unit 05

1. Histology : 30 Marks
   a) Haematological Experiments
   b) Fresh tissue experiments (except haematological experiments) 20 Marks
   c) Identification of histological permanent slides 10 marks
2. Biochemistry : 30 Marks
   a) Qualitative Experiments 10 marks
   b) Quantitative Experiments 20 marks
3. Experimental Physiology (Including Human Experiments) 15 Marks
   a) Amphibian skeletal muscle and heart experiments
   b) Experiments on Human
4. *Viva voce* 15 Marks
5. Laboratory note books 10 Marks

PART - III

THEORETICAL

Paper – IV A (F.M. 70) Lectures required
(Each period of 45 minutes duration)

Unit – 06: 70 Marks

1.	Haematology	10
2.	Biochemistry & Molecular Biology	14
3.	Microbiology and Immunology	10
4.	Social Physiology	08
5.	Work Physiology	10
6.	Environmental Physiology	10
7.	Biostatistics	08

PRACTICAL

Paper - IVB F.M. 30
(One practical class is of 3 periods) Classes required 20
(Each period of 45 minutes duration)

Unit – 07: 30 Marks

1. a) Haematology
   b) Biochemistry } 18 Marks
   c) Human Experiments
2. Field Study Report 4 Marks
3. *Viva voce* 5 Marks
4. Laboratory Note-Books 3 Marks

PART - I

THEORETICAL

Paper I (F.M. 100)

Unit - 01: 50 Marks

1. Units of Human System :

Structure and functions of plasma membrane, nucleus and different cell organelles – Endoplasmic reticulum, Golgi bodies, Mitochondria, Lysosome and Peroxisome. Structure, function and classification of Epithelial, Connective, Muscular and Nervous tissues. (06 lectures)

2. Biophysical and Biochemical Principles:

Physiological importance of the following physical processes: Diffusion , Osmosis, Dialysis, Ultrafiltration , Surface tension, Adsorption and Absorption. A brief idea about acids, bases, buffers, indicators. pH – definition, significance and maintenance of pH in the blood. Colloids - definition, classification and physiological importance. Enzymes: definition, classification, factors affecting enzyme action. Concept of coenzymes and isozymes. (10 lectures)

3. Digestive System :

Structure in relation to functions of alimentary cana1 and digestive glands. Composition, functions and regulation of secretion of digestive juices including bile. Digestion and absorption of carbohydrate, protein and lipid. Movements of the stomach and small intestine. (12 lectures)

4. Biochemistry and Metabolism :

Carbohydrates : Definition and classification.

Monosaccharides – Classification, structure. Chemical reactions of monosaccharides (Glucose & Fructose) **—** Reactions with concentrated mineral acids, alkali, phenylhydrazine and their biochemical importance.

Disaccharides **–** Maltose, Lactose and Sucrose: Structure, occurrence and physiological importance.

Polysaccharides **–** Starch, Glycogen, Dextrin, Cellulose.

Lipids : Definition and classification. Fatty acids **——** Classification. Properties of Fat and Fatty acids—Hydrolysis, Saponification,Saponification number, Iodine number, Hydrogenation, Rancidity-Acid number. Phospholipids, Cholesterol & its ester **–** physiological importance.

Amino acids, Peptides and Proteins : Classification and structure. Structure of peptide bonds.
Glycolysis, TCA cycle, Glycogenesis, Glycogenolysis. Gluconeogenesis. Depot fat. Beta oxidation of saturated fatty acid Ketone bodies – formation and significance. Deamination, Transamination. Amino acid pool - fate and functions of amino acids in the body. Formation of urea and its importance. (10 lectures)

5. Nutrition :

Basic constituents of food and their nutritional significance. Vitamins: definition, classification, functions, deficiency symptom.s and daily requirements. Hypervitaminosis. Mineral metabolism - Ca. P, Fe. BMR: definition, factors affecting, determination by Benedict-Roth apparatus. Respiratory quotient: definition, factors affecting and significance. Biological value of proteins. Essential and non-essential amino acids, Nitrogen equilibrium. Minimum protein requirement-Positive and negative nitrogen balance. SDA : definition and: importance. (08 lectures)

Unit – 02 : 50 Marks

1. Blood and Body Fluids :

Blood: composition and functions. Plasma proteins: origin and functions. Plasmapheresis. Bone marrow. Formed elements of blood - their morphology and functions. Erythropoiesis and leucopoiesis. Haemoglobin : different types of compounds and derivatives. Blood volume and its determination (dye method and radioisotope method) and regulation. Coagulation of blood : mechanism, factors affecting, procoagulants, anticoagulants, and disorders of coagulation. Lymph and tissue fluids: composition, formation, and functions. (10 lectures)

2 Cardiovascular Physiology I :

Anatomy and histology of the heart. Properties of cardiac muscle. Origin and propagation of cardiac impulse. Cardiac cycle : events. Heart sounds. Heart rate. Cardiac output: methods of determination (dye dilution and Fick principle), factors affecting, regulation. (10 lectures)

3. Cardiovascular Physiology II :

Structure of arteries, arterioles, capillaries. venules and veins. Pulse - arterial and venous. Blood pressure and its regulation and factors controlling. Baro- and chemoreceptors. Vasomotor reflexes. Methods of measurement of blood pressure. Peculiarities of regional circulations: coronary, pulmonary, renal, hepatic and cerebral. (10 lectures)

4. Respiratory Physiology :

Anatomy and histology of the respiratory passage and organs. Role of respiratory muscles in breathing. Artificial respiration. Significance of physiological and anatomical dead space. Lung volumes and capacities. Exchange of respiratory gases between lung and blood and between blood and tissues. Transport of oxygen and carbon dioxide in blood. Regulation of respiration - neural and chemical. Hypoxia. (10 lectures)

5. Renal Physiology :

Relationship between structure and functions of kidney. Mechanism of formation of urine. Normal and abnormal constituents of urine. Physiology of urine storage and micturition. Renal regulation of acid-base balance. Non-excretory functions of kidney. (10 lectures)

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PART - II

THEORETICAL

Paper II (F.M. 100)

Unit – 03 : 50 Marks

1. Muscle Physiology :

Different types of muscle and their structure. Red and white muscle. Muscular contraction: structural, mechanical and chemical changes in skeletal muscle during contraction and relaxation. Isotonic and isometric contractions. Properties of muscle: all or none law, beneficial effect, summation. refractory period, tetanus, fatigue. A brief idea about the muscle spindle.

(08 lectures)

2. Nerve Physiology :

Structure and classification of nerves. Origin and propagation of nerve impulse. Velocity of impulse in different types of nerve fiber. Properties of nerve fibers: all or none law, rheobase and chronaxie, refractory period. indefatiguability. Synapses: structure, different types, mechanism of synaptic transmission. Motor unit. Myoneural junction: structure, mechanism of impulse transmission. Degeneration and regeneration in nerve fibers. (10 lectures)

3. Nervous System I :

A brief outline of organization and basic functions (sensory, motor and association) of the nervous system, central and peripheral nervous system. (emphasis on the structure of spinal cord and brain stem). Ascending tracts carrying touch, kinaesthetic, temperature and pain sensations. Descending tracts: pyramidal tract and brief outline of the extra-pyramidal tracts. Pain. Reflex action - definition, reflex arc, classification, properties. Functions of the spinal cord. Outline of functions of brain stem.

(10 lectures)

4. Nervous System II :

A brief idea of the structure, connections and functions of cerebellum. Different nuclei and functions of thalamus and hypothalamus. Cerebral cortex: histological structure and localization of functions. CSF : composition, formation, circulation and functions. A brief description of the organization of the autonomic (sympathetic and parasympathetic) nervous system. Functions of sympathetic and parasympathetic nervous system. A brief idea of speech, aphasia, conditioning, learning and memory.

(10 lectures)

5. Sensory Physiology :

Classification of general and special senses and their receptors. Receptors as biological transducer.

(a) *Olfaction and Gustation*: Structure of sensory organ, neural pathway of olfactory and gustatory sensation. Physiology of olfactory and gustatory sensation. Olfactory and gustatory adaptation. After-taste.

(b) *Audition:* Structure of ear, auditory pathway, mechanism of hearing.

(c) *Vision:* Structure of the eye. Histology of retina. Visual pathway. Light reflex. Chemical changes in retina on exposure to light. Accommodation - mechanism and pathway. Errors of refraction. Positive and negative after-image. Light and dark adaptation. Elementary idea of colour vision and colour blindness. (12 lectures)

Unit – 04 : 50 Marks

1. Skin and Regulation of Body Temperature:

Structure and functions of skin. Insensible and sensible perspiration Regulation of body temperature — physical and physiological processes involved in it. Physiology of sweat secretion and its regulation. (08 lectures)

2. Endocrine System I :

Anatomy of endocrine system. Hormones - classification. Basic concept of regulation of hormone actions. Positive and negative feedback mechanism. Elementary idea of hormone action.

Hypothalamus : Basic concept of neurohormone. Hypothalamo-hypophyseal tract and portal system.

Pituitary: Histological structure, hormones, functions. Hypo and hyperactive states of pituitary gland.

Thyroid: Histological structure. Functions of thyroid hormones (T_4T_3) Thyrocalcitonin. Hypo and hyper-active states of thyroid.

Parathyroid: Histological structure, functions of parathyroid hormone. Tetany. (12 lectures)

3. Endocrine System II :

Adrenal Cortex: Histological structure and functions of different hormones. Hypo and hyper-active states of adrenal cortex.

Adrenal Medulla: Histological structure and functions of medullary hormones. The relation of adrenal medulla with the sympathetic nervous system.

Pancreas: Histology of islets of Langerhans. Origin and functions of pancreatic hormones. Diabetes mellitus.

Brief idea of the origin and functions of renin-angiotensin, prostaglandins. erythropoietin and melatonin. Elementary idea of gastrointestinal hormone. (12 lectures)

4. Reproductive Physiology I :

Primary and accessory sex organs and secondary sex characters. Testis: histology, spermatogenesis, testicular hormones and their functions. Ovary: histology, oogenesis, ovarian hormones and their functions. (09 lectures)

5. Reproductive Physiology II :

Oestrus and menstrual cycles and their hormonal control. Fertilization, implantation and structure and functions of placenta. Maintenance of pregnancy – role of hormones. Development of mammary gland and lactation - role of hormones.

(09 lectures)

DISTRIBUTION OF QUESTIONS IN THEORETICAL PAPER

1. From each unit, **five** questions of 10 marks each with one alternative will be set from the same sub-unit . Each 10 marks question may be sub-divided.

2. Candidates have to **attempt all five** questions from the unit amongst the alternatives.

Practical

Paper III (F.M. 100)

Unit – 05

1. Histology : **30 Marks**

Only ONE question will be set from the following two groups [i) & ii)] in the examination (20 Marks) :

i) Haematological experiments :

a) Leishman's staining of human blood film and identification of different types of blood corpuscles.

b) Preparation of Haemin crystals.

ii) Fresh tissue experiments:

a) Examination and staining of fresh tissues (other than blood) squamous, cornified, ciliated and columnar epithelium, skeletal muscle, cardiac muscle by methylene blue stain.

b) Silver nitrate preparation of node of Ranvier.

Demonstration: Staining of adipose tissue by Sudan III or IV.

iii) Identification of permanent slides: Bone, Lung, Trachea, Spleen, Lymph gland, Liver, Salivary gland, Pancreas, Adrenal gland, , Thyroid gland, Spinal cord, Cerebellum, Cerebral cortex, Kidney, Skin, Testis, Ovary, Tongue, Oesophagus, Stomach, Small intestine, Large intestine. (5 slides - 10 Marks)

2. Biochemistry : **30 Marks**

Qualitative Experiments: 10 Marks

Qualitative tests for identification of starch, dextrin, lactose, sucrose, glucose, fructose, albumin, gelatin, peptone, lactic acid, hydrochloric acid, uric acid, acetone, glycerol, bile salts, urea.

Quantitative Experiments: 20 Marks

a) Quantitative estimation of glucose by Benedict's method.

b) Quantitative estimation of amino-nitrogen by Sorensen's formol titration method. *Percentage and total quantity to be done.*

Demonstration:

a) Quantitative estimation of Sucrose by Benedict's method.

b) Analysis of wheat, rice, milk and oil to test the presence of carbohydrate, protein and fat.

c) Salivary amylase activity on starch at body temperature (37.5 C), above 40°C and in presence of HCl.

3. Experimental Physiology with Human Experiment : **15 Marks**

a) Use of kymograph, induction coil and key.

b) Recording of simple muscle curve with sciatic-gastrocnemius muscle preparation of toad and determination of latent period, period of contraction and period of relaxation and maximum height of contraction.

c) Normal tracing of toad's unperfused heart beat.

d) Effect of warm saline on toad's unperfused heart beat.

e) Measurement of systolic and diastolic arterial pressure by sphygmomanometer and determination of pulse pressure and mean pressure during rest and exercise.

Demonstration :

a) Effect of temperature on simple muscle twitch.

b) Effect of calcium and potassium ions on unperfused toad's heart beat.

c) Effect of adrenaline/acetylcholine on unperfused toad's heart beat.

4. Laboratory Note Books : **10 Marks**

i) Biochemistry - 4 marks; ii) Histology - 3 marks; iii) Experimental - 3 marks

5. *Viva – voce* **15 Marks**

a) Questions are to be asked from the experiments given in the examination.

i) From Biochemistry - 4 marks; ii) From Histology - 4 marks;

iii) From Experimental -3 marks ; iv) From Instruments – 4 marks

(Questions are to be asked on the different instruments used in the practical classes.)

PART - III

THEORETICAL

Paper IV A (F.M. 70) Unit – 06 : 70 Marks

1. Haematology :

Blood groups - ABO and Rh. Blood transfusion - precaution and hazards. Immunological basis of identification of ABO and Rh blood groups. Functions and estimation of haemoglobin. Abnormal haemoglobins - thalassaemia and sickle-cell anaemia. Definition, determination and significance of TC, DC, ESR, Arneth count, PCV, MCV, MHC, MCHC, bleeding time, clotting time and prothrombin time. Anaemia - types (definition and causes). Leucocytosis, leucopenia and leukaemia. Purpura. (10lectures)

2. Biochemistry and Molecular Biology :

Brief idea of HMP shunt and its significance (detailed enzymatic reactions are not required). Lipoproteins - types and functions. Purine and pyrimidine bases, nucleosides, nucleotides and polynucleotides. Structure of DNA and RNA. Elementary idea of gene, genome, transcription, genetic code, translation and genetic engineering. (10 lectures)

Pathophysiological significance of the following blood constituents: glucose, urea, creatinine, uric acid, cholesterol, bilirubin, SGPT and SGOT, alkaline and acid phosphatases and ketone bodies. (4 lectures)

3. Microbiology and Immunology :

Virus - DNA virus and RNA virus. Bacteriophage. Bacteria-structure and morphological classification. Gram positive and Gram negative and acid-fast bacteria. Pathogenic and non-pathogenic bacteria - definition with a few examples. Sterilization and Pasteurization. A brief idea of antibiotics. Elementary knowledge of innate and acquired immunity. Humoral and cell mediated immunity Vaccination - principles and importance of immunization. Basic principle of immunological detection of pregnancy. (10 lectures)

4. Social Physiology :

Composition and nutritional value of common Indian foodstuffs – rice, wheat, pulses, egg, meat, fish and milk. Dietary fibers. Calorie requirement. Concept of ACU. Principle of balanced diet formulation of individuals - infants, growing children, students, pregnant women, lactating women and aged persons. Dietary management or obese, diabetic person, hypertensive person and athlete. Diet survey. Malnutrition and its causes - PCM, marasmus, kwashiorkor their prevention. Iron and iodine deficiency.

Population problem and its control. Problem of infertility and brief idea about *in vitro* fertilization and intrauterine gamete transfer. Brief idea of AIDS and hepatitis B and their preventions. (08 lectures)

5. Work Physiology :

Physical work - definition and units of measurement. Concept and classification of physical work – static and dynamic work, positive & negative work. Cardiovascular and respiratory changes during physical exercise. Brief idea of maximal aerobic power and excess post-exercise oxygen consumption. Basic idea of doping. EMG. Physical fitness index - Harvard step test. ECG – normal waves and leads. Anthropometry and its uses. (10 lectures)

6. Environmental Physiology :

Environment - its physiological aspects. Effect of extreme temperature on humans. Hypobaric environment - effects on physiological system, acclimatization. Hyperbaric conditions and Caisson disease. Brief idea of cyanosis, dyspnoea, hyperpnoea, apnoea and asphyxia. Some common pollutants and their effects - carbon monoxide, lead and arsenic. Effects of noise on human body and preventive measures. (l0 lectures)

7. Biostatistics :

Basic concepts – variable, population, parameter, sample, statistic. Classification of data – qualitative and quantitative, continuous and discontinuous. Presentation of data–frequency distribution, bar diagram, pie diagram, frequency polygon and histogram. Mean, median, mode, standard deviation and standard error. (08 Lectures)

Distribution of QuestionS In THEORETICAL Paper

1. From each unit, **seven** questions of 10 marks each with one alternative will be set from the same sub-unit. Each 10 marks question may be sub-divided.
2. Candidates have to **attempt all seven** questions from the unit amongst the alternatives.

8

PRACTICAL

Paper IV B (F.M. 30)

Unit – 07 : 30 Marks

1. Any two questions from the following three groups (A, B and C) are to be set in the examination:
9 x 2 = **18 marks**

A. *Haematology:*

a) DC of WBC, estimation of haemoglobin, blood group determination, bleeding time and coagulation time.

Demonstration: Haematocrit, MCV, TC of RBC and WBC, ESR.

B. *Biochemistry:*

a) Identification of normal constituents of urine - chlorIde. sulphate, phosphate, creatinine and urea. Identification of abnormal constituents of urine - glucose, protein, acetone blood and bile salts.

Demonstration: Blood sugar estimation (Folin -Wu method)

C. *Human Experiments:*

a) Determination of Physical Fitness Index (PFI) of an individual by modified Harvard step test and recording of recovery heart-rate after standard exercise.
b) Pneumographic recording of respiratory movements along with the effect of drinking of water, talking, forced hyperventilation and breath holding.
c) Measurement of some common anthropometric parameters : stature, weight, eye height, shoulder height, elbow height. sitting height, elbow rest height (sitting), knee height (sitting), arm reach from wall, mid-arm circumference, waist circumference, hip circumference, neck circumference,head circumference, chest circumference.
d) Calculation of Body Surface Area (using a nomogram) and Body Mass Index from anthropometric measurements.

Demonstration:

a) Tests for colour blindness, test for visual acuity using Snellen’s Chart. Exploration of conductive and perceptive deafness by tuning for method.

b) Ergographic recording of muscular fatigue by' Moss's ergograph. Clinical classification of reflexes : superficial reflex - planter reflex, Deep reflex – knee jerk, Visceral reflex - pupillary light reflex.

2. Field Study Report: **4 Marks**

Any one of the followings:

a) Diet survey of a family as per ICMR specification.
b) Population study of physiological parameters such as height, weight, heart-rate, blood pressure, respiratory rate, PFI, TC of RBC, estimation of haemoglobin, DC of WBC as far as practicable.

3. *Viva- Voce:* **5 Marks**

4. Laboratory Note- Book : **3 Marks**

RECOMMENDED TEXT AI\D REFERENCE BOOKS FOR PHYSIOLOGY (GENERAL) COURSE

(The latest edition available should be used for all books)

1. *Human Physiology Vol. 1* & 2, C. C. Chatterjee, Medical Allied Agency.
2. *Sharirbigyan (Bengali) Vol. I* & 2, J. Debnath, Sridhar Prakashani.
3. *Principles of Physiology,* D.Pramanik, Academic Publishers, Kolkata.
4. *Concise Medical Physiology,S.* K. Chaudhuri, New Central Book Agency.
5. *Biochemistry,* D. Das, Academic Publishers.
6. *Paripak, Bipak* 0 *Pusti,* D. Das, Paschim Banga Rajya Pustak Parshad.
7. *Bailey'sText Book of Histology,* W. M. Compenhaver, Williams and Wilkins.
8. *Atlas of Human Histology,* M. S. H Di Fiore, Lea & Febiger.
9. *Essentials of Exercise Physiology,* L.G. Shaver, Surjeet Publications.
10. I .*Text Book of Medical Physiology,* A.C.Guyton, W.B. Saunders Co.
    II. *The Living Body,* O.H Best & N.B Taylor, Williams & Wilkins.
11. *Human Physiology Vol 1* &2, T. K. Basu, Biomed Publications.
12. *Biomedical Instruments and Measurements,* L. Cromwell, FJ Weibell, E.A.Pfaiffer,Prentice-Hall of India Pvt. Ltd.
13. A *Text Book of Practical Physiology,* C.L. Ghai, Jaypee Brothers Medical Publishers Pvt. Ltd.
14. *Medical Physiology,* A.K. Das, Books and Allied (P) Ltd.
15. *Medical Physiology,* A.B. Singha Mahapatra, Current Books International.
16. *Essentials of Medical Physiology:* K. Sembulingam and P. Sembulingam, Jaypee Brothers Medical Publishers Pvt. Ltd.
17. *ImmunoLogy* by D. M. Weir, ELBS.
18. *Park's Text Book of Preventive and Social Medicine* by K. Park, *MIs* Banarsi Bhanot Publishers.
19. *Nutritive Value of Indian Foods* by C. Gopalan and other, NIN, Hyderabad.
20. *Practical Physiology,* by M.K. Manna, Sritara Prakashani, Kolkata
21. Note Books on Practical Biochemistry, Experimental Physiology and Histology (Published by the Physiological Society of India, Kolkata.)

Note: In order to maintain the uniformity of practical knowledge among the students of different Colleges, Physiological Society of India has published Practical Note Books on Physiology comprising syllabi of different Universities, including Calcutta University with the help of experienced teachers of both Honours and General teaching degree colleges. Hence, members of Undergraduate Board of Studies in Physiology recommend the aforesaid Note Books (Experimental, Biochemistry and Histology) for use by the students in undergraduate degree course (General) practical in Physiology.

SYLLABUS FOR

B. SC. ZOOLOGY

(HONOURS & GENERAL) 2016

UNIVERSITY OF CALCUTTA

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DRATF SYLLABUS FOR B. Sc. ZOOLOGY (HONOURS & GENERAL) 2016

Paper	Unit	No. of Classes	Group	Topic	Marks	
					Gr.	Tot.
PART – I HONOURS						
Paper 1	**Unit I**	**75**	Group A	Diversity & Functional Anatomy of Non-chordate Forms	**25**	**50**
			Group B	Diversity & Functional Anatomy of Chordate Forms	**25**	
	Unit II	**75**	Group A	Cell biology	**15**	**50**
			Group B	Genetics	**35**	
Paper 2	**Unit I**	**75**	Developmental Biology			**50**
	Unit II	**75**	Practical	Animal forms and Comparative anatomy, Cytological methods and Genetics, Osteology and Embryology		**50**
PART – II HONOURS						
Paper 3	**Unit I**	**75**	Group A	Systematics	**15**	**50**
			Group B	Evolutionary Biology & Adaptation	**25**	
			Group C	Animal Behaviour	**10**	
	Unit II	**75**	Group A	Ecology	**25**	**50**
			Group B	Biodiversity and Conservation	**25**	
Paper 4	**Unit I**	**75**	Group A	Animal physiology	**25**	**50**
			Group B	Biochemistry	**25**	
	Unit II	**75**	Practical	Ecological methods, Systematics and Evolutionary Biology, Animal Physiology and Biochemistry		**50**
PART – III HONOURS						
Paper 5	**Unit I**	**75**	Molecular Biology			**50**
	Unit II	**75**	Group A	Parasitology and Microbiology	**25**	**50**
			Group B	Immunology	**25**	
Paper 6	**Unit I**	**75**	Integration Biology and Homeostasis			**50**
	Unit II	**75**	Animal Biotechnology & Applied Zoology			**50**
Paper 7	**Practical**	**75**	Molecular biology, Parasitology and Microbiology, Immunology, Histological techniques and staining methods, Adaptation			**100**
Paper 8	**Practical**	**75**	Instrumentation, Report on Environmental audit, Field work assessment, Biostatistics			**100**

PART - I

(PAPER 1: UNIT I)

(Diversity & Functional Anatomy of Non-chordate & Chordate Forms)

[Note: Classification will be dealt in practical section of the course]

Group A: Non chordate **Marks = 25**

1. Animal architecture and Bauplan concept.
2. Classification up to Phylum of Protozoa (according to Levine *et. al.*, 1981); from Phylum to living Subclass with reasons of other non-chordates (according to Ruppert and Barnes, 1994)(Invertebrate chordates excluded)
3. Movement: Ameoboid movement: Mechanism of pseudopodia formation by cytoskeletal proteins. Flagellar movement in *Euglena* – ultra structure of Flagella and mechanism of locomotion
4. Reproduction in *Paramoecium* sp. with **special** reference to conjugation
5. Canal system in Porifera
6. Polymorphism in Siphonophores and its evolutionary significance
7. Coral reef: Types, distribution in India and conservation aspects
8. Metamerism in Annelida and its evolutionary significance
9. Respiration: Terrestrial respiration in *Periplaneta* – Structure of tracheal system and mechanism of respiration. Aquatic respiration in Prawn–structure and types of gills and mechanism of respiration.
10. Nervous system in *Pila* and effect of torsion on it. Nervous system in *Aplysia* and effect of de-torsion on it.
11. Water vascular system in *Asterias* sp.
12. Structural organization of Placozoans

Group B: Chordate **Marks = 25**

1. Basic body plan in chordates. Basic concept of chordate classification. Classification up to living Subclass of Fish and Aves; up to living Order of Amphibia and Reptilia; up to Infra-class of Mammals (according to J. Z. Young 1981)
2. Structure of pharynx and feeding mechanism in *Branchiostoma* sp.
3. Metamorphosis in *Ascidia* – justification in the light of survival of the species
4. Comparative anatomy & structural organization of aortic arches in vertebrates.
5. Accessory respiratory structure in teleosts
6. Paedomorphosis with special reference to Axolotl larva
7. Non-poisonous and poisonous snakes; Poison apparatus and biting mechanism of poisonous snake
8. Distinguishing features of Ratites and Carinates
9. Feather of Birds – its type, development, structure, colour variations as adaptive feature and function
10. Exoskeletal structure in Mammals – hair, horns and antlers
11. Distinguishing features of Artiodactyla and Perissodactyla.
12. Functional anatomy of ruminant stomach in cow.

[Note: Eight short questions of 2 marks to be set from both the Groups, of which 5 will be answered. 4 questions from Group A and 4 questions from Group B to be set. Each question will be of 10 marks. Students will answer 2 questions from each group]

PAPER 1, UNIT II
(Cell Biology and Genetics)

Group A: Cell Biology **Marks = 15**

1. **Principles of microscopy**: Light Microscopy; Phase contrast microscopy; Electron microscopy (EM) - Scanning EM (SEM) and Transmission EM (TEM)
2. **Cell Membrane**: Chemical composition and properties of membrane components, Fluid mosaic model of membrane structure, membrane fluidity and its experimental demonstration, membrane asymmetry, selective permeability of the membranes, membrane transport, Liposomes, Freeze-etching and freeze fracture technique for membrane study.
3. **Mitochondria**- Marker enzymes distribution, mitochondrial biogenesis, Symbiont hypothesis of mitochondrial origin; mitochondrial DNA.
4. **Endo membrane system of cell**: Signal peptide hypothesis, N-linked & O-linked glycosylation in ER and Golgi body; protein transport and trafficking.

GROUP B: GENETICS **[Marks = 35]**

1. **Properties of DNA:** Chargaff's rule, Re-naturation and De-naturation, Hyper-chromic shift, c-value paradox.
2. **Concept of genetic information flow**
    a. **DNA Replication**
        i. **In prokaryotes:** Semi-conservative replication; unit of replication, enzymes involved, replication origin replication fork, replication slippage
        ii. **In eukaryotes:** Origin, polymerase enzymes and telomeric replication
    b. **Transcription in prokaryotes and eukaryotes**:
        i. Transcription factors: Transcription activators, Repressors, Motifs (only Basic helix loop helix [BHLH], Leucine zipper – definition and example)
        ii. Formation of initiation complex (in Prokaryotes and RNA Polymerase II in Eukaryotes)
        iii. RNA polymerase, chain elongation and termination.
    c. **RNA processing**: Polyadenylation, methyl capping, splicing.
    d. **Protein synthesis in prokaryotes**: formation of initiation complex, initiation factors, elongation and elongation factors, termination
3. **Allele concept**: Cis-trans test for allelism, Multiple allele: ABO blood group in human; Isoallele: White eye locus in *Drosophila*; Complex locus: Lozenge locus in *Drosophila*.
4. **Linkage**: Complete and Incomplete linkage; Experiments by Bridges
5. **Crossing over**: Three point mapping method; cytogenetic evidence of crossing over in *Drosophila* by Stern's experiment.
6. **Mutation**
    a. Types: transition, transversion, frame shift, nonsense, mis-sense, hypomorphic, null, lethal, forward, backward, suppressor, enhancer.
    b. Mutagens and their effects: UV radiation, ionizing radiation, 5-BU, EMS.
    c. Mutation detection: X linked mutation detection in *Drosophila* by ClB method, Attached X methods, Autosomal mutation detection by CyLPm (balanced lethal) method, and detection of biochemical mutation in *Neurospora crassa*.

7. **Sex determination in *Drosophila* and Human**
8. **Dosage compensation**
    a. **In *Drosophila*:** Hyper activation of ♂*X* by *msl, mle* and *roX* RNA followed by *histone Ac16* acetylation
    b. **In human:** Inactivation of ♀*X* by *XIST* RNA followed by DNA methylation
9. **Chromosomal Aberration**: Types and examples from *Drosophila* and human only.
10. **Cytoplasmic inheritance**: Shell coiling in snail, kappa particle in *Paramoecium*.

[Note: Eight short questions of 2 marks are to be set from both the Groups, of which 5 will be answered. 3 questions from Group A and 5 questions from Group B are to be set. Each question will be of 10 marks. Students will answer 1 question from Group A and 3 questions from Group B]

PAPER 2, UNIT I

DEVELOPMENTAL BIOLOGY **(Marks = 50)**

1. **Gametogenesis**: Spermatogenesis & Oogenesis.
2. **Ultra structure**: sperm and ovum in Sea-urchin and mammals.
3. **Egg Membranes**
4. **Fertilization:** In Sea-urchin and mammals
5. **Cleavage**: Cleavage plane, types, role of yolk in cleavage; cleavage process in sea-urchin and mammals.
6. **Blastula formation**: sea urchin and chick
7. **Fate map**: fate mapping methods. Fate map in chick blastula.
8. **Morphogenetic movements**: Types and examples.
9. **Gastrulation:** Frog & chick
10. **Organizer**: Speman-Mangold organiser experiment; concept of induction, determination, and differentiation
11. **Placenta**: Types, examples and functions.
12. **Extra-embryonic membrane**: Formation and function in chick.
13. Concepts of cryopreservation of gametes and embryo of man, IVF and embryo transfer in man
14. **Stem cell**: ES and adult stem cell, characteristic features, definition of potency and niche, markers in human stem cell, potential application of stem cells as regenerative medicine
15. **Organogenesis** – development of eye as an example of reciprocal and repeated inductive events

[Note: Eight short questions of 2 marks to be set, of which 5 will be answered. 8 questions of 10 marks to be set. Students will answer 4 questions]

PAPER 2, UNIT II {PRACTICAL} Marks = 50

Animal forms & comparative anatomy (10)

1. **Study of internal organ systems** of one non-chordate (*Periplaneta)* and one chordate (*Oreochromis)* – [***Periplaneta***: Nervous system, Digestive system, Reproductive system. ***Oreochromis***: Digestive system, Urinogenital system, Olfactory apparatus.]
2. **Anatomical study:** kidney, brain, heart, limb bones of different vertebrates using picture/photo or models (clay/plastic/plasticin) or computer generated models.

Cytological methods & Genetics (15)

1. Demonstration and description of compound microscope. Measurement of size (length/breadth) by micrometry of any Cell/organ/protozoa.
2. Pedigree analysis (autosomal, X linked and Y linked traits only).
3. Study of meiotic stages from Grasshopper

Osteology & Embryology (15)

1. Identification of bones with reasons: (a) Skull of *Calotes*, a poisonous snake, *Chelonia, Columba, Cavia* (b) Vertebrae of *Columba* & *Cavia* (c) Appendicular bones of *Columba* & *Cavia* (d) Girdle bones of *Columba* & *Cavia*
2. Identification of whole mount embryo (24 hrs, 48 hrs, 72 hrs and 96 hrs) of chick;
3. Identification of larval forms: *Nauplius, Ephyra, Zoea, Mysis, Megalopa, Glochidium, Trochophore, Veliger, Bipinnaria,* tadpole.

Laboratory note Book (5)

Viva Voce (5)

PAPER 3, UNIT I

Systematics, Evolutionary Biology & Animal Behaviour

Group A: Systematics Marks = 15

1. Taxonomy – Levels of taxonomy (alpha, beta and gamma taxonomy, micro and macro taxonomy), scope of taxonomy
2. Systematics – Place of Systematics in Biology, contribution of Systematics in Biology
3. Classification (Phenetic and Cladistics)
4. Concept of dendogram and cladogram
5. Biological Species concept, Subspecies, Polytypic species, Sibling species and Ring species
6. Isolation and its role in speciation (pre mating and post mating)
7. Modes of speciation – Sympatric, Allopatric and Parapatric
8. Type concept – names of primary and secondary types, their definitions and applications
9. Basic principle and use of DNA bar coding in species identification

Group B: EVOLUTION AND ADAPTATION Marks = 25

1. RNA world & Origin of life (Chemical origin only)
2. Natural selection, Synthetic theory. Concept of selection: stabilizing, directional and disruptive with example
3. Hardy-Weinberg equilibrium; calculating allele & genotype frequency, mathematical calculation of frequency changes in mutation, migration

4. Genetic drift, founder effect and population bottleneck
5. Bathymetric and discontinuous distribution
6. Barriers and dispersals - types and their impact on animal distribution
7. Zoogeographical realms – names & animal distribution according to Wallace scheme, Avian and Mammalian faunal distribution in different realms
8. Origin of birds
9. Evolution in horse
10. Xeric (camel and lizard); Arboreal (sloth bear) adaptation
11. Adaptive radiation with special reference to Darwin's finches

Group – C: ANIMAL BEHAVIOUR **Marks = 10**

1. Instinctive and learning behavior, fixed action pattern
2. Communication in honey bees (dance language and pheromone)
3. Altruism, kinship and selfishness
4. Echolocation in bat
5. Parental investment (fish only); cost and benefit analysis of parental investment; parent-offspring conflict
6. Bird migration

[Note: Total 8 short questions of 2 marks are to be set covering all the Groups, of which 5 will be answered. 2 questions from Group A, 4 questions from Group B and 2 questions from Group C are to be set. Each question will be of 10 marks. Students will answer 1 question from Group A, 2 questions from Group B and 1 question from Group C]

PAPER 3, UNIT II

[Ecology, Biodiversity and Conservation]

Group A: ECOLOGY **(Marks = 25)**

1. Concept of Ecosystem – structure and function; generalized model of energy flow in ecosystem
2. Wetland as ecosystem service provider
3. Population attributes – dispersal, dispersion, survivorship curves, age distribution
4. Population growth models – natality, mortality exponential and logistic, density dependent and density independent factors
5. Life history analysis, r and k strategies
6. Population interactions – emergence of competition as a central theory experiments of Tansley, Gause and Park, competition exclusion principle, interspecific and intraspecific competitions, Lotka Volterra model
7. Animal's space and resource use. Resource partitioning. Coupled oscillations of predator and prey population – modeling
8. Community and ecosystem – assemblage, guild and community concept, niche concept, edge effect
9. Ecological succession, types of ecological succession with examples, concept of Climax, Connell and Slatyer' model of succession. Tilman's resource-ratio hypothesis
10. Brief idea on El nino, La nina and their consequences

Group B: BIODIVERSITY AND CONSERVATION (Marks – 25)

1. Types of biodiversity, biodiversity and human welfare, mega diversity zones and biodiversity hot spots with special reference to India
2. Concept of wildlife, wildlife heritage of India, reasons for wildlife depletion in Indian context
3. Concept of threatened fauna – IUCN categories.
4. Protected area concept – Sanctuary, National Park, Biosphere reserve, Core Zone, Buffer Zone, Corridor concept. Conservation reserves
5. JFM & Arabari model for conservation – key stone, flagship and umbrella species
6. Special management program with special reference to Tiger project
7. Man–animal conflict (man-tiger and man-elephant) – causes and concern
8. Environmental audit and impact assessment
9. Role of NGO's in wildlife conservation in India

[Note: Eight short questions of 2 marks are to be set from both the Groups, of which 5 will be answered. 4 questions from Group A and 4 questions from Group B are to be set. Each question will be of 10 marks. Students will answer 2 question from Group A and 2 questions from Group B]

PAPER 4, UNIT I

Animal physiology and Biochemistry

Group A: ANIMAL PHYSIOLOGY Marks = 25

1. Structure & function of haemoglobin, transport of O_2 and CO_2 in mammals, Bohr and Haldane effect, Chloride shift.
2. Physiology of excretion – physiology of urine formation, urea cycle, nitrogenous wastes-ammonia, urea, uric acid, creatinine.
3. Physiology of osmo-regulation in vertebrates
4. Origin and propagation of nerve impulse through nerves, synaptic and neuro-muscular junctions, functional significance of Giant nerve fibers in mollusks
5. Physiology of skeletal muscle contraction
6. Temperature regulation in cold desert
7. Physiology of vision in human, compound eyes and image formation in insects
8. Physiology of hibernation and aestivation with reference to amphibians, reptilians and gastropods

Group B: BIOCHEMISTRY Marks = 25

1. Carbohydrate metabolism – Glycogenesis, Glycogenolysis, Neoglucogenesis
2. Metabolism of amino acids; transamination and oxidative and non-oxidative deamination
3. Nucleic acid metabolism – Purine salvage pathway
4. Beta-oxidation of fatty acids –
    a. Palmitic acid {saturated (C 16:0)}
    b. Linoleic acid {unsaturated (C 18:2)}
5. Integration: Krebs cycle, Oxidative phosphorylation and Electron transport chain
6. Enzymes - Classes; kinetics and factors affecting enzyme action, enzyme inhibition
7. Structure and function of neuro-transmitter: **glutamate**, γ-aminobutyric acid (**GABA**), **dopamine** (DA), **norepinephrine** (**noradrenaline**; NE, NA), epinephrine (adrenaline)

[Note: Eight short questions of 2 marks are to be set from both the Groups, of which 5 will be answered. 4 questions from Group A and 4 questions from Group B are to be set. Each question will be of 10 marks. Students will answer 2 question from Group A and 2 questions from Group B]

PAPER 4, UNIT II **(PRACTICAL)** **Marks = 50**

Ecological methods: (10)

1. Use of pH meter for estimation of pH in water and soil samples
2. Study of micro arthropods of water and soil samples
3. Determination of dissolved O_2, free CO_2 of water
4. Zoo-plankton count by standard methods

Systematic & Evolutionary Biology: (10+10)

- General discussion, distinguishing characters and classification of respective Phylum should be taken into consideration. In Laboratory Note Book scheme of classification of all Phylum should be written before identification
- Key making with the specimens both from non-chordate (e.g., insects) and chordates (e.g., fishes)
- Identification with reasons of the following Museum specimens should be done

Non-chordates: *Elphidium, Scypha* (*Syn, Sycon)*, Neptune's cup, *Aurelia, Pennatula,* Sea anemone, *Fasciola, Chaetopterus, Beroe,* Madrepora, *Nereis, Aphrodite, Squilla, Hippa, Eupagurus,* King crab, *Peripatus, Belostoma, Achatina, Chiton, Patella, Aplysia, Mytilus, Sepia, Loligo, Nautilus, Asterias,* Sea-urchin, Sea-lily, *Balanoglossus*

Chordates: *Branchiostoma, Ascidia, Petromyzon, Myxine, Torpedo, Sphyrna, Hippocampus, Mystus, Necturus, Ichthyophis, Tylototriton, Cryptobranchus, Hyla, Chameleon, Gekko, Vipera, Calotes, Mabuya, Varanus, Naja, Hydrophis,* Mega Chiroptera

Animal Physiology and Biochemistry (10)

1. Quantitative estimation of protein by modified Lowry's colorimetric method
2. Qualitative tests for Carbohydrate (Starch, Sucrose, Maltose Fructose, Glucose), Protein (Albumin, Gelatin, Peptone), fat, uric acid (in Alkaline solution) and urea (Tests to be performed – Red Litmus Test, Hypobromite test, Biuret test, Millon's test, Iodine test, Benedict's test, Barfoed test, Seliwanof's test)
3. Counting of cockroach haemocytes using haemocytometer
4. Preparation of Normal, molar and standard solutions, phosphate buffers, serial dilutions

Submission of Laboratory note Book (5)

Viva Voce (5)

PART III
(PAPER 5, UNIT I – THEORY)
Molecular Biology (Marks = 50)

1. **Genome analysis**
   a. DNA sequencing: Principle of Dideoxy sequencing
   b. Restriction enzyme: Types and use in gene cloning
   c. Cloning vectors: Characteristic features, Plasmid vector (pBR322, pUC19), Cosmid, phage vector, Concept of expression and Shuttle vector
   d. Construction of genomic DNA and cDNA libraries
   e. PCR: Basic Principle. Use of Allele specific RT-PCT
   f. DNA fingerprinting: Principle of RFLP, mini-satellites, microsatellites, RAPD and its uses
   g. Blot Technique: Southern Blot and Northern Blot
2. **Proteome Analysis**: Principle and use of SDS PAGE, affinity chromatography and Gel Filtration chromatography, immuno-electrophoresis, Western blot (excluding methodology)
3. **Regulation of gene expression**: Operon concept (inducible and repressible viz. Lac and Tryptophan operon)
4. **Epigenetic regulation of gene expression**: DNA methylation (CpG) and histone acetylation.
5. **Recombination**: Homologous recombination , Holliday Model of recombination, definition and example of site specific and transpositional recombination; Gene conversion
6. **DNA repair mechanism**: Base and nucleotide excision repair in bacteria, Mismatch repair, SOS repair
7. **Apoptosis**: concept, molecular signaling (extrinsic and intrinsic) and significance
8. **Cell cycle & cancer genetics**: Concept of cell cycle check points and molecular regulation, concept of normal and transformed cell, role of proto-oncogene, tumour suppressor genes. Molecular mechanism of proto-oncogene activation
9. **Molecular basis and detection technique for human genetic disorders**: Sickle cell Anemia, Thalassemia, Hemophilia
10. **Transposable Genetic Element**: Concept of transposon and retrotransposon, Characteristic features of IS element in bacteria SINE and LINE element in mammals and their role in chromosomal aberration

[Note: Eight short questions of 2 marks are to be set from the Group, of which 5 will be answered. 7 questions of 10 marks each from the Group are to be set. Students will answer 4 questions]

PAPER 5, UNIT II
Parasitology, Microbiology and Immunology

Group A: PARASITOLOGY and MICROBIOLOGY **Marks = 25**

1. Inter-specific associations
2. Origin and evolution of parasitism with special reference to nematodes
3. Host-parasite interaction, parasitic adaptations in internal parasites with special reference to protozoa and helminths
4. Life cycle of important parasites; Mechanism of host-finding; establishment in host; growth; reproduction and modes of transmission of a) *Plasmodium vivax*, b) *Entamoeba histolytica*, c)

Leishmania donovani, d) *Wuchereria bancrofti*, e) *Fasciola hepatica*, and f) *Ascaris lumbricoides*

5. Concept of Vector with special reference to resurgence of malaria (bio-ecology, vector potentiality, present susceptibility status to commonly used insecticide of important rural malaria vectors of India - *Anopheles culicifacies*)
6. Characterization and classification of bacteria (on the basis of staining methods)
7. Techniques of microorganism culture (sterilization reproduction and growth, maintenance and preservation of pure cultures), Control of micro-organisms
8. Microbes in relation to common diseases of man and control (Cholera and Shigella)

Group B: IMMUNOLOGY **Marks = 25**

1. Cells and organs associated with immune system; Innate and adaptive immunity
2. Antigens – characteristics, antigenic determinants, antigen processing and presentation
3. Antibody – structure, types, binding sites and binding mechanisms
4. Cytokines, adjuvants – complete and incomplete
5. Complement proteins – pathways and activation (classical, alternative and lectin mediated pathway, MAC formation
6. Humoral and cell mediated immunity in man, mollusks and insects
7. T-cell – structure, receptor and maturation (signal hypothesis excluded); B-cell – activation and differentiation (signal hypothesis excluded); Macrophage – types, generation and function
8. **MHC:** Structure and Function.
9. Monoclonal antibody production strategy and use of monoclonal antibody

[Note: Eight short questions of 2 marks are to be set from both the Groups, of which 5 will be answered. 4 questions from Group A and 4 questions from Group B are to be set. Each question will be of 10 marks. Students will answer 2 question from Group A and 2 questions from Group B]

PAPER 6, UNIT I

INTEGRATION BIOLOGY & HOMEOSTASIS **Marks = 50**

1. Neuro-endocrine integration
    a. General concept of hormone action and receptors
    b. Chemical messengers – kiromones, synomones, info-chemicals, semio-chemicals – their types, mode of action and behavior modulation
    c. Homeostasis of Ca^{++} regulation and Blood glucose regulation
    d. Mechanism of hormone action (cAMP, ip3, DAG, TRK), neuro-hypophysis, adenohypophysis, hypothalamic regulatory peptides, endocrine tissues of the gastrointestinal endoderm
    e. Biosynthesis, secretion, mode of action, functional significance and regulation of T_3, T_4, Adrenalin, Nor-adrenalin, Insulin and Glucagon
    f. Insect hormones – neuro-endocrine regulation of diapauses and metamorphosis
    g. Environmental signaling in sex reversals in fish and mollusks – role of endocrine disruption and signals

h. Endocrine regulation of estrous and menstrual cycle.

2. Biological light production in animals
   a. Chemistry of bioluminescence in insect and it significance
   b. Electric organs in electric rays
3. Biological rhythm – concept, types and its control by pineal and SCN

[Note: Eight short questions of 2 marks are to be set from the Group, of which 5 will be answered. 7 questions of 10 marks each from the Group are to be set. Students will answer 4 questions]

PAPER 6, UNIT II

ANIMAL BIOTECHNOLOGY & APPLIED ZOOLOGY **Marks = 50**

1. **Transgenic animals**
   (i) Production of transgenic animals: cloning (methodology and application)
   (ii) Contribution of transgenic animals to human welfare (Poultry and Dairy)
2. **Biotechnology and Applied Zoology**
   (i) Modern techniques of fish hybridization and induced breeding in carps.
   (ii) Application of biotechnology in – (a) Sericulture, (b) Lac culture, (c) Api culture, (d) Pearl culture practice, (e) Prawn culture
   (iii) Integrated pest management and biological control of pests: principles and significance.
   (iv) Principle of LD_{50} and LC_{50} and their application in applied Zoology
3. **Animal cell culture**
   (i) Cell culture types
   (ii) Cell culture technology (suspended and adherent culture)
   (iii) Cell culture media (RPMI-1640,M-199 and its components)
4. **Gene therapy**: Principle: Ex-vivo & In-vivo gene therapy. Strategies, Viral and non-viral vectors, antisense therapy.

[Note: Eight short questions of 2 marks are to be set from the Group, of which 5 will be answered. 7 questions of 10 marks each from the Group are to be set. Students will answer 4 questions]

PAPER 7 **PRACTICAL** **Marks = 100**

Molecular Biology: (15)

(a) Paper Chromatography for amino acid separation,
(b) Slide TLC for oil separation,
(c) Quantitative estimation of DNA in solution by Diphenyl method (at 595 nm).

Parasitology & Microbiology: (20)

(a) Study of gut contents of cockroach (fixation, staining & identification)
(b) Identification, systematic position, characters & clinical importance of the following parasites – *Entamoeba, Giardia, Trypanosoma, Plasmodium spp., Leismania, Wuchereria bancrofti, Ascaris* (male & female)
(c) Gram staining of bacteria

Immunology: **(5)**

(a) Determination of human blood group

(b) Histology of primary and secondary lymphoid organs – thymus and spleen only

Histological techniques and staining methods: (15+10)

(a) Tissue fixation, embedding, microtomy, staining and mounting of histological tissues (liver, pancreas, thyroid, kidney, ovary and testis) of white rat

(b) Identification of mammalian histological tissue sections: liver, pancreas, thyroid, kidney, adrenal, ovary, testis, stomach and lung

(c) Identification of stages of estrous cycle in white rat

Adaptations: (15)

Study of animals from museum specimens to analyze adaptive features for cursorial, aquatic, desert, volant and deep sea adaptations; features for parasitic mode of life.

Laboratory note Book: (10)

Viva Voce: (10)

PAPER 8 **PRACTICAL** **Marks = 100**

Instrumentation (20)

Principle/function and laboratory use of micropipette, pH meter, colorimeter, centrifuge, digital balance, autoclave

Report on Environmental audit (20)

Local Biodiversity Record (in group/individual of a particular area) – at least two records of faunal diversity along with ecological notes and photographic documentations in two seasons should be done. For example: butterfly community or bird community of a particular area.

Field work assessment (20)

Submission of field study report on any two of the following

a. Ecosystem and its biodiversity assessment. (Any suitable ecosystem) (various diversity indices with explanation must be presented)

b. Estuarine bheri/freshwater fish farm (species cultured/reared, whether exotic/ornamental fishes are cultured, viability of the farm, cost benefit accounts, impact on local people and prospect in the specific area)

c. Poultry farm (species/breed cultured/reared, homeland of the breed, viability of the farm, cost benefit accounts, impact on local people and prospect in the specific area)

d. Apiary (species cultured, types of bees cultured, fixed/mobile, viability of the farm, cost benefit accounts, impact on local people and prospect in the specific area)

e. Sericulture center (species cultured/reared, description of moth and its host plant cultured, viability of the farm, cost benefit accounts, impact on local people and prospect in the specific area)

f. Visit a place of wild life interest (Sanctuary, National Park, Biosphere Reserve etc.) {Man-wildlife conflict, eco-tone, edge effect, eco-sensitivity, economics of the native inhabitants, logging and lopping effect, conservation process practiced etc.}

g. Agriculture farms for pest study & idea of IPM practices (type of farm, season visited, status of the farm at the time of visit, observed practices, reported practice, viability of

the farm, cost benefit accounts, impact on farmers and impact on the specific beneficiaries)

h. Visit to an institution of zoological importance – its documentation. For example: Zoo Garden, ZSI, Zoological Gallery of the Indian Museum, etc.

[Note: Field study may be made in any time of the three year course]

Biostatistics (20)

Experimental project work and Data Analysis – Mean, Mode, Median, Probability, Hypothesis testing (Chi-square, t-test. Correlation test, Work shop for advanced biological methods (to be organized once in two years during Part II and Part III)

Laboratory note Book (10)

Viva Voce (10)

Draft Syllabus for three years B.Sc. (General Course), Zoology, University of Calcutta, 2016

PART – I		
PAPER – I		Marks
Group A	Non-Chordate	**35**
Group B	Cell Biology and Genetics, Molecular Biology	**35**
Group C	Developmental Biology	**30**
	Total	**100**
PART – II		
PAPER II		**Marks**
Group A	Chordate	**35**
Group B	Ecology, Animal Behavior, Biodiversity and Wildlife	**35**
Group C	Histology, Endocrinology, Animal Physiology & Biochemistry	**30**
	Total	**100**
PAPER – III		
Laboratory Course (all Groups)		**100**
PART – III		
PAPER – IV		**Marks**
Group A	Applied Zoology	**30**
Group B	Evolutionary Biology	**20**
Group C	Parasitology & Immunology	**20**
Group D	Laboratory course	**30**
	Total	**100**
Total = 400		

Zoology General

Part –I **(100 Marks)**

Paper I: Theory (Full Marks –100)

Group-A: (Course No ZG-01) Functional Anatomy of Non-Chordates (Full marks –35)

(Lectures: 35)

1. Classification with distinctive features and suitable examples of sub-kingdom Protozoa (up to Phylum) (Levine *et al*, 1980) and Phylum Porifera, Cnidaria, Platyhelminthis, Annelida, Arthropoda, Mollusca and Echinodermata (up to Class)
2. General structure & function of the following with reference to the specimens mentioned:
   (a) **Locomotion** – Microfibrils (*Amoeba*), Cilia (*Paramoecium*)
   (b) **Feeding & digestion** – Microphagy (*Amoeba*), Macrophagy (*Periplanata*)
   (c) **Respiration** – Ctenidium & pulmonary sac (*Pila*), gills (prawn), Trachea (cockroach)
   (d) **Excretion** – Nephridia (Earthworm)
   (e) **Circulation** – Open circulation (Cockroach), Closed circulation (Earth worm)
   (f) **Nervous system –** Cockroach, Apple snail
   (g) **Reproduction** : (a) Fission (*Amoeba*); (b) Budding (*Hydra*) (c) Conjugation (*Paramoecium*), (d) Metagenesis in *Obelia*

[**Note:** Scheme of classification other than Protozoa as per Ruppert and Barnes (1994), 6th Ed., Invertebrate Zoology.]

Group – B: (Course No ZG-02) Cell Biology, Genetics and Molecular Biology

(Full marks –35) **(Lectures: 35)**

1. Fluid mosaic model of plasma membrane
2. Cell cycle check points
3. Physio chemical properties, types, structures and functions of DNA and RNA.
4. DNA as a genetic material explanation with experiment
5. Mechanisms of replication, transcription and translation in *E. coli*
6. Linkage and recombination
7. Modes of inheritance of autosomal and sex linked genes in man (Thalassemia & Haemophilia, colour blindness)
8. Sex determination in *Drosophila* (Genic Balance Theory only)

Group – C (Course No. ZG-03) Developmental Biology

(Full Marks –30) **(Lecture: 30)**

1. Spermatogenesis and Oogenesis
2. Fertilization in sea urchin
3. Types of eggs and cleavages; process of cleavage in *Amphioxus*
4. Gastrulation in *Amphioxus*
5. Extra-embryonic membranes in chick
6. Placenta types and function

PART –II

Paper II Theory (Full Marks –100)

Group A: (Course No.ZG-04) Functional Anatomy of Chordates

(Full Marks –35) **(Lectures: 35)**

1. Classification of Phylum Chordata with distinctive features and suitable examples – up to living subclass (Amphibia, Reptilia and Mammalia); up to subclass (Fishes and Aves) (Scheme of classification as per J.Z. Young 1980, Life of vertebrates)
2. Functional anatomy – digestive system in *Oreochromis*; Circulatory system in *Columba*
3. Structure & function of the followings:
    a. Integument – general structure & function; integumentary derivatives (scales in fishes, feathers of *Columba*
    b. Pharynx (*Branchiostoma*); stomach (*Bos*)
    c. Respiratory structures and Respiration : Gill (Fish); lung and Air sac (*Columba*)
    d. Circulatory structure and circulation: Single circuit heart (fish); double circuit heart (Amphibia and Mammals)
    e. Nervous system – Brain in *Oreochromis*
    f. Origin and distribution of cranial nerves in fish.

Group B. (Course No ZG-05) Ecology, Animal Behavior, Biodiversity and Wildlife

(Full Marks 35) **(Lectures 35)**

1. Population – definition and growth
2. Community – definition and types
3. Basic concept of Biodiversity, Biodiversity hotspots.
4. Honey bee – Hive, castes and their roles
5. Conservation of wild life – purpose & methods, concept of Biosphere Reserve, importance & strategies of wildlife conservation; National park & Wildlife Sanctuary.
6. Basic idea of ecotoxicology and xenobiotics
7. Climate change – Global warming, acid rain, ozone depletion (cause and effect)

Gr. C (Course No ZG-06) Histology, Endocrinology, Animal Physiology & Biochemistry

(Full marks- 30) **(Lectures: 30)**

1. General characters of hormones: Naming and function of hormones secreted from Pituitary
2. Histology of pancreas (theory)
3. Enzyme – classification & characteristics; mechanism of enzyme action; effects of pH and temperature on enzymatic action
4. Nerve impulse propagation & synaptic transmission
5. Osmoconformers and Osmoregulators – definition and example; Osmoregulation in fishes

Paper III. PRACTICAL (Course No. ZG 07) (Full marks 100)

1. Demonstration (15+15=30)
   i) Cockroach: digestive, nervous and female reproductive system
   ii) *Oreochromis*: digestive and urino-genital system
2. Mounting and preparation (7½+7½=15)
   (i) Mouth parts of cockroach
   (ii) Cycloid and Ctenoid scale of fin fish
   (iii) Haemolymph of cockroach (Leishman/Giemsa stain)
   (iv) Gut contents of cockroach for protozoa (Fixation, staining and identification)
   (v) Whole mount of aquatic and soil micro-arthropods
   (vi) Epithelial cells from buccal smears with staining
3. Identification with reasons: 1 from bones, 1 from histological slides, 2 from non-chrodates and 2 from chordate specimens; systematic position up to taxon as mentioned in the theory. (30)
   (i) Bones: Skull, vertebrae, limb and girdle bones of *Columba*
   (ii) Histological slides: Sections of mammalian liver, pancreas, testis, ovary, and thyroid.
   (iii) Non-chordate specimens: *Paramoecium,* Scypha, *Sea*-anaemone, Ascaris (male & female), *Hirudinaria,* Scorpion, *Bombyx mori* (adult male & female), *Lamellidens, Pila, Loligo,* Starfish, *Balanoglossus.*
   (iv) Chordate specimens: *Amphioxus, Petromyzon, Scolidon, Lates, Rhacophorus,* Axolotl larva, *Tylototriton, Gekko; Hemidactylus,* Turtle, *Naja,* Chiroptera
4. Report on field study tours: 10 marks
   Zoological importance: Zoological garden or Museum
5. Viva 10
6. Laboratory Note Book 5

Part III **Full marks –100**

Paper IV Group A. (Course No **ZG-8): Applied Zoology**

(Full Marks 30) **(Class 30)**

1. Sericulture: Life history and rearing of *Bombyx mori,* harvesting & processing of cocoon, reeling and extraction of silk, diseases of worms of *Bombyx mori* and control measures.
2. Aquaculture: Principles, definition and scope. Exotic fishes- their merits and demerits. Basic principles of different aquaculture system (Polyculture and integrated farming); culture of prawn
3. Pest and Management: a) Definition and types of pests with examples. Life history, behaviour, ecology, damage and control of the following pests: i) Paddy *Scirpophaga* (Syn. *Tryporyza*) *incertulas,* ii) Stores grain-*Sitophilus oryzae,* iii) Mammalian pest (*Bandicota bengalensis*).
4. Apiculture: Development of Apiary in India. Types of honey bees, modern methods of apiary management, products and its uses. Problems and prospects.
5. Poultry: fowl - Types of breeds, rearing and disease management.

Gr. B. (Course No **ZG-09) Parasitology & Immunology**

(Full Marks: 20) **(Lectures-20)**

1. Parasitism (definition and types) and other inter-specific interactions (symbiosis, commensalism and mutualism).
2. Life history, Pathogenecity and clinical features of *(i) Entamoeba histolytica, (ii) Plasmodium vivax, iii) Ascaris*
3. Outline structure and classification of immunoglobulin, antigen-antibody reaction

Group – C. Evolutionary Biology Course No **ZG-10**

(Full marks: 20) **(Lectures-20)**

1. Definition of systematics & taxonomy
2. Species as a unit of evolution (definition and types: biological, sibling and polytypic species)
3. Chemical basis of origin of life
5. Anatomical and Physiological adaptations: Aquatic (fish), Desert (Camel) and Volant (Pigeon) animals.
6. Zoogeographical realms (Wallace scheme) with characteristic mammalian fauna.

Group – D. Laboratory course **(**Course No.**ZG-11)** **(Full marks –30)**

1. Experimental works
   a. Estimation of dissolved O_2 content of water **or** Estimation of free CO_2 content of water 8
   b. Pedigree analysis: sex linked recessive, autosomal recessive and dominant 4
   c. Determinant of ABO blood group & Rh factor in man **or** Measurement of water pH and handling of pH meter 4
2. Field training – Submission of report on **any one** place from the following: 8
   a. Freshwater fish farm
   b. Poultry farm
   c. Apiary
   d. Sericulture center
   e. Place of wild life interest (Sanctuary, National Park)
   f. Species diversity studies in local area.

[**Note**: Field report = 5 and Viva on Field report = 3; Students will not be allowed to sit in the examination without valid Field Report]

3. Identification: (Write specimen characters and applied importance) **any three** $3 \times 2 = 6$

Taenia solium, Scirpophaga (Syn. Tryporyza) incertulas, Sitophilus oryzae, Epilachna, Lepisma, Termite queen, *Bandicota bengalensis, Labeo rohita, Catla catla, Cyprinus carpio, Tenualosa (Hilsa) ilisha, Penaeus sp, Macrobrachium rosenbergi.*

SUGGESTED READINGS WITH REGARD TO B. Sc. COURSE IN ZOOLOGY

Animal Diversity – I: Non-chordate

1. Text book of Zoology, Volume–I: Invertebrates – Parker & Haswell (Eds. A. J. Marshall & W. D. Williams) {ELBS Macmillan}
2. Invertebrate Zoology – E. E. Ruppert and R. D. Barnes (Harcourt Asia)
3. Invertebrate – R. C. Brusca & G. J. Brusca (Sinauer Asoc. Inc.)
4. Invertebrate – J. A. Pechenick (TATA McGraw Hill)
5. Invertebrate structure and function – E. J. W. Barrington (ELBS Nelson)
6. IMM's General Text Book of Entomology – (Chapman & Hall)
7. Reef evolution – R. Wood (Oxford Univ. Pr.)
8. The Diversity of Living Organisms – R. S. K. Barnes (Blackwell Science)
9. An introduction to the Invertebrates – J. Moore (Cambridge Univ. Pr.)
10. Introduction to General Zoology, Volume I – K. K. Chaki, G. Kundu, S. Sarkar (NCBA)
11. Biology of non-chordates – H.C. Nigam (Vishal Pub.)
12. General Zoology – C. A. Villee, W. F. Walker and R. D. Barnes (Saunders College Pub.)
13. Invertebrate Zoology – P. A. Meglisch and F. R. Schram (Oxford Univ Pr.)
14. Invertebrate inter relationship – P. Wilmer (Cambridge Univ. Pr.)
15. Modern Text Book of Invertebrates – R. L. Kotpal (Rastogi)

Animal diversity – II: Chordate

1. Text book of Zoology, Volume II, Vertebrates – Parker & Haswell (Ed. A. J. Marshall){ELBS Macmillan}
2. Vertebrate life – F. H. Pough & W. N. McFarland (Prentice Hall)
3. The Life of Vertebrates – J. Z. Yong (ELBS Oxford)
4. Vertebrates : Comparative anatomy, function, Evolution – K. V. Kardong (WCB McGraw Hill)
5. Comparative Anatomy of Vertebrates – G.C. Kent & L. Miller (WCB Pub)
6. The Vertebrate body – A. S. Romer & T. S. Parsons (Saunders)
7. Biology of Vertebrates – H. E. Walter & L. P. Sayles (Macmillan)
8. Elements of Chordate Anatomy – C. K.Weichert & W. Presch (TATA McGraw Hill)
9. Analysis of Vertebrate Structure – M. Hildebrand & G. Goslow (Wiley)
10. An introduction to Ornithology & biology of the blue rock pigeon – B. N. Bhattacharyya (NCBA)
11. Introduction to General Zoology, Volume II – K. K. Chaki, G. Kundu, S. Sarkar (NCBA)
12. Biology of Amphibians – W. E. Duellman & L. Trueb (McGraw Hill)
13. Vertebrate Zoology – F. B. Mondal (Oxford IBH)
14. Modern Text Book of Vertebrates – R. L. Kotpal (Rastogi)

Cell Biology, Genetics, Molecular Biology and Biotechnology

1. Principles of Genetics – R. H. Tamarin (McGraw Hill)
2. The World of Cell – W. M. Becker, L. J. Kleinsmith, J. Hardin
3. Genetics – M. W. Strickberger (Macmillam)
4. Genetics – S. Elrod and W. Stansfield (Schaum)

5. Concepts of Genetics – W. S. Klug and M. K. Cummings (Pearson)
6. Cell Biology – G. M. Cooper (Sinauer)
7. Cell Structure, Function and Metabolism – N. Cohen (Hodder & Stoughton)
8. Cell and Molecular Biology – Concepts and Experiments – G. Karp (Wiley)
9. I-Genetics – P. J. Russel (Pearson, Benjamin Cummings)
10. Genetics – P. C. Winter, G. I. Hickey & H. L. Fletcher (Viva)
11. Molecular Biology of the Cell – B. Alberts, A. Johnson, J. Lewis, M. Raff, K. Roberts & P. Walter (Garland Science)
12. Molecular and cell biology – W. D. Stansfield, J. S. Colome and R. J. Cano (Schams)
13. Human Molecular Genetics – T. Strachan & A. Read (BIOS Scientific)
14. Cell cycle control – C. Hutchison & D.M. Glover (IRL Oxford Univ.)
15. A Text Book of Genetics & Molecular Biology – S. Roychoudhuri (NCBA)
16. Problems on Genetics, Molecular Genetics and evolutionary genetics – P. K. Banerjee (NCBS)
17. Animal Cell Culture – a practical approach – J. R. W. Masters (Oxford Univ. Pr.)
18. Genetic Engineering – P. S. Verma & V. K. Agarwal (S. Chand)
19. Introduction to Biotechnology- W. J. Thieman and M.A. Palladino (Pearson)
20. Molecular Biology of the gene – J. D. Watson (Pearson)
21. Advanced Molecular Biology – Twyman (Springer)
22. Genes IX – B. Lewin (Oxford)
23. Molecular Biology and Biotechnology – R. A. Meyers (VCH Pub.)
24. Animal cell culture – S. J. Morgan & D. C. Darling (Oxford)
25. Genetics – V. B. Rastogi (Kedarnath Ramnath)

Animal Physiology & Biochemistry

1. Lehninger Principle of Biochemistry – D. L. Nelson & M. M. Cox (Maxmillan)
2. Harper's Illustrated Biochemistry – (McGraw Hill)
3. Fundamentals of Biochemistry – A. C. Deb (NCBA)
4. A Clinical Companion to Accompany Biochemistry – J. Berg & G. Tomaselli (Freeman & Co)
5. Outlines of Biochemistry – E. E. Conn & P. K. Stumpf (Wiley Eastern)
6. Biochemistry – B. D. Hames, N. M. Hooper & J. D. Houghton (Viva)
7. Aestivation: Molecular and Physiological Aspects – A. Navas, C. Carvalho, J. Eduardo (Springer)
8. Comparative Physiology of Fasting, Starvation, and Food Limitation – Mc Cue, D. Marshall (Springer)
9. Physiological Studies on Aestivation in Pomacea Urceus – M. A. Thomas (University of the West Indies Pr., Trinidad)
10. Comparative Animal Physiology – C. L. Prosser and F. A. Brown (Saunders)
11. Animal Physiology – Adaptation & Environment – K. Schmidt-Neilson (Cambridge University Press)
12. General and Comparative Physiology – W. S. Hoar (PHI)
13. Text Book of Medical Physiology – A. C. Guyton (Holt Saunders)
14. Ganong's Review of Medical Physiology – (McGraw Hill)
15. Biochemistry – D. Das (Academic Publishers)
16. A clinical companion to accompany biochemistry – K. Saltsman, J. Berg & G. Tomaselli (Freeman & Co.)

Histology, Endocrinology & Reproductive Biology

1. Endocrinology – M. E. Hadley and J. E. Levine (Prentice Hall)
2. Endocrinology – G. J. Goldsworhy, J. Robinson & W. Mordue (Blackie)
3. General Endocrinology – C. D. Turner & J. T. Bagnara (Saunders)
4. Comparative Vertebrate Endocrinology – P. J. Bentley (Cambridge Univ. Pr.)
5. Text book of Comparative Endocrinology – A. Gorbman & H. W. Bern (Wiley)
6. Introduction to Endocrinology – C. S. Negi (PHI)
7. Mammalian Endocrinology – A. K. Boral (NCBA)
8. Essential Endocrinology – C. G. D. Brook & N. J. Marshall (Wiley)
9. Vertebrate Endocrinology – D. Norris (Elsevier)
10. Histology: A text and atlas – M. H. Ross & E. J. Reith (Williams & Wilkins)
11. Bloom & Fawcett: Concise Histology – D. W. Fawcett (Arnold)
12. Basic Histology – L. C. Janqueira, J. Carneiro & R. O. Kelly (Appleton & Lange)
13. Histology and Histological techniques – Bankroft (Elsevier)
14. Review of Histology – M. B. Ganz, D. L. Levick & J. W. Lash (J.B. Lippincott Co.)
15. Endocrinology and Reproductive Biology – K. V. Shastry (Rastogi)

Developmental Biology

1. An introduction of Embryology – B. I. Balinsky (Sunders Int.)
2. Foundations of Embryology – B. M. Carlson (McGraw Hill)
3. Comparative Embryology of the Vertebrates – O. E. Nelson (McGraw Hill)
4. Developmental Biology – S. Gilbert (Sinauer)
5. Principles of Development – L. Wolpert (Oxford Univ. Pr.)
6. Developmental Biology – R. M. Twyman (Viva)
7. Essential Reproduction – M. H. Johnson & B. J. Everitt (Blackwell Science)
8. Essential Developmental Biology – J. M. W. Slack (Blackwell)
9. Principles of Developmental Biology – F. H. Wilt and S. C. Hake (Norton & Co.)

Microbiology, Parasitology & Immunology

1. Microbiology : An Introduction – G. J. Tortora, B. R. Funke and C. L. Case (Pearson)
2. Principles of Microbiology – G. Sumbali and R. S. Mehrotra (TATA McGraw Hill)
3. Microbiology – M. J. Pelczar Jr., E. C. S. Chan & N.R. Krieg (TATA McGraw Hill)
4. Medical microbiology – S. Baron (Addison Wesley Pub. Co.)
5. Animal Parasitology – J. D. Smyth (Cambridge Uni. Pr.)
6. General Parasitology – T. C. Cheng (Academic Pr.)
7. Parasitology – Protozoology and Helminthology – K. D. Chatterjee (Chatterjee Medical Pub.)
8. Text book of Medical Parasitology – P. Chakraborty (NCBA)
9. Foundation of Parasitology – L. S. Schmidt, G. D. Roberts & J. Janovy (McGraw Hill Int.)
10. Parasitism – The diversity and ecology of animal parasites- A. O. Bush, J. C. Fernandez, G. W. Esch and J. R. Seed (Cambridge Univ. Pr.)
11. Simplified course on Parasitology and Immunology – S. K. Rej & R. Roy (NCBA)
12. Invertebrate Immunity – K. Söderhäll (Springer)

13. Insect infection and immunity – evolution, ecology and mechanism – J. Rolff & S. E. Reynolds (Oxford Univ. Pr.)
14. The elements of Immunology – F. H. Khan (Pearson)
15. Text book of Basic and Clinical Immunology – S. Gangal & S. Sontakke (University Pr.)
16. Immunology – D.Male, J. Brostoff, D. B. Roth & I. Roitt (Mosby Elsevier)
17. Kuby Immunology – T. J. Kindt, R. A. Goldsby & B. A. Osborne (Freeman)
18. Immunology and immunotechnology – A. K. Chakraborty (Oxford Univ. Pr.)
19. Principles of Cellular and Molecular immunology – J, M. Austyn & K. J. Wood (Oxford Univ. Pr.)

Evolution, Systematics and Animal Behaviour

1. Evolutionary Biology – D. J. Futuyama (Sinauer Associates Inc.)
2. Evolution – M. W. Strickberger (CBS Pub.)
3. Evolution of the Vertebrates – E. H. Colbert, M. Morales & E. I. Minkoff (Science)
4. Introduction to Evolution – P. A. Moody (Kalyani Pub.)
5. Evolution – T. Dobzhansky, F. J. Ayala, G. L. Stebbins & J. W. Valentine (Surjeet Pub.)
6. Understanding Evolution – E. D. Hanson (Oxford Univ. Pr.)
7. Life: Origin, Evolution and Adaptation – S. Chattopadhyay (Books & Allied Pub.)
8. Organic Evolution – V. B. Rastogi (Kedarnath Ramnath)
9. Principles of Systematic Zoology – E. Mayr & P. D. Ashlock (McGraw Hill Int.)
10. Principle of Systematic Zoology – E. Mayr (TATA McGraw Hill)
11. Principles of Animal Taxonomy – G. G. Simpson (Oxford IBH)
12. Zoogeography – P. J. Darlington (John Wiley)
13. Animal Behaviour – D. McFarland (Longman)
14. An introduction to Animal Behaviour – A. Manning & M. S. Dawkins (Science)
15. Animal Behaviour – L. Drickamar & S. H. Vessey (McGraw Hill)
16. Animal Behaviour – R. Mathur (Rastogi)

Ecology, Biodiversity and Conservation

1. Elements of Ecology – T. H. Smith and R. L. Smith
2. Microbial Ecology : Fundamentals and Applications – R. M. Atlas and R. Bartha
3. Essentials of Ecology – C. Townsand, J. L. Harper, M. Bagon
4. Fundamentals of Ecology – E. P. Odum (Saunders)
5. Ecology: Principles and Applications – J. L. Chapman & M. J. Reiss(Cambridge Univ. Pr.)
6. Ecology – the experimental analysis distribution and disturbance – C. J. Krebs (Benjami Cummings)
7. Ecology: Science and Practice – C. Faurie, C. Ferra, P. Medori & J. Devaux (Oxford IBH)
8. Ecology – A. Mackenzie, A. S. Ball & S. R. Virdee (Viva)
9. Principles of Ecotoxicology – C. H. Walker, S. P. Hopkin, R. M. Sibley & D. B. Peakall (Taylor & Francis)
10. Wetland: Crisis and options – G. K. Saha (Astral)
11. Animal Ecology and distribution of animals – V. B. Rastogi & M. S. Jayaraj (KNRN, N Delhi)
12. Biodiversity – E. O. Wilson (National Academic Press)

13. Fundamentals of Conservation Biology – M. L. Hunter, J. James & P. Gibbs (John Willey & Sons)
14. Loss of biodiversity and its ethical implications – A. Ghosh, S. P. Agarwala & B. Sau (Sadesh)
15. An introduction to Behavioural Ecology – J. R. Krebs & N. B. Davies (Blackwell Scientific)
16. Environmental Science – G. T. Miller (Brookes Kole)
17. Environmental Biology – Park
18. Wildlife of India – T. C. Majupuria (Techpress, Bangkok)
19. An introduction to Wildlife Biology: Indian perspective – G. K. Saha & S. Majumder (PHI)
20. Endangered animals of India – A. K. Mukherjee (Z.S.I)
21. Ecology – R. E. Ricklefs & G. L. Miller (McMillan)
22. Invertebrate Surveys for Conservation – T. R. New (Oxford Univ. Pr.)
23. Threatened Mammals of India – G. K. Saha & S. Majumdar (Daya Publication House)
24. Wild life (Protection) Act 1972 – Wild life Society of India (Nataraj Publication)

Applied Zoology

1. Pest Control – H. F. Van Emden (Cambridge Univ. Pr.)
2. Applied Entomology – P. G. Fenemore, A Prakash (Wiley Eastern Ltd.)
3. A manual of Freshwater Aquaculture – E. Santhanam, N. Sukumaran & P. Natarajan (Oxford IBH)
4. Aquaculture: Principle and practice – T. V. R. Pillay (Wiley Int)
5. Fish and Fisheries – S. Kumar & M. Tembhre (NCBS)
6. Fish and Fisheries – K. Pandey & J. P. Shukla (Rastogi)
7. Animal Husbandry – G. C. Banerjee (ICAR)
8. Hand Book of Animal Husbandry – ICAR
9. Sericulture & Silk Industry – D. C. Sarkar (NBT)
10. An introduction to Sericulture – G. Ganga & J. S. Chetty (Oxford IBH)
11. Lac Culture – N. Ghorai (International Books & Periodicals Supply Service)
12. Bee keeping in India – ICAR
13. Introduction to Economic Zoology – S. Sarkar, G. Kundu, K. K. Chaki (NCBS)
14. Economic Zoology – G. S. Shukla & V. B. Upadhyay (Rastogi)
15. Livestock & Poultry Production –E. N. Moore & H. Singh (PHI)
16. Insect Pest of crop – S. Pradhan (PHI)
17. অর্থনৈতিক প্রাণিবিদ্যা – শঙ্কর প্রসাদ মাইতি, প্রদীপ দাশগুপ্ত ও ত্রিলোচন মিদ্দা (NCBS)

Biostatistics

1. Biostatistics: Principles and Practice – B. Antonisamy, S. Christopher, and P. P. Samuel (Kugler Pub.)
2. Statistics – Concepts and Controversies – D. S. Moore (Freeman & Co.)
3. Statistics – F. McGill, S. McLennan & J. Migliorini (Stanley Thornes)
4. Experimental design and data analysis for Biologists – G. P. Quinn & M. J. Keough (Cambridge Univ. Pr.)
5. Statistics – N. G. Das (Central)
6. Basic Statistics – A. M. Goon, M. K. Gupta & B. Dasgupta (World Pr.)
7. Problems on Biomathematics – P. K. Banerjee (NCBA)

8. Elements of Biostatistics – S. Prasad (Rastogi)

Text Books covering various aspects of the syllabus

1. Introduction to General Zoology, Volume I – K. K. Chaki, G. Kundu, S. Sarkar (NCBA)
2. Introduction to General Zoology, Volume II – K. K. Chaki, G. Kundu, S. Sarkar (NCBA)
3. Biology of Animals, Volume I – B. B. Ganguli, A. K. Sinha & S. Adhikary (NCBS)
4. Biology of Animals, Volume II – A. K. Sinha, S. Adhikary, B. B. Ganguli & B. C. B. Goswami (NCBS)
5. Fundamental of Biology of Animals – S. Adhikary & A. K. Sinha (NCBS)
6. Text Book of Zoology – A. Chatterjee & C. Chakraborty (Nirmala Library)
7. স্নাতক প্রাণিবিদ্যা – ১ম, ২য়, ৩য় খণ্ড – দেবপ্রসাদ চট্টোপাধ্যায় (Book Syndicate)
8. স্নাতক প্রাণিবিদ্যা – কেদারনাথ ভট্টাচার্য (Books & Allied Pub)
9. সমকালীন প্রাণিবিদ্যা (পার্ট ১,২) – শঙ্কর প্রসাদ মাইতি, ত্রিলোচন মিদ্দা (NCBA)
10. ত্রি-বার্ষিক প্রাণিবিদ্যা (পার্ট ১,২,৩) – অসীম চট্টোপাধ্যায়, চন্দ্রশেখর চক্রবর্তী (Nirmala)
11. স্নাতক প্রাণিবিদ্যা (পার্ট ১,২) – নীতীশ রঞ্জন দাস, চিরঞ্জীব দে, অমিত চট্টোপাধ্যায় (রুবী দাস)

Practical

1. Practical Zoology – K. C. Ghosh & B. Manna (NCBA)
2. Practical Zoology – A. K. Chatterjee & C. Chakraborty (Nirmala)
3. An Advanced Laboratory Manual of Zoology – T. K. Poddar, S. Mukherjee & S. K. Das (MacMillan)
4. Advanced Practical Zoology – J. K. Sinha, A. K. Chatterjee & P. Chatterjee (Books & Allied P. Ltd.)
5. ব্যাবহারিক প্রাণিবিদ্যা – অসীম কুমার মান্না
6. ত্রি-বার্ষিক ব্যাবহারিক প্রাণিবিদ্যা – শঙ্কর প্রসাদ মাইতি (শ্রীতারা প্রকাশনী)
7. ত্রি-বার্ষিক ব্যাবহারিক প্রাণিবিদ্যা – অসীম চট্টোপাধ্যায়, চন্দ্রশেখর চক্রবর্তী (Nirmala Library)
8. Laboratory Note Book (Part II & Part III) – The Zoological Society, Kolkata

UNIVERSITY OF CALCUTTA

SYLLABI

FOR

THREE-YEAR B.Sc. HONOURS & GENERAL COURSES OF STUDIES

Chemistry

2010

w.e.f. 2010-2011

CONTENTS

Chemistry Hons: Syllabus Scheme in modular form

Course names and distribution

PART – I (Year 1), total marks = 200 (Theory = 150, Practical = 50)

CHT	11a, 11b,	each 25 marks, Theory
CHT	12a, 12b,	each 25 marks, Theory
CHT	13a, 13b,	each 25 marks, Theory
CHP	14a+14b,	50 marks, Practical

PART – II (Year 2), total marks = 200 (Theory = 150, Practical = 50)

CHT	21a, 21b,	each 25 marks, Theory
CHT	22a, 22b,	each 25 marks, Theory
CHT	23a, 23b,	each 25 marks, Theory
CHP	24a+24b,	50 marks, Practical

PART – III (Year 3), total marks = 400 (Theory = 250, Practical = 150)

CHT	31a, 31b, 31c, 31d,	each 25 marks, Theory
CHT	32a, 32b, 32c,	each 25 marks, Theory
CHT	33a, 33b, 33c,	each 25 marks, Theory
CHP	34a, 34b,	25 and 50 marks, Practical
CHP	35a, 35b,	25 and 50 marks, Practical

Abbreviations:
CHP: Chem Hons Practical; CHT: Chem Hons Theory
First digit refers to year, second to paper.

Each CHT Exam = 1 hr for 25 marks, 2 hr for 50 marks, etc.
Each CHP Exam = 2-3 hr for 25 marks, 4 hr for 50 marks on each day

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Notes:
1. Each Theory module of 25 marks contains units I (marks = 15) and II (marks = 10).

2. Number of class hours = 25-35 for a 25-mark Theory module, 70-80 for a 25-mark Practical module.

Chemistry Hons: Course Description
Year 1
PART – I

CHT 11a

Unit-I. Radioactivity and Atomic Structure

Nuclear stability and nuclear binding energy. Nuclear forces: meson exchange theory. Nuclear models (elementary idea): Concept of nuclear quantum number, magic numbers. Nuclear Reactions: Artificial radioactivity, transmutation of elements, fission, fusion and spallation. Nuclear energy and power generation. Separation and uses of isotopes. Radio chemical methods: principles of determination of age of rocks and minerals, radio carbon dating, hazards of radiation and safety measures.

Bohr's theory to hydrogen-like atoms and ions; spectrum of hydrogen atom. Quantum numbers. Introduction to the concept of atomic orbitals; shapes, radial and angular probability diagrams of s, p and d orbitals (qualitative idea). Many electron atoms and ions: Pauli's exclusion principle, Hund's rule, exchange energy, Aufbau principle and its limitation. Electronic energy level diagram and electronic configurations of hydrogen-like and polyelectronic atoms and ions. Term symbols of atoms and ions for atomic numbers < 30.

Unit-II. Chemical periodicity I

Periodic table, group trends and periodic trends in physical properties. Classification of elements on the basis of electronic configuration. Modern IUPAC Periodic table. General characteristic of s, p, d and f block elements. Position of hydrogen and noble gases in the periodic table.

Effective nuclear charges, screening effects, Slater's rules, atomic radii, ionic radii (Pauling's univalent), covalent radii. Ionization potential, electron affinity and electronegativity (Pauling's, Mulliken's and Allred-Rochow's scales) and factors influencing these properties. Inert pair effect. Group trends and periodic trends in these properties in respect of s-, p- and d-block elements.

CHT 11b

Unit-I. Chemical Bonding and structure

Ionic bonding: Size effects, radius ratio rules and their limitations. Packing of ions in crystals, lattice energy, Born-lande equation and its applications, Born-Haber cycle and its applications. Solvation energy, polarizing power and polarizability, ionic potential, Fazan's rules. Defects in solids (elemementary idea).

Covalent bonding: Lewis structures, formal charge. Valence Bond Theory, directional character of covalent bonds, hybridizations, equivalent and non-equivalent hybrid orbitals, Bent's rule, VSEPR theory, shapes of molecules and ions containing lone pairs and bond pairs (examples from main groups chemistry), Partial ionic Character of covalent bonds, bond moment, dipole moment and electronegativity differences. Concept of resonance, resonance energy, resonance structures

Unit-II. Acid-Base reactions

Acid-Base concept: Arrhenius concept, theory of solvent system (in H_2O, NH_3, SO_2 and HF), Bronsted-Lowry's concept, relative strength of acids, Pauling rules. Amphoterism. Lux-Flood concept, Lewis concept. Superacids, HSAB principle. Acid-base equilibria in aqueous solution and p^H. Acid-base neutralisation curves; indicator, choice of indicators.

CHT 12a

Unit I. Acyclic stereochemistry

Representation of molecules in saw horse, Fischer, flying-wedge and Newman formulae and their inter translations, symmetry elements, molecular chirality.

Configuration: stereogenic units i) stereocentres: systems involving 1, 2, 3 centres, stereogenicity, chirotopicity. pseudoasymmetric (D/L and R/S descriptor, threo/erythro and syn/anti nomenclatures (for aldols) ii) stereoaxis: chiral axis in allenes & biphenyls, R/S descriptor; cis/trans, syn/anti, E/Z descriptors (for C=C, C=N).

Optical activity of chiral compounds: specific rotation, optical purity (enantiomeric excess), racemic compounds, racemisation (through cationic and anionic and radical intermediates), resolution of acids, bases and alcohols via diastereomeric salt formation.

Topicity of ligands and faces (elementary idea): Pro-R, Pro-S and Re /Si descriptors.

Conformation: Conformational nomenclature, eclipsed, staggered, gauche and anti; dihedral angle, torsion angle, energy barrier of rotation, relative stability of conformers on the basis of steric effect, dipole-dipole interaction, H-bonding; conformational analysis of ethane, propane, n-butane, haloethane, 1,2-haloethane, 1,2-glycol, 1,2-halohydrin; invertomerism of trialkylamines.

Unit II. Bonding and physical properties

Valence bond theory: concept of hybridisation, resonance (including hyperconjugation), orbital pictures of bonding (sp^3, sp^2, sp: C-C, C-N & C-O system). Inductive effect, bond polarization and bond polarizability, steric effect, steric inhibition of resonance.

MO theory: sketch and energy levels of MOs of i) acyclic p orbital system (C=C, conjugated diene and allyl systems) ii) cyclic p orbital system (neutral system: [4], [6] annulenes; charged system: 3,4,5-ring system); Frost diagram, Huckel's rules for aromaticity & antiaromaticity; homoaromaticity.

Physical properties: bond distance, bond angles, mp/bp & dipole moment in terms of structure and bonding (covalent & non covalent). Heat of hydrogenation and heat of combustion.

CHT 12b

Unit I. General treatment of reaction mechanism

Mechanistic classification: ionic, radical and pericyclic; heterolytic bond cleavage and heterogenic bond formation, homolytic bond cleavage and homogenic bond formation; representation of mechanistic steps using arrow formalism.

Reactive intermediates: carbocations (cabenium and carbonium ions), carbanions, carbon radicals, carbenes – structure using orbital picture, electrophilic/nucleophilic behaviour, stability, generation and fate (elementary idea)

Reaction thermodynamics: free energy and equilibrium, enthalpy and entropy factor, intermolecular & intramolecular reactions. Application of thermodynamic principles in tautomeric equilibria [keto-enol tautomerism, composition of the equilibrium in different systems (simple carbonyl, 1,3 and 1,2- dicarbonyl systems, phenols and related system), substituent and solvent effect].

Concept of acids and bases: effect of structure, substituent and solvent on acidity and basicity.

Reaction kinetics: transition state theory, rate const and free energy of activation, free energy profiles for one step and two step reactions, catalyzed reactions, kinetic control and thermodynamic control of reactions, isotope effect , primary kinetic isotopic effect (k_H/k_D), principle of microscopic reversibility, Hammond postulate.

Unit II. Nucleophilic substitution reactions

Sustitution at sp^3 centre - Mechanism: S_N1, S_N2, S_N2', S_Ni mechanisms, effect of solvent, substrate structure, leaving group, nucleophiles including ambident nucleophiles (cyanide & nitrite) substitution involving NGP; relative rate & stereochemical features [systems: alkyl halides, allyl halides, alcohols, ethers, epoxides].

Halogenation of alkanes and carbonyls.

Substitution at sp^2 carbon (carbonyl system) - Mechanism: $B_{AC}2$, $A_{AC}2$, $A_{AC}1$, $A_{AL}1$ (in connection to acid and ester). Systems: amides, anhydrides & acyl halides [formation and hydrolysis]

CHT 13a

Unit I. Kinetic theory and the gaseous state

Concept of pressure and temperature. Nature of distribution of velocities in one, two and three dimensions. Maxwell's distribution of speeds. Kinetic energy distribution in one, two and three dimensions, calculations of average, root mean square and most probable values in each case; calculation of number of molecules having energy $\geq \varepsilon$, Principle of equipartition of energy and its application to calculate the classical limit of molar heat capacity of gases.

Collision of gas molecules; collision diameter; collision number and mean free path; frequency of binary collisions (similar and different molecules); wall collision and rate of effusion.

Deviation of gases from ideal behaviour; compressibility factor; Andrew's and Amagot's plots; van der Waals equation and its characteristic features. Existence of critical state. Critical constants in terms of van der Waals constants. Law of corresponding state and significance of second virial coefficient. Boyle temperature. Intermolecular forces (Debye, Keesom and London interactions; Lennard-Jones potential, elementary idea).

Unit II. Thermodynamics – I

Importance and scope, definitions of system and surroundings; type of systems (isolated, closed and open). Extensive and intensive properties. Steady state and equilibrium state. Concept of thermal equilibrium and the zeroth-law of thermodynamics. Thermodynamic coordinates, state of a system, equation of state, state functions and path functions. Partial derivatives and cyclic rule. Concept of heat and work (IUPAC

convention). Graphical explanation of work done during expansion and compression of an ideal gas. Reversible and irreversible processes and work done.

First law of thermodynamics, internal energy (U) as a state function. Enthalpy as a state function. Heat changes at constant volume and constant pressure; relation between C_P and C_V using ideal gas and van der Waals equations. Joule's experiment and its consequence. Explanation of term $(\delta U/\delta V)_T$. Isothermal and adiabatic processes.

Thermochemistry: heat changes during physicochemical processes at constant pressure/volume. Kirchoff's relations. Bond dissociation energies. Changes of thermodynamic properties in different chemical changes.

CHT 13b

Unit I. Thermodynamics – II

Second law of thermodynamics – need for a Second law. Concept of heat reservoirs and heat engines. Kelvin – Planck and Clausius statements and equivalence of the two statements with entropic formulation. Carnot cycle and refrigerator. Carnot's theorem; thermodynamic scale of temperature.

Physical concept of entropy. Entropy as a measure of the microscopic but not macroscopic disorder. Values of §dQ/T and Clausius inequality. Entropy change of systems and surroundings for various processes and transformations. Entropy change during the isothermal mixing of ideal gases. Entropy and unavailable work. Auxiliary state functions (G and A) and their variation with T, P and V. Criteria for spontaneity and equilibrium.

Thermodynamic relations: Maxwell's relations, thermodynamic equation of state. Gibbs- Helmholtz equation, Joule-Thomson experiment and its consequences; inversion temperature. Joule-Thomson coefficient for a van der Waals gas. General heat capacity relations.

Unit II. Chemical kinetics

Introduction of reaction rate in terms of extent of reaction; rate constants, order and molecularity of reactions. Reactions of zero order, first order, second order and fractional order. Pseudo first order reactions (example using acid catalyzed hydrolysis of methyl acetate). Determination of order of a reaction by half-life and differential method. Rate-determining and steady-state approximation – explanation with suitable examples.

Opposing reactions, consecutive reactions and parallel reactions (with explanation of kinetic and thermodynamic control of products; all steps first order).

Temperature dependence of rate constant: Arrhenius equation, energy of activation. Homogeneous catalysis with reference to acid-base catalysis. Enzyme catalysis: Michaelis-Menten equation, turn-over number.

CHP 14a+14b

Qualitative inorganic analysis of mixtures containing not more than 4 radicals from the following:

Cation Radicals: Na^{+}, K^{+}, Ca^{+2}, Sr^{+2}, Ba^{+2}, Al^{+3}, Cr^{+3}, Mn^{+2}, Fe^{+3}, Co^{+3}, Ni^{+3}, Cu^{+2}, Zn^{+2}.

Anion Radicals: F^{-}, Cl^{-}, Br^{-}, BrO_3^{-}, I^{-}, SCN^{-}, S^{2-}, SO_4^{2-}, $S_2O_3^{2-}$, NO_3^{-}, NO_2^{-}, PO_4^{3-}, BO_3^{3-}, CrO_4^{2-}/ $Cr_2O_7^{2-}$, $Fe(CN)_6^{4-}$, $Fe(CN)_6^{3-}$.

Insoluble Materials: Al_2O_3, Fe_2O_3, Cr_2O_3, SnO_2, $SrSO_4$, $BaSO_4$, CaF_2.

Experiment A: Preliminary Tests for acid and basic radicals in given samples.
Experiment B: Wet tests for Acid and Basic radicals in given samples.
Experiment C: Confirmatory tests.

Notes:
At least 10 unknown samples are to be analyzed by each student during the laboratory session. Oxide, hydroxide, carbonate and bicarbonate should not be reported as radicals.

Chemistry Hons: Course Description
Year 2
PART – II

CHT 21a

Unit I. Chemical Periodicity II

General trends of variation of electronic configuration, elemental forms, metallic nature, magnetic properties (if any), catenation and catalytic properties (if any), oxidation states, inert pair effect (if any), aqueous and redox chemistry in common oxidation states, properties and reactions of important compounds such hydrides, halides, oxides, oxy-acids (if any), complex chemistry (if any) in respect of the following elements:

(i) s-block elements: Li-Na-K, Be-Mg-Ca-Sr-Ba.

(ii) p-block elements: B-Al-Ga-In-Tl, C-Si-Ge-Sn-Pb, N-P-As-Sb-Bi, O-S-Se-Te, F-Cl-Br-I, He-Ne-Ar-Kr-Xe

Unit II. Other Types of Bonding

Molecular orbital concept of bonding (elementary pictorial approach):sigma and pi-bonds, multiple bonding, MO diagrams of H_2, F_2, O_2, C_2, B_2, CO, NO, CN^-, HF, and H_2O; bond orders, bond lengths, Walsh Diagram. Coordinate bonding: Lewis acid-base adducts (examples), double salts and complex salts, Werner theory of coordination compounds. Ambidentate and polydentate ligands, chelate complexes. IUPAC nomenclature of coordination compounds (up to two metal centers). Coordination numbers, constitutional isomerism. Stereoisomerism in square planar and octahedral complexes.

Hydrogen bonding and its effects on the physical properties of compounds of the main group elements.

Metallic bonding: qualitative idea of band theory, conducting, semi conducting and insulating properties with examples from main group elements.

CHT 21b

Unit I. Chemistry of s- and p-block Elements

(i) Structure, bonding and reactivity of B_2H_6; $(SN)_x$ with x = 2, 4; phosphazines; interhalogens. (ii) Structure of borates, silicates, polyphosphates, borazole, boron nitride, silicones, thionic acids. (iii) Reactivity of polyhalides, pseudo halides, fluorocarbons, freons and NO_x with environmental effects. (iv) Chemistry of hydrazine, hydroxylamine, N_3^-, thio- and per-sulphates.

Noble gases from air; oxides, fluorides and oxofluorides of xenon; chemical and photochemical reactions of ozone.

Unit II. Precipitation and Redox Reactions

Solubility product principle, common ion effect and their applications to the precipitation and separation of common metallic ions as hydroxides, sulfides, phosphates, carbonates, sulfates and halides. Ion-electron method of balancing equation of redox reaction. Elementary idea on standard redox potentials with sign conventions, Nernst equation (without derivation). Influence of complex formation, precipitation and change

of pH on redox potentials; formal potential. Feasibility of a redox titration, redox potential at the equivalence point, redox indicators. Redox potential diagram (Latimer and Frost diagrams) of common elements and their applications. Disproportionation and comproportionation reactions (typical examples).

CHT 22a

Unit I. Addition reactions

Electrophilic addition to C=C: Mechanism, reactivity, regioselectivity and stereoselectivity. Reactions: halogenations, hydrohalogenation, hydration, hydrogenation, epoxidation, hydroxylation, ozonolysis, electrophiilic addition to diene (conjugated dienes and allenes). Radical addition: HBr addition. Dissolving metal reduction of alkynes and bezenoid aromatics (Birch). Pericyclic addition: Diels-Alder reaction. Addition of singlet and triplet carbenes.

Nucleophilic addition to C=O: Mechanism, reactivity, equilibrium and kinetic control. Reactions with alcohols, amines, thiols, HCN, bisulfate, Wittig reaction. Carbonyl Reduction: hydride addition, Wolff-Kishner reduction, dissolving metal (Bouveault-Blanc reduction, Clemmensen Reduction), Cannizzaro reaction, Tischenko reaction, aldol condensation, benzoin condensation. Hydrolysis of nitriles and isonitriles. Nucleophilic addition to α,β-unsaturated carbonyl system (general principles).

Unit II. Elimination and aromatic substitution

Elimination - Mechanisms: E1, E2 and E1cB; reactivity, orientation (Saytzeff/ Hofmann) and stereoselectivity; substitution vs elimination,

Electrophilic aromatic substitution: Mechanisms, orientation and reactivity. Reactions: nitration, nitrosation, sulfonation, halogenation, Friedel-Crafts reactions, one-carbon electrophiles (reactions: chloromethylation, Gatterman-Koch, Gatterman, Hoesch, Vilsmeier-Haack reaction, Reimer-Tiemann, Kolbe-Schmidt).

Nucleophilic aromatic substitution: Addition-elimination mechanism, S_N1 mechanism, benzyne mechanism.

CHT 22b

Unit I. Nitrogen compounds and Organometallics

Nitrogen compounds: amines (aliphatic & aromatic) [preparation, separation and identification of primary, secondary and tertiary amines], E. Clarke reaction, enamines, Mannich reaction, diazomethane, diazoacetic ester, aromatic nitro compounds, aromatic diazonium salts, nitrile and isonitrile.

Organometallics: preparation of Grignard reagent and organo lithium. Reactions: addition of Grignard and organo lithium to carbonyl compounds, substitution on -COX, conjugate addition by Gilman cuprates, Reformatsky reaction.

Unit II. Reactions: Rearrangements

1,2-shift: Rearrangement to electron-deficient carbon (Wagner-Meerwein rearrangement, pinacol rearrangement, dienone-phenol; Wolff rearrangement in Arndt-Eistert synthesis, benzil-benzilic acid rearrangement).

Electron-deficient nitrogen (Beckmann rearrangement, Schmidt rearrangement, Hofmann rearrangement, Lossen rearrangement, Curtius rearrangement).

Electron-deficient oxygen (Baeyer-Villiger oxidation, hydroperoxide rearrangement (cumene hydroperoxide-phenol rearrangement), Dakin reaction.

Aromatic rearrangements [migration from oxygen to ring carbon (Fries rearrangement, Claisen rearrangement); migration from nitrogen to ring carbon (Hofmann-Martius rearrangement**,** Fischer-Hepp rearrangement, N-azo to C-azo rearrangement, Bamberger rearrangement, Orton rearrangement, benzidine rearrangement.

CHT 23a

Unit I. Thermodynamics and Equilibrium

Open system, chemical potential and activity, partial molar quantities, chemical potential in terms of Gibb's free energy and other thermodynamic state functions and its variation with temperature and pressure. Gibbs-Duhem equation; fugacity of gases and fugacity coefficient.

Thermodynamic conditions for equilibrium, degree of advancement. van't Hoff's reaction isotherm (deduction from chemical potential). Explanation of the free energy versus degree of advancement plot . Equilibrium constant and standard Gibbs free energy change. Definitions of K_P, K_C and K_x ; van't Hoff's reaction isobar and isochore from different standard states. Shifting of equilibrium due to change in external parameters e.g. temperature and pressure. Le Chatelier's principle and degree of advancement.

Activity and activity coefficients of electrolyte / ion in solution. Debye-Huckel limiting law (statement and applications only). Solubility equilibrium and influence of common ions and indifferent ions thereon. P^H, buffer solution, buffer capacity, salt hydrolysis (detailed treatment).

Unit II. Liquid State and Viscosity of Fluids

Nature of the liquid state, (short range order and long range disorder). Vapor pressure. Surface tension, surface energy, excess pressure, capillary rise and measurement of surface tension. Work of cohesion and adhesion, spreading of liquid over other surface. Vapour pressure over curved surface. Temperature dependence of surface tension.

General features of fluid flow (streamline flow and turbulent flow). Reynold number, nature of viscous drag for streamline motion, Newton' equation, viscosity coefficient. Poiseuille's equation (with derivation), temperature dependence of viscosity, principle of determination of viscosity coefficient of liquids by falling sphere method.

Viscosity of gases vs. liquids and kinetic theory of gas viscosity.

CHT 23b

Unit I. Quantum Chemistry I

Wave-particle duality, light as particles: photoelectric and Compton effects; electrons as waves and the de Broglie hypothesis.

Elementary concepts of operators, eigenfunctions and eigenvalues. Linear operators. Commutation of operators, fundamental commutator and uncertainty relation (without proof). Expectation value. Hermitian operator. Schrodinger time-independent equation: nature of the equation, acceptability conditions imposed on the wave functions and probability interpretations of wave function.

Particle in a box: setting up of Schrodinger equation for one-dimensional box and its solution. Comparison with free particle eigenfunctions and eigenvalues. Properties of PB wave functions (normalisation, orthogonality, probability distribution). Expectation values of x, x^2, p_x and p_x^2 and their significance in relation to the uncertainty principle. Extension of the problem to two and three dimensions and the concept of degenerate energy levels.

Unit II. Electrochemistry

Conductance and measurement of conductance, cell constant, specific conductance and molar conductance. Variation of specific and equivalent conductance with dilution for strong and weak electrolytes. Kohlrausch's law of independent migration of ions, ion conductance and ionic mobility. Equivalent and molar conductance at infinite dilution and their determination for strong and weak electrolytes. Ostwald's dilution law. Debye-Huckel model (physical idea only). Application of conductance measurement (determination of solubility product and ionic product of water). Conductometric titrations. Determination of transport number by moving boundary method.

Types of electrochemical cells and examples , cell reactions, emf and change in free energy, ΔH and ΔS of cell reactions from emf measurements. Thermodynamic derivation of Nernst equation. Standard cells. Half-cells / electrodes, different types of electrodes (with examples). Standard electrode potential (IUPAC convention) and principles of its determination. Types of concentration cells. Liquid junction potential and its minimisation.

Glass electrode and determination of pH of a solution. Potentiometric titrations: acid-base and redox.

CHP 24a

Analytical Estimations

1. Iodometry/iodimetry: Vitamin C.
2. Permanganometry: Fe^{III} and Mn^{II} in a mixture.
3. Dichromatometry: Fe^{III} and Cu^{II} in a mixture; Fe^{III} and Cr^{III} in a mixture.
4. Complexometry (EDTA): $CaCO_3$ and $MgCO_3$ in mixture; Mg^{II} and Zn^{II} in mixture.

CHP 24b

Instrumental Estimations

1. Spectrophotometry: Mn^{II}; $p^K{}_{in}$.
2. Conductometry: HCl-AcOH mixture; dibasic acid.
3. Potentiometry: Halide ion.
4. p^H-metry: HCl-AcOH mixture; dibasic acid.
5. Ion-exchanger: Cation content of a sample by cation exchanger

Chemistry Hons: Course Description

Year 3

PART – III

CHT 31a

Unit I. Chemistry of coordination compounds

Isomerism, reactivity and stability: Determination of configuration of cis- and trans- isomers by chemical methods. Labile and inert complexes, substitution reaction on square planer complexes, trans effect (example and applications). Stability constants of coordination compounds and their importance in inorganic analysis.

Structure and bonding: VB description and its limitations. Elementary Crystal Field Theory: splitting of d^n configurations in octahedral, square planar and tetrahedral fields, crystal field stabilization energy in weak and strong fields; pairing energy. Jahn-Teller distortion. Metal-ligand bonding (MO concept, elementary idea), sigma- and pi-bonding in octahedral complexes (qualitative pictorial approach) and their effects on the oxidation states of transitional metals (examples).

Magnetism and Colour: Orbital and spin magnetic moments, spin only moments of d^n ions and their correlation with effective magnetic moments, including orbital contribution; quenching of magnetic moment: super exchange and antiferromagnetic interactions (elementary idea with examples only); d-d transitions; L-S coupling; qualitative Orgel diagrams for $3d^1$-$3d^9$ ions and their spectroscopic ground states; selection rules for electronic spectral transitions; spectrochemical series of ligands; charge transfer spectra (elementary idea).

Unit II. Chemistry of d- and f- block elements

General comparison of 3d, 4d and 5d elements in term of electronic configuration, elemental forms, metallic nature, atomization energy, oxidation states, redox properties, coordination chemistry, spectral and magnetic properties.

f-block elements: electronic configuration, ionization energies, oxidation states, variation in atomic and ionic (3+) radii, magnetic and spectral properties of lanthanides, comparison between lanthanide and actinides, separation of lanthanides (by ion-exchange method).

Chemistry of some representative compounds: $K_2Cr_2O_7$, $KMnO_4$, $K_4[Fe(CN)_6]$, $K_2[Ni(CN)_4]$, H_2PtCl_6, $Na_2[Fe(CN)_5NO]$.

CHT 31b

Unit I. Organometallic Compounds

18-electron rule and its applications to carbonyls (including carbonyl hydrides and carbonylates), nitrosyls, cyanides, and nature of bonding involved therein. Simple examples of metal-metal bonded compounds and metal clusters. Metal-olefin complexes: zeises salt (preparation, structure and bonding), Ferrocene (preparation, structure and reactions). Hapticity(η) of organometallic ligands, examples of mono tri and penta-hapto cyclopentadienyl complexes. Simple examples of fluxional molecules. Coordinative unsaturation: oxidative addition and insertion reactions. Homogeneous catalysis by

organometallic compounds: hydrogenation, hydroformylation and polymerization of alkenes (Ziegler-Natta catalysis).

Unit II. Bioinorganic Chemistry

Elements of life: essential major, trace and ultratrace elements. Basic chemical reactions in the biological systems and the role of metal ions (specially Na+, K+, Mg2+, Ca2+, Fe3+/2+, Cu2+/+, and Zn2+).Metal ion transport across biological membrane Na+-ion pump, ionophores. Biological functions of hemoglobin and myoglobin, cytochromes and ferredoxins, carbonate bicarbonate buffering system and carbonicanhydrase. Biological nitrogen fixation, Photosynthesis: Photosystem-I and Photosystem-II. Toxic metal ions and their effects, chelation therapy (examples only), Pt and Au complexes as drugs (examples only), metal dependent diseases.

CHT 31c

Unit I. Electrochemical and spectral analysis, and analytical separation

Electrochemical methods: Conductometry, Potentiometry, pH-metry. Electrogravimetry, Coulometry. Spectrophotometry: Lambert-Beer law, Limits to Beer's law, Principle of spectrophotometric estimation of iron, manganese and phosphorous. Principles and instrumentations of atomic absorption and atomic emission spectrometry; estimation of sodium and potassium in water samples.

Ion exchange resins and their exchange capacities, principle and simple applications of ion exchange separation. Chromatographic separations: General description and classification of chromatographic methods, thin layer, paper and column chromatographic techniques and their simple applications, Rf-values and their significance, elution in column chromatography, migration rates of solutes, band broadening and column efficiency, column resolution.

Unit 2. Statistical methods in chemical analysis and environmental analysis

Errors in chemical analysis: Accuracy and precision of measurements, determinate indeterminate, systematic and random errors in chemical analysis with examples, absolute and relative errors; source, effect and detection of systematic errors; distribution of random errors, normal error curve, standard deviations, standard deviation of calculated results- sum or difference, product or quotient, significant figures, rounding and expressing results of chemical computations.

Principles for determination of BOD, COD, DO, TDS, in water samples.
Detection and estimation of As, Hg, Cd, Pb, NH_4^+, and F^-, NO_3^-, NO_2^- in water sample.
Detection, collection and principles of estimation of CO, NOx, SO_2, H_2S and SPM in air samples.

CHT 31d

Unit I: Gravimetric and tritimetric methods of analysis

Requirements of gravimetry: properties of precipitates and precipitating regents, particle size and filterability of precipitates, colloidal and crystalline precipitates coprecipitation and post-precipitation drying and ignition of precipitates, principles of gravimetric estimation of chloride, phosphate, zinc, iron, aluminum and magnesium singly.

Primary and secondary standard substances in acid-base, redox, complexometric (EDTA) and argentometric titrations. Principle and application of redox tritimetric estimation based on the use of the following reagents: $KMNO_4$, $K_2Cr_2O_7$, I_2, $Na_2S_2O_3.5H_2O$, $KH(IO_3)_2$ and $KBrO_3$. Principle of argentimetric estimation of chloride using adsorption indicators.

Principle of complexometric EDTA titration, metal ion indicators (examples), masking and demasking reactions, estimation of Cu-Zn, Fe-Al and Ca-Mg mixture by EDTA titration methods.

Dissolution, scheme of analysis and principles of estimation of the constituents of the following materials: dolomite, pyrolusite, chalchopyrites, Portland cement, basic slag, brass, steel and type metal.

Unit II. Thermodynamics of dissolution

Acidities of cations, factors influencing acidities (effects of charge and size); basicities of anions, factors influencing basicities (size and charge effects). Hydration energies of ions, Born-equation, enthalpy change associated with dissolution, solubility rules, thermodynamic interpretations of the rules; application of the rules for precipitation reactions, uses of the rules in quantitative and qualitative analysis, complexation reactions and their roles in dissolution processes.

CHT 32a

Unit I. Carbanion chemistry and cyclic stereochemistry

Carbanions: formation of enols and enolates (metal), alkylation of enolates, reactions of enolates with carbonyls (aldehydes, ketones and esters), conjugate addition of enolates.

Cyclic Stereochemistry: Baeyer strain theory.

Conformational analysis: cyclohexane, mono and disubstituted cyclohexane, symmetry properties and optical activity. Conformation & reactivity in cyclohexane system: elimination (E2), rearrangement, nucleophilic substitution (S_N1, S_N2, NGP), oxidation of cyclohexanol, esterification, saponification, lactonisation.

Unit II. Spectroscopy UV, IR, NMR (elementary)

UV Spectra: Electronic transition (σ-σ*, n-σ*, π-π* and n-π*), relative positions of λ_{max} considering conjugative effect, steric effect, solvent effect, red shift (bathochromic shift), blue shift (hypsochromic shift), hyperchromic effect, hypochromic effect (typical examples).

IR Spectra: Modes of molecular vibrations, application of Hooke's law, characteristic stretching frequencies of O-H, N-H, C-H, C-D, C=C, C=N, C=O functions; factors effecting stretching frequencies (H-bonding, mass effect, electronic factors, bond multiplicity, ring size).

PMR Spectra: Nuclear spin, NMR active nuclei, principle of proton magnetic resonance, equivalent and non-equivalent protons, chemical shift δ), shielding / deshielding of protons, up-field and down-field shifts. NMR peak area (integration), diamagnetic anisotropy, relative peak positions of different kinds of protons (alkyl halides, olefins, alkynes, aldehyde H), substituted benzenes (toluene, anisole,

nitrobenzene, halobenzene, dinitrobenzenes, chloronitrobenzene), first order coupling (splitting of the signals: ordinary ethanol, bromoehane, dibromoehanes), coupling constants.

CHT 32b

Unit I. Synthetic strategies and Asymmetric synthesis

Retrosynthetic analysis: disconnections, synthons, donor and acceptor synthons, functional group interconversion, C-C disconnections and synthesis [one group and two-group (1,2 to 1,6-dioxygenated], reconnection (1,6-di carbonyl), natural reactivity and umpolung, protection-deprotection strategy [alcohol, amine, carbonyl, acid]

Strategy of ring synthesis: thermodynamic factor, synthesis through enolate anion chemistry and carbonyl condensation reactions (including acetoaceticester & malonic ester synthesis) ,synthesis through rearrangement (including pinacol, Favorski), synthesis of large rings, high dilution technique and acyloin reaction, Stobbe condensation.

Asymmetric synthesis: stereoselective and stereospecific reactions, diastereo-selectivity and enantioselectivity (only definition), diastereoselectivity: addition of nucleophiles to C=O, adjacent to a stereogenic centre (Felkin-Anh model).

Unit II. Carbohydrate chemistry

Monosaccharides: Aldoses upto 6 carbons, structure of D-glucose & D-fructose (configuration & conformation), anomeric effect, mutarotation.

reactions: osazone formation, bromine – water oxidation, stepping–up (Kiliani method) and stepping–down (Ruff's & Wohl's method)of aldoses.

Disaccharides: glycosidic linkages, structure of sucrose.

CHT 32c

Unit I. Carbocycles and Heterocycles

Polynuclear hydrocarbons: syntheses and reactions of naphthalene, anthracene and phenanthrene.

Heterocyclic compounds: reactivity, orientation and important reactions of furan, pyrrole, pyridine, indole, synthesis (including retrosynthetic approach) pyrrole: Knorr pyrrole synthesis and Hantzsch synthesis. Hantzsch pyridine synthesis. Indole: Fischer, Madelung and Reissert synthesis, Skaurp quinoline and Bischler-Napieralski Synthesis of isoquinoline.

Unit II. Amino acids, peptides and nucleic acids

Amino acids: Synthesis: (Strecker, Gabriel, acetamido malonic ester, azlactone); isoelectric point, ninhydrin reaction.

Peptides: peptide linkage, syntheses of peptides using N-protection & C-protection, solid phase synthesis; peptide sequence: C–terminal and N–terminal unit determination (Edmann, Sanger & dansyl chloride).

Nucleic acids: pyrimidine & purine bases (only structure & nomenclature), nucleosides and nucleotides, DNA: Watson-Crick model, complimentary base –pairing in DNA.

CHT 33a

Unit I. Properties of solids, interfaces and dielectrics

Crystal, crystal planes, law of rational indices, Calculation of fraction occupied for simple cubic, bcc, and fcc. Miller indices. Bragg's law and its applications for the

determination of crystal structure for cubic system single crystal. Crystal structures of NaCl and KCl.

Special features of interfaces compared to bulk. Surface dynamics: Physical and chemical adsorption. Freundlich and Langmuir adsorption isotherms; multilayer adsorption and BET isotherm (no derivation required). Gibbs adsorption isotherm and surface excess. Heterogeneous catalysis (single reactant).

Colloids: lyophobic and lyophilic sols. Origin of charge and stability of lyophobic colloids. Coagulation and Schultz-Hardy rule. Zeta potential and Stern double layer (qualitative idea). Tyndall effect. Electrokinetic phenomenon (qualitative idea only).

Electrical properties of molecules: Polarizability of atoms and molecules, dielectric constant and polarisation, molar polarisation for polar and non-polar molecules. Clausius-Mosotti equation and Debye equation (both with derivation) and their application. Determination of dipole moments.

Unit II. Quantum Chemistry – II

Simple Harmonic Oscillator: setting up of the Schrodinger stationary equation, energy expression (without derivation), expression of wave function for n = 0 and n = 1 (without derivation) and their characteristic features.

Stationary Schrodinger equation for the H-atom in polar coordinates, separation of radial and angular (θ, φ) parts. Solution of φ-part and emergence of quantum number 'm'; energy expression (without derivation), degeneracy. Hydrogenic wave functions up to n = 2 (expression only); real wave function. Concept of orbitals and shapes of s and p orbitals.

CHT 33b

Unit I. Phase equilibrium and colligative properties

Definitions of phase, component and degrees of freedom. Phase rule and its derivations. Definition of phase diagram. Phase equilibria for one component system – water, CO_2. First order phase transition and Clapeyron equation; Clausius-Clapeyron equation - derivation and use.

Liquid vapour equilibrium for two component systems. Ideal solution at fixed temperature and pressure. Principle of fractional distillation. Duhem-Margules equation. Henry's law. Konowaloff's rule. Positive and negative deviations from ideal behaviour. Azeotropic solution. Liquid-liquid phase diagram using phenol-water system. Solid-liquid phase diagram. Eutectic mixture. Nernst distribution law. Solvent extraction.

ΔG, ΔS ΔH and ΔV of mixing for binary solutions. Vapour pressure of solution. Ideal solutions, ideally diluted solutions and colligative properties. Raoult's law. Thermodynamic derivation of colligative properties of solution (using chemical potentials) and their inter-relationships. Abnormal colligative properties.

Unit II. Statistical thermodynamics and the third law

Macrostates and microstates, thermodynamic probability, entropy and probability, Boltzmann distribution formula (with derivation). Applications to barometric distribution. Partition function and Einstein’s theory of heat capacity of solids. Limitations of Einstein’s theory and Debye's modification (qualitative).

Nernst heat theorem. Approach to zero kelvin, adiabatic demagnetisation. Planck's formulation of third law and absolute entropies.

CHT 33c

Unit I. Kinetics and photochemistry

Collision theory (detailed treatment); outline of Transition State theory. Primary kinetic salt effect. Lindemann theory of unimolecular reaction.

Potential energy curves (diatomic molecules), Frank-Condon principle and vibrational structure of electronic spectra. Bond dissociation and principle of determination of dissociation energy (ground state). Decay of excited states by radiative and non-radiative paths. Fluorescence and phosphorescence, Jablonsky diagram.

Laws of photochemistry: Grotthus-Draper law, Stark-Einstein law of photochemical equivalence and Lambert-Beer's law; quantum yield and its measurement for a photochemical process, actinometry. Photostationary state. Photosensitized reactions. Kinetics of HI decomposition, H_2-Br_2 reaction, dimerisation of anthracene.

Unit II. Spectroscopy

Rotational spectroscopy of diatomic molecules: rigid rotor model, selection rules, spectrum, characteristic features of spectral lines (spacing and intensity). Determination of bond length, effect of isotopic substitution.

Vibrational spectroscopy of diatomic molecules: SHO model, selection rules, spectra; anharmonicity and its consequences on energy levels, overtones, hot bands.

Raman Effect. Characteristic features and conditions of Raman activity with suitable illustrations. Rotational and vibrational Raman spectra. Rule of mutual exclusion with examples.

CHP 34a

Spectroscopic Analysis of Organic Compounds

A. Assignment of labelled peaks in the ^1H NMR spectrum of the known organic compounds explaining the relative ∂ values and splitting pattern.

B. Assignment of labeled peaks in the IR spectrum of the same compound.

(C-H, O-H, N-H, C=C, C=O, NO_2 stretching frequencies)

At least 10-15 compounds from among the list given below are to be chosen:

(i) p-Bromoacetanilide (ii) p-Methyl-α-bromoacetophenone (iii) Vanillin (iv) Cinnamic acid (v) p-Aminobenzoic acid (vi) Salicylamide (vii) o-Hydroxy acetophenone (viii) 4-keto pentanoic acid (ix) Benzylacetate (x) Diethylmaleate (xi) Diethylfumarate (xii) p-Nirtobenzaldehyde (xiv) Mesityl oxide (xv) o-Hydroxybenzaldehyde (xvi) p-Nitroaniline

A separate laboratory workbook should be maintained for these experiments.

CHP 34b

Experiment -1. Qualitative analysis of single solid organic compounds

A. Detection of special elements (N, Cl, S) by Lassaigne's test

B. Solubility and Classification (solvents: H_2O, 5% HCl, 5% $NaHCO_3$, 5% NaOH)

C. Detection of the following functional groups by systematic chemical tests:
Aromatic amino ($-NH_2$), aromatic nitro ($-NO_2$), Aimdo ($-CONH_2$, including imide), Phenolic –OH, Carboxylic acid (-COOH), Carbonyl (>C=O); only one test for each functional group is to be reported.

Each student, during laboratory session, is required to carry out qualitative chemical tests for all the special elements and the functional groups in known and unknown (at least 5) organic compounds.

Experiment - 2. Organic preparations

A. The following reactions are to be performed, noting the yield of the crude product:
1. Nitration of aromatic compounds
2. Condesation reactions
3. Hydrolysis of amides/ imides/ esters
4. Acetylation of phenols / aromatic amines
5. Benzoylation of phenols / aromatic amines
6. Side chain oxidation of aromatic compounds
7. Diazo coupling reactions of aromatic amines
8. Bromination of anilides
9. Redox reaction
10. Green 'multi-component –coupling' reaction

B. Purification of the crude product is to be made by crystallisation (water/alcohol, crystallisation after charcoal treatment, or sublimation, whichever is applicable).

C. MP of the purified product is to be noted.

Note: Each student is required to perform ALL the experiments cited above (in A, B and C) in classes.

CHP 35a

Experiments:

1. Determination of surface tension of a given solution by drop weight method using a stalagmometer, considering aqueous solutions of NaCl, acetic acid, ethanol etc, as systems.
2. Determination of viscosity coefficient of a given solution with Ostwald's viscometer considering aqueous solutions of cane-sugar, glycerol, ethanol, etc.
3. Determination of solubility of sparingly soluble salts in water and various Electrolyte medium by titrimetric method. KHTa as sparingly soluble salt in water, KCl, $NaNO_3$ may be used.

4. Determination of partition coefficient of Iodine or Acetic acid in water and an immiscible organic solvent.
5. Determination of the rate constant for the first order acid catalyzed hydrolysis of an ester (V_0 and V_∞ be supplied).
6. Determination of rate constant of decomposition of H_2O_2 by acidified KI solution using clock reactions.

A separate laboratory workbook should be maintained for these experiments.

CHP 35b

Experiments:
1. To study the kinetics of inversion of sucrose using polarimeter.
2. To study the phase diagram of a binary system (Phenol + water) and the effect of impurities (e.g. NaCl).
3. Determination of ionization constant of a weak acid by conductometric method.
4. To study the kinetics of saponification of ester by conductometric method.
5. Determination of the equilibrium constant of the reaction $KI + I_2 = KI_3$ by partition method (partition coefficient to be supplied).
6. Determination of E_0 of Fe^{+3}/Fe^{2} couple in the hydrogen scale by potentiometric titration of ferrous ammonium sulfate solution using $KMnO_4$, or, $K_2Cr_2O_7$ as standard.
7. Determination of concentration of (i) $AgNO_3$ solution and (ii) solubility product of AgCl by potentiometic titration of standard KCl solution against $AgNO_3$ solution.
8. Determination of pK values of weak monobasic, dibasic and polybasic acid by pH-metric method (e.g. using, acetic acid, succinic acid, oxalic acid, phosphoric acid, etc.).
9. Study of the kinetics of the reaction $I^- + S_2O_8^{2-}$ by colorimetric method.

Chemistry General: Syllabus Scheme in modular form

Course names and distribution

PART – I (Year 1), total marks = 100 (Theory = 100)
CGT 11a, 11b each 25 marks, Theory
CGT 12a, 12b each 25 marks, Theory

PART – II (Year 2), total marks = 200 (Theory = 100, Practical = 100)
CGT 21a, 21b each 25 marks, Theory
CGT 22a, 22b each 25 marks, Theory
CGP 23 50 marks, Practical
CGP 24 50 marks, Practical

PART – III (Year 3), total marks = 100 (Theory = 75, Practical = 25)
CGT 31a, 31b, 31c each 25 marks, Theory
CGP 32 25 marks, Practical

Abbreviations:
CGT: Chem General Theory; CGP: Chem General Practical
First digit refers to year, second to paper

Each CGT Exam = 1½ hr for 50 marks, or as stated later
Each CGP Exam = 3 hr for 25/50 marks on each day, or as stated later
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Notes:
1. A Theory module of 25 marks would contain units I (marks = 15) and II (marks = 10).

2. Number of class hours = number of marks (Theory)
Number of class hours = 2-3 times the number of marks (Practical)

Chemistry Gen: Course Description
Year 1
PART - I

CGT 11a

Unit I. General Chemistry

Extra-nuclear Structure of atoms: Bohr's theory for hydrogen atom (simple mathematical treatment), atomic spectra of hydrogen and Bohr's model, Sommerfeld's model, quantum numbers and their significance, Pauli's exclusion principle, Hund's rule, electronic configuration of many-electron atoms, *Aufbau* principle and its limitations.

Radioactivity and Nuclear Structure of Atoms: Natural radioactivity; radioactive disintegration series, group displacement law, law of radioactive decay, half-life of radio elements. Atomic Nucleus: Stability of atomic nucleus, n/p ratio, nuclear binding energy, mass defect. Nuclear reactions: fission, fusion, transmutation of elements.

Chemical Periodicity: classification of elements on the basis of electronic configuration: general characteristics of s-, p-, d- and f-block elements. Positions of hydrogen and noble gases. Atomic and ionic radii, ionization potential, electron affinity, and electronegativity; periodic and group-wise variation of above properties in respect of s- and p- block elements.

Unit II. Principles of organic qualitative analysis

Reactions involving the detection of special elements N, S and Cl in an organic compound (only Lassaigne's test).

Reactions involving the detection of the following functional groups:
Aromatic primary amino group (Diazo-coupling reaction); Nitro group (Mulliken Barker's test); Carboxylic acid group (reaction with $NaHCO_3$); Phenolic OH ($FeCl_3$ test); Carbonyl (aldehyde and ketone) group (DNP Test, etc.).

CGT 11b

Unit I. Basic organic chemistry I

Inductive effect, resonance and resonance energy. Homolytic and heterolytic bond breaking, electrophiles and nucleophiles; carbocations, carbanions and radicals (stability and reactivity)

Stereochemistry of carbon compounds: Different types of isomerism, geometrical and optical isomerism, optical activity, asymmetric carbon atom, elements of symmetry (plane and centre), chirality, enantiomers and diastereomers, R and S nomenclature, E and Z nomenclature, D and L nomenclature, Fischer projection formula of simple molecules containing one and two asymmetric carbon atoms.

Alkanes, alkenes and alkynes: Synthesis and chemical reactivity of alkanes, mechanism of free-radical halogenation of alkanes, general methods of synthesis of alkenes, electrophilic addition reaction, mechanism of bromination and hydrohalogenation, Markownikoff's addition, peroxide effect, hydroboration, ozonide formation, polymerization reaction of alkenes (definition and examples only), general methods of synthesis, acidity, hydration and substitution reactions of alkynes.

Aromatic Hydrocarbons: Structure of benzene, general mechanism of electrophilic substitution, reactions of benzene, synthesis of aromatic compounds using nitration, halogenation, Friedel-Craft's reactions.

Unit II. Basic organic chemistry II

Aldehydes and ketones: the nature of carbonyl group, methods of synthesis, physical properties, Cannizzaro reaction, relative reactivities and distinction of aldehydes and ketones, Aldol condensation (with mechanism), Perkin reaction, Benzoin condensation, Claisen condensation, Oxidation and reduction reactions.

Alkyl and Aryl halides: S_N1, S_N2, E1 and E2 reactions (elementary mechanistic aspects), Saytzeff and Hoffmann elimination reactions. Nucleophilic aromatic substitution.

CGT 12a

Unit I. Basic inorganic chemistry I

Ionic bonding: General characteristics of ionic compounds, sizes of ions, radius ratio rule and its limitation. Lattice energy, Born Haber cycle.

Covalent bonding: General characteristics of covalent compounds, valence-bond approach, directional character of covalent bond, hybridization involving s-, p-, d-orbitals, multiple bonding, Valence Shell Electron Pair Repulsion (VSEPR) concept, shapes of simple molecules and ions (examples from main group chemistry). Bond moment and dipole moment, partial ionic character of covalent bonds, Fajan's rules. Hydrogen bonding and its effect on physical and chemical properties.

Coordinate bonds and Coordination compounds: complex salts and double salts, Warner's theory of coordination, chelate complexes, stereochemistry of coordination numbers 4 and 6. IUPAC nomenclature of coordination complexes (mononuclear complexes only).

Unit II. Basic inorganic chemistry II

Comparative study of p-block elements: Group trends in electronic configuration, modification of pure elements, common oxidation states, inert pair effect, and their important compounds in respect of the following groups of elements:

i) B-Al-Ga-In-Tl
ii) C-Si-Ge-Sn-Pb
iii) N-P-As-Sb-Bi
iv) O-S-Se-Te
v) F-Cl-Br-I

CGT 12b

Unit I. Basic organic chemistry III

Carboxylic acids and their derivatives: acidity of carboxylic acids and effects of substituents on acidity, chemical reactivity, mechanism of esterification of carboxylic acids and hydrolysis of esters ($B_{AC}2$ and $A_{AC}2$ only)

Phenols: synthesis, acidic character and chemical reactions of phenols, Kolbe reactions, Reimer-Tiemann reaction, Fries rearrangement, Claisen rearrangement.

Organometallic compounds: Grignard reagents – preparations and reactions, application of Grignard reagents in organic synthesis. [1^0-, 2^0- and 3^0-alcohols, aldehydes, ketones and carboxylic acids.]

Organic compounds containing nitrogen: aromatic nitro compounds – reduction under different conditions. [acidic, neutral and alkaline]. Methods of synthesis of aliphatic amines, Heinsberg's method of amine separation, Hofmann degradation, Gabriel's phthalimide synthesis, distinction of primary, secondary and tertiary amines; methods of synthesis of aromatic amines, basicity of aliphatic and aromatic amines. Diazotization and coupling reactions and their mechanisms; synthetic applications of benzene diazonium salts. [Sandmeyer's reaction, preparation of nitro compounds, phenols, carboxylic acids and hydrocarbons thereby]

Unit II. Basic organic chemistry IV

Carbohydrates: Introduction, occurrence and classification of carbohydrates, constitution of glucose, osazone formation, reactions of glucose and fructose, mutarotation, cyclic structures – pyranose and furanose forms (determination of ring-size excluded), epimerization, chain-lengthening (Kiliani –Fischer method) and chain-shortening (Ruff's method) in aldoses.

Amino acids, Proteins: methods of synthesis of α –amino acids (glycine and alanine using Gabriel's phthalimide synthesis and Strecker synthesis). Physical properties. Zwitterion structures, isoelectric point.

Chemistry Gen: Course Description
Year 2
PART - II

CGT 21a

Unit I. Basic physical chemistry I

Gaseous state: Gas laws, kinetic theory of gas, collision and gas pressure, derivation of gas laws from kinetic theory, average kinetic energy of translation, Boltzmann constant and absolute scale of temperature, Maxwell's distribution law of molecular speeds (without derivation), most probable, average and root mean square speed of gas molecules, principle of equipartition of energy (without derivation). Mean free path and collision frequencies. Heat capacity of gases (molecular basis); viscosity of gases.

Real gases, compressibility factor, deviation from ideality, van der Waals equation of state, critical phenomena, continuity of states, critical constants.

Liquid state: physical properties of liquids and their measurements: surface tension and viscosity.

Unit II. Basic physical chemistry II

Chemical kinetics and catalysis: order and molecularity of reactions, rate laws and rate equations for first order and second order reactions (differential and integrated forms); zero order reactions. Determination of order of reactions. Temperature dependence of reaction rate, energy of activation. Catalytic reactions: homogeneous and heterogeneous catalytic reactions, autocatalytic reactions, catalyst poisons, catalyst promoters (typical examples).

CGT 21b

Unit I. Principles of qualitative inorganic analysis

Formation of sublimates; principle of flame test, borax-bead test, cobalt nitrate test, fusion test, chromyl chloride test; analytical reactions for the detection of nitrate, nitrite, halides, phosphate, arsenate, arsenite, sulphide, thiosulphate, sulphate, thiocyanate, borate, boric acid, carbonate. Analytical reactions for the detection of Cr^{3+}, Fe^{3+}, , Ni^{2+}, Cu^{2+}, As^{3+}, Mn^{2+}, Importance of common-ion effect in the separation of Group II cations, and Group III cations.

Unit II. Basic inorganic chemistry III

Comparative study of s-block elements: Group trends in electronic configuration, modification of pure elements, common oxidation states, inert pair effect, chemical properties and reactions in respect of the following group elements:

i) Li-Na-K
ii) Be-Mg-Ca-Sr-Ba

Extraction and purification of elements from natural sources: Li, Cr, Ni, Ag, Au. Electroplating, galvanizing and anodizing.

CGT 22a

Unit I. Basic physical chemistry III

Thermodynamics: Definition of thermodynamic terms: Intensive and extensive variables, isolated, closed and open systems. Cyclic, reversible and irreversible processes. Thermodynamic functions and their differentials. Zeroth law of thermodynamics, concept of heat (q) and work (w).

First law of thermodynamics, internal energy (U) and enthalpy (H); relation between Cp and Cv, calculation of w, q, ΔU and ΔH for expansion of ideal gas under isothermal and adiabatic conditions for reversible and irreversible processes including free expansion. Joule-Thomson Coefficient and inversion temperature.

Application of First law of thermodynamics: standard state, standard enthalpy changes of physical and chemical transformations: fusion, sublimation, vaporization, solution, dilution, neutralization, ionization,. Hess's law of constant heat summation. Bond-dissociation energy, Born haber cycle for calculation of lattice energy. Kirchhoff's equation, relation between ΔH and ΔU of a reaction.

Spontaneous processes, heat engine, Carnot cycle and its efficiency, Second law of thermodynamics, Entropy (S) as a state function, molecular interpretation of entropy, entropy changes in simple transformations. Free energy: Gibbs function (G) and Helmholtz function (A), Gibbs-Helmholtz equation, criteria for thermodynamic equilibrium and spontaneity of a process.

Unit II. Basic physical chemistry IV

Chemical equilibrium: chemical equlibria of homogeneous and heterogeneous systems, derivation of expression of equilibrium constants; temperature, pressure and concentration dependence of equilibrium constants (K_P, K_C, K_X); Le Chatelier's principle of dynamic equilibrium.

Colloids: colloids and crystalloids, classification of colloids, preparation and purification of colloids: ferric hydroxide sol and gold sol. Properties of colloids: Brownian motion, peptization, dialysis, Tyndal effect and its applications. Protecting colloids, gold number, isoelectric points, coagulation of colloids by electrolytes, Schulze-Hardy rule.

CGT 22b

Unit 1. Basic physical chemistry V

Acids-bases and solvents: Modern aspects of acids and bases: Arrhenius theory , theory of solvent system, Bronsted and Lowry's concept, Lewis concept with typical examples, applications and limitations. Strengths of acids and bases (elementary idea). Ionization of weak acids and bases in aqueous solutions, application of Ostwald's dilution law, ionization constants, ionic product of water, pH-scale, buffer solutions and their pH values, buffer actions; hydrolysis of salts.

Solutions of electrolytes: Electrolytic conductance, specific conductance, equivalent conductance and molar conductance of electrolytic solutions. Influence of temperature and dilution on weak electrolytes.

Unit II. Basic physical chemistry VI

Electrode potential: Electrode potentials, Nernst Equation, reference electrodes: normal hydrogen electrode and calomel electrodes, Emf of electrochemical cells and its measurement, electrode potential series and its applications.

Solutions of non-electrolytes: Colligative properties of solution, Raoult's Law, relative lowering of vapor pressure, osmosis and osmotic pressure; elevation of boiling point and depression of freezing point of solvents.

CGP 23

Qualitative Analysis of Single Organic Compound(s)

Experiment A: Detection of special elements (N, Cl, and S) in organic compounds.

Experiment B: Solubility and Classification (solvents: H_2O, dil. HCl, dil. NaOH)

Experiment C: Detection of functional groups $-NO_2$, $-NH_2$, -COOH, carbonyl (-CHO, >C=O), -OH (phenolic) in solid organic compounds.

Experiments A - C with unknown (at least 6) solid samples containing not more than two of the above types of functional groups should be done.

CGP 24

Qualitative Analysis of Inorganic Mixtures:

Experiments A: Preliminary Tests for Acid and Basic radicals in given samples.

Experiments B: Wet tests for Acid and Basic radicals in given samples.

Experiments C: Confirmatory tests.

Acid Radicals: Cl^-, Br^-, I^-, NO_2^{-1}, S^{2-}, SO_4^{-2}, PO_4^{-3}, BO_3^{3-}, H_3BO_3.
Basic Radicals: Na^+, K^+, Ca^{+2}, Sr^{+2}, Ba^{+2}, Cr^{+3}, Mn^{+2}, Fe^{+3}, Ni^{+3}, Cu^{+2}, NH_4^+.

Note: At least 6 unknown samples are to be analyzed by each student during the laboratory session.

Chemistry Gen: Course Description
Year 3
PART - III

CGT 31a

Unit I. Chemical analysis

Gravimetric Analysis: Solubility product and common ion effect. Requirements of gravimetry. Gravimetric estimation of chloride, sulphate, lead, barium, nickel, copper and zinc.

Volumetric Analysis: Primary and secondary standard substances, principles of acid-base, xidation –reduction, and complexometric titrations; acid-base, redox and metal-ion indicators. Principles of estimation of mixtures of $NaHCO_3$ and Na_2CO_3 (by acidimetry); iron, copper, manganese, chromium (by redox titration); zinc, aluminum, calcium, magnesium (by complexometric EDTA titration). Chromatographic methods of analysis: column chromatography and thin layer chromatography.

Unit II. Error analysis and computer applications

Accuracy and precision of quantitative analysis, determinate-, indeterminate-, systematic- and random-errors. Methods of least squares and standard deviations.

General introduction to computers, different components of a computer, hardware and software, input and output devices, binary numbers and arithmetic. Introduction to computer languages, programming and operating systems.

CGT 31b

Unit I. Industrial chemistry I

Fuels: Classification of fuel, heating values. Origin of coal, carbonization of coal, coal gas, producer gas, water gas, coal based chemicals. Origin and composition of petroleum, petroleum refining, cracking, knocking, octane number, anti-knock compounds, Kerosene, liquefied petroleum gas (LPG), liquefied natural gas (LNG), petrochemicals (C1 to C3 compounds and their uses).

Fertilizers: Manufacture of ammonia and ammonium salts, urea, superphosphate, biofertilizers.

Glass and Ceramics: Definition and manufacture of glasses, optical glass and coloured glass. Clay and feldspar, glazing and vitrification, glazed porcelein, enamel. Portland cement: composition and setting of cement, white cement.

Unit II. Industrial chemistry II

Polymers: Basic concept, structure and types of plastics, polythene, polystyrene, phenol-formaldehydes, PVC; manufacture, physical properties and uses of natural rubber, synthetic rubber, silicone rubber; synthetic fibres: Nylon-66, polyester, terylene, rayon; foaming agents, plasticizers and stabilizers.

Paints, Varnishes and Synthetic Dyes: Primary constituents of a paint, binders and solvents for paints. Oil based paints, latex paints, baked-on paints (alkyd resins). Constituents of varnishes. Formulation of paints and varnishes. Synthesis of Methyl orange, Congo red, Malachite green, Crystal violet.

Drugs and pharmaceuticals: Concept and necessity of drugs and pharmaceuticals. Preparation, and uses of Aspirin, Paracetamol, Sulphadiazine, Quinine, Chloroquine, Phenobarbital, Metronidazole. Fermentation Chemicals : Production, and purification of ethyl alcohol, citric acid, lactic acid, Vitamin B12, Penicillin.

CGT 31c

Unit I. Environmental chemistry

The Atmosphere: Composition and structure of the atmosphere: troposphere, stratosphere, mesosphere and thermosphere. Ozone layer and its role. Major air pollutants : CO, SO_2, NO and particulate matters –their origins and harmful effects, problems of ozone layer depletion, green house effect, acid rain and photochemical smog. Air pollution episodes. Air quality standard. Air pollution control measures: cyclone collector, electrostatic precipitator, catalytic converter.

The Hydrosphere : Environmental role of water, natural water sources, water treatment for industrial, domestic and laboratory uses. Water pollutants : action of soaps and detergents, phosphates, industrial effluents, agricultural run off, domestic wastes; thermal pollution radioactive pollution and their effects on animal and plant life, water pollution episodes. Water pollution control measures : waste water treatment: chemical treatment and microbial treatment; water quality standards : DO. BOD, COD, TDS and hardness parameters. Desalination of sea water : reverse osmosis, electro dialysis.

The Lithosphere: Water and air in soil, waste matters and pollutants in soil, waste classification, treatment and disposal. Soil pollution and control measures.

Unit II. Industrial chemistry III

Fats-Oils-Detergents : Fats and oils, natural fat, edible and inedible oil of vegetable origin. Common fatty acids, glycerides. Hydrogenation of unsaturated oil, production of vanaspati and margarine. Production of toilet and washing soaps, Enzyme-based detergents, detergent powder, liquid soaps.

Pesticides: Common pesticides : Production, applications and residual toxicity of gammaxane, aldrin, parathion, malathion, DDT, paraquat, decamethrin.

Food Additives: Food flavour, food colour, food preservatives, artificial sweeteners, acidulants, alkalies, edible emulsifiers and edible foaming agents, sequesterants – uses and abuses of these substances in food beverages.

CGP 32

Experiments:

1. Titration of Na_2CO_3 + $NaHCO_3$ mixture vs HCl using phenolphthalein and methyl orange indicators.
2. Titration of HCl + CH_3COOH mixture vs NaOH using two different indicators to find the composition.
3. To find the total hardness of water by EDTA titration.
4. To find the PH of an unknown solution by comparing color of a series of HCl solutions + 1 drop of methyl orange, and a similar series of NaOH solutions + 1 drop of phenolphthalein.
5. To determine the rate constant for the acid catalysed hydrolysis of an ester.
6. Determination of the strength of the H_2O_2 sample.
7. To determine the solubility of a sparingly soluble salt, e.g. KHTa (one bottle)

Appendix 1

Hons. Examination

Paper-wise distribution of modules CHT and CHP

Year 1				
Paper IA (50 M):	CHT (12a+12b)	1day exam	2 hr	Theory
Paper IB (50 M):	CHT (13a+13b)	1day exam	2 hr	Do
Paper IIA (50 M):	CHT (11a+11b)	1day exam	2 hr	Do
Paper IIB (50 M):	CHP (14a+14b)	1day exam	4 hr	Practical
Year 2				
Paper IIIA (50 M):	CHT (22a+22b)	1day exam	2 hr	Theory
Paper IIIB (50 M):	CHT (23a+23b)	1day exam	2 hr	Do
Paper IVA (50 M):	CHT (21a+21b)	1day exam	2 hr	Do
Paper IVB (50 M):	CHP (24a+24b)	1day exam	4 hr	Practical
Year 3				
Paper V (100 M):	CHT (31a+31b+31c+31d)	1day exam	4 hr	Theory
Paper VIA (75 M):	CHT (32a+32b+32c)	1day exam	4 hr	Do
Paper VIIA (75 M):	CHT (33a+33b+33c)	1day exam	4 hr	Do
Paper VIIIA (50 M):	CHP 34b	1day exam	4 hr	Practical
Paper VIIIB (50 M):	CHP 35b	1day exam	4 hr	Do
Paper VIB (25 M) + Paper VIIB (25 M):	CHP (34a+35a)	1day exam	4 hr	Do

Gen. Examination

Paper-wise distribution of modules CGT and CGP

Year 1				
Paper I (100 M):	CGT (11a+11b+12a+12b)	1day exam	3 hr	Theory
Year 2				
Paper IIA (100 M):	CGT (21a+21b+22a+22b)	1day exam	3 hr	Theory
Paper IIIA (50 M):	CGP 23	1day exam	3 hr	Practical
Paper IIIB (50 M):	CGP 24	1day exam	3 hr	Practical
Year 3				
Paper IVA (75 M):	CGT (31a+31b+31c)	1day exam	3 hr	Theory
Paper IVB (25 M):	CGP 32	1day exam	3 hr	Practical

Appendix 2

Instructions about Theoretical Examinations
Hons./Genl.

For a Theoretical Examination, any particular module of 25 marks is already subdivided into two units: Unit I (15 marks) and Unit II (10 marks). In any case [Hons./Gen. (yearly)] , the following scheme will be effective.

Unit – I: 5 questions of marks 5 each are to be set, out of which 3 are to be answered. Minimum marks for a part of a question will be 2.

Unit – II: 3 questions of marks 5 each are to be set, out of which 2 are to be answered. Minimum marks for a part of a question will be 2.

Appendix 3

General instructions about Practical Examinations
Hons./Genl.

1. Candidates at the practical examinations are required to submit the *day to day record of all types of laboratory works* prescribed in the syllabus, performed by them, and duly signed by their teachers. Candidates failing to submit their laboratory work-books may be debarred from the examination.

2. One experiment/sample shall be assigned to a candidate through single draw lottery.

3. Outline of the procedure, wherever applicable, should be provided.

4. Use of *hazardous/toxic* chemicals should be avoided as far as practicable.

5. Weighing is to be done, wherever applicable, by *digital electronic balance* only.

6. Depending on the time and type of an experiment, *Primary standard solutions are to be provided at the time of examination*. The HE may decide the issue.

7. Drawing of linear least square plots, wherever applicable, is to be encouraged.

8. Theoretical classes, explaining the principles, should be taken.

9. Hons. practical examinations involving viva-voce of not less than 10 marks may be replaced by a *Lab. Quiz Test* (10 questions, 10 min for 10 marks; roughly one line answer for each question). This step will ensure better uniformity. Questions for different batches will be different. These are to be answered by students at the start of the first day of examination of a given batch. Questions will be prepared by the concerned HE for the specific practical examination during sample preparation. A viva-voce examination for 10 marks should not exceed 10 min.

10. In Appendix 5, different practical examinations are associated with specified "modalities of evaluation". While the concerned HE may not strictly follow it under special circumstances (or, in case of specific experiments set by him), a general adherence to such a splitting pattern is expected to be beneficial to the students.

Appendix 4

Specific instructions about Practical Examinations

CHP (14a+14b), 50 M, 4 hr (Year 1)

Note for examination:

1. The sample must contain three, and only three, radicals.
2. Observation must be indicative of some changes in the sample under the experimental conditions. Vague observations such as "no characteristic change, inconclusive observation etc" are not to be entertained.
3. Presence as well as absence of radicals must be incorporated in the 'Inference' column according to observations.
4. Whenever a particular radical is detected in any experiment, its presence may mask the normal observations for the other radicals that are also responsive to the same test. Under the circumstances, the presence of the detected radicals should be shown in the 'Inference' column. It is needless to show the absence of the other radicals in the above experiment.
5. All the candidates must perform the "Preliminary orientational tests". The proforma for the tests will be supplied to them.
6. The indicated radicals in the preliminary tests are to be confirmed by the student by appropriate test of his/her own choice.
7. In the preliminary 'orientational test' the following experiments are to be performed:

A. Dry heating of the sample
B. Flame test
C. Borax-bead test
D. Fusion test
E. Fluorescence test
F. Filtrate of the boiling mixture of the (sample + dil HCl + KNO_2 (a pinch)) + DMG +NH_4OH until ammoniacal
G. HCl extract + NaOH until alkaline, boiled and filtered: filtrate +H_2S
H. NaOH extract of the sample + NH_4Cl + H_2O – boiled and allowed to settle
I. Iodine-azide test
J. Heating of sample with dil H_2SO_4
K. Heating of sample with dil H_2SO_4 + Zn-dust
L. Heating of sample with conc. H_2SO_4
M. Heating of sample with conc. H_2SO_4 + Cu-turnings
N. Heating of sample with conc. H_2SO_4 + MeOH and ignition of the evolved gas

O. HNO_3 extract + $(NH_4)_2MoO_4$ (excess)
P. Na_2CO_3 extract + HNO_3 until acidic, boiled + $Ba(NO_3)_2$
Q. Na_2CO_3 extract + HNO_3 until acidic, boiled + $AgNO_3$
R. Na_2CO_3 extract + HCl until acidic, boiled + $FeCl_3$ + $K_3[Fe(CN)_6]$
S. Na_2CO_3 extract + HCl until acidic, boiled + KI + starch
T. Na_2CO_3 extract + HCl until acidic, boiled + $FeCl_3$

Marks:

1. Orientational tests:	20 M
2. Confirmatory tests:	12 M (4x3)
3. Reporting of the radicals:	3M
4. Lab workbook:	5 M
5. Lab quiz/viva-voce:	10 M

CHP (24a+24b), 50 M, 4 hr (Year 2)

At least 4 experiments from 24a and 5 experiments from 24b are to be set in the examination. A student will take any one experiment.

Modalities of Evaluation:

1) Principle and derivation of working formula = 5 M
2) Preparation of primary standard = 5 M
3) Tabular presentation of data = 5 M
4) Lab quiz/viva voce = 10 M
5) Lab. workbook = 5 M

Non-instrumental Expt.	Instrumental Expt.
Calculations based on working formula = 5 M	Plotting of data, etc. = 5 M Calculation = 5 M
Accuracy = 15 M	Accuracy = 10 M

CHP 34a, 25 M, total 4 hr with CHP 35a (Year 3)

At least 10 spectral analyses are to be set.

Modalities of Evaluation:

Expt. A (PMR)	14 M
Expt. B (IR)	8 M
Lab. workbook	3 M

CHP 34b 50 M, 4 hr (Year 3)

At the practical examination, two experiments, one each from 1 and 2, are to be assigned to a candidate. For qualitative analysis, one unknown solid organic compound containing not more than two of the functional groups included in the syllabus shall be assigned to a candidate. At least 6 different preparations are to be set in experiment 2.

Modalities of Evaluation:

Expt. 1A	3 M	Expt. 2A	12 M
Expt. 1B	3 M	Expt. 2B	5 M
Expt. 1C	6x1½= 9 M	Expt. 2C	3 M
Viva voce/Lab quiz	10 M	Lab workbook	5 M

CHP 35a, 25 M, total 4 hr with CHP 34a (Year 3)

At least 5 experiments out of 6 are to set in the practical examination.
Modalities of Evaluation:

1)	Working formula	= 2 M
2)	Presentation of data and graphs, if any	= 10 M
3)	Correct calculations and quality of results	= 5+5 M
4)	Lab. workbook	= 3 M
	Total Marks	= 25

Marks in 2) and 3) may be redistributed depending on the emphasis on graphs or numerical works, as appropriate to a particular experiment.

CHP 35b, 50 M, 4 hr (Year 3)

At least 6 experiments out of 9 are to set in the practical examination.
Modalities of Evaluation:

1)	Theory and working formula	= 5 M
2)	Presentation of data and graphs, if any	= 10+5 M
3)	Correct calculations and quality of results	= 10 +5 M
4)	Lab. workbook	= 5 M
5)	Viva-voce/lab quiz test	= 10 M
	Total Marks	= 50

Marks in 2) and 3) may be redistributed depending on the emphasis on graphs or numerical works, as appropriate to a particular experiment.

CGP 23, 50 M, 3 hr (Year 2)

In the practical examination one unknown solid organic compound containing not more than two of the functional groups mentioned shall be assigned to a candidate.
Marks distribution should be as follows:

Expt. A: Tests for special elements (positive/negative responses) –	9 M
Expt. B: Solubility tests and classification –	6 M
Expt. C: Tests for the 5 functional groups (positive/negative responses) [5 x 5] -	25 M
Lab record book –	10 M

CGP 24, 50 M, 3 hr (Year 2)

In the practical examination, one unknown sample shall be assigned to a candidate. The mixture may contain more than two radicals. But, *at least two radicals*, one acid and one basic, are to be reported. Radicals may be detected by systematic analysis or by semimicro tests, or both. Both positive and negative responses are to be recorded.
Marks distribution should be as follows:

(a) Dry tests for basic and acid radicals –	10 M
(b) Wet tests for acid and basic radicals –	15 M

(c) Confirmatory tests for radicals found – 10 M (2x5)
(d) Correct reporting of two radicals – 5 M
(e) Lab record book – 10 M
[For wrong reporting of both the radicals, ½ mark may be awarded for each correct reporting of absence of a radical.]

CGP 32, 25 M, 3 hr (Year 3)

At least 3 experiments will be set in the practical examination. One experiment will be assigned to a candidate. To avoid accurate weighing by the students, standard solutions should be supplied.
Marks distribution:

Theory/Working formula	05 M
Presentation of data	05 M
Calculations and results	10 M
Lab. Record book	05 M

Appendix -5

Recommended list of books

1. Hons. Course

A. Textbooks

J. E Huheey, E. A. Keiter, R. L. Keiter: Inorganic Chemistry (Principle and structure and reactivity).
N. N. Greenwood, A. Earnshaw: Chemistry of the Elements
D. F. Shriver, P. W. Atkins, C. H. Langford: Inorganic Chemistry
A. G. Sharpe: Inorganic Chemistry
D. S. Skoog, D. M. West, F. G. Holler, S. R. Crouch: Fundamentals of Analytical Chemistry

D. Nasipuri: Stereochemistry of organic compounds: Principles and Applications
P. Sykes: A Guide to Mechanism in Organic Chemistry
J. March: Advanced Organic Chemistry
I. L. Finar: Organic Chemistry (Vol. I)

R. T. Morrison and R. N. Boyd: Organic Chemistry
W. Kemp: Organic spectroscopy
R. O. C. Norman and J. M. Coxon: Principle of organic synthesis
S. Warren: Organic synthesis: The disconnection approach

D. A. Mcquarrie and J. D. Simon: Physical Chemistry – A Molecular Approach
I. N. Levine: Physical Chemistry
G. W. Castellan: Physical Chemistry
P. W. Atkins: Physical Chemistry

B. Reference books

I. Kaplan: Nuclear Physics
S. N. Ghosal: Atomic and Nuclear Physics
F. A. Cotton, G. Wilkinson: Advanced Inorganic Chemistry
G. Wulfsberg: Inorganic Chemistry
D. M. P. Mingos: Essential Trends in Inorganic Chemistry
C. S. C. Phillips and R.J.P. Williams: Inorganic Chemistry

J. Clayden, N. Greeves, S. Warren and P. Wothers: Organic chemistry
J. A. Joule and K. Mills: Heterocyclic Chemistry (4 th Edition)
W. Carruthers: Modern methods of organic synthesis

K. Denbigh: The Principles of Chemical Equilibrium
C. N. Banwell and E.M. McCash: Fundamentals of Molecular Spectroscopy
R. S. Berry, S. A. Rice and J. Ross: Physical Chemistry
T. Engel and P. Reid: Physical Chemistry
W. J. Moore: Physical Chemistry
K. J. Laidler: Chemical Kinetics

C. Practical Chemistry books

G. Svehla: Vogel's Qualitative Inorganic Analysis.

J. Mendham, R. C. Denny, J. D. Barnes, M. J. K. Thomas: Vogel's Text Book of Quantitative Chemical Analysis.

G. N. Mukherjee: Semi-Micro Qualitative Inorganic Analysis (CU Publications)

Vogel's Text Book of Practical Organic Chemistry (5^{th} Edition)

N. G. Mukherjee: Selected Experiments in Physical Chemistry

2. Gen. Course

A. Textbooks
P. K. Dutt: General and Inorganic Chemistry (Vol-I + Vol-II)

S. Sengupta: Organic Chemistry
S. R. Palit: Elementary Physical Chemistry

B. Practical Chemistry book
A. K. Nad, B. Mahapatra and A. Ghoshal: An Advanced Course in Practical Chemistry

Syllabus of Three Year Degree Course in **EDUCATION (**Hons)

EDUCATION-HONOURS

Part-I
Paper-I

PHILOSOPHICAL FOUNDATION OF EDUCATION AND CONTRIBUTION OF GREAT EDUCATORS

COURSE OBJECTIVES:

1. To understand the meaning, aims, functions and role of education.
2. To understand the relation between education and philosophy.
3. To be acquainted with Indian and western schools of philosophy and their impact on education.
4. To be acquainted with the contribution of great educators.

GROUP-A

Philosophical foundation of education

MODULE-I

		Approximate lecture Hours
1.	Concept and aims of modern education with special reference to Delor' s commission (UNESCO, 1997)	(4)
2.	Child centric and Life centric education.	(4)
3.	Functions and scope of education-Individual and social perspective. Education for Human Resource development.	(9)
4.		(3)

MODULE-II

5.	Role of Philosophy in Education.	(2)
6.	Schools of philosophy and their influence on education: Idealism, Naturalism, and Pragmatism.	(9)
7.	Schools of Indian Philosophy *** Basic features and Influence on Education- a) Vedic schools (Sankhya, yoga, Nyaya) b) Non-Vedic schools (Charvak, Buddhist, Jain)	(9) Total Lect. 40

*No broad question from this portion.

GROUP-B

CONTRIBUTION OF GREAT EDUCATORS:

MODULE-I

	Approximate Lecture Hours
1. Rousseau.	(6)
2. Froebel	(5)
3. Montessori	(5)
4. Bertard Russell.	(4)

MODULE-II

5. Dewey.	(7)
6. Rabindranath Tagore	(7)
7. Vivekananda	(6)
	Total Lect. 40

References:

1. Aggarwal.J.C. -Theory and Principles of education Philosophical and Sociological Bases of education.
2. Banerjee, A -Philosophy and principles of education.
3. Chakraborty, J.C. -Modern education.
4. Kundu and Majumder -Theories of education.
5. Mukherjee, K.K. -Some great educators of the world.
6. Mukherjee, K.K. -Principles of education.
7. Munro. -History of education.
8. Purkait, B.R. -Great Educators.

Bengali Books:

2) A r u n - S G h h i o k s s h h - S h i k s h
3) ibhuBanjan uha G -Shikshaya Pathikrita.
4) Gouridas Halder & Prasanta Sharma -Shiksha Tatta & Shiksha Niti.

PAPER-II

PSYCHOLOGICAL FOUNDATION OF EDUCATION

COURSE OBJECTIVES:

1. To understand the meaning of Psychology, and be acquainted with its different perspectives.
2. To realize the relationship between Psychology and education.
3. To know the patterns of different aspects of human developments and relate this knowledge with Education.
4. To be acquainted with the cognitive approach to development and thus to understand the processes and factors of cognition.

GROUP-A

DEVELOPMENTAL ASPECTS OF PSYCHOLOGY

MODULE-I

A pproximate Lecture Hours

1. Introduction to Psychology, relation between education and Psychology. Different perspectives of psychology (Biological, Cognitive, Developmental, Associationist – A brief overview). (12)
2. Personality development. Psychoanalytical theory of Personality, Erikson's Stages of Psycho-social development. (8)

MODULE-II

3. Stages and types of Development and their Educational significance:

   a) Physical and motor development, Factors affecting Physical and motor development.
   b) Cognitive development, brief outline of Piaget's theory of Cognitive development.
   c) Emotional development, Common patterns, Emotional balance and Emotional Quotient.
   d) Moral development, Theories of Piaget and Kohlberg. (20)

Total 40

GROUP-B

Cognitive approach

MODULE –I

Approximate Lecture Hours

1) Neural basis of cognition: Neuron – structure and electrical Potentials, synoptic transmission, structure and functions of human brain, Neuro –endocrinal system. (6)
2) Perception: Factors influencing perception, role in cognition. (3)
3) Attention: Selective and divided attention. Role of attention in the Cognitive process. Factors of attention. (4)
4) Memory: acquisition, storage and retrieval of information. Sensory memory, short term and long term memory, forgetting. (7)

MODULE–II

5) Motivation: types and factors. (2)
6) Learning: Laws of learning, classical and operant conditioning. Insight learning, concept learning, Bandura's social learning theory. Transfer of learning: Concept and application. (10)
7) Intelligence : Theories of intelligence –Spearman, Thurston, Guilford and Gardener. (8)

Total Lect. 40

References:

1) Spear, P.D., Penrod, S.D., and Baker, T.B. (1988), Psychology: Perspectives on Behaviour, New York: John Wiley.
2) Berk, L.A. (2003). Child development, Delhi: Pearson Education.
3) Baron, R.A. (2001). Psychology, Delhi: Prentice Hale.
4) Bichler, R.F., and Snowman, J. (1993). Psychology applied to teaching. Boston: Houghton Mifflin.
5) Normann Sprinthall and Richard, C. Sprinthall, Educational psychology: McGraw-Hill Publishing Company.
6) Chauhan. S.S., Advanced Educational psychology: Vikash Publishing House Pvt. Ltd.
7) Diane. E., Papalia and Sally wendkos olds. Human Development: McGraw-Hill.
8) Elizabeth, B., Hurlock, Child Development: McGraw-Hill Book Company.
9) Kundu, C.H. and Tutoo, D.N., Educational Psychology: Sterling Publication.
10) Aggarawal. J.C., Essentials of Educational Psychology: Vikash Publishing house Pvt. Ltd.
11) Clifford.C.Morgan. Richard. A. King, John R. Weisz, John R. Schopler, Introduction of Psychology.
12) Glietman, Alan, J., Fridland, Daniel Reisberg, Basic Psychology.

Bengali Books:
1) Sushil Ray -Shiksha Manobigyan.
2) Arun Ghosh -Shiksha-Shrai Monobigyan.
3) Pramodbandhu Sengupta & Prasanta Sharma -Shiksha Manobigyan.

EDCATION –HONOURS

Part –II

PAPER –III

DEVELOPMENT OF EDUCATION IN INDIA

COURE OBJECTIVES:

1. To be acquainted with the salient features of education in India in Ancient & Medieval times.
2. To be acquainted with the development of education in British India.
3. To be acquainted with the development of education in Independent India, including significant points of selected Education.
4. To be acquainted with current issues and trends in Education.

GROUP –A

Education in Ancient, Medieval and British India.

MODULE – I

Approximate Lect. Hours.

1. Synoptic study of Brahmanic, Buddhist and Islamic Education in Ancient and Medieval India with respect to
   - a) Aims and Objectives (2)
   - b) Subject of study (2)
   - c) Methods of teaching including teacher – Pupil relationship. (2)
   - d) Evaluation (1)
   - e) Centre of Learning. (2)
   - f) Education of woman (1)

2. Brief outline of events relating education from 1757 to 1947
   - Missionaries activities (Srirampur Trio) (3)
   - Charter Act of 1813 (1)
   - Bengal Renaissance – Contribution of Rammohan Ray H.L.V. Derozio. And Vidyasagar. (6)
   - Adams Report. (2)
   - Anglicist –Orientalist controversy – Macaulay's Minute & Bentinck's resolution. (4)
   - Wood dispatch (Recommendations only) (2)

MODULE –II

Brief outline of

- Hunter Commission 1882-83 (Primary and Secondary Education) (3)
- Curzon Policy (Quantitative development of Primary education, Quantitative and Qualitative development of Secondary education,

Qualitative development of Higher education). (4)

- National Education Movement (cause and effect) (2)
- Calcutta University Commission (1917-1919) (2)
- Basic Education(concept & development) (2)
- Sargent Plan (1)

Total Lect. 42

GROUP –B

Development of Education after 1947.

MODULE-I

1. Constitutional provision for Education in India (4)
2. Brief outline of the recommendations made by different Education Commission:
   - University Education Commission (1948-49) (4)
     (Aims of Higher education & Rural University)
   - Secondary Education Commission (1952-53) (5)
     (Aims, Structure & Curriculum of Secondary education)
   - Indian Education Commission (1964-66) (7)

MODULE-II

3. National Policy on Education (1986). (7)
4. Current issues in education:
   - Equalization of Education Opportunities. (5)
   - Programmes on Universal Elementary Education (DPEP &SSA) (4)
   - Non-formal education and alternative schooling, Education of women (5)

Total Lect. 41

References:

1. Atlekar, A.S. -Education in Ancient India.
2. Basu, A.N. -Education in modern India.
3. Basu, A.N. -Adam's Report.
4. Banerjee.J.P. -Education in India-past, Present and future.
5. Dhar, Niranjan. -Fundamentals of Social Education.
5. Keay, E.E. -India Education in Ancient times.
6. Law, N.N. -Promotion of Learning in India.
7. Mukherjee, S.N. -Education in India, Today & Tomorrow.
8. Mukherjee, S.N. -History of Education (Modern Period).
9. Nurulla, S., Naik, J.P. -History of Education in India.
10. Purkait, B.R. -History of Indian Education.

11. Rawat, P.L. -History of Indian Education.
12. Sreemali, K.L. -The Wardha Scheme.
13. Indian Education act. -1904
14. Govt. of India report of University Education Commission (1948-49).
15. Govt. of India report of Secondary Education Commission (1952-530.
16. Report of education Commission (1966) education and National development, Ministry of Education, New Delhi.
17. Govt. of India, Ministry of Human Resource – Development, National Policy on Education, 1986. New Delhi.
18. Govt. of India, Ministry of Human Resources Development, National Policy on Education, 1986, Programme of Action, New Delhi.
19. Govt. of India, Ministry of Human Resource Development, Policy of Action, 1992, New Delhi.
20. Dayal` Bhagwan – Development of Modern Indian education.
21. Education of Women key to progress, Ministry of education, New Delhi.
22. Kundu, C.L. -Adult Education.
23. Shah. A. & Ban, S. -National Education.
24. Singh, R.K. -Open University.
25. Srinivastava, K.N. -Education in Free India.

Bengali Books:

1) Jotiprasad Bandyapadhay – Bharatiya Shikhan & Sampratik Samashya.
2) Sanyal, Mitra - Bharate Shikhar Itihas.
3) Gourdas Halder & Prasanta Sharma
- Adhunik Bharatiya Shikhar Bikash.
4) Jotiprasad Bandyapadhay – Shikhar Itihas.
5) Ranjit Ghosh - Shkha rItihas.

PAPER –IV

SOCIOLOGICAL FOUNDATION OF EDUCATION

AND

EDUCATIONAL ORGANIZATION & MANAGEMENT.

COURSE OBJECTIVES:

1. To understand the meaning of sociology and Education and realize its pertinence to education.
2. To become aware of the different social factors that influence education.
3. To become aware of social groups that influence education.
4. To become aware of the processes of social change and their impact on education.
5. To be acquainted with current social issues and their relationship with education.
6. To understand the concept of school organization.
7. To be acquainted with modern aspects of school organization.
8. To understand the difference between educational Management & Administration at different levels of education.

9. To understand the meaning, types and need for educational management.
10. To understand the meaning, types, need and strategies of educational planning.
11.

GROUP-A

Sociological Foundation of Education

MODULE-I

Lecture hours

1. Sociological Foundation of Education-Sociology of education, Nature, Scope, Method of Study. (5)
2. Society and Education-
   (a)Society: its origin and factors and their influences on education (population, Location, religion, class, culture, technology, Economy).
   (b)Impact of different political systems on education (capitalism and socialism). (10)
3. Social groups and education- (6)
   (a)Social groups (primary, Secondary and tertiary)
   (b)Socialization: the role of the family and school.

MODULE-II

4. Social change and Education-
   (a)Social change: Its definition and role of education (2)
   (b)Social change in India (Sankritization, Westernization, Modernization and Globalization). (8)
5. Education and Social Communications- (3)
   Informal agencies of Social Communication.
6. Edcation and Contemporary Social Issues: (6)
   (a) Unemployment.
   (b) Poverty
   (c) National Disintegration
   (d) Population explosion.

Total lecture 40

GROUP – B

Educational organization & Management Lecture Hours

MODULE- I

1. Principlesoe Educational organization: Concept of School organization it's principle. (3)

2. Aspects of school Organization –

(a) School Plant, building, Equipment, Sanitation. ,Play ground, Workshop, library, Computer Room. (6)

(b) Midday meal, School medical service, co- curricular activities. (3)

(c) Inclusive education. (1)

3. Educational Management and Administration (8)

Difference between the two administrations at different levels (Primary, Secondary and Tertiary)

Board of Secondary Education, Council of H.S Education, Council of Higher education.

MODULE- II

4. Concept of educational management- (7)

Meaning, nature, need and scope, Role of Educational manager.

5. Types of Educational Management- (4)

Autocratic, Democratic, Lassie- Fair supervision.

6. Educational Planning- (8)

Meaning, need and significance of educational planning.

Types and strategies of educational planning. Steps in Educational planning

Institutional Planning.

Total lect.40

Reference:

1. Sharma, Y. - Sociology of Education
2. Brown, F.L. -Educational Sociology
3. Gisbert, P. -Fundamentals of sociology.
4. Chakraborty, J.C. -Educational Sociology.
5. Durkhiem -Sociology of Education
6. Bottroll - Applied principles of Educational Sociolo
7. Rao, M.s.A - Education, Social stratification
8. Dighburn, W.F - Social exchange.
9. Gaind -Educational organizational.
10. Chandana - School Organization
11. Kochar, S.K - Secondary School Organization
12. Aggarwal - School Organization

Bengal Books:

1) Bishnupada Panda- Shiksah-Shrai samajtantra
2) Ranjit Ghosh - Vidyalaya Paribesh & Padhyati
3) Arun Ghosh -Vidyalaya Sanghathan.

EDUCATION –HONOURS
Part –III

PAPER- V

PSYCHOLOGY OF ADJUSTMENT AND EDUCATIONAL GUIDENCE & COUNCELLING

COURSE OBJECTIVES

1. To understand the concept of adjustment and maladjustment.
2. To identify some commonly found problem behaviors along with the etiology and remedial measures.
3. To be aware of the role of parents and educational institution in promoting mental health.
4. To be aware about different coping strategies for successful stress – management.
5. To understand the concept of guidance and counseling.
6. To become aware about tools and techniques for conducting guidance and counseling services.

GROUP – A

Psychology of adjustment

MODULE – I

Lecture hours

1. Concept of adjustment- adjustment and adaptability, homeostasis, Psychodynamic concept of adjustment, socio-cultural concept: Criteria of good adjustment. (5)
2. Maladjustment- meaning of maladjustment-Conflict and frustration, Manifestation of maladjustment in Childhood and adolescence – a synoptic view of problem behaviours. (9)
3. (6)

MODULE - II

4. (9)
5. Multi axial classification of mental disorders- DSM IV Axis I and Axis II category – Brief outline of schizophrenia, anxiety disorder, depressive disorder, substance abuse, Personality disorder. (11)

Total ecture‡ 0 4

GROUP-B

Educational guidance and counseling.

Lecture hours

MODULE- I

1. Concept of guidance- meaning and nature of guidance-different forms of Guidance (group and individuals) Types of Guidance (educational, vocational) (8)
2. Counseling- meaning- types and techniques- directive, non directive, eclectic –individual and group counseling. (8)
3. Identification and guidance for special learners- gifted, slow learners, learner with learning disabilities, MR/ mentally challenged. (6)

MODULE-II

4. Basic data necessary for Guidance – pupil courses, vocation- tools and Techniques of collecting Information on pupils (Intelligence test, Personality test, Interest inventory, Aptitude test, CRC, Case study, ARC. Courses and occupations- Dissemination of information on courses and occupation prospectus, career (20)

Conference, pamphlets, newspaper, periodicals)

Total lect.42

References:

1. Guidance and counseling in college and university - S K.Kochar.
2. Guidance and counseling- Gibson – -Pearson publisher.
3. Sangathi Bidhane Nirdeshona & paramarshadan- - Dr. Subir Nag, Gargi Dutta.
4. Carson R C & Butcher, J.N - - Abnormal psychology and modern life.
5. Kisker G .W. - -The disorganized personality.
6. Coleman,J.c- -Psychology and Effective Behaviour.
7. Sarasan and Sarasan – -The problem of maladaptive Behaviour
8. Mohanty, G - -Abnormal Psychology.
9. Chauhan, S.S – - Principle and technique of Guidance.

PAPER –VI

EVALUATION IN EDUCATION

Course Objectives:

1) To develop understanding of the concepts of measurement and evaluation in education
2) To be acquaint with different types of measuring instruments and their uses.
3) To acquaint with the principles of test construction. To develop understanding of the concepts of validity and reliability and their importance in educational measurement.
4) To develop the ability to organize relevant educational data. To develop the ability to use various statistical measure in analysis and interpretation of educational data. To develop the ability to interpret test data.
5) To develop the ability to represent educational data through graphs. To develop skill in analyzing descriptive measures.

GROUP – A

MODULE-1

Lecture Hours

1. Educational Measurement and Evaluation-
   Concept, Scope and Needs. (5)

2. Tools and Techniques of Evaluation
   a) Test: Types, use of Norm- Referenced test and Criterion-
      Referenced test, essay type and objective type tests.
   b) Observation- Concept and Use
   c) Inquiry - concept and use
   d) Cumulative Record Card – concept and Use (15)

MODULE - II

3. Scales of Measurement- Nominal, Ordinal, Interval, Ratio. (3)
4. Criteria of Standardized test
   a) Validity b) reliability C) objectivity d) Usability e) Norms (11)
5. Construction of a Standardized Achievement Test (6)

Total Lecture hours 40

GROUP B -

Statistics and Measurement

MODULE-I

Lecture hours

1. Statistics- Use in Education (1)
2. Organization and Graphical Representation of data – Pie Chart, Bar diagram, Histogram, Frequency polygon, Ogive. (9)
3. Measures of Central tendency – Mean, Median, Mode- Calculation and application (6)
4. Measures of Variability – Range, Quartile Deviation, Standard Deviation – Calculation and application (7)

Module-II

5. Percentile and percentile rank- Calculation and application, including graphical representation (6)
6. Characteristics of Normal curve. (2)
7. Skewness and Kurtosis – Concept. (2)
8. Concept of Z – Score _ Calculation and use. (6)

9. Linear Correlation – Concept and Use – Co- efficient of Linear Correlation: Product – moment method and Rank difference Method – calculation (8)

Total lect. 47

Reference:

1. Anastasi, A. Psychological testing.
2. Freeman, F.S. Theory and practice of Psychological testing.
3. Thorndike, R.L., Hegen, S. Measurement & Evaluation in psychology and Education.
4. Singh, A.K. Tests, Measurement and research Methods in Behavioural Science.
5. Garret, E. Statistics in psychology and Education.
6. Mongal, S.K. Statistics in psychology and Education.
7. Giulford, J.P. & Fruchter, G. Fundamental Statistics in Psychology & education.
8. Medhi. Statistical Methods and Introductory test.

Bengali Books: 1) Sishil Ray -Mullayan: Niti & Kaushal.

PAPER –VII

EDUCATIONAL TECHNOLOGY AND CURRICULUM

COURSE OBJECTIVES:

1. To enable the student to understand the concept of educational technology.
2. To expose the students to the basic developments in educational technology.
3. To Acquaints students with different instructional techniques.
4. To develop the ability to analyze classroom teaching – learning and the ability to observe classroom behaviour and group dynamics.
5. To understand the meaning and scope of curriculum.
6. To understand the basis of curriculum construction, evaluation and innovation.

GROUP –B

MODULE - I

Educational Technology

Approximate ect. 6urs.H

1. Concepts need and scope of educational technology. (2)
2. Systems approach to education: Definition of systems, need for systems approach, classification of systems & components of a System. (6)
3. Computer and its role in education. (2)
4. Use of media in education: Audio (Radio & Tape), Visual (Projector). Audio-visual (T.V. & CCTV). (4)
5. Models of teaching: Nature, Concepts and different families of Teaching Models, advantages of the use of Models of Teaching. (6)

MODULE -II

6. Communication and educational technology: Components of Communication process, role of communication in effective teaching-learning process, Factors affecting classroom communication. (7)
7. Instructional techniques: Mass instructional techniques (basic concepts only), Personalized techniques – Programmed learning, Mastery Learning, Microteaching (basic concepts). (7)
8. Distance education: Concepts, types and usefulness –Application of technology in Distance education. (6)

Total lect.40

GROUP-B

Curriculum Studies.

MODULE -I

Approximate lect.Hours.

1. Concept of curriculum: Explicit Curriculum, Hidden Curriculum. (3)
   Nature of Curriculum (2)
   Bases of Curriculum: Philosophical Sociological & Psychological. (3)
2. Systems Approach to Curriculum. (2)
3. Objectives of curriculum: Need to form objectives of curriculum. Sources of objectives of the curriculum: society, discipline, needs of students. (5)
4. Bloom's Taxonomy of educational objectives: an overview (Cognitive & Affective domains) with examples. (5)

MODULE –II

5. Determinants of content selection: culture based, Knowledge based, Need based. (6)
6. Curriculum transaction: Bruner's Theory of Instruction and learning. (6)
7. Curriculum evaluation: meaning and utility, Sources and means of curriculum evaluation. Formative and Summative evaluation. (8)

Total lect. 40

References:

1.kumari, Sarita & Srivastava, D.S., "Curriculum and Instruction", Isha books, Delhi, 2005.
2.Olivia, P.F. Devoloping the curriculum, Harper Collins, 1992.
3.Sen, M.K., Shiksha Prajuktibibnan, soma Books Agency, 2006.
4.Taylor, P.H., & Richards. C.M., An introduction to curriculum studies.
5.Kelly, A.K. The curriculum, Theoryand Practice.
6.Hooper, Richard, "Curriculum Design".
7.Lawton, D.,Gordon P., ing. M., Gibby, B., Pring, r., t. "Theory and Practice of Curriculum Studies".
8.Sampath. Pannerselvan, Santhanam-Introduction to educational technology.
9.Rao, Usha -Educational technology.
10. Anand Rao, B. ravishankar, S. –Reading in educational technology.
11. mohanty, J. -Educational technology.
12. Bharma, R.D. -An Introductional Technology.
13. Vashist, S.R.(ed) Perspectives in Curriculum Development Vol.1-5
14. Khan, M.I.& Nigam, B.K. Evaluation and research in curriculum construction.
15. Lawton, D., Gordon, P., Ihg, M., Gibby, B., Pring, R. Moore, T. -Theory and practice of curriculum studies.
16. Kelly, A.V. –The curriculum, Theory and Practice.
17. taylor, P.H. & Richards, C.M. –An introduction to curriculum studies.

PAPER-VIII

COMPARATIVE EDUCATION AND PRACTICAL

COURSE OBJECTIVES:

1.To analyze and compare Indian educational system with abroad.
2.To be acquainted with the process of collecting data.
3.To apply relevant statistical techniques to display and analyze data.
4.To acquire the skills of observation and inference in relation to some selected constructs in educational psychology.

GROUP-A

Comparative Education.

Module – I

Approximate Lect. Hours.

Any one country from UK. USA. Chiana.

1. Concept, meaning, scope of Comparative Education. (8)
2) Various issues of the Indian educational system with special reference to school education in comparison with one of the above mentioned countries:
a) Structure of education (6)
b) Administration (6)

Module – II

Various issues of the Indian educational system with special reference to school education in comparison with one of the above mentioned countries.
a) Curriculum (5)
b) Examination (5)
c) Teacher education (4)
d) Education for all (4)
e) Distance education and open learning (3)

Total lect: 41

GROUP-B

Practical

A. Statistics Practical — Lecture hours
B. Pedagogy practical.

A. statistics: The students are expected to collect relevant data from their colleges or neighborhood (minimum sample size must be 50) for the following:
1. Determination of central tendencies and standard deviation. (4)
2. Graphical representation of data: Bar chart, frequency polygon, Cumulative Frequency curve and location of median and quartile therein. (6)
3. determination of types of association between two sets of data by drawing scatter diagram (linear relations only). (3)

B. Pedagogy.
1. Determination of memory span (4)
2. Index of complete learning / capacity of memorization (4)
3. Comparison of recall and recognition as modes of measuring retention (4)

Total lect.25

Syllabus of Three Year Degree Course in **EDUCATION (**General)

Part I FULL MARKS-100

Paper 1 Full marks -100
Principles of Education

Module I

1. Concept, scope and functions of education:
   Education as a social process. Education and Social Changes.
2. Aims of education: Individualistic and socialistic aims of education. Education for emotional, social and cultural adjustment. education for productivity and vocation.
3. Freedom and Discipline:Concept and need for free discipline. Self discipline and student self government.

Module II

4. Factors of education:
   a)
   b) The Teacher - qualities and responsibilities.

c)

d) The educational institutions – Formal, informal, non formal. Their interrelations.

Module III

5. Agencies of education:
   a) Home,
   b) School,
   c) Socio-cultural and Religious organizations,
   d) State,
   e) Mass- media

Module IV

6. Child - centricism in education: Its significance.
7. Play and play- way in education: Kindergarten, Montessori, Basic education and Project.

References

1. J.C. Chakraborty- Modern Education: Its Aims and principles
2. Archana Banerjee- Principles of education
3. J.C. Agarwal- Theory and Prinvciples of education
4. J.C. Agarwal- Philosophy and social basis of education.
5. B.R. Purkait- Principles and practices of education

PART II

Paper II

Educational Psychology Full Marks 100

Module I

1. Relation between Psychology and education. Nature and scope of Educational Psychology.
2. Development of the Child: Infancy, Childhood, Adolescence-Physical, Social, Emotional and Cognitive development.

Module II

3. Personality: Concept, traits and theories
4. Emotion: Meaning and characteristics, places of emotion in education.
5.

Module III

6. Intelligence: Concept and measurement. Classification of intelligence tests. Examples of each type of test. Uses of intelligence tests.
7. Attention and Interest: Nature and conditions of attention, their educational implications.

Module IV

8. Learning: Its nature, relation to motivation and maturation. Theories of learning: trial and error including laws of learning, conditioned response (Classical and Operant) and Gestalt theory.
9. Remembering and forgetting: Process involved in memory. Marks of good memory. Forgetting - its meaning and causes.

References:

1.C.F. Skinner- Educational Psychology
2. J.P. Guilford- General Psychology
3.H.R. Bhatia- Textbook of educational psychology
4. S.S. Chauhan- Advance educational psychology
5. S. Mangal- Educational psychology.

Paper III

Development of Education in Modern India Full Marks 100

Module I

1. A synoptic view of ancient and medieval history of education in India
2. Advent of missionaries: Serampore Missionaries activities in education
3. Official introduction of English education by Lord Bentinck.
4. Adam's Report on indigenous system of education.
5. The Despatch of 1854.

Module II

6. Contributions of Raja Rammohan and Vidyasagar in social and educational reforms
7. The First Education Commission (W. Hunter.) 1882
8. Growth of national consciousness: Conflict with Lord Curzon (1902 to 1905)
9. National Education Movement- Contributions of Vivekananda, Rabindranath and Aurobindo.

Module III

10. A synoptic view of the suggestions for educational reforms by the Sadler Commission, Wood-Abbot, Wardha Scheme.
11. The Sargent Plan 1944
12. The Radhakrishnan Commission 1948-1949

13. A synoptic study of changes in school system, primary and secondary (structure and curriculum only) after independence-Mudaliar Commission's (1952-1953) report and Kothari Commission's report (1964-1966)

Module IV

14. Education of Women since independence
15. Educational policy 1968- A brief overview
16. Educational policy 1986- A brief overview.

References:

1. J.P. Banerjee- Education in India: Past Present and Future
2. B.R. Purkait- Milestones of modern Indian education
3. S.P. Chauhan- History of Indian education
4. S.Nurulla and J.P. Naik- History of education in India.

PART- III

PAPER IV Full Marks 100

Evaluation and Guidance in education

Module I

1. Concept of evaluation
2. Need and scope of evaluation in education : Evaluation of student achievement, evaluation of curriculum, evaluation of teaching, evaluation of institute
3. Evaluation of student progress: Examination and evaluation. Tools of evaluation: Examination-essay type and objective type, criterion-referenced test and standardized test, Cumulative Record Card(CRC).

Module II

4. How to make a good test: Specification of objectives, item selection.
5. Measurement in education: Tabulation of educational data, measures of central tendency, measures of variability, (S.D only), Graphical representation
(frequency polygon, histogram and ogive). Idea of linear correlation.

Module III

6. Guidance: Concept, need and scope and types
7. Basic data necessary for guidance (data about students, courses and vocations)
8. Counseling: Meaning and types of counseling for adjustment problem

Module IV

9. Meaning of adjustment.
10. Causes of maladjustment: role of parents, teachers, peers and educational institutions in the development of maladjustment.

References:

1. A. Anastasi- Psychological Testing
2. F.S. Freeman – Theory and practice of psychological testing
3. E.L. Thorndike and Hagen- Measurment and evaluation in education
4. J.N. Fuster-Psychological Counseling in India
5. H.W. Bernard and D. W. Fulner- Principles of guidance- a basic text.
6. P. Milner- Counselling in education.

Proposed Question Patterns

A For honours in Education.

Each half of each paper consists of two modules of 25 marks each.
The question pattern for each module is as follows

1. One question of 15 marks to be answered from **two** alternatives = 15 marks
2. Two questions of 5 marks to be answered from **three** alternative = 10

Total -25

B. For General Course in Education

Each paper consists of four modules of 25 marks . The question pattern for each module is as follows

1. One question of 10 marks to be answered from **two** alternatives= 10 marks
2. Three questions of 5 marks to be answered from **five** alternatives =15 marks

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Total- 25

Sl. No.	Subject	Ethical Issues	Environmental Sustainability	Gender Issues
1	BOTANY	**Research methodology (BOT-A-DSE-B-6-7-TH)** Unit 1; Unit3; Unit 7	**Natural resource management (BOT-A-DSE-B-6-8-TH)** Full Paper	
		Plant biotechnology (BOT-A-DSE-B-5-5-TH) Unit 6	**Industrial and environmental microbiology (BOT-A-DSE-A-5-2-TH)** Unit 5-7	
2	CHEMISTRY		**DSE-A-3: green chemistry and chemistry of natural products** Full Paper	
3	ENVIRONMENTAL SCIENCE		**CC3: Water and Water Resources Management** Full Paper	
			CC4: Land management and soil conservation Full Paper	
			CC5: Ecology and Ecosystems Full Paper	
			CC6: Environmental Biotechnology Full Paper	
			Cc 7: atmosphere and global climate change Full Paper	
			CC9: Urban Ecosystems Full Paper	
			CC 10: Environmental Legislation & Policy Full Paper	

Rajyasri Mistry

Principal
Vijaygarh Jyotish Ray College
Kolkata-700 032

			CC 11: Biodiversity & Conservation Biology Full Paper	
			CC 13: Environmental Pollution and Human Health Full Paper	
			CC 14: Natural Resources Management & Sustainability Full Paper	
			SEC A2: Wildlife Management Full Paper	
			DSE A1: Energy & Environment Full Paper	
			DSE A2: Environmental Economics and Statistics Full Paper	
			DSE B2: Solid Waste Management Full Paper	
			DSE A3: Green Technologies Full Paper	
			DSE B3: Environmental Health and Toxicology Full Paper	
4	**MICROBIOLOGY (UG)**	**CC-10: Recombinant DNA Technology (MCB-A-CC-4-10-TH)** Unit 6	**CC-9: Environmental Microbiology (MCB-A-CC-4-9-TH)** Full Paper	
		DSE-A1: Microbial Biotechnology (MCB-A-DSE-A-5-1-TH) Unit 6, Unit 7	**DSE-A1: Microbial Biotechnology (MCB-A-DSE-A-5-1-TH)** Unit 1-3, Unit 5	

		SEC-A1: Microbial Quality Control in Food and Pharmaceutical Industries (MCB-A-SEC-A-3-1) Unit 1	**DSE-B2: Microbes In Sustainable Agriculture And Development (MCB-A-DSE-B-6-2-TH)** Full Paper	
			SEC-A2: Biofertilizers And Biopesticides (MCB-A-SEC-A-3-2) Full Paper	
5	**MICROBIOLOGY (PG)**	**Micro C43: Medical Biotechnology and Gene Therapy** Gene therapy and stem cell part	**Micro C23: Diversity of life forms and environmental applications** Full Paper	
6	**PHYSICS (UG)**		**SEC-B 4.4: Renewable Energy and Energy Harvesting (PHS-A-SEC-B-TH)** Full Paper	
7	**PHYSIOLOGY (UG)**	**DSE A 4 TH: Community and Public Health** Full Paper	**CC14TH: Excretory System, Environmental Pollutants and Human Health** Unit 3	
8	**ZOOLOGY (UG)**	**DSE1: Animal Cell Biotechnology (ZOOA-DSE(A)-6-1-TH)** Full Paper	**CC11: Ecology (ZOOA-CC5-11-TH)** Unit 2; Unit 5	
		DSE2: Animal Biotechnology (ZOOA-DSE(A)-6-2-TH) Unit 2-4		
9.	**ECONOMICS (UG)**	**Skill Enhancement Course I: ECO-A-SEC-3-A(1)-TH Data Analysis [DA]** **Unit- 1-2**	**Discipline Specific Elective- B(2) : ECO-A-DSE-6-B(2)-TH-TU Environmental Economics [EE]** **Full Paper**	**Discipline Specific Elective –B(2): ECO-A-DSE-6-B(2)-TH-TU Issues in Development Economics [IDE]** **Unit-1**
			Discipline Specific Elective –B(2): ECO-A-DSE-6-B(2)-TH-TU Issues in Development Economics [IDE] **Unit- 4**	**Economics Core Course XIV: ECO-A-CC-6-14-TH-TU Development Economics** **Unit-2: Gender Inequality**

			Discipline Specific Elective Course [Economics] (DSE -A) BA/BSc (General) Name of the Course: Sustainable Development (SD) Full Paper	Economics Core Course XII: ECO-A-CC-5-12-TH-TU Indian Economy Unit-2
10.	EDUCATION	CC-14, Basic Concept of Educational Research Unit- 1		CC – 7 (Semester 3) Guidance and Counselling Unit-2
				CC – 10 (Semester 4) Inclusive Education Unit- 3
				CC – 13 (Semester 6) Psychology of Adjustment Unit-1
				SEC – A (Semester – 3) Skill for Democratic Citizenship Full Paper
				DSE – A (Semester – 6) Gender and Society Full Paper
				DSE – A (Semester – 6) Population Education Unit- 3
				DSE – B (Semester – 6) Human Rights Education Full Paper
				DSE – B (Semester – 6) Women Education Full Paper
11.	PHILOSOPHY			PHI-G-SEC-B E. Eco-feminism
				b) Philosophy of Human Rights
				C. Feminist Philosophy

				b)Man and Environment
				PHI-A-CC-12-Ethics (Indian) Concept of Ṛṇa and Ṛta
				PHI-A-CC-3 Outlines of Indian Philosophy – II
	POLITICAL SCIENCE			Understanding Political Theory: Approaches and Debates Approaches III: Postcolonial; Feminist.
				Politics in India: Structures and Processes Module IV: women's movements
				Political Sociology Module II: Gender and politics: basic issues.
				Gender and Politics Full Paper
				Development Process and Social Movements in Contemporary India Module II: Women's movements
				Human Rights in a Comparative Perspective Module I: Human Rights: Theory and Institutionalization Module II Structural Violence: Gender and Violence: India and Pakistan
				Democratic Awareness through Legal Literacy Full Paper
				DSE: Feminism: Theory and Practice
				Introduction to Political Theory Module I 1. Political Science: nature and scope; Different approaches---Normative, Behavioural, Post-

				Behavioural, Marxist, Feminist.
				Government and Politics in India **Module I: d) women's movements**
				International Relations **Module I: (d) Feminist Perspective (J. Ann Tickner)**
				Feminism: Theory and Practice **Full Paper**
				Legal Literacy **Full Paper**

Rajyasri Mistry

Principal
Vijaygarh Jyotish Ray College
Kolkata-700 032

UNIVERSITY OF CALCUTTA

Notification No. CSR/ 74 /18

It is notified for information of all concerned that the Syndicate in its meeting held on 13.07.2018 (vide Item No.11) approved the Syllabus of Two-Year (Four-Semester) M.Sc. Course of Study in Microbiology under CBCS in the Post-Graduate Departments of the University and in the affiliated Colleges offering Post-Graduate Courses under this University, as laid down in the accompanying pamphlet.

The above shall be effective from the academic session 2018-2019.

SENATE HOUSE
KOLKATA-700073
The 17th August, 2018

17/08/18
(Debabrata Manna)
Deputy Registrar (Acting)

Syllabus for
M. Sc. Course in Microbiology
(from the academic session 2018-2019)

University of Calcutta

The regulations and academic syllabus for the Two-year M.Sc. course in Microbiology, University of Calcutta offering Choice Based Credit Courses (CBCC)

ADMISSION CRITERIA

1. A candidate who has passed the 3-year B.Sc. Examination **with a minimum of 55% aggregate marks in Honours in Microbiology** will be eligible for admission to this course. Reservation of seats will be governed by the rules of Govt. of West Bengal**.** At present, applicants from University of Calcutta will get admission to the 60% of seats (Part-A) in the order of their aggregate marks in B. Sc. Hons. Examination.
2. Seats available to the non-C.U. candidates will be guided by the directives of University applicable during the time of notification of admission process. These students, however, will have to satisfy the same eligibility criteria applicable to the students of University of Calcutta. Currently, forty percent of the seats (Part-B) will be filled up from a merit list prepared from the performance in a multiple choice question based admission test. This admission test is open to both C.U. and non-C.U. candidates.
3. The courses shall comprise a total of 1000 marks and 80 (eighty) credits evenly distributed over four semesters. The courses grouped as Core, Supportive and Choice based, will carry credits according to the number of theoretical classes required, study hours and laboratory hours. The duration of the semesters shall be as follows:

1st Semester	**July - December**
2nd Semester	**January - June**
3rd Semester	**July – December**
4th Semester	**January – June**

Examinations would be held after the completion of curriculum at the end of each semester. However, evaluation of the practical will be based on continuous assessment as well as on the final Viva-Voce examination of the students on the experiments.

Semester-wise distribution of courses:

Courses	**No. of courses**	**Marks**	**Credits**
1st Semester			
Core courses	5	190	17
Supportive courses	1	60	3
2nd Semester			
Core Courses	5	220	18
Supportive Courses	1	30	2
3rd Semester			
Core Courses	3	125	10
Summer Project Seminar	1	25	2
Choice based Courses	2	100	8
4th Semester			
Core Courses	4	140	12
Supportive Courses	1	50	3
Dissertation		30	3
Grand Viva		30	2
Total		1000	80

Orientation of courses in different semesters for M.Sc. in Microbiology

1st Semester

CORE COURSES	**Theoretical**	**Practical**	**17 credits**
Micro C11: Biomolecular Structures & Their Interactions	30	-	3 + 0
Micro C12: Microbial Cell Biology	30	20	3 + 1
Micro C13: Molecular Biology	30	-	3 + 0
Micro C14: Biophysical Methods & Instrumentation	30	20	3 + 1
Micro C15: Microbial Metabolism	30	-	3 + 0
SUPPORTIVE COURSES			**3 credits**
Micro S11: Enzymes and Reaction Kinetics	30	30	2 + 1

2nd Semester

CORE COURSES			**18 credits**
Micro C21: Eukaryotic Microbiology	30	-	3 + 0
Micro C22: Recombinant DNA Technology	30	25	3 + 1
Micro C23: Diversity of life forms and environmental applications	30	25	3 + 1
Micro C24: Genetics (Prokaryotes & Eukaryotes)	50	-	4 + 0
Micro C25: Antibiotics	30	-	3 + 0
SUPPORTIVE COURSES			**2 credits**
Micro S21: Biostatistics	30	-	2 + 0

3rd Semester

CORE COURSES			**10 credits**
Micro C31: Fermentation and Bioprocess Engineering	25	-	2 + 0
Micro C32: Proteomics and Genomics	40	20	4 + 1
Micro C33: Regulation of Eukaryotic Gene Expression	40	-	3 + 0
CHOICE BASED COURSES			**8 credits**
CBCC- A: Choice Based Credit Course A	50	-	4 + 0
CBCC- B: Choice Based Credit Course B	50	-	4 + 0
Summer project and Seminar	25		0 + 2

4th Semester

CORE COURSES			**12 credits**
Micro C41: Virology	30	-	2+ 0
Micro C42: Immunology	30	20	3 + 1
Micro C43: Medical Biotechnology and Gene Therapy	30	-	3 + 0
Micro C44: Host-microbe interactions	30	-	3 + 0
SUPPORTIVE COURSES			**3 credits**
Micro S41: Computer Application and Bioinformatics	30	20	2 + 1
Dissertation	-	30	0 + 3
Grand Viva	-	30	0 + 2

Duration of theoretical examinations in different semesters for M.Sc. in Microbiology

All theoretical papers of 30 marks will be of 1hour 30 minutes duration. The examination for papers with 25 and 50 marks will be of 1 and 2 hours duration.

4. **FEES STRUCTURE:** Monthly and yearly fees to be collected from a student as per academic year July to June. Examination fees and other related fees are payable by the candidates as may be prescribed by university from time to time.

5. **ATTENDANCE:** A candidate shall be eligible for appearing at the examination provided he/she prosecutes a regular course of studies in the concerned Post Graduate (PG) Department for that semester in the subject and attends at least 65% of the total number of the Theoretical, Practical and Seminars separately held during the semester. A candidate failing to secure pass marks in a specific paper(s) shall not have to attend classes for appearing in the corresponding back paper(s) in a subsequent semester. *Condonable Limit:* A student who has attended at least 55% of the classes but less than 65% of the classes shall, however, be eligible to appear in the examination upon payment of a fee as may be prescribed by the university from time to time and after obtaining the order order from the Vice Chancellor.
A candidate who becomes ineligible to appear in a semester examination due to shortage of attendance will have to attend the classes in the corresponding semester of the following academic session by paying prescribed fees.

6. **MAXIMUM PERMISSIBLE TIME FOR COMPLETING THE COURSE:** Students have to clear the entire course within 4 years from the year of first admission.

7. **EXAMINER:** Paper setters, moderators, examiners, and scrutineers for each paper will be appointed on the recommendations of the Board of Post Graduate studies in the concerned subject. Scripts will be examined by single/multiple examiner(s) for all theory papers and double/multiple (internal and external) for all practical papers, dissertation, viva voce etc.

8. **PASSING CRITERIA**: A candidate is required to appear at the examination in each and every paper/course/module/part/group of the respective syllabus. A candidate in order to be declared to have passed an examination, must obtain at least 40% marks in each paper/course/module/part/group. In case of a paper/course/module/part/group containing both theoretical and practical portions, a candidate is required to secure at least 35% marks separately in the theoretical and practical portions and at least 40% marks in aggregate in that paper. Candidates shall not be allowed to appear at any higher semester examination without appearing and clearing the minimum number of requisite paper(s) of all the previous semester examinations as mentioned hereinafter.

9. **CRITERIA FOR RE-APPEARING AT SUPPLEMENTARY EXAMINATION:** If a student gets 'F' in a particular paper, he/she shall be deemed to have failed in that paper only and shall be required to appear in a supplementary examination to be offered within one year of the original examination. Candidate who fails in one or two papers can clear the paper/s in two more consecutive chances **(excluding the first examination)** along with higher semester examination. If the candidate is unable to clear the same within two consecutive chances, he/she shall be dropped from the concerned course.

   A candidate who has **failed** in more than two papers will have to appear at the same semester without appearing at the higher semester. In that case, attendance in the theoretical classes will not be mandatory; however, the candidate has to attend practical classes, considering the evaluation of practical is through continuous assessment. A failed

candidate, intending to re-appear in a subsequent semester has to take permission from the concerned Faculty Secretary through the Head of the Department immediately after publication of result.

If all the chances of a candidate (first attempt + 2) has been exhausted, he/she has to drop or leave the course. He may apply for re-admission in the same course of study in the 1st Semester of the next academic session along with the fresh applicants. In any case, the candidate has to clear the entire course within 4 years from the year of first admission.

10. **ABSENT CRITERIA:** Failure to fill up the examination form shall be considered as missing a chance and such candidates who have not filled up the examination form shall have to appear at the same semester examination with required attendance. A candidate who has filled up the examination form but remains absent in the entire examination or more than two courses will be considered to have lost a chance and shall be required to re-appear at the same semester examination. A candidate remaining absent in one or two papers/courses but clearing the other papers/courses shall be considered to have failed in those papers/courses in which he remains absent and shall be eligible to clear those as stated above.

11. **READMISSION CRITERIA:** If a student is dropped from the respective course of study because of his failure to clear a particular course within 4 years, he/she may apply for readmission in the same course of study in the 1st semester of the next academic session along with the fresh applicants.

12. **CONSOLIDATED MARK SHEET:** After passing all the semesters a candidate may apply for a consolidated mark sheet to the Controller of Examinations upon payment of such fees as prescribed by the university.

13. **DATE OF PUBLICATION OF FINAL RESULT:** For a regular student who has cleared all the semesters in normal course, the date of publication of final result shall be the date of publication of result of the 4th semester. The final date of publication of result for students clearing previous semester(s) subsequent to their clearing 4th semester examination will be **date of publication of the last result clearing all papers.**

14. **CALCULATION OF GRADE POINTS, SGPA AND CGPA:** The schedule of papers, distribution of marks and credits, for the M.Sc course shall be determined by the concerned department duly approved by the respective Faculty Council/PG Board of studies. Credit-weighted grade point system will be followed and therefore only the grade points but not the overall percentage of marks either in individual paper or in aggregate marks will be provided. The grade points will be given according to the following computation.

Grading of students' performance:

Grade scores will be calculated in a scale of 6 (six) as per the following table:

Marks (%)	Grade Score Brackets	Grade Score added per each additional mark to minimum grade score in the bracket
80-100	5.00 - 6.00	0.05
70-79	4.50 – 4.99	0.05
60-69	4.00 – 4.49	0.05
55-59	3.75 – 3.99	0.05
50-54	3.50 – 3.74	0.05
40-49	3.00 – 3.49	0.05

00-39	Below 3.00	0.075

Award of Grade Points:

For example, if a student scores 53% in theory and 68% in practical in a 3-credit course (2+1), his/her grade point for the course will be as follows:

$$\text{Grade point} = \frac{2x(3.5+0.05x3)+1x(4.0+0.05x8)}{2+1} = 3.90$$

For a credit course with no practical component, for example a 2-credit course, if a student scores say, 56%, then the grade point will be:

$$\text{Grade point} = \frac{2x(3.75+0.05x1)}{2} = 3.80$$

Semester Grade Point Average (SGPA):

The computation of average grade point of a student in a semester will be worked out as follows:

N^{th} Semester

Course	Credits	Grade Scored
1	3+1	5.65
2	3+1	5.33
3	2+0	3.99
4	2+0	5.05
5	3+1	4.22
6	3+1	4.46

Semester Grade Point Average (SGPA) = 4.836

$$\text{SGPA} = \frac{(5.65x4)+(5.33x4)+(3.99x2)+(5.05x2)+(4.22x4)+(4.46x4)}{20} = 4.836$$

Cumulative Grade Point Average (CGPA) over four semesters:

Working out simple average of SGPA obtained over four semesters, cumulative grade point average will be given after four semesters.

Significance of grades:

On the basis of the cumulative results of the student's performance, the following grades will be given in each semester as well as over four semesters.

Grade points	Grades	Class
5.00 - 6.00	Outstanding (O)	First (I)
4.50 – 4.99	Excellent (A+)	First (I)
4.00 – 4.49	Very good (A)	First (I)
3.75 – 3.99	Good (B+)	Second (II)
3.50 – 3.74	Fair (B)	Second (II)
3.00 – 3.49	Satisfactory(C)	Second (II)
Below 3.00	Fail (F)	Fail

If a candidate gets "F" grade in one or more courses/modules/groups in a semester examination, his SGPA in that semester shall be temporarily withheld and GPW (Grade Point Withheld) shall be marked against SGPA on the mark sheet. A fresh mark sheet with duly calculated SGPA shall be issued only when a candidate clears the course subsequently but within the stipulated period.

15. **GRACE MARKS:** A candidate failing to obtain the pass marks in a semester examination shall be given benefit of one additional mark in the paper in which he/she secured lowest marks and the same shall be shown in the Tabulation Rolls. A candidate failing to obtain 50% or 55% or 60% marks in the aggregate of all the semesters by one mark only shall be given the benefit of one additional mark in the result of final semester and the same shall be reflected both in the Tabulation Roll as well as in the mark sheet.

16. **RANKING**: Candidate unable to clear each part of all the semester examinations in one chance shall not be entitled to any position in order of merit. To be eligible for award of rank in order of merit, a candidate must pass all the semesters at first chance as regular candidate.

17. **CANCELLATION OF EXAMINATION:** Candidates may apply to the Controller of Examinations for cancellation of enrolment of the said examination within fifteen days from the date of completion of theory papers. The said cancelled examination will also be counted as a chance.

18. **DIPLOMA**: A candidate shall be declared to have obtained the degree of M.Sc (2 year course) and shall get a degree certificate in the format specified hereunder (a candidate who has passed his/her undergraduation with honours in B.Sc will get the M.Sc degree)

"This is to certify that _____ obtained the degree of Master of Science in this university in ____ , under semester examination system, the special branch in which he/she was examined having been_____ and that he/she was placed in the class attaining grade_____ ."

Senate house

Dated *Vice Chancellor*

19. **CHOICE BASED CREDIT COURSE**: A student will have to take two courses from Choice Based Credit Courses (CBCCs) in addition to courses offered by the department. The students will have to choose one course each from two different groups. Each course is of 50 marks and carries 4 credits.

20. **Detailed academic syllabus for the two year M. Sc. Course in Microbiology**

1st Semester

CORE COURSES

Micro C11: Biomolecular Structures & Their Interactions, Theoretical : 30

(3 + 0 credits)

General structure of proteins in relation to biological function; chemistry of amino acids, polypeptides; four levels of protein structure, shape of protein molecules; there-dimensional protein structure determination; concept of protein structure motif, idea of prosthetic groups, chemical modification of proteins, protein splicing, unfolding of protein structure, effect of heat, pH and chemicals, denaturation and refolding of proteins, in vivo protein folding: concept of chaperones. Structure of DNA, (A, B, Z), supercoiling, nucleosomes, RNA, lipids, fatty acids and carbohydrates

Micro C12: Microbial Cell Biology Theoretical: 30, Practical: 20

(3 + 1 credits)

Cell as a basic unit of living systems; precellular evolution of cell; the evolution of cell from prokaryotes to eukaryotes and from single cells to multicellular organisms; Structure of the cell;

Bacterial Cell wall: structures, diversities and biosynthesis, different cell wall hydrolyzing enzymes; bacterial endospores: structure, formation and germination; Uncommon bacterial genera: Rickettsia, Chlamydia, Mycoplasma, sheathed bacteria, stalked and budding bacteria, gliding bacteria including Myxobacteria. Cellular structure and function; flagella, pili, capsules; specialized features of higher bacteria like budding, gliding bacteria etc.; fruiting body formation in myxobacteria.
Internal organization of the cell; Cell membrane structure; membrane constituents; phospholopids, glycolipids, cholesterol, membrane proteins, receptors and phospholipases; bilayer structure, asymmetry, fluid mosaic model of random diffusion of membrane components, domains in membrane- natural and artificial membranes;
General strategies of cell division: bacteria and yeast, molecular genetics of cell cycle regulation; Cell signaling; Chemotaxis, Quorum sensing; Regulation of biofilm formation,

Practical: Subcellular fractionation of nucleus, cell membrane and cytoplasm by differential centrifugation , nuclear staining by DAPI, subcellular localization of proteins: immunostaining methods and GFP-tagging.

Micro C13: Molecular Biology Theoretical: 30 (3 + 0 Credits)

DNA replication in prokaryotes and eukaryotes: General features and enzymology; detailed mechanisms of initiation, elongation and termination; experiments underlying each step and role of individual factors; telomerases: mechanism of replication, maintenance of integrity and role in cancer; Transcription: RNA polymerase subunits, different sigma factors- related to stress, viral infections etc., initiation, elongation and termination (rho- dependent and independent) of RNA synthesis; antitermination, attenuation and other influences of translational apparatus on the process of transcription; various protein motifs involved in DNA-protein interactions during transcription; translation: in prokaryotes and eukaryotes, processing of mRNA for translation and involvement of different translational factors at different stages of the process.

Micro C14: Biophysical Methods & Instrumentation Theoretical: 30, Practical: 20
(3 + 1 Credits)

Thermodynamics: extensive and intensive variables; mathematical description of a system with two or more variables, exact and partial differential; first law of thermodynamics, isothermal process, entropy and second law of thermodynamics, reversible and irreversible process, free energy and chemical potential; Gibb's free energy; potentiometric determination of pK's of amino acids. Free energy of charged macro-ions; Debye-Huckel theory; Hydration, solvation number.

Instrumentation: Principles of light absorption, extinction coefficient, ultraviolet, visible and infrared absorption spectrophotometer and their working principles; molecular vibrations, normal modes and group vibrations- hydrogen bonding effect on vibrational spectra; resonance Raman spectroscopy and its biological applications; Circular Dichroism (CD) and Optical Rotatory Dispersion (ORD) and their application in the study of macromolecules; fluorescence and phosphorescence. Introduction to Mass Spectrometry, MALDI-TOF, ESI.

Practical: General laboratory practices and handling of instruments; training on centrifugation, microscopy and spectroscopy.

Micro C15: Microbial Metabolism Theoretical: 30 (3 + 0 Credits)

Bacterial photosynthesis (different types of photosynthetic bacteria, photopigments, paths of carbon and electron in bacterial photosynthesis); metabolism of energy reserve compounds (polyglycans, poly- and β-hydroxybutyrate); metabolic energetics: basic differences in anaerobic and respiratory kinds of energy metabolism; electron transport system; basic mechanisms of ATP synthesis; energy conservation in chemolithotrophic bacteria (*Nitrobacter, Nitrosomonas, Thiobacilli* including *Thiobacillus ferrooxidans*, methanogens, hydrogen oxidizing bacteria); respiratory metabolism- Embden-Meyerhoff pathway, Entner-Doudroff pathway, phosphoketolase pathway, glyoxalate pathway, Krebs' cycle, oxidative and substrate level phosphorylation, reverse TCA cycle, gluconeogenesis- Pasteur effect; energy metabolism and microbial growth; growth yield coefficients, theoretical growth yield; fermentation of carbohydrates-homo and heterolactic ferementations- mixed acid, propionic acid, butyric acid, acetone-butanol etc. fermentations, substrate level phosphorylation in anaerobic energy metabolism; transport processes

SUPPORTIVE COURSES

Micro S11: Enzymes and Reaction Kinetics Theoretical: 30, Practical: 30 (2 + 1 credits)

Definition of enzymes; active site, substrate, coenzyme, cofactor and different kinds of enzyme inhibitors; enzyme kinetics, two substrate kinetics, three substrate kinetics, deviation from linear kinetics; ligand binding studies; rapid kinetics; association and dissociation constants; use of isotopes in enzyme kinetics mechanism analysis; effect of pH, temperature and isotopically labeled substrates on enzyme activity; allosteric model of enzyme regulation; substrate induced conformational change in enzyme; techniques for purifying and characterizing proteins and enzymes; idea of all analytical techniques like electrophoresis, liquid chromatography, crystallography, column chromatography for enzyme protein analysis.

Practical: Estimation of proteins, enzyme kinetics, effects of pH and temperature on enzyme, use of inhibitors for active site determination, chromatographic techniques, purification of enzymes, chemical estimation of vitamins, minerals like calcium, iron etc, separation of biomolecules by electrophoresis, determination of molecular weight by gel filtration.

2nd Semester

CORE COURSES

Micro C21: Eukaryotic Microbiology Theoretical: 30 (3 + 0 Credits)

Important human and veterinary parasites, life cycle and biology of *Plasmodium, Entamoeba, Leishmania, Wuchereria, Fasciola, Schistosoma*, host parasite interaction. Protozoa: Classification of Protozoa, general biology of protozoal cell, process of reproduction in common protozoal classes, importance of protozoa in soil and water eco-system.

Elements of mycology: General classification of fungi, fungal cell structure, structure and biology of fungal spores of different kinds, reproduction in fungi, mycotoxins.

Micro C22: Recombinant DNA Technology Theoretical: 30, Practical: 25 (3 + 1 Credits)

Principles and methods of recombinant DNA technology- hybridization, cloning, sequencing, polymerase chain reaction, genome projects; gene manipulations; cloning in *E.coli*, plasmids,

bacteriophages and cosmid vectors, cloning strategies, genomic and cDNA library; expression of cloned genes in *E. coli*, products made in *E. coli* by genetic engineering; cloning in yeast: transformation in yeast, yeast vector development: Yep, YRp, YCp and YIp, 2µ plasmid, yeast artificial chromosome (YAC), expression of proteins in yeast; yeast 2-hybrid system. Genetic engineering of plants: transformation of plants, manipulating gene expression in plants, selectable markers and reporter genes, *Agrobacterium tumefaciens*; Genetic elements present on the Ti plasmid, genetic engineering of the Ti plasmid, vectors used to introduce foreign DNA into plant cells- binary cloning vector, disarmed Ti plasmid, cointegrate cloning vector; comparison of methods for transfer of DNA to plants, manipulation of gene expression in plants; production of transgenic plants without reporter or marker genes.

Practical: Isolation of bacterial genome and plasmid DNA, restriction enzyme digestion, restriction mapping and cloning, Southern blotting, RT-PCR.

Micro C23: Diversity of life forms and environmental applications **Theoretical: 30, Practical: 25 (3+ 1 Credits)**

Evolution of environment and Origin of life, Diversification of life and speciation; Classifying organisms: Concepts of phenetics and cladistics; Principles of ecological organization; Basics of structural & functional ecology; Concept of Population genetics; Basic approach to evolutionary biology and behavioral ecology; Evolutionary principles and stable strategies; types of selections.

Biodiversity- levels of biodiversity, alpha, beta and gamma diversity, Values and ethics of biodiversity; Global patterns of biodiversity, hotspots of biodiversity and megadiversity country; Biogeographic zones in India; factors influencing local and regional biodiversity, Biodiversity documentation.

Threat to species diversity, Extinction vortex, Causes of extinction; Population viability analysis; Red Data Book, Biodiversity conservation approaches: Local, National and International, In situ and ex situ conservation, Concept of protected area network, Selecting protected areas, criteria for measuring conservation value of areas, Sanctuary, National Park and Biosphere reserves; Design and management of protected areas; Threats to wildlife conservation and wildlife trade; Tools for wildlife research, Wildlife threat, Use of Radiotelemetry and Remote sensing in wildlife research

Perception on Bioresource; Legal binding of biological materials- concept of Biopatents

Environmental biotechnology: Understanding biotechnology, Concept and outlines of various applications- GM crops and GMO: Environmental implications;; Biodegradation, Phytoremediation: types and applications Bio-fuel production, Bio fertilizer, Bio pesticides; Integrated Pest Management,

Microorganisms and environmental pollutants: Overall process of biodegradation, Environmental biomonitoring and indicator microorganisms, biodegradation of organic pollutants, anaerobic biodegradation, in-situ and ex-situ bioremediation, case studies of microbial remediation, lagoon and Vadose zone bioremediation, surface bioremediation of soils and sludge, Applied bioremediation and industrial applications, developing bioremediation technologies, Concept of Fermentation technology and Bioreactor, microorganisms and metal pollutants, metal – microbial interaction and metal remediation; Microbial transformation of pesticides.

Waste treatment – modern wastewater treatment, traditional methods, wetlands and aqua-culture systems, Surface Bioremediation of soil and sludge

Practical: Isolation of heavy metal resistant bacteria, Metabolic fingerprinting of microbes by BIOLOG, isolation of cellulolytic bacteria from soil sample, preparation of total DNA from soil and water, amplification of 16S rDNA and DGGE electrophoresis.

Micro C24: Genetics (Prokaryotes & Eukaryotes) Theoretical: 50 (3 + 0 Credits)

Prokaryotic

DNA damage and repair: factors affecting DNA bases, identification and molecular characterization of repair enzymes in photoreactivation, excision, recombination, and SOS pathways; recombination and transposition: models for homologous recombination- the Holliday, Meselson-Radding and RecBCD pathways and their experimental supports; meiotic recombination- mechanism, the double-stranded DNA breaks; site-specific recombination and transposition: lambda phage integration and excision, bacterial use of site-specific recombination, eukaryotic (yeast, maize, fruitfly) and prokaryotic transposons.

Genetic recombination in Bacteria: Identification and selection of mutants; transformation: natural transformation systems, mechanism, gene mapping by transformation; chemical and electrotransformation. Conjugation: discovery, nature of donor strains and compatibility, interrupted mating and temporal mapping, Hfr, F12 heteroduplex analysis, chromosome transfer in other bacteria, Transduction: Generalized and specialized transduction; gene mapping by specialized transduction, mechanism of generalized transduction, abortive transduction.

Techniques of studying Bacteriophages-virulent phage(T4) and Temperate phage(phage lambda). Important aspects of life cycles; phage genome and gene mapping; host parasite relationship, immunity and repression; site specific recombination (lambda and PI), Transposable phage (Phage Mu), genetic organization and transposition , Phase variation in Salmonella and others.

Eukaryotic

Physical basis of Heredity: Cells, chromosomes, cell division, Mendel's laws, gametogenesis, life cycle (yeast, *C.elegans*); Single gene inheritance, terminology, allelic releationship, single gene crosses, Pedigree analysis; Two or more genes: Independent assortment, dihybrid cross, Genetic interactions: Two factor interaction, epistatic interaction, non-epistatic interaction, interactions with three or more factors. Linkage and Chromosome mapping: Linkage, cross over, chi square test for linkage, recombination frequency and map construction, tetrad analysis in yeast and recombination mapping with tetrad, mapping with molecular markers.

Yeast genetics: isolation and characterization of auxotrophic and temperature sensitive mutants, synthetic lethality, meiotic mapping, multicopy suppression.

Micro C25: Antibiotics Theoretical: 30 (3 + 0 Credits)

Definition, phenomenon of antibiotics, concept of secondary metabolites. Role of antibiotics in the producer organism. Assay of antibiotics: chemical versus microbiological assay system, different methods of antibiotic assays (serial dilution, photometric and agar-diffusion methods) - theory and practice; Chemical and biochemical modification of antibiotic structures: development of antibiotics (different generations of antibiotics) taking penicillins and chloramphenicols as parent compounds. Phenomenon of antibiotic resistance. Different biochemical mechanisms of resistance development, multiple-drug resistance, its genetics and chemical significance. Biochemical modes of action of antibiotics acting as inhibitors of ribosomal function (as for example aminoglycosides, tetracyclines, puromycin, choloramphenicol, microlides etc.), inhibitors of nucleic acid metabolism (actinomycin D, mitomycin C etc.), inhibitors of cell wall biosynthesis (penicilline, bacitracins etc.) and inhibitors of membrane function (polyenes, tunicamycin, ionophores etc.).

SUPPORTIVE COURSES

Micro S21: Biostatistics Theoretical: 30 (2 + 0 Credits)

Probability and statistics; population, variables, collection, tabulation and graphical representation of data, frequency distribution, central tendency and skewness, binomial, Poisson and Gaussian distributions, additive and multiplicative laws of probability, concept and correlation; regression; methods of least squares; chi-square tests, random number generation- testing and use; probability density and cumulative distribution function; systematic and random sampling.

3rd Semester

CORE COURSES

Micro C31: Fermentation and Bioprocess Engineering Theoretical: 25

(2 + 0 Credits)

Introduction to Bioprocess Engineering, Bioreactors, and Membrane Bio reactors, Isolation, preservation, and Maintenance of Industrialn Microorganisms, Kinetics of microbial growth and death, Media and medial sterilization for industrial Fermentation. Air quality Management and air sterilization. Types of Fermentation processes: Analysis of batch, Fed-batch and continuous bioreactors, stability of microbial reactors, analysis of mixed microbial populations, specialized bioreactors (pulsed, fluidized, photobioreactors etc.); Fermentation kinetic and monitoring; Measurements and control of bioprocess parameters.

Downstream processing: Introduction, removal of microbial cells and solid matter, foam preparation, precipitation, filtration, centrifugation, cell disruptions, liquid liquid extraction, chromatography, Membrane process, Drying and Crystaliztion, Effluent treatment: D.O.C. and C.O.D. treatment and disposal of effluents. Whole cell immobilization and their industrial applications: Immobilized enzymes, enzymes in aqueous and nonaqueous media, Bioconversion and biotransformation. Industrial production of chemicals: alcohol (ethanol), Acids (citric, acetic, and gluconic), solvents (glycerol, acetone, and butanol) antibiotics (ampicillin, streptomycin and tetracyclin), microlodes, anticancer antibiotics, aminoacids (lysine, glutamic acids), single cell protein, single cell lipids. Use of microbes in mineral beneficiation and oil recovery. Introduction to food technology: Elementary idea of canning and packing– fat based edible products, sterilization and pasteurization of food products, fat-based nutraceuticals technology of typical food/food products (bread, cheese, idli, agro-products (oilseeds), food preservation, food colors, flavors, and antioxidants. Introduction to Bioprocesses technology: Hydrogenation, oxidation, esterification.

Micro C32: Proteomics and Genomics Theoretical: 40 Practical: 20

(4 + 1 Credits)

Proteomics

Mass spectroscopy, basic principle, MALDI-TOF, ESI; 2-D Gel electrophoresis, Nuclear magnetic resonance spectroscopy (NMR), basic principles, chemical shift, spin-spin interaction, NOE, 2D-NMR**,** NOESY, COSEY.

X-ray Crystallography: Principle of X-ray diffraction, scattering vector, structure factor, phase problem, reciprocal lattice and Ewald sphere, Miller indices, Zone axes, crystal lattice, Lane Equations, Bragg's law, special properties of protein crystals, model building, refinement and R-factor.

Genomics

Genetic and physical maps, physical mapping and map-based cloning, choice of mapping population, simple sequence repeat loci, southern and fluorescence in situ hybridization for genome analysis, chromosome microdisection, molecular markers in genome analysis; RAPD and AFLP analysis, molecular markers linked to disease resistant genes, application of RFLP in forensic, disease prognosis, genetic counseling, pedigree, varietal etc. Genome sequencing: genome sizes, organelle genomes, genoimc libraries, strategies for genome sequencing, packaging, transfection and recovery of clones, application of sequence information for identification of defective genes. Pharmacogenetics, genetics of globin triplet repeat disorders, cancer genetics; immunogenetics; mapping of human genome; somatic cell genetics; DNA polymorphism in mapping; structure and function; biochemical genetics; polygenic inheritance, Microarray

Practical: DNA sequencing, PCR based site directed mutagenesis, Protein electrophoresis-1D + 2D.

Micro C33: Regulation of Eukaryotic Gene Expression Theoretical: 40 (3+0 Credits)

Chromatin organization, cis- acting sequences in transcriptional regulation, mechanisms of action at a distance, trans- control of transcription, different modes of mRNA, tRNA splicing, general discussion on various snRNPs, capping, polyadenylation and other processing events in eukaryotes, RNA editing; discussion on ribozyme; RNA interference: mechanisms and enzymology; regulation of gene expression by miRNP pathway; regulation of translation, tissue specific regulation of transcription, dissecting eukaryotic regulatory elements. Intracellular protein trafficking

Summer Project and Seminar: Marks 25 (0+ 2 Credits)

A project performance report based on the summer research training in a reputed laboratory of excellence will have to be submitted. A presentation of the accomplishments will be required before a panel of experts. Evaluation will be based on both the project report and presentation.

4th Semester

CORE COURSES

Micro C41: Virology Theoretical: 30 (2+ 0 Credits)

Classification and modes of propagation, bacterial, plant and animal viruses: morphology and ultra structure; assay of viral particle, cell culture, viral enzymes, nuclic acids, bacterio phages; lambda, T4, T7, M13, lytic cycle, lysogeny; viral replication, nucleic acid and protein synthesis, viral diseases. Virus host interaction: virus infection, viral diseases and pathogenesis: Herpes, adeno, hepatitis, rhabdo, oncogenic viruses etc. DNA viruses: Herpes, hepatitis B, adenovirus; RNA viruses: polio, VSV, influenza, retroviruses: structure and life cycle, transformation; baculovirues.; molecular biology of genetic shift and drift in influenza virus, cellular trophism of HIV; Plant viruses: TMV.

Micro C42: Immunology Theoretical: 30, Practical: 20 (3 + 1 Credits)

Immunoglobins, organization and expressions of Ig genes; B cell maturation, activation and differentiation; MHC/ HLA; antigen processing and presentation; T-cells, T-cell receptors, T-cell maturation, activation and differentiation; cytokines; cell mediated and humoral effector responses, auto immunity, immunodeficiency diseases, transplantation immunology, cancer and immune system. Monoclonal and polyclonal antibodies, monoclonal antibody technique.

Practical: Immunization with a specific antigen and raising of the antibody, Determination of blood group (ABORL), Bacterial agglutination (raising antibody in rabbit using bacteria as antigen), ODD (Ouchterlony double diffusion), SRID (Mancini's method), Immunoelectrophoresis. Lymphocyte

preparation from peripheral blood and separation of macrophages. Antibody producing CFU form mouse spleen.

Micro C43: Medical Biotechnology and Gene Therapy **Theoretical: 30 (2 + 0 Credits)**

Disease diagnosis-probe, PCR, LCR immunological assay. Detection of genetic, Neurogenetic disorders involving Metabolic and Movement disorders. Treatment-products from recombinant and non-recombinant organisms, Interferons, Antisense therapy, cell penetrating peptides.
Gene therapy, Types of gene therapy, somatic virus germline gene therapy, mechanism of gene therapy, Immunotherapy, Detection of mutations in neoplastic diseases MCC, SSCP, DGGE, PTTC. Focusing on emerging infections, viral classifications, transmissions and preventions, viral pathogenesis, mechanisms of viral induced cancer and viral evolution, developmental biology of virally induced birth defects, factors in pathogenesis and transmission of prions. Cell mediated and Gene therapy as a novel form of drug delivery, vectors, cell types. Responses to viral infections; slow and persistent infections, anti viral agents, interferons, equipments and materials for animal cell culture technology. Primary and established cell line cultures. Introduction to the balanced salt solution and the simple growth medium. Brief discussion on the chemical, physical and metabolic functions of different constituents of culture medium. Serum and protein free defined media and their applications. Measurements of viability and cytotoxicity. Biology and characterization of the culture cells, measuring parameters of growth. Basic techniques of mammalian cell culture in vitro; desegregation of tissue and primary culture, maintenance of cell culture, cell separation. Scaling up of animal cell culture. Cell synchronization. Cell cloning and micromanipulation. Cell transformation. Application of animal cell culture. Stem cell culture, embryonic stem cells and their applications. Cell culture based vaccines, somatic cell genetics, organ and histotypic cultures.

Micro C44: Host-microbe interactions **Theoretical: 30** **(3 + 0 Credits)**

Pathogenic bacteria, bacterial diseases, mechanism of pathogenesis, prophylaxis, therapy etc. (*Staphylococcus, Streptococcus, Pneumococcus, Neisseria, Corynebacterium, B acillus, Closridium,*) enterobactriacae (*Shigella, Salmonella, E.coli*), *Vibrio* etc., *Mycobacterium* etc. Accute diarrhoeal diseases, food poisoning , Meningitis, tuberculosis, diptheria, leprosy, urinary tract infection, cystic fibrosis, typhoid, enteritis (in *Helicobacter pylorae*), gastritis, cholera, pneumonia; Bioweapons- infectious agents and their epidemiology. Common mycotic infections in human: superficial, subcutaneous, cutaneous, and systemic mycoses.
Plant-microbe interactions: Rhizosphere and phyllosphere microorganisms and their interactions with plants; Symbiotic vs nonsymbiotic nitrogen fixation, symbionts and their cognate hosts, regulation of nitrogen fixation in a symbiotic vs a non-symbiotic N fixer; mechanism of inception of symbiosis, symbiosis vs pathogenesis. Plant pathogens (bacterial, fungal, algal and mycoplasmal); mechanisms of plant pathogenicity, beneficial association between plant and microorganisms (association of plants with cyanobacteria, actinomycetes and fungi).
Human-microbe mutualism and disease, manipulation of host cell pathways by bacterial and parasitic pathogens. Different types of secretory bacterial pathways

Supportive Courses

Micro S41: Computer Application and Bioinformatics Theoretical 30, Practical: 20
(2 + 1 Credits)

Computer Application

Basic idea to work on Linux platform – basic concept of OS. Simple shell commands.

Bioinformatics

Concept of homology, paralogy, orthology, analogy and xenology

Comparison of sequences of biological macromolecules – Pairwise alignment: local and global alignment; Concept of indel, affine gap penalty; Database search algorithm, significance of hits, Karlin Altschul equation; Multiple sequence alignment, concept of consensus, interpretation with regular expression, concept of protein profile and PSSM, algorithm of PSI-BLAST. PHI-BLAST and other forms of BLAST.

Concept of tree, reading and interpreting phylogenetic trees, distance-based and character-based methods for the construction of phylogenetic trees, judging strength of clades (with BS or PP values) in a tree.

Kyte-Doolittle plot and Hopp-Woods plot- prediction of localization of a protein, prediction of TMD. Secondary, tertiary and quaternary structure prediction –concept of propensity in Chou-Fasman method; Homology modeling, threading and ab initio method; Docking – rigid and flexible, protein-protein and protein-ligand.

Practical: Pairwise alignment- local and global alignment using Smith-Waterman and Needleman-Wunsch algorithm respectively. Comparison of the results with reference to percentage identity, percentage gaps etc.
Comparison of the different BLOSUM matrices
Cross dot plot to identify regions of similarity/identity and self dot plot to identify repeats
Two BLAST searches - one using a house keeping protein and another using a rare protein. Comparison of the results with reference to elements of the search list
Study of the CATH and SCOP database to write a report followed by classification of a given protein
Hydropathy plot of a globular and a membrane protein followed by a comparison of the two plots
Identification of consensus sequence through multiple sequence alignment
Using the multiple sequence alignment for the construction of phylogenetic tree
Tertiary structure prediction using homology modelling and threading

Dissertation: **30** **(0+ 2 credits)**

A grant proposal on any relevant topic in biology will have to be prepared by students following the format of National Institute of Health, USA. The students will also be required to defend the proposal before a panel of experts. Both the written proposal and its defense will be taken into consideration for evaluation.

Grand viva: **30** **(0+ 2 credits)**

Students will be evaluated on all the topics discussed in the two years programme by a panel of experts.

CBCC to be offered to the students of other departments: Fundamentals of Bacteriology

1) The discovery of microorganisms, the conflict over spontaneous generation, Koch's postulates, an overview of prokaryotic cell structure, cell wall, cell membrane, nucleoid, plasmids, endospore, comparison of prokaryotic and eukaryotic cells.

2) Microbial nutrition, growth and control: Common nutrient requirements, nutritional types of organisms, culture media, isolation of pure culture, continuous cultures of microorganism; control of microorganism by physical and chemical agents, basics of water bacteriology, influence of environmental factors on microbial growth in natural environments.

3) Identification of microbe and microbial community, comparison of ribosomal RNA sequences – Pairwise alignment: local and global alignment, Multiple sequence alignment, construction of phylogenetic tree.

UNIVERSITY OF CALCUTTA

Notification No. CSR/ 12 /18

It is notified for information of all concerned that the Syllabi of different subjects in Undergraduate Honours / General / Major courses of studies (CBCS) under this University, as laid down in the accompanying pamphlet:

List of the subjects

Sl. No.	Subject	Sl. No.	Subject
1	Anthropology (Honours / General)	29	Mathematics (Honours / General)
2	Arabic (Honours / General)	30	Microbiology (Honours / General)
3	Persian (Honours / General)	31	Mol. Biology (General)
4	Bengali (Honours / General /LCC2 /AECC1)	32	Philosophy (Honours / General)
5	Bio-Chemistry (Honours / General)	33	Physical Education (General)
6	Botany (Honours / General)	34	Physics (Honours / General)
7	Chemistry (Honours / General)	35	Physiology (Honours / General)
8	Computer Science (Honours / General)	36	Political Science (Honours / General)
9	Defence Studies (General)	37	Psychology (Honours / General)
10	Economics (Honours / General)	38	Sanskrit (Honours / General)
11	Education (Honours / General)	39	Social Science (General)
12	Electronics (Honours / General)	40	Sociology (Honours / General)
13	English ((Honours / General/ LCC1/ LCC2/AECC1)	41	Statistics (Honours / General)
14	Environmental Science (Honours / General)	42	Urdu (Honours / General /LCC2 /AECC1)
15	Environmental Studies (AECC2)	43	Women Studies (General)
16	Film Studies (General)	44	Zoology (Honours / General)
17	Food Nutrition (Honours / General)	45	Industrial Fish and Fisheries – IFFV (Major)
18	French (General)	46	Sericulture – SRTV (Major)
19	Geography (Honours / General)	47	Computer Applications – CMAV (Major)
20	Geology (Honours / General)	48	Tourism and Travel Management – TTMV (Major)
21	Hindi (Honours / General /LCC2 /AECC1)	49	Advertising Sales Promotion and Sales Management –ASPV (Major)
22	History (Honours / General)	50	Communicative English –CMEV (Major)
23	Islamic History Culture (Honours / General)	51	Clinical Nutrition and Dietetics CNDV (Major)
24	Home Science Extension Education (General)	52	Bachelor of Business Administration (BBA) (Honours)
25	House Hold Art (General)	53	Bachelor of Fashion and Apparel Design – (B.F.A.D.) (Honours)
26	Human Development (Honours / General)	54	Bachelor of Fine Art (B.F.A.) (Honours)
27	Human Rights (General)	55	B. Music (Honours / General) and Music (General)
28	Journalism and Mass Communication (Honours / General)		

The above shall be effective from the academic session 2018-2019.

SENATE HOUSE
KOLKATA-700073
The 4th June, 2018

Paul 4/6/18
(Dr. Santanu Paul)
Deputy Registrar

Semester Wise Microbiology Courses for B. Sc. (Honours)

	Sem-1	Sem-2	Sem-3	Sem-4	Sem-5	Sem-6
Core Courses (CC)	**CC1 & 2** 2Th+2P (2X4+2X2=12 Credits) **CC1:** Introduction to microbiology and microbial diversity **CC2:** Bacteriology	**CC3 & 4** 2Th+2P (2X4+2X2=12 Credits) **CC3:** Biochemistry **CC4:** Cell Biology	**CC5,6 & 7** 3Th+3P (3X4+3X2=18 Credits) **CC5**: Virology **CC6:** Microbial physiology and metabolism **CC7:**Molecular Biology	**CC-8,9 &10** 3Th+3P (3X4+3X2=18 Credits) **CC8:**Microbial Genetics **CC9:**Environmental Microbiology **CC10:**Recombinant DNA Technology	**CC11 & 12** 2T+2P (2X4+2X2=12 Credits) **CC11**:Food and Dairy Microbiology **CC12**:Industrial Microbiology	**CC-13 & 14** 2T+2P (2X4+2X2=12 Credits) **CC13**:Immunology **CC14**:Medical Microbiology
Elective Courses:						
i) Generic Elective (GE)	1Th+1P **GE1** (1X4+1X2=6 Credits)	1Th+1P **GE2** (1X4+1X2=6 Credits)	1Th+1P **GE3** (1X4+1X2=6 Credits)	1Th+1P **GE4** (1X4+1X2=6 Credits)		
ii) Discipline Specific Elective Courses					**DSE-A*** 2Th+2P **Any two:** (2X4+2X2=12 Credits) A1. Microbial Biotechnology A2. Advances in Microbiology **DSE-B*** B1. Inheritance Biology B2.Microbes in Sustainable Agriculture and Development	**DSE-A*** 2Th+2P **Any two:** (2X4+2X2=12 Credits) A3.Plant Pathology nstrumentation and Biotechniques A4. Biomathematics and Biostatistics **DSE-B*** B3. Instrumentation and Biotechniques B4. Project Work

Ability Enhance-ment Compulsory Course (AECC)	1Th+0P **AECC-1: Communicative English** (2 Credits)	1Th+0P **AECC-2: Environmental Studies** (2 Credits)				
Skill Enhance-ment Courses (SEC)			1Th+0P **SEC-A** (1X2=2 Credits) **Any one** 1.Microbial Quality Control in Food and Pharmaceutical Industries 2. Biofertilizers and Biopesticides	1Th+0P **SEC-B** (1X2=2Credits) **Any one** 1. Food Fermentation Techniques 2. Microbiological Analysis of Air and Water		
Total No. of Courses and Marks	**4 X 100=400**	**4 X 100=400**	**5 X 100=500**	**5 X 100=500**	**4 X 100=400**	**4 X 100=400**
Total Credit 140	**20 Credits**	**20 Credits**	**26 Credits**	**26 Credits**	**24 Credits**	**24 Credits**

***DSE-A: Any one to be chosen in the 5th Semester and another one to be chosen in the 6th Semester.**

***DSE-B: Any one to be chosen in the 5th Semester and another one to be chosen in the 6th Semester.**

These choices must be made by the students before 5th Semester begins.

Semester wise Courses for B.Sc. Microbiology (General)

	Sem-1	Sem-2	Sem-3	Sem-4	Sem-5	Sem-6
Core Courses (CC)/GE	3Th+3P (3X4+3X2=18 Credits) **CC1:** Introduction and Scope of microbiology, Bacteriology	3Th+3P (3X4+3X2=18 Credits) **CC2:**Bacteriology and Virology,	3Th+3P (3X4+3X2=18 Credits) **CC3:**Biomolecules and Microbial metabolism	3Th+3P (3X4+3X2=18 Credits) **CC4:**Microbial Genetics and Molecular Biology		
Elective Courses						
I) Generic elective						
Discipline Specific Elective Courses (DSE)					3Th+3P (3X4+3X2=18 Credits) **DSE-A** Any **one** from 1. Genetic Engineering and Biotechnology 2. Microbes in Environment	3T+3P (3X4+3X2=18 Credits) **DSE-B** Any **one** from 1. Medical Microbiology and Immunology 2. Industrial Microbiology and Food Microbiology
Ability Enhancement Compulsory Course (AECC)	1 Th + 0 P **AECC-1 Communicative English/MIL**	1 Th + 0 P **AECC-2 Environmental Studies**				
Skill Enhance-ment Elective(SEC)			1Th+0P (1X2=2 Credits) **SEC-A**	1T+0P (1X2=2Credits) **SEC-B**	1T+0P (1X2=2 Credits) **SEC-A**	1T+0P (1X2=2 Credits) **SEC-B**

			(any one: either in Sem-3 or in Sem-5 1.Biofertilizers and Biopesticides 2.Microbial Quality Control in Food and Pharmaceutical Industries	**(any one: either in Sem-4 or in Sem-6)** 1.Microbiological Analysis of Air and Water 2. Food Fermentation Techniques	**(any one: either in Sem-3 or in Sem-5)** 1.Biofertilizers and Biopesticides 2. Microbial Quality Control in Food and Pharmaceutical Industries	**(any one: either in Sem-4 or in Sem-6)** 1. Microbiological Analysis of Air and Water 2. Food Fermentation Techniques
Total No. of Courses and Marks	**4 X 100 =400**	**4 X 100 = 400**	**4 X 100 = 400**	**4 X 100 = 400**	**4 X 100 = 400**	**4 X 100 = 400**
Total Credit 120	**20 Credits**	**20 Credits**	**20 Credits**	**20 Credits**	**20 Credits**	**20 Credits**

UNIVERSITY OF CALCUTTA

CBCS SYLLABUS

F
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THREE-YEAR HONOURS
DEGREE COURSE OF STUDIES

MICROBIOLOGY

2018

Structure of B. Sc. Honours Microbiology under CBCS

Core Course: CC

CC-1: **Introduction to Microbiology and Microbial Diversity**

CC-2: **Bacteriology**

CC-3: **Biochemistry**

CC-4: **Cell Biology**

CC-5: **Virology**

CC-6: **Microbial Physiology and Metabolism**

CC-7:Molecular Biology

CC-8: **Microbial Genetics**

CC-9:Environmental Microbiology

CC-10: **Recombinant DNA Technology**

CC-11: **Food and Dairy Microbiology**

CC-12: **Industrial Microbiology**

CC-13: **Immunology**

CC-14: **Medical Microbiology**

Discipline Specific Elective (DSE) (Any Four)

DSE-A*(Any Two)

A1. Microbial Biotechnology

A2. Advances in Microbiology

A3. Plant Pathology

A4. Biomathematics and Biostatistics

***DSE-A: Any one to be chosen in the 5th Semester and another one to be chosen in the 6th Semester.**

DSE-B *(Any Two)

B1. Inheritance Biology

B2. Microbes in Sustainable Agriculture and Development

B3. Instrumentation and Biotechniques

B4. Project Work

***DSE-B: Any one to be chosen in the 5th Semester and another one to be chosen in the 6th Semester.**

These choices must be made by the students before 5th Semester begins.

Skill Enhancement Elective Courses (SEC) (Any Two)

SEC-A (Any One)

A1. Microbial Quality Control in Food and Pharmaceutical Industries

A2. Biofertilizers and Biopesticides

SEC-B (Any One)

B1. Food Fermentation Techniques

B2. Microbiological Analysis of Air and Water

SUBJECT/PAPER CODE FORMAT

1. **Subject Code: MCB**
2. **Honours Code: A**
3. **Course Code: a) Core Course:CC**
   b) Discipline Specific Elective: DSE-A/DSE-B
   c) Skill Enhancement Course: SEC-A/SEC-B
4. **Semester Code: 1/2/3/4/5/6**
5. **Paper No. Code: 1/2/3…../14**
6. **Paper Component Code: a) Theory:TH, b) Practical: P**

SEMESTER –1

B.Sc (HONOURS) MICROBIOLOGY (CBCS STRUCTURE)
CC-1: INTRODUCTION TO MICROBIOLOGY AND MICROBIAL DIVERSITY (THEORY)

MCB-A-CC-1-1-TH

TOTAL HOURS: 50 **CREDITS: 4**

Unit 1 History of Development of Microbiology **No. of Hours: 15**

Development of microbiology as a discipline, Spontaneous generation *vs*. biogenesis. Contributions of Anton von Leeuwenhoek, Louis Pasteur, Robert Koch, Joseph Lister, Alexander Fleming
Role of microorganisms in fermentation, Germ theory of disease, Development of various microbiological techniques and golden era of microbiology, Development of the field of soil microbiology: Contributions of Martinus W. Beijerinck, Sergei N. Winogradsky, Selman A.Waksman Establishment of fields of medical microbiology and immunology through the work of Paul Ehrlich, Elie Metchnikoff, Edward Jenner

Unit 2 Diversity of Microbial World **No. of Hours: 30**

A. Systems of classification

Binomial Nomenclature, Whittaker's five kingdom and Carl Woese's three kingdom classification systems and their utility. Difference between prokaryotic and eukaryotic microorganisms

B. General characteristics of different groups:**Acellular**microorganisms (Viruses, Viroids, Prions)and **Cellular** microorganisms (Bacteria, Algae, Fungi and Protozoa) with emphasis on distribution and occurrence, morphology, mode of reproduction and economic importance.

• **Algae**

History of phycology with emphasis on contributions of Indian scientists; General characteristics of algae including occurrence, thallus organization, algae cell ultra-structure, pigments, flagella, eyespot food reserves and vegetative, asexual and sexual reproduction. Different types of life cycles in algae with suitable examples: Haplobiontic, Haplontic, Diplontic, Diplobiontic and Diplohaplontic life cycles. Applications of algae in agriculture, industry, environment and food.

• **Fungi**

Historical developments in the field of Mycology including significant contributions of eminent mycologists. General characteristics of fungi including habitat, distribution, nutritional requirements, fungal cell ultra- structure, thallus organization and aggregation, fungal wall structure and synthesis, asexual reproduction, sexual reproduction, heterokaryosis, heterothallism and parasexual mechanism. Economic importance of fungi with examples in agriculture, environment, Industry, medicine, food, biodeterioration and mycotoxins.

• **Protozoa**

General characteristics with special reference to *Amoeba, Paramecium, Plasmodium, Leishmania andGiardia*

Unit 3 An overview of Scope of Microbiology **No. of Hours: 5**

SEMESTER –1

CC-1: INTRODUCTION TO MICROBIOLOGY AND MICROBIAL DIVERSITY (PRACTICALS)
MCB-A-CC-1-1-P

TOTAL HOURS: 60 **CREDITS: 2**

1. Microbiology Good Laboratory Practices and Biosafety.
2. To study the principle and applications of important instruments (biological safety cabinets, autoclave, incubator, BOD incubator, hot air oven, light microscope, pH meter) used in the microbiology laboratory.
3. Preparation of culture media for bacterial cultivation.
4. Sterilization of medium using Autoclave and assessment for sterility
5. Sterilization of glassware using Hot Air Oven and assessment for sterility
6. Sterilization of heat sensitive material by membrane filtration and assessment for sterility
7. Demonstration of the presence of microflora in the environment by exposing nutrient agar plates to air.
8. Study of *Rhizopus*, *Penicillium*, *Aspergillus* using temporary mounts
9. Study of *Spirogyra* and *Chlamydomonas*, *Volvox* using temporary Mounts
10. Study of the following protozoans using permanent mounts/photographs: *Amoeba*, *Entamoeba*, *Paramecium* and *Plasmodium*

SUGGESTED READING

1. Tortora GJ, Funke BR and Case CL. (2008). Microbiology: An Introduction. 9th edition. Pearson Education

2. Madigan MT, Martinko JM, Dunlap PV and Clark DP. (2014). Brock Biology of Microorganisms. 14th edition. Pearson International Edition

3. Cappucino J and Sherman N. (2010). Microbiology: A Laboratory Manual. 9th edition. Pearson Education Limited

4.Wiley JM, Sherwood LM and Woolverton CJ. (2013) Prescott's Microbiology. 9th Edition. McGraw Hill International.

5. Atlas RM. (1997). Principles of Microbiology. 2nd edition. WM.T.Brown Publishers.

6. Pelczar MJ, Chan ECS and Krieg NR. (1993). Microbiology. 5th edition. McGraw Hill Book Company.

7. Stanier RY, Ingraham JL, Wheelis ML, and Painter PR. (2005). GeneralMicrobiology. 5thedition. McMillan.

B.Sc (HONOURS) MICROBIOLOGY (CBCS STRUCTURE)

CC-2: BACTERIOLOGY (THEORY)

SEMESTER –1

MCB-A-CC-1-2-TH

TOTAL HOURS: 50 **CREDITS: 4**

Unit 1 Cell organization **No. of Hours: 10**

Cell size, shape and arrangement, glycocalyx, capsule, flagella, endoflagella, fimbriae and pili. Cell-wall: Composition and detailed structure of Gram-positive and Gram-negative cell walls, Archaebacterial cell wall, Gram and acid fast staining mechanisms, lipopolysaccharide (LPS), sphaeroplasts, protoplasts, and L-forms. Effect of antibiotics and enzymes on the cell wall.
Cell Membrane: Structure, function and chemical composition of bacterial and archaeal cell membranes.
Cytoplasm: Ribosomes, mesosomes, inclusion bodies, nucleoid, chromosome and plasmids
Endospore: Structure, formation, stages of sporulation.

Unit 2 Bacteriological techniques **No. of Hours: 5**

Pure culture isolation: Streaking, serial dilution and plating methods; cultivation, maintenance and preservation/stocking of pure cultures; cultivation of anaerobic bacteria, and accessing non-culturable bacteria.

Unit 3 Microscopy No. of Hours: 6 Bright Field Microscope, Dark Field Microscope, Phase Contrast Microscope, Fluoresence Microscope, Confocal microscopy, Scanning and Transmission Electron Microscope

Unit 4 Growth and nutrition **No. of Hours: 8**

Nutritional requirements in bacteria and nutritional categories;
Culture media: components of media, natural and synthetic media, chemically defined media, complex media, selective, differential, indicator, enriched and enrichment media
Physical methods of microbial control: heat, low temperature, high pressure, filtration, desiccation,osmotic pressure, radiation
Chemical methods of microbial control: disinfectants, types and mode of action

Unit 5 Reproduction in Bacteria **No. of Hours: 3**

Asexual methods of reproduction, logarithmic representation of bacterial populations, phases of growth, calculation of generation time and specific growth rate

Unit 6 Bacterial Systematics **No. of Hours: 8**

Aim and principles of classification, systematics and taxonomy, concept of species, taxa, strain; conventional, molecular and recent approaches to polyphasic bacterial taxonomy, evolutionary chronometers, rRNA oligonucleotide sequencing, signature sequences, and protein sequences. Differences between eubacteria and archaebacteria

Unit 7 Important archaeal and eubacterial groups **No. of Hours: 10**

Archaebacteria: General characteristics, phylogenetic overview, genera belonging to Nanoarchaeota(*Nanoarchaeum*), Crenarchaeota (*Sulfolobus, Thermoproteus*) and Euryarchaeota [Methanogens (*Methanobacterium, Methanocaldococcus*), thermophiles (*Thermococcus, Pyrococcus, Thermoplasma*), and Halophiles (*Halobacterium, Halococcus*)]
Eubacteria: Morphology, metabolism, ecological significance and economic importance of followinggroups:
Gram Negative:
Non proteobacteria: General characteristics with suitable examples
Alpha proteobacteria: General characteristics with suitable examples
Beta proteobacteria: General characteristics with suitable examples
Gamma proteobacteria: General characteristics with suitable examples

Delta proteobacteria: General characteristics with suitable examples
Epsilon proteobacteria: General characteristics with suitable examples Zeta proteobacteria: General characteristics with suitable examples ***Gram Positive:***
Low G+ C (Firmicutes): General characteristics with suitable examples
High G+C (Actinobacteria): General characteristics with suitable examples
***Cyanobacteria*:**An Introduction

CC-2: BACTERIOLOGY (PRACTICAL)
SEMESTER –1
MCB-A-CC-1-2-P

TOTAL HOURS: 60 **CREDITS: 2**

1. Preparation of different media: synthetic media CzapekDox media and /or BG-11, Complex media-Nutrient agar, McConkey agar, EMB agar.
2. Simple staining
3. Negative staining
4. Gram's staining
5. Acid fast staining-permanent slide only.
6. Capsule staining
7. Endospore staining.
8. Isolation of pure cultures of bacteria by streaking method.
9. Preservation of bacterial cultures by various techniques.
10. Estimation of CFU count by spread plate method/pour plate method.
11. Motility by hanging drop method.

SUGGESTED READINGS

1. Atlas RM. (1997). Principles of Microbiology. 2nd edition. WM.T.Brown Publishers.
2. Black JG. (2008). Microbiology: Principles and Explorations. 7th edition. Prentice Hall
3. Madigan MT, and Martinko JM. (2014). Brock Biology of Micro-organisms. 14th edition. Parker J. Prentice Hall International, Inc.
4. PelczarJr MJ, Chan ECS, and Krieg NR. (2004). Microbiology. 5th edition Tata McGraw Hill.
5. Srivastava S and Srivastava PS. (2003). Understanding Bacteria. Kluwer Academic Publishers, Dordrecht
6. Stanier RY, Ingraham JL, Wheelis ML and Painter PR. (2005). General Microbiology. 5th edition McMillan.
7. Tortora GJ, Funke BR, and Case CL. (2008). Microbiology: An Introduction. 9th edition Pearson Education.
8. Willey JM, Sherwood LM, and Woolverton CJ. (2013). Prescott's Microbiology. 9th edition. McGraw Hill Higher Education.
9. Cappucino J and Sherman N. (2010). Microbiology: A Laboratory Manual. 9th edition. Pearson Education Limited

B.Sc (HONOURS) MICROBIOLOGY (CBCS STRUCTURE)
CC-3: BIOCHEMISTRY (THEORY)
SEMESTER –2
MCB-A-CC-2-3-TH

TOTAL HOURS: 50 **CREDITS: 4**

Unit 1 Bioenergetics **No. of Hours: 6**

First and second laws of Thermodynamics. Definitions of Gibb's Free Energy, enthalpy,and Entropy and mathematical relationship among them, Standard free energy change and equilibrium constant Coupled reactions and additive nature of standard free energy change, Energy rich compounds: Phosphoenolpyruvate, 1,3- Bisphosphoglycerate, Thioesters, ATP

Unit 2 Carbohydrates **No. of Hours: 10**

Families of monosaccharides: aldoses and ketoses, trioses, tetroses, pentoses, and hexoses. Stereo isomerism of monosaccharides, epimers, Mutarotation and anomers of glucose.Furanose and pyranose forms of glucose and fructose, Haworth projection formulae for glucose; chair and boat forms of glucose, Sugar derivatives, glucosamine, galactosamine, muramic acid, N- acetyl neuraminic acid, Disaccharides; concept of reducing and non-reducing sugars, occurrence and Haworth projections of maltose, lactose, and sucrose, Polysaccharides, storage polysaccharides, starch and glycogen. Structural Polysaccharides, cellulose, peptidoglycan and chitin

Unit 3 Lipids **No. of Hours: 10**

Definition and major classes of storage and structural lipids.Storage lipids.Fatty acids structure and functions.Essential fatty acids.Triacylglycerols structure, functions and properties. Saponification Structural lipids.Phosphoglycerides: Building blocks, General structure, functions and properties. Structure of phosphatidylethanolamine and phosphatidylcholine, Sphingolipids: building blocks, structure of sphingosine, ceramide. Special mention of sphingomyelins, cerebrosides and gangliosides Lipid functions: cell signals, cofactors, prostaglandins, Introduction of lipid micelles, monolayers, bilayers

Unit 4 Proteins **No. of Hours: 10**

Functions of proteins, Primary structures of proteins: Amino acids, the building blocks of proteins. General formula of amino acid and concept of zwitterion. Titration curve of amino acid and its Significance, Classification, biochemical structure and notation of standard protein amino acids Ninhydrinreaction.Natural modifications of amino acids in proteins hydrolysine, cystine and hydroxyproline, Non protein amino acids: Gramicidin, beta-alanine, D-alanine and D- glutamic acid Oligopeptides: Structure and functions of naturally occurring glutathione and insulin and synthetic aspartame, Secondary structure of proteins: Peptide unit and its salient features. The alpha helix, the beta pleated sheet and their occurrence in proteins, Tertiary and quaternary structures of proteins. Forces holding the polypeptide together. Human haemoglobin structure, Quaternary structures of proteins

Unit 5. Enzymes **No. of Hours: 10**

Structure of enzyme: Apoenzyme and cofactors, prosthetic group-TPP, coenzyme NAD,metal cofactors, Classification of enzymes, Mechanism of action of enzymes: active site, transition state complex and activation energy. Lock and key hypothesis, and Induced Fit hypothesis. Significance of hyperbolic, double reciprocal plots of enzyme activity, Km, and allosteric mechanism Definitions of terms – enzyme unit, specific activity and turnover number, Multienzymecomplex : pyruvate dehydrogenase; isozyme: lactate dehydrogenase, Effect of pH and temperature on enzyme activity. Enzyme inhibition: competitive- sulfa drugs; non-competitive-heavy metal salts

Unit 6. Vitamins **No. of Hours: 4**

Classification and characteristics with suitable examples, sources and importance

CC-3: BIOCHEMISTRY (PRACTICALS)
SEMESTER –2
MCB-A-CC-2-3-P

TOTAL HOURS: 60 **CREDITS: 2**

1. Properties of water, Concept of pH and buffers, preparation of buffers and Numerical problems to explain the concepts
2. Numerical problems on calculations of Standard Free Energy Change and Equilibrium constant
3. Standard Free Energy Change of coupled reactions
4. Qualitative/Quantitative tests for carbohydrates, reducing sugars, non reducing sugars
5. Qualitative/Quantitative tests for lipids and proteins
6. Study of protein secondary and tertiary structures with the help of models
7. Study of enzyme kinetics – calculation of V_{max} , Km, Kcat values
8. Study effect of temperature, pH and Heavy metals on enzyme activity
9. Estimation of any one vitamin

SUGGESTED READING

1. Campbell, MK (2012) Biochemistry, 7th ed., Published by Cengage Learning
2. Campbell, PN and Smith AD (2011) Biochemistry Illustrated, 4th ed., Published by Churchill Livingstone
3. Tymoczko JL, Berg JM and Stryer L (2012) Biochemistry: A short course, 2nd ed., W.H.Freeman
4. Berg JM, Tymoczko JL and Stryer L (2011) Biochemistry, W.H.Freeman and Company
5. Nelson DL and Cox MM (2008) Lehninger Principles of Biochemistry, 5th Edition., W.H. Freeman and Company,
6. Willey MJ, Sherwood, LM &Woolverton C J (2013) Prescott, Harley and Klein's Microbiology by. 9th Ed., McGrawHill
7. Voet,D. and Voet J.G (2004) Biochemistry 3rd edition, John Wiley and Sons,

B.Sc (HONOURS) MICROBIOLOGY (CBCS STRUCTURE)
CC-4: CELL BIOLOGY (THEORY)
SEMESTER –2

MCB-A-CC-2-4-TH

TOTAL HOURS: 50 **CREDITS: 4**

Unit 1 Structure and organization of Cell **No. of Hours: 12**

Cell Organization – Eukaryotic (Plant and animal cells) and prokaryotic
Plasma membrane: Structure and transport of small molecules
Cell Wall: Eukaryotic cell wall, Extra cellular matrix and cell matrix interactions, Cell-Cell Interactions - adhesion junctions, tight junctions, gap junctions, and plasmodesmata (only structural aspects)
Mitochondria, chloroplasts and peroxisomes
Cytoskeleton: Structure and organization of actin filaments, association of actin filaments with plasma membrane, cell surface protrusions, intermediate filaments, microtubules

Unit 2 Nucleus **No. of Hours: 4**

Nuclear envelope, nuclear pore complex and nuclear lamina
Chromatin – Molecular organization
Nucleolus

Unit 3 Protein Sorting and Transport **No. of Hours: 12**

Ribosomes, Endoplasmic Reticulum – Structure, targeting and insertion of proteins in the ER, protein folding, processing and quality control in ER, smooth ER and lipid synthesis, export of proteins and lipids
Golgi Apparatus – Organization, protein glycosylation, protein sorting and export from Golgi Apparatus
Lysosomes

Unit 4 Cell Signalling **No. of Hours: 10**

Signalling molecules and their receptors
Function of cell surface receptors
Pathways of intra-cellular receptors – Cyclic AMP pathway, cyclic GMP and MAP kinase pathway

Unit 5 Cell Cycle, Cell Death and Cell Renewal **No. of Hours: 12**

Eukaryotic cell cycle and its regulation, Mitosis and Meiosis
Development of cancer, causes and types
Programmed cell death
Stem cells
Embryonic stem cell, induced pleuripotent stem cells

CC-4: CELL BIOLOGY (PRACTICAL)
SEMESTER –2

MCB-A-CC-2-4-P

TOTAL HOURS: 60 **CREDITS: 2**

1. Study a representative plant and animal cell by microscopy.
2. Study of the structure of cell organelles through electron micrographs
3. Cytochemical staining of DNA – Feulgen
4. Demonstration of the presence of mitochondria in striated muscle cells/ cheek epithelial cell using vital stain Janus Green B
5. Study of polyploidy in Onion root tip by colchicine treatment.

6. Identification and study of cancer cells by photomicrographs.
7. Study of different stages of Mitosis.
8. Study of different stages of Meiosis.

SUGGESTED READING

1. Hardin J, Bertoni G and Kleinsmith LJ. (2010). Becker's World of the Cell. 8th edition. Pearson.
2. Karp G. (2010) Cell and Molecular Biology: Concepts and Experiments. 6th edition. John Wiley & Sons. Inc.
3. De Robertis, EDP and De Robertis EMF. (2006). Cell and Molecular Biology. 8th edition. Lipincott Williams and Wilkins, Philadelphia.
4. Cooper, G.M. and Hausman, R.E. (2009). The Cell: A Molecular Approach. 5th Edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.

B.Sc (HONOURS) MICROBIOLOGY (CBCS STRUCTURE)
CC-5: VIROLOGY (THEORY)
SEMESTER –3

MCB-A-CC-3-5-TH

TOTAL HOURS: 50 **CREDITS: 4**

Unit 1 Nature and Properties of Viruses **No. of Hours: 10**

Introduction: Discovery of viruses, nature and definition of viruses, general properties, concept of viroids, virusoids, satellite viruses and Prions. Theories of viral origin
Structure of Viruses: Capsid symmetry, enveloped and non-enveloped viruses Isolation, purification and cultivation of viruses
Viral taxonomy: Classification and nomenclature of different groups of viruses

Unit 2 Bacteriophages **No. of Hours**: **10**

Diversity, classification, one step multiplication curve, lytic and lysogenic phages (lambda phage) concept of early and late proteins, regulation of transcription in lambda phage

Unit 3 Viral Transmission, Salient features of viral nucleic acids and Replication
No. of Hours: **14**

Modes of viral transmission: Persistent, non-persistent, vertical and horizontal
Salient features of viral Nucleic acid : Unusual bases (TMV,T4 phage), overlapping genes (ϕX174, Hepatitis B virus), alternate splicing (HIV), terminal redundancy (T4 phage), terminal cohesive ends (lambda phage), partial double stranded genomes (Hepatitis B), long terminal repeats (retrovirus), segmented (Influenza virus), and non-segmented genomes (picornavirus), capping and tailing (TMV) Viral multiplication and replication strategies: Interaction of viruses with cellular receptors and entry of viruses. Replication strategies of viruses as per Baltimore classification (phi X 174, Retroviridae, Vaccinia, Picorna) , Assembly, maturation and release of virions

Unit 4 Viruses and Cancer **No. of Hours: 6**

Introduction to oncogenic viruses
Types of oncogenic DNA and RNA viruses: Concepts of oncogenes and proto-oncogenes

Unit 5 Prevention & control of viral diseases **No. of Hours: 6**

Antiviral compounds and their mode of action
Interferon and their mode of action
General principles of viral vaccination

Unit 6 Applications of Virology **No. of Hours: 4**

Use of viral vectors in cloning and expression, Gene therapy and Phage display

CC-5: VIROLOGY (PRACTICAL)
SEMESTER –3

MCB-A-CC-3-5-P

TOTAL HOURS: 60 **CREDITS: 2**

1. Study of the structure of important animal viruses (rhabdo, influenza, paramyxo hepatitis B and retroviruses) using electron micrographs
2. Study of the structure of important plant viruses (caulimo, Gemini, tobacco ring spot, cucumber mosaic and alpha-alpha mosaic viruses) using electron micrographs
3. Study of the structure of important bacterial viruses (ϕX 174, T4, λ) using electron micrograph.
4. Isolation and enumeration of bacteriophages (PFU) from water/sewage sample using double agar layer technique

5. Studying isolation and propagation of animal viruses by chick embryo technique
6. Study of cytopathic effects of viruses using photographs
7. Perform local lesion technique for assaying plant viruses.

SUGGESTED READING

1. Dimmock, NJ, Easton, AL, Leppard, KN (2007). Introduction to Modern Virology. 6th edition, Blackwell Publishing Ltd.
2. Carter J and Saunders V (2007). Virology: Principles and Applications. John Wiley and Sons.
3. Flint SJ, Enquist, LW, Krug, RM, Racaniello, VR, Skalka, AM (2004). Principles of Virology, Molecular biology, Pathogenesis and Control. 2nd edition. ASM press Washington DC.
4. Levy JA, Conrat HF, Owens RA. (2000). Virology. 3rd edition. Prentice Hall publication, New Jersey.
5. Wagner EK, Hewlett MJ. (2004). Basic Virology. 2nd edition. Blackwell Publishing.
6. Mathews. (2004). Plant Virology. Hull R. Academic Press, New York.
7. Nayudu MV. (2008). Plant Viruses. Tata McGraw Hill, India.
8. Bos L. (1999) Plant viruses-A text book of plant virology by. Backhuys Publishers.
9. Versteeg J. (1985). A Color Atlas of Virology. Wolfe Medical Publication.

B.Sc (HONOURS) MICROBIOLOGY (CBCS STRUCTURE)
CC-6: MICROBIAL PHYSIOLOGY AND METABOLISM
(THEORY)
SEMESTER –3

MCB-A-CC-3-6-TH

TOTAL HOURS: 50 **CREDITS: 4**

Unit 1 Microbial Growth and Effect of Environment on Microbial Growth **No. of Hours: 10**

Definitions of growth, measurement of microbial growth, Batch culture, Continuous culture, generation time and specific growth rate, synchronous growth, diauxic growth curve

Microbial growth in response to environment -Temperature (psychrophiles, mesophiles, thermophiles, extremophiles, thermodurics, psychrotrophs), pH (acidophiles, alkaliphiles), solute and water activity (halophiles, xerophiles, osmophilic), Oxygen (aerobic, anaerobic, microaerophilic, facultative aerobe, facultative anaerobe),barophilic.

Microbial growth in response to nutrition and energy – Autotroph/Phototroph, heterotrophy, Chemolithoautotroph, Chemolithoheterotroph, Chemoheterotroph, Chemolithotroph, photolithoautotroph, Photoorganoheterotroph.

Unit 2 Nutrient uptake and Transport **No. of Hours: 8**

Passive and facilitated diffusion

Primary and secondary active transport, concept of uniport, symport and antiport

Group translocation

Iron uptake

Unit 3 Chemoheterotrophic Metabolism - Aerobic Respiration **No. of Hours: 10**

Concept of aerobic respiration, anaerobic respiration and fermentation

Sugar degradation pathways i.e. EMP, ED, Pentose phosphate pathway

TCA cycle

Electron transport chain: components of respiratory chain, comparison of mitochondrial and bacterial ETC, electron transport phosphorylation, uncouplers and inhibitors

Unit 4 Chemoheterotrophic Metabolism- Anaerobic respiration and fermentation
No. of Hours: 6

Anaerobic respiration with special reference to dissimilatory nitrate reduction (Denitrification; nitrate /nitrite and nitrate/ammonia respiration; fermentative nitrate reduction)

Fermentation - Alcohol fermentation and Pasteur effect; Lactate fermentation (homofermentative and heterofermentative pathways), concept of linear and branched fermentation pathways

Unit 5 Chemolithotrophic and Phototrophic Metabolism **No. of Hours: 10**

Introduction to aerobic and anaerobic chemolithotrophy with an example each. Hydrogen oxidation (definition and reaction) and methanogenesis (definition and reaction) Introduction to phototrophic metabolism - groups of phototrophic microorganisms,

anoxygenic*vs.* oxygenic photosynthesis with reference to photosynthesis in green bacteria, purple bacteria and cyanobacteria

Unit 6 Nitrogen Metabolism - an overview **No. of Hours: 6**

Introduction to biological nitrogen fixation

Ammonia assimilation

Assimilatory nitrate reduction, dissimilatory nitrate reduction, denitrification

CC-6: MICROBIAL PHYSIOLOGY AND METABOLISM (PRACTICAL)
SEMESTER –3
MCB-A-CC-3-6-P

TOTAL HOURS: 60 **CREDITS: 2**

1. Study and plot the growth curve of *E. coli* by turbidometric and standard plate count methods.
2. Calculations of generation time and specific growth rate of bacteria from the graph plotted with the given data
3. Effect of temperature on growth of *E. coli*
4. Effect of pH on growth of *E. coli*
5. Effect of carbon and nitrogen sources on growth of *E.coli*
6. Effect of salt on growth of *E. coli*
7. Demonstration of alcoholic fermentation
8. Demonstration of the thermal death time and decimal reduction time of *E. coli*.

SUGGESTED READINGS

1. Madigan MT, and Martinko JM (2014). Brock Biology of Microorganisms. 14th edition. Prentice Hall International Inc.
2. Moat AG and Foster JW. (2002). Microbial Physiology. 4th edition. John Wiley & Sons
3. Reddy SR and Reddy SM. (2005). Microbial Physiology. Scientific Publishers India
4. Gottschalk G. (1986). Bacterial Metabolism. 2nd edition. Springer Verlag
6. Stanier RY, Ingrahm JI, Wheelis ML and Painter PR. (1987). General Microbiology. 5th edition, McMillan Press.
7. Willey JM, Sherwood LM, and Woolverton CJ. (2013). Prescott's Microbiology. 9th edition. McGraw Hill Higher Education.

B.Sc (HONOURS) MICROBIOLOGY (CBCS STRUCTURE)
CC-7: MOLECULAR BIOLOGY (THEORY)
SEMESTER –3

MCB-A-CC-3-7-TH

TOTAL HOURS: 50 **CREDITS: 4**

Unit 1 Structures of DNA and RNA / Genetic Material **No. of Hours: 10**

DNA Structure: Miescher to Watson and Crick- historic perspective, DNA structure, Salient features of double helix, Types of DNA, Types of genetic material, denaturation and renaturation, cot curves. DNA topology - linking number, topoisomerases; Organization of DNA Prokaryotes,Viruses, Eukaryotes.RNA Structure, Organelle DNA -- mitochondria and chloroplast DNA.

Unit 2 Replication of DNA (Prokaryotes and Eukaryotes) **No. of Hours: 8**
Bidirectional and unidirectional replication, semi- conservative, semi- discontinuous replication
Mechanism of DNA replication: Enzymes and proteins involved in DNA replication –DNA polymerases, DNA ligase, primase, telomerase – for replication of linear ends
Various models of DNA replication including rolling circle, D- loop (mitochondrial), Ɵ (theta) mode of replication and other accessory protein, Mismatch and excision repair

Unit 3 Transcription in Prokaryotes and Eukaryotes **No. of Hours: 8**
Transcription: Definition, difference from replication, promoter - concept and strength of promoter RNA Polymerase and the transcription unit
Transcription in Eukaryotes: RNA polymerases, general Transcription factors

Unit 4 Post-Transcriptional Processing **No. of Hours: 6**
Split genes, concept of introns and exons, RNA splicing, spliceosome machinery**,** concept of alternative splicing, Polyadenylation and capping, Processing of rRNA, RNA interference: si RNA, miRNA and its significance

Unit 5 Translation (Prokaryotes and Eukaryotes) **No. of Hours: 8**
Translational machinery, Charging of tRNA, aminoacyltRNA synthetases, Mechanisms of initiation, elongation and termination of polypeptides in both prokaryotes and eukaryotes, Fidelity of translation, Inhibitors of protein synthesis in prokaryotes and eukaryote

Unit 6 Regulation of gene Expression in Prokaryotes and Eukaryotes **No. of Hours: 10**
Principles of transcriptional regulation, regulation at initiation with examples from *lac* and *trp* operons, Sporulation in *Bacillus*,Yeast mating type switching , Changes in Chromatin Structure - DNA methylation and Histone Acetylation mechanisms.

CC-7: MOLECULAR BIOLOGY (PRACTICAL)
SEMESTER –3
MCB-A-CC-3-7-P

TOTAL HOURS: 60 **CREDITS: 2**

1. Study of different types of DNA and RNA using micrographs and model / schematic representations
2. Study of semi-conservative replication of DNA through micrographs / schematic representations
3. Isolation of genomic DNA from *E. coli*
4. Estimation of salmon sperm / calf thymus DNA using colorimeter (diphenylamine

reagent) or UV spectrophotometer (A_{260} measurement)
5. Estimation of RNA using colorimeter (orcinol reagent) or UV spectrophotometer (A_{260} measurement)
6. Resolution and visualization of DNA by Agarose Gel Electrophoresis.
7. Resolution and visualization of proteins by Polyacrylamide Gel Electrophoresis (SDS-PAGE).

SUGGESTED READINGS

1. Watson JD, Baker TA, Bell SP, Gann A, Levine M and Losick R (2008) Molecular Biology of the Gene, 6th edition, Cold Spring Harbour Lab. Press, Pearson Publication
2. Becker WM, Kleinsmith LJ, Hardin J and Bertoni GP (2009) The World of the Cell, 7th edition, Pearson Benjamin Cummings Publishing, San Francisco
3. De Robertis EDP and De Robertis EMF (2006) Cell and Molecular Biology, 8th edition. Lippincott Williams and Wilkins, Philadelphia
4. Karp G (2010) Cell and Molecular Biology: Concepts and Experiments, 6th edition, John Wiley & Sons. Inc.
5. Sambrook J and Russell DW. (2001). Molecular Cloning: A Laboratory Manual. 4th Edition, Cold Spring Harbour Laboratory press.
6. Krebs J, Goldstein E, Kilpatrick S (2013). Lewin's Essential Genes, 3rd Ed., Jones and Bartlett Learning
7. Gardner EJ, Simmons MJ, Snustad DP (2008). Principles of Genetics. 8th Ed. Wiley-India

B.Sc (HONOURS) MICROBIOLOGY (CBCS STRUCTURE)
CC-8: MICROBIAL GENETICS (THEORY)
SEMESTER –4

MCB-A-CC-4-8-TH

TOTAL HOURS: 50 **CREDITS: 4**

Unit 1 Genome Organization and Mutations **No. of Hours: 14**

Genome organization: *E. coli, Saccharomyces, Tetrahymena*

Mutations and mutagenesis: Definition and types of Mutations; Physical and chemical mutagens; Molecular basis of mutations; Functional mutants (loss and gain of function mutants); Uses of mutations

Reversion and suppression: True revertants; Intra- and inter-genic suppression; Ames test; Mutator genes

Unit 2 Plasmids **No. of Hours: 8**

Types of plasmids – F plasmid, R Plasmids, colicinogenic plasmids, Ti plasmids, linear plasmids, yeast- 2 μ plasmid, Plasmid replication and partitioning, Host range, plasmid-incompatibility, plasmid amplification, Regulation of copy number, curing of plasmids

Unit 3 Mechanisms of Genetic Exchange Transformation - **No. of Hours: 10**

Discovery, mechanism of natural competence

Conjugation - Discovery, mechanism, Hfr and F' strains, Interrupted mating technique and time of entry mapping

Transduction - Generalized transduction, specialized transduction, LFT & HFT lysates, Mapping by recombination and co-transduction of markers

Unit 4 Phage Genetics **No. of Hours: 8**

Features of T4 genetics , Genetic basis of lytic *versus* lysogenic switch of phage lambda

Unit 5 Transposable elements **No. of Hours: 10**

Prokaryotic transposable elements – Insertion Sequences, composite and non-composite transposons, Replicative and Non replicative transposition, Mu transposon

Eukaryotic transposable elements - Yeast (Ty retrotransposon), Drosophila (P elements), Maize (Ac/Ds)

Uses of transposons and transposition

CC-8: MICROBIAL GENETICS (PRACTICAL)
SEMESTER –4

MCB-A-CC-4-8-P

TOTAL HOURS: 60 **CREDITS: 2**

1. Preparation of Master and Replica Plates
2. Study the effect of chemical (HNO_2) and physical (UV) mutagens on bacterial cells
3. Study survival curve of bacteria after exposure to ultraviolet (UV) light
4. Isolation of Plasmid DNA from *E.coli*
5. Study different conformations of plasmid DNA through Agaraose gel electrophoresis.
6. Demonstration of Bacterial Conjugation
7. Demonstration of bacterial transformation and transduction
8. Demonstration of AMES test

SUGGESTED READING

1. Klug WS, Cummings MR, Spencer, C, Palladino, M (2011). Concepts of Genetics, 10th Ed., Benjamin Cummings
2. Krebs J, Goldstein E, Kilpatrick S (2013). Lewin's Essential Genes, 3rd Ed., Jones and Bartlett Learning
3. Pierce BA (2011) Genetics: A Conceptual Approach, 4th Ed., Macmillan Higher Education Learning
4. Watson JD, Baker TA, Bell SP et al. (2008) Molecular Biology of the Gene, 6th Ed., Benjamin Cummings
5. Gardner EJ, Simmons MJ, Snustad DP (2008). Principles of Genetics. 8th Ed. Wiley-India
6. Russell PJ. (2009). *i* Genetics- A Molecular Approach. 3rd Ed, Benjamin Cummings
7. Sambrook J and Russell DW. (2001). Molecular Cloning: A Laboratory Manual. 4th Edition, Cold Spring Harbour Laboratory press.
8. Maloy SR, Cronan JE and Friefelder D(2004) Microbial Genetics 2nd EDITION., Jones and Barlett Publishers

B.Sc (HONOURS) MICROBIOLOGY (CBCS STRUCTURE)
CC-9: ENVIRONMENTAL MICROBIOLOGY (THEORY)
SEMESTER –4

MCB-A-CC-4-9-TH

TOTAL HOURS: 50 **CREDITS: 4**

Unit 1 Microorganisms and their Habitats **No. of Hours: 10**

Structure and function of ecosystems
Terrestrial Environment: Soil profile and soil microflora
Aquatic Environment: Microflora of fresh water and marine habitats
Atmosphere: Aeromicroflora and dispersal of microbes
Animal Environment: Microbes in/on human body (Microbiomics) & animal (ruminants) body.
Extreme Habitats: Extremophiles: Microbes thriving at high & low temperatures, pH, high hydrostatic & osmotic pressures, salinity, & low nutrient levels. Microbial succession in decomposition of plant organic matter

Unit 2 Microbial Interactions **No. of Hours: 10**

Microbe interactions: Mutualism, synergism, commensalism, competition, amensalism, parasitism, predation
Microbe-Plant interaction: Symbiotic and non symbiotic interactions
Microbe-animal interaction: Microbes in ruminants, nematophagus fungi and symbiotic luminescent bacteria

Unit 3 Biogeochemical Cycling **No. of Hours: 10**

Carbon cycle: Microbial degradation of cellulose, hemicelluloses, lignin and chitin
Nitrogen cycle: Nitrogen fixation, ammonification, nitrification, denitrification and nitrate reduction
Phosphorus cycle: Phosphate immobilization and solubilisation
Sulphur cycle: Microbes involved in sulphur cycle
Other elemental cycles: Iron and manganese

Unit 4 Waste Management **No. of Hours: 10**

Solid Waste management: Sources and types of solid waste, Methods of solid waste disposal (composting and sanitary landfill)
Liquid waste management: Composition and strength of sewage (BOD and COD), Primary, secondary (oxidation ponds, trickling filter, activated sludge process and septic tank) and tertiary sewage treatment

Unit 5 Microbial Bioremediation **No. of Hours: 5**

Principles and degradation of common pesticides, organic (hydrocarbons, oil spills) and inroganic (metals) matter, biosurfactants

Unit 6 Water Potability **No. of Hours: 5**

Treatment and safety of drinking (potable) water, methods to detect potability of water samples: (a) standard qualitative procedure: presumptive test/MPN test, confirmed and completed tests for faecal coliforms (b) Membrane filter technique and (c) Presence/absence tests

CC-9: ENVIRONMENTAL MICROBIOLOGY (PRACTICAL)
SEMESTER –4
MCB-A-CC-4-9-P

TOTAL HOURS: 60 **CREDITS: 2**

1. Analysis of soil - pH, moisture content, water holding capacity, percolation, capillary action.
2. Isolation of microbes (bacteria & fungi) from soil (28ºC & 45ºC).
3. Isolation of microbes (bacteria & fungi) from rhizosphere and rhizoplane.
4. Assessment of microbiological quality of water.
5. Determination of BOD of waste water sample.
6. Study the presence of microbial activity by detecting (qualitatively) enzymes (dehydrogenase, amylase, urease) in soil.
7. Isolation of *Rhizobium* from root nodules.

SUGGESTED READINGS

1. Atlas RM and Bartha R. (2000). Microbial Ecology: Fundamentals & Applications. 4th edition. Benjamin/Cummings Science Publishing, USA
2. Madigan MT, Martinko JM and Parker J. (2014). Brock Biology of Microorganisms. 14th edition. Pearson/ Benjamin Cummings
3. Maier RM, Pepper IL and Gerba CP. (2009). Environmental Microbiology. 2nd edition, Academic Press
4. Okafor, N (2011). Environmental Microbiology of Aquatic & Waste systems. 1st edition, Springer, New York
5. Singh A, Kuhad, RC & Ward OP (2009). Advances in Applied Bioremediation. Volume 17, Springer-Verlag, Berlin Hedeilberg
6. Barton LL & Northup DE (2011). Microbial Ecology. 1st edition, Wiley Blackwell, USA
Campbell RE. (1983). Microbial Ecology. Blackwell Scientific Publication, Oxford, England.
7. Coyne MS. (2001). Soil Microbiology: An Exploratory Approach. Delmar Thomson Learning.
8. Lynch JM &Hobbie JE. (1988). Microorganisms in Action: Concepts & Application in Microbial Ecology. Blackwell Scientific Publication, U.K.
9. Martin A. (1977). An Introduction to Soil Microbiology. 2nd edition. John Wiley & Sons Inc. New York & London.
10. Stolp H. (1988). Microbial Ecology: Organisms Habitats Activities. Cambridge University Press, Cambridge, England.
11. SubbaRao NS. (1999). Soil Microbiology. 4th edition. Oxford & IBH Publishing Co. New Delhi.
12. Willey JM, Sherwood LM, and Woolverton CJ. (2013). Prescott's Microbiology. 9th edition. McGraw Hill Higher Education.

B.Sc (HONOURS) MICROBIOLOGY (CBCS STRUCTURE)
CC-10: RECOMBINANT DNA TECHNOLOGY (THEORY)
SEMESTER –4
MCB-A-CC-4-10-TH

TOTAL HOURS: 50 **CREDITS: 4**

Unit 1 Introduction to Genetic Engineering **No. of Hours: 2**
Milestones in genetic engineering and biotechnology

Unit 2 Molecular Cloning- Tools and Strategies **No. of Hours: 15**
Cloning Tools; Restriction modification systems: Types I, II and III. Mode of action, nomenclature, applications of Type II restriction enzymes in genetic engineering
DNA modifying enzymes and their applications: DNA polymerases. Terminal deoxynucleotidyl transferase, kinases and phosphatases, and DNA ligases Cloning Vectors: Definition and Properties
Plasmid vectors: pBR and pUC series
Bacteriophage lambda and M13 based vectors
Cosmids, BACs, YACs
Use of linkers and adaptors
Expression vectors: *E.coli* lac and T7 promoter-based vectors, yeast YIp, YEp and YCp vectors, Baculovirus based vectors, mammalian SV40-based expression vectors

Unit 3 Methods in Molecular Cloning **No. of Hours: 12**
Transformation of DNA: Chemical method, Electroporation,
Gene delivery: Microinjection, electroporation, biolistic method (gene gun), liposome and viral-mediated delivery, *Agrobacterium* - mediated delivery
DNA, RNA and Protein analysis: Agarose gel electrophoresis, Southern - and Northern - blotting techniques, dot blot, DNA microarray analysis, SDS-PAGE and Western blotting.

Unit4 DNA Amplification and DNA sequencing **No. of Hours: 9**
PCR: Basics of PCR, RT-PCR, Real-Time PCR
Sanger's method of DNA Sequencing: traditional and automated sequencing
Primer walking and shotgun sequencing

Unit 5 Construction and Screening of Genomic and cDNA libraries **No. of Hours: 6**
Genomic and cDNA libraries: Preparation and uses, Screening of libraries: Colony hybridization and colony PCR, Chromosome walking and chromosome jumping

Unit 6 Applications of Recombinant DNA Technology **No. of Hours: 6**
Products of recombinant DNA technology: Products of human therapeutic interest - insulin, hGH, antisense molecules. Bt transgenic - cotton, brinjal, Gene therapy, recombinant vaccines, protein engineering and site directed mutagensis

CC-10: RECOMBINANT DNA TECHNOLOGY (PRACTICAL)
SEMESTER –4
MCB-A-CC-4-10-P

TOTAL HOURS: 60 **CREDITS: 2**

1. Preparation of competent cells for transformation
2. Demonstration of Bacterial Transformation and calculation of transformation efficiency.
3. Digestion of DNA using restriction enzymes and analysis by agarose gel electrophoresis
4. Ligation of DNA fragments
5. Cloning of DNA insert and Blue white screening of recombinants.
6. Interpretation of sequencing gel electropherograms
7. Designing of primers for DNA amplification
8. Amplification of DNA by PCR
9. Demonstration of Southern blotting

SUGGESTED READING

1. Brown TA. (2010). Gene Cloning and DNA Analysis. 6th edition. Blackwell Publishing, Oxford, U.K.
2. Clark DP and Pazdernik NJ. (2009). Biotechnology: Applying the Genetic Revolution. Elsevier Academic Press, USA
3. Primrose SB and Twyman RM. (2006). Principles of Gene Manipulation and Genomics, 7th edition. Blackwell Publishing, Oxford, U.K.
4. Sambrook J and Russell D. (2001). Molecular Cloning-A Laboratory Manual. 3rd edition. Cold Spring Harbor Laboratory Press
5. Wiley JM, Sherwood LM and Woolverton CJ. (2008). Prescott, Harley and Klein's Microbiology. McGraw Hill Higher Education
6. Brown TA. (2007). Genomes-3. Garland Science Publishers
7. Primrose SB and Twyman RM. (2008). Genomics: Applications in human biology. Blackwell Publishing, Oxford, U.K.

B.Sc (HONOURS) MICROBIOLOGY (CBCS STRUCTURE)
CC-11: FOOD AND DAIRY MICROBIOLOGY (THEORY)
SEMESTER –5
MCB-A-CC-5-11-TH

TOTAL HOURS: 50 **CREDITS: 4**

Unit 1 Foods as a substrate for microorganisms **No. of Hours: 6**
Intrinsic and extrinsic factors that affect growth and survival of microbes in foods, natural flora and source of contamination of foods in general.

Unit 2 Microbial spoilage of various foods **No. of Hours: 8**
Principles, Spoilage of vegetables, fruits, meat, eggs, milk and butter, bread, canned Foods

Unit 3 Principles and methods of food preservation **No. of Hours: 8**
Principles, physical methods of food preservation: temperature (low, high, canning, drying), irradiation, hydrostatic pressure, high voltage pulse, microwave processing and aseptic packaging, chemical methods of food preservation: salt, sugar, organic acids, SO_2, nitrite and nitrates, ethylene oxide, antibiotics and bacteriocins

Unit 4 Fermented foods **No. of Hours: 8**
Dairy starter cultures, fermented dairy products: yogurt, acidophilus milk, kumiss, kefir, dahi and cheese, other fermented foods: dosa, sauerkraut, soy sauce and tampeh, Probiotics: Health benefits, types of microorganisms used, probiotic foods available in market.

Unit 5 Food borne diseases (causative agents, foods involved, symptoms and preventive measures) **No. of Hours: 10**
Food intoxications: *Staphylococcus aureus*, *Clostridium botulinum* and mycotoxins;
Food infections: *Bacillus cereus*, *Vibrio parahaemolyticus*, *Escherichia coli*, Salmonellosis, Shigellosis, *Yersinia enterocolitica*, *Listeria monocytogenes* and *Campylobacter jejuni*

Unit 6 Food sanitation and control **No. of Hours: 5**
HACCP, Indices of food sanitary quality and sanitizers

Unit 7 Cultural and rapid detection methods of food borne pathogens in foods and introduction to predictive microbiology. **No. of Hours: 5**

C-11: FOOD AND DAIRY MICROBIOLOGY (PRACTICAL)
SEMESTER –5
MCB-A-CC-5-11-P

TOTAL HOURS: 60 **CREDITS: 2**

1. MBRT of milk samples and their standard plate count.
2. Alkaline phosphatase test to check the efficiency of pasteurization of milk.
3. Isolation of any food borne bacteria from food products.
4. Isolation of spoilage microorganisms from spoiled vegetables/fruits.
5. Isolation of spoilage microorganisms from bread.
6. Preparation of Yogurt/Dahi.

SUGGESTED READINGS

1. Adams MR and Moss MO. (1995). Food Microbiology. 4th edition, New Age International (P) Limited Publishers, New Delhi, India.
2. Banwart JM. (1987). Basic Food Microbiology. 1st edition. CBS Publishers and Distributors, Delhi, India.
3. Davidson PM and Brannen AL. (1993). Antimicrobials in Foods. Marcel Dekker, New York.
4. Dillion VM and Board RG. (1996). Natural Antimicrobial Systems and Food Preservation. CAB International, Wallingford, Oxon.
5. Frazier WC and Westhoff DC. (1992). Food Microbiology. 3rd edition. Tata McGraw-Hill Publishing Company Ltd, New Delhi, India.
6. Gould GW. (1995). New Methods of Food Preservation. Blackie Academic and Professional, London.
7. Jay JM, Loessner MJ and Golden DA. (2005). Modern Food Microbiology. 7th edition, CBS Publishers and Distributors, Delhi, India.
8. Lund BM, Baird Parker AC, and Gould GW. (2000). The Microbiological Safety and Quality of Foods. Vol. 1-2, ASPEN Publication, Gaithersberg, MD.
9. Tortora GJ, Funke BR, and Case CL. (2008). Microbiology: An Introduction. 9th edition. Pearson Education.

B.Sc (HONOURS) MICROBIOLOGY (CBCS STRUCTURE)
CC-12: INDUSTRIAL MICROBIOLOGY (THEORY)
SEMESTER –5

MCB-A-CC-5-12-TH

TOTAL HOURS: 50 **CREDITS: 4**

Unit 1 Introduction to industrial microbiology **No. of Hours: 2**
Brief history and developments in industrial microbiology

Unit 2 Isolation of industrially important microbial strains and fermentation media
No. of Hours: 10
Sources of industrially important microbes and methods for their isolation, preservation and maintenance of industrial strains, strain improvement, Crude and synthetic media; molasses, corn-steep liquor, sulphite waste liquor, whey, yeast extract and protein hydrolysates

Unit 3 Types of fermentation processes, bio-reactors and measurement of fermentation parametersNo. of Hours: 12
Types of fermentation processes - Solid-state and liquid-state (stationary and submerged) fermentations; batch, fed-batch (eg. baker's yeast) and continuous fermentations
Components of a typical bio-reactor, Types of bioreactors-Laboratory, pilot- scale and production fermenters, constantly stirred tank and air-lift fermenters, Measurement and control of fermentation parameters - pH, temperature, dissolved oxygen, foaming and aeration

Unit 4 Down-stream processing **No. of Hours: 6**
Cell disruption, filtration, centrifugation, solvent extraction, precipitation, lyophilization and spray drying

Unit 5 Microbial production of industrial products (micro-organisms involved, media, fermentation conditions, downstream processing and uses) **No. of Hours: 18**

Citric acid, ethanol, penicillin, glutamic acid, Vitamin B12 Enzymes (amylase, protease, lipase)

Wine, beer

Unit 6 Enzyme immobilization **No. of Hours: 4**
Methods of immobilization, advantages and applications of immobilization, large scale applications of immobilized enzymes (glucose isomerase and penicillin acylase)

CC-12: INDUSTRIAL MICROBIOLOGY (PRACTICAL)
SEMESTER –5

MCB-A-CC-5-12-P

TOTAL HOURS: 60 **CREDITS: 2**

1. Study different parts of fermenter
2. Microbial fermentations for the production and estimation (qualitative and quantitative) of:
   (a) Enzymes: Amylase and Protease
   (b) Amino acid: Glutamic acid
   (c) Organic acid: Citric acid
   (d) Alcohol: Ethanol
3. A visit to any educational institute/industry to see an industrial fermenter, and other downstream processing operations.

SUGGESTED READINGS

1. Patel A.H. (1996). Industrial Microbiology. 1st edition, Macmillan India Limited
2. Okafor N. (2007). Modern Industrial Microbiology and Biotechnology. 1st edition. Bios Scientific Publishers Limited. USA
3. Waites M.J., Morgan N.L., Rockey J.S. and Higton G. (2001). Industrial Microbiology: An Introduction. 1st edition. Wiley – Blackwell
4. Glaze A.N. and Nikaido H. (1995). Microbial Biotechnology: Fundamentals of Applied Microbiology. 1st edition. W.H. Freeman and Company
5. Casida LE. (1991). Industrial Microbiology. 1st edition. Wiley Eastern Limited.
6. Crueger W and Crueger A. (2000). Biotechnology: A textbook of Industrial Microbiology. 2nd edition. Panima Publishing Co. New Delhi.
7. Stanbury PF, Whitaker A and Hall SJ. (2006). Principles of Fermentation Technology. 2nd edition, Elsevier Science Ltd.

B.Sc (HONOURS) MICROBIOLOGY (CBCS STRUCTURE)
CC-13: IMMUNOLOGY (THEORY)
SEMESTER –6

MCB-A-CC-6-13-TH

TOTAL HOURS: 50 **CREDITS: 4**

Unit 1 Introduction **No. of Hours: 2**
Concept of Innate and Adaptive immunity; Contributions of following scientists to the development of field of immunology - Edward Jenner, Karl Landsteiner, Robert Koch, Paul Ehrlich, Elie Metchnikoff, Peter Medawar, MacFarlane Burnet, Neils K Jerne, Rodney Porter and Susumu Tonegawa

Unit 2 Immune Cells and Organs **No. of Hours: 6**
Structure, Functions and Properties of: Immune Cells – Stem cell, T cell, B cell, NK cell, Macrophage, Neutrophil, Eosinophil, Basophil, Mast cell, Dendritic cell; and Immune Organs – Bone Marrow, Thymus, Lymph Node, Spleen, GALT, MALT, CALT

Unit 3 Antigens **No. of Hours: 4**
Characteristics of an antigen (Foreignness, Molecular size and Heterogeneity); Haptens; Epitopes (T & B cell epitopes); T-dependent and T-independent antigens; Adjuvants

Unit 4 Antibodies **No. of Hours: 6**
Structure, Types, Functions and Properties of antibodies; Antigenic determinants on antibodies (Isotypic, allotypic, idiotypic); VDJ rearrangements; Monoclonal and Chimeric antibodies

Unit 5 Major Histocompatibility Complex **No. of Hours: 4**
Organization of MHC locus (Mice & Human); Structure and Functions of MHC I & II molecules; Antigen processing and presentation (Cytosolic and Endocytic pathways)

Unit 6 Complement System **No. of Hours: 2**
Components of the Complement system; Activation pathways (Classical, Alternative and Lectin pathways); Biological consequences of complement Activation

Unit 7 Generation of Immune Response **No. of Hours: 8**
Primary and Secondary Immune Response; Generation of Humoral Immune Response (Plasma and Memory cells); Generation of Cell Mediated Immune Response (Self MHC restriction, T cell activation, Co- stimulatory signals); Killing Mechanisms by CTL and NK cells, Introduction to tolerance

Unit 8 Immunological Disorders and Tumor Immunity **No. of Hours: 8**
Types of Autoimmunity and Hypersensitivity with examples; Immunodeficiencies - Animal models (Nude and SCID mice), SCID, DiGeorge syndrome, Chediak- Higashi syndrome, Leukocyte adhesion deficiency, CGD; Types of tumors, tumor Antigens, causes and therapy for cancers.

Unit 9 Immunological Techniques **No. of Hours: 10**
Principles of Precipitation, Agglutination, Immunodiffusion, Immunoelectrophoresis, ELISA, ELISPOT, Western blotting, Immunofluoresence, Flow cytometry, Immunoelectron microscopy.

CC-13: IMMUNOLOGY (PRACTICAL)
SEMESTER –6
MCB-A-CC-6-13-P

TOTAL HOURS: 60 **CREDITS: 2**

1. Identification of human blood groups.
2. Perform Total Leukocyte Count of the given blood sample.
3. Perform Differential Leukocyte Count of the given blood sample.
4. Separate serum from the blood sample (demonstration).
5. Perform immunodiffusion by Ouchterlony method.
6. Perform DOT ELISA.
7. Perform immunoelectrophoresis.

SUGGESTED READINGS

1. Abbas AK, Lichtman AH, Pillai S. (2007). Cellular and Molecular Immunology. 6th edition Saunders Publication, Philadelphia.
2. Delves P, Martin S, Burton D, Roitt IM. (2006). Roitt's Essential Immunology.11th edition Wiley-Blackwell Scientific Publication, Oxford.
3. Goldsby RA, Kindt TJ, Osborne BA. (2007). Kuby's Immunology. 6th edition W.H. Freeman and Company, New York.
4. Murphy K, Travers P, Walport M. (2008). Janeway'sImmunobiology. 7th edition Garland Science Publishers, New York.
5. PeakmanM, and Vergani D. (2009). Basic and Clinical Immunology. 2nd edition Churchill Livingstone Publishers, Edinberg.
6. Richard C and Geiffrey S. (2009). Immunology. 6th edition. Wiley Blackwell Publication.

B.Sc (HONOURS) MICROBIOLOGY (CBCS STRUCTURE)
CC-14: MEDICAL MICROBIOLOGY (THEORY)
SEMESTER –6
MCB-A-CC-6-14-TH

TOTAL HOURS: 50 **CREDITS: 4**

Unit 1 Normal microflora of the human body and host pathogen interaction
No. of Hours: 7

Normal microflora of the human body: Importance of normal microflora, normal microflora of skin, throat, gastrointestinal tract, urogenital tract
Host pathogen interaction: Definitions - Infection, Invasion, Pathogen, Pathogenicity, Virulence, Toxigenicity, Carriers and their types, Opportunistic infections, Nosocomial infections. Transmission of infection, Pathophysiologic effects of LPS

Unit 2 Sample collection, transport and diagnosis **No. of Hours: 5**

Collection, transport and culturing of clinical samples, principles of different diagnostic tests (ELISA, Immunofluorescence, Agglutination based tests,Complement fixation, PCR, DNA probes).

Unit 3 Bacterial diseases **No. of Hours: 10**

List of diseases of various organ systems and their causative agents. The following diseases in detail with Symptoms, mode of transmission, prophylaxis and control
Respiratory Diseases: *Streptococcus pyogenes, Haemophilusinfluenzae, Mycobacterium tuberculosis*
Gastrointestinal Diseases: *Escherichia coli, Salmonella typhi, Vibrio cholerae, Helicobacter pylori*
Others: *Staphylococcus aureus, Bacillus anthracis, Clostridium tetani, Treponemapallidum,Clostridium difficie*

Unit 4 Viral diseases **No. of Hours: 10**

List of diseases of various organ systems and their causative agents. The following diseases in detail with Symptoms, mode of transmission, prophylaxis and control
Polio, Herpes, Hepatitis, Rabies, Dengue, AIDS, Influenza with brief description of swine flu, Ebola, Chikungunya, Japanese Encephalitis

Unit 5 Protozoan diseases **No. of Hours: 5**

List of diseases of various organ systems and their causative agents. The following diseases in detail with Symptoms, mode of transmission, prophylaxis and control Malaria, Kala-azar

Unit 6 Fungal diseases **No. of Hours: 5**

Brief description of each of the following types of mycoses and one representative disease to be studied with respect to transmission, symptoms and prevention
Cutaneous mycoses: Tineapedis (Athlete's foot)
Systemic mycoses: Histoplasmosis
Opportunistic mycoses: Candidiasis

Unit 7 Antimicrobial agents: General characteristics and mode of action **No. of Hours: 8**

Antibacterial agents: Five modes of action with one example each: Inhibitor of nucleic acid synthesis; Inhibitor of cell wall synthesis; Inhibitor of cell membrane function; Inhibitor of protein synthesis; Inhibitor of metabolism
Antifungal agents: Mechanism of action of Amphotericin B, Griseofulvin
Antiviral agents: Mechanism of action of Amantadine, Acyclovir, Azidothymidine Antibiotic resistance, MDR, XDR, MRSA, NDM-1

CC-14: MEDICAL MICROBIOLOGY (PRACTICAL)
SEMESTER –6
MCB-A-CC-6-14-P

TOTAL HOURS: 60 **CREDITS: 2**

1. Identify bacteria (any three of *E. coli, Salmonella, Pseudomonas, Staphylococcus, Bacillus*) using laboratory strains on the basis of cultural, morphological and biochemical characteristics: IMViC, TSI, nitrate reduction, urease production and catalase tests
2. Study of composition and use of important differential media for identification of bacteria: EMB Agar, McConkey agar, Mannitol salt agar, Deoxycholate citrate agar, TCBS
3. Study of bacterial flora of skin by swab method
4. Perform antibacterial sensitivity by Kirby-Bauer method
5. Determination of minimal inhibitory concentration (MIC) of an antibiotic.
6. Study symptoms of the diseases with the help of photographs: Polio, anthrax, herpes, chicken pox, HPV warts, AIDS (candidiasis), dermatomycoses (ring worms)
7. Study of various stages of malarial parasite in RBCs using permanent mounts.

SUGGESTED READING

1. Ananthanarayan R. and Paniker C.K.J. (2009) Textbook of Microbiology. 8th edition, University Press Publication
2. Brooks G.F., Carroll K.C., Butel J.S., Morse S.A. and Mietzner, T.A. (2013) Jawetz, Melnick and Adelberg's Medical Microbiology. 26th edition. McGraw Hill Publication
3. Goering R., Dockrell H., Zuckerman M. and Wakelin D. (2007) Mims' Medical Microbiology. 4th edition. Elsevier
4. Willey JM, Sherwood LM, and Woolverton CJ. (2013) Prescott, Harley and Klein's Microbiology. 9th edition. McGraw Hill Higher Education
5. Madigan MT, Martinko JM, Dunlap PV and Clark DP. (2014). Brock Biology of Microorganisms. 14th edition.Pearson International Edition.

B.Sc (HONOURS) MICROBIOLOGY (CBCS STRUCTURE)

DSE-A:

1. MICROBIAL BIOTECHNOLOGY (THEORY)

SEMESTER –5

MCB-A-DSE-A-5-1-TH

TOTAL HOURS: 50 **CREDITS: 4**

Unit 1 Microbial Biotechnology and its Applications **No. of Hours: 8**

Microbial biotechnology: Scope and its applications in human therapeutics, agriculture (Biofertilizers, PGPR, Mycorrhizae), environmental, and food technology

Use of prokaryotic and eukaryotic microorganisms in biotechnological applications

Genetically engineered microbes for industrial application: Bacteria and yeast

Unit 2 Therapeutic and Industrial Biotechnology **No. of Hours: 8**

Recombinant microbial production processes in pharmaceutical industries - Streptokinase, recombinant vaccines (Hepatitis B vaccine)

Microbial polysaccharides and polyesters, Microbial production of bio-pesticides, bioplastics Microbial biosensors

Unit 3 Applications of Microbes in **No. of Hours: 6**

BiotransformationsMicrobial based transformation of steroids and sterols

Bio-catalytic processes and their industrial applications: Production of high fructose syrup and production of cocoa butter substitute

Unit 4 Microbial Products and their Recovery **No. of Hours: 8**

Microbial product purification: filtration, ion exchange & affinity chromatography techniques

Immobilization methods and their application: Whole cell immobilization

Unit 5 Microbes for Bio-energy and Environment **No. of Hours: 10**

Bio-ethanol and bio-diesel production: commercial production from lignocellulosic waste and algal biomass, Biogas production: Methane and hydrogen production using microbial culture.

Microorganisms in bioremediation: Degradation of xenobiotics, mineral recovery, removal of heavy metals from aqueous effluents

Unit 6 RNAi **No. of Hours: 6**

RNAi and its applications in silencing genes, drug resistance, therapeutics and host pathogen interactions

Unit 7 Intellectual Property Rights **No. of Hours: 4**

Patents, Copyrights, Trademarks

DSE-A: 1. MICROBIAL BIOTECHNOLOGY (PRACTICAL)

SEMESTER –5

MCB-A-DSE-A-5-1-P

TOTAL HOURS: 60 **CREDITS: 2**

1. Study yeast cell immobilization in calcium alginate gels
2. Study enzyme immobilization by sodium alginate method
3. Pigment production from fungi (*Trichoderma* / *Aspergillus* / *Penicillium*)
4. Isolation of xylanase or lipase producing bacteria
5. Study of algal Single Cell Proteins

SUGGESTED READING

1. Ratledge, C and Kristiansen, B. (2001). Basic Biotechnology, 2nd Edition, Cambridge University Press.
2. Demain, A. L and Davies, J. E. (1999). Manual of Industrial Microbiology and Biotechnology, 2nd Edition, ASM Press.
3. Swartz, J. R. (2001). Advances in Escherichia coli production of therapeutic proteins. Current Opinion in Biotechnology, 12, 195–201.
4. Prescott, Harley and Klein's Microbiology by Willey JM, Sherwood LM, Woolverton CJ (2014), 9th edition, McGraw Hill Publishers.
5. Gupta PK (2009) Elements of Biotechnology 2nd edition, Rastogi Publications,
6. Glazer AN and Nikaido H (2007) Microbial Biotechnology, 2nd edition, Cambridge University Press
7. Glick BR, Pasternak JJ, and Patten CL (2010) Molecular Biotechnology 4th edition, ASM Press,
8. Stanbury PF, Whitaker A, Hall SJ (1995) Principles of Fermentation Technology 2nd edition., Elsevier Science
9. Crueger W, Crueger A (1990) Biotechnology: A text Book of Industrial Microbiology 2nd edition Sinauer associates, Inc.

B.Sc (HONOURS) MICROBIOLOGY (CBCS STRUCTURE) DSE-A:
2. ADVANCES IN MICROBIOLOGY (THEORY)
SEMESTER –5

MCB-A-DSE-A-5-2-TH

TOTAL HOURS: 50 **CREDITS: 4**

Unit 1 Evolution of Microbial Genomes **No. of Hours: 10**

Salient features of sequenced microbial genomes, core genome pool, flexible genome pool and concept of pangenome, Horizontal gene transfer (HGT), Evolution of bacterial virulence - Genomic islands, Pathogenicity islands (PAI) and their characteristics

Unit 2 Metagenomics **No. of Hours: 15**

Brief history and development of metagenomics, Understanding bacterial diversity using metagenomics approach, Prospecting genes of biotechnological importance using metagenomics Basic knowledge of viral metagenome, metatranscriptomics, metaproteomics and metabolomics.

Unit 3 Molecular Basis of Host-Microbe Interactions **No. of Hours: 15**

Epiphytic fitness and its mechanism in plant pathogens, Hypersensitive response (HR) to plant pathogens and its mechanism, Type three secretion systems (TTSS) of plant and animal pathogens, Biofilms: types of microorganisms, molecular aspects and significance in environment, health care, virulence and antimicrobial resistance

Unit 4 Systems and Synthetic Biology **No. of Hours: 10**

Networking in biological systems, Quorum sensing in bacteria, Co-ordinated regulation of bacterial virulence factors, Basics of synthesis of poliovirus in laboratory, Future implications of synthetic biology with respect to bacteria and viruses

DSE-A: 2.ADVANCES IN MICROBIOLOGY (PRACTICAL)
SEMESTER –5
MCB-A-DSE-A-5-2-P

TOTAL HOURS: 60 **CREDITS: 2**

1. Extraction of metagenomic DNA from soil
2. Understand the impediments in extracting metagenomic DNA from soil
3. PCR amplification of metagenomic DNA using universal 16s ribosomal gene primers
4. Case study to understand how the poliovirus genome was synthesized in the laboratory
5. Case study to understand how networking of metabolic pathways in bacteria takes place

SUGGESTED READING

1. Fraser CM, Read TD and Nelson KE. Microbial Genomes, 2004, Humana Press
2. Miller RV and Day MJ. Microbial Evolution- Gene establishment, survival and exchange, 2004, ASM Press
3. Bull AT. Microbial Diversity and Bioprospecting, 2004, ASM Press
4. Sangdun C. Introduction to Systems Biology, 2007, Humana Press
5. Klipp E, Liebermeister W. Systems Biology – A Textbook, 2009, Wiley –VCH Verlag
6. Caetano-Anolles G. Evolutionary Genomics and Systems Biology, 2010, John Wiley and Sons
7. Madigan MT, Martink JM, Dunlap PV and Clark DP (2014) Brook's Biology of Microorganisms, 14th edition, Pearson-Bejamin Cummings
8. Wilson BA, Salyers AA Whitt DD and Winkler ME (2011)Bacterial Pathogenesis- A molecular Approach, 3rd edition, ASM Press,
9. Bouarab K, Brisson and Daayf F (2009) Molecular Plant-Microbe interaction CAB International
10. Voit EO (2012) A First Course in Systems Biology, Istedition,Garland Science

B.Sc (HONOURS) MICROBIOLOGY (CBCS STRUCTURE)
DSE-A:
3. PLANT PATHOLOGY (THEORY)
SEMESTER –5

MCB-A-DSE-A-5-3-TH

TOTAL HOURS: 50 **CREDITS: 4**

Unit 1 Introduction and History of plant pathology **No. of Hours: 5**

Concept of plant disease- definitions of disease, disease cycle & pathogenicity, symptoms associated with microbial plant diseases, types of plant pathogens, economic losses and social impact of plant diseases. Significant landmarks in the field of plant pathology- Contributions of Anton DeBary, Millardet, Burrill, E. Smith, Adolph Mayer, Ivanowski, Diener, Stakman, H.H. Flor, Van Der Plank, molecular Koch's postulates. Contributions of eminent Indian plant pathologists.

Unit 2 Stages in development of a disease **No. of Hours: 2**

Infection, invasion, colonization, dissemination of pathogens and perennation.

Unit 3 Plant disease epidemiology **No. of Hours: 5**

Concepts of monocyclic, polycyclic and polyetic diseases, disease triangle & disease pyramid, forecasting of plant diseases and its relevance in Indian context.

Unit 4 Host Pathogen Interaction **No. of Hours: 15**

A. *Microbial Pathogenicity*
Virulence factors of pathogens: enzymes, toxins (host specific and non specific) growth regulators, virulence factors in viruses (replicase, coat protein, silencing suppressors) in disease development. Effects of pathogens on host physiological processes (photosynthesis, respiration, cell membrane permeability, translocation of water and nutrients, plant growth and reproduction). B. *Genetics of Plant Diseases*
Concept of resistance (R) gene and avirulence (avr) gene; gene for gene hypothesis, types of plant resistance: true resistance– horizontal & vertical, apparent resistance. C. *Defense Mechanisms in Plants*
Concepts of constitutive defense mechanisms in plants, inducible structural defenses (histological-cork layer, abscission layer, tyloses, gums), inducible biochemical defenses [hypersensitive response (HR), systemic acquired resistance (SAR), phytoalexins, pathogenesis related (PR) proteins, plantibodies, phenolics, quinones, oxidative bursts].

Unit 5 Control of Plant Diseases **No. of Hours: 8**

Principles & practices involved in the management of plant diseases by different methods, *viz.*
regulatory - quarantine, crop certification, avoidance of pathogen, use of pathogen free propagative material
cultural - host eradication, crop rotation, sanitation, polyethylene traps and mulches chemical - protectants and systemic fungicides, antibiotics, resistance of pathogens to chemicals.
biological - suppressive soils, antagonistic microbes-bacteria and fungi, trap plants
genetic engineering of disease resistant plants- with plant derived genes and pathogen derived genes

Unit 6 Specific Plant diseases **No. of Hours: 15**

Study of some important plant diseases giving emphasis on its etiological agent, symptoms, epidemiology and control
A. Important diseases caused by fungi
White rust of crucifers - *Albugo candida*
Downy mildew of onion - *Peronospora destructor*
Late blight of potato - *Phytophthorainfestans*
Powdery mildew of wheat - *Erysiphegraminis*
Ergot of rye - *Clavicepspurpurea*

Black stem rust of wheat - *Pucciniagraministritici*
Loose smut of wheat - *Ustilagonuda*
Wilt of tomato - *Fusariumoxysporum*f.sp. *lycopersici*
Red rot of sugarcane - *Colletotrichumfalcatum*
Early blight of potato - *Alternariasolani*
B. Important diseases caused by phytopathogenic bacteria: Angular leaf spot of cotton, bacterial leaf blight of rice, crown galls, bacterial cankers of citrus
C. Important diseases caused by phytoplasmas: Aster yellow, citrus stubborn
D. Important diseases caused by viruses: Papaya ring spot, tomato yellow leaf curl, banana bunchy top, rice tungro
E. Important diseases caused by viroids: Potato spindle tuber, coconut cadangcadang

DSE-A:
3.PLANT PATHOLOGY (PRACTICAL)
SEMESTER –5
MCB-A-DSE-A-5-3-P

TOTAL HOURS: 60 **CREDITS: 2**

1. Demonstration of Koch's postulates in fungal, bacterial and viral plant pathogens.
2. Study of important diseases of crop plants by cutting sections of infected plant material - *Albugo,Puccinia,Ustilago, Fusarium, Colletotrichum.*

SUGGESTED READINGS

1. Agrios GN. (2006). Plant Pathology. 5th edition. Academic press, San Diego,
2. Lucas JA. (1998). Plant Pathology and Plant Pathogens. 3rd edition. Blackwell Science, Oxford.
3. Mehrotra RS. (1994). Plant Pathology. Tata McGraw-Hill Limited.
4. Rangaswami G. (2005). Diseases of Crop Plants in India. 4th edition. Prentice Hall of India Pvt. Ltd., New Delhi.
5. Singh RS. (1998). Plant Diseases Management. 7th edition. Oxford & IBH, New Delhi.

B.Sc (HONOURS) MICROBIOLOGY (CBCS STRUCTURE)
DSE-A:
4. BIOMATHEMATICS AND BIOSTATISTICS (THEORY)
SEMESTER –5

MCB-A-DSE-A-5-4-TH

TOTAL HOURS: 50 **CREDITS: 4**

Unit 1 Biomathematics **No of Hours: 25**

Sets. Functions and their graphs : polynomial, sine, cosine, exponential and logarithmic functions. Motivation and illustration for these functions through projectile motion, simple pendulum, biological rhythms, cell division, muscular fibres etc.
Simple observations about these functions like increasing, decreasing and, periodicity.
Sequences to be introduced through the examples arising in Science beginning with finite sequences, followed by concepts of recursion and difference equations.For instance, the Fibonacci sequence arising from branching habit of trees and breeding habit of rabbits.Intuitive idea of algebraic relationships and convergence.
Infinite Geometric Series.Series formulas for ex, log (1+x), sin x, cos x. Step function.Intuitive idea of discontinuity, continuity and limits.
Differentiation.Conception to be motivated through simple concrete examples as given above from Biological and Physical Sciences.Use of methods of differentiation like Chain rule, Product rule and Quotient rule. Second order derivatives of above functions. Integration as reverse process of differentiation.
Integrals of the functions introduced above. Differential Equations of first order, Linear Differential Equations.
Points in plane and space and coordinate form.Examples of matrices arising in Biological Sciences and Biological networks. Sum and Produce of matrices upto order 3.

Unit 2 Biostatistics **No of Hours: 25**

Measures of central tendency, Measures of dispersion; skewness, kurtosis; Elementary Probability and basic laws; Discrete and Continuous Random variable, Mathematical Expectation; Curve Fitting; Correlation and Regression. Emphasis on examples from Biological Sciences;
Mean and Variance of Discrete and Continuous Distributions namely Binomial, Poisson, Geometric, Weibull, Logistic and Normal distribution. Fitting of Distributions;
Statistical methods: Scope of statistics: utility and misuse. Principles of statistical analysis of biological data.Sampling parameters.Difference between sample and Population, Sampling Errors,Censoring, difference between parametric and non-parametric statistics;
Sampling Distributions, Standard Error, Testing of Hypothesis, Level of Significance and Degree of Freedom;
Large Sample Test based on Normal Distribution, Small sample test based on t-test, Z- test and F test; Confidence Interval; Distribution-free test - Chi-square test;Basic introduction to Multivariate statistics, etc.

DSE-A:

4. BIOMATHEMATICS AND BIOSTATISTICS (PRACTICAL)

SEMESTER –5

MCB-A-DSE-A-5-4-P

TOTAL HOURS: 60 **CREDITS: 2**

1. Word Problems based on Differential Equations
2. Mean, Median, Mode from grouped and ungrouped Data set
3. Standard Deviation and Coefficient of Variation
4. Skewness and Kurtosis
5. Curve fitting
6. Correlation
7. Regression
8. Finding area under the curve using normal probability
9. Testing of Hypothesis- Normal Distribution, t-test and Chi-Square-test
10. Confidence Interval

SUGGESTED READINGS

1. H. S. Bear: Understanding Calculus, John Wiley and Sons (Second Edition); 2003.
2. E. Batschelet : Introduction to Mathematics for Life Scientists,SpringerVerlag, International Student Edition, Narosa Publishing House, New Delhi (1971, 1975)
3. A. Edmondson and D. Druce : Advanced Biology Statistics, Oxford University Press; 1996.
4. W. Danial : Biostatistics : A foundation for Analysis in Health Sciences, John Wiley and Sons Inc; 2004.

B.Sc (HONOURS) MICROBIOLOGY (CBCS STRUCTURE) DSE-B:
1. INHERITANCE BIOLOGY (THEORY)
SEMESTER 6

MCB-A-DSE-B-6-1-TH

TOTAL HOURS: 50 **CREDITS: 4**

Unit 1 Introduction to Genetics **No. of Hours: 5**

Historical developments

Model organisms in genetic analyses and experimentation: *Escherichia coli, Saccharomycescerevisiae, Neurospora crassa, Caenorhabditiselegans Drosophila melanogaster, Arabidopsis thaliana*

Unit 2 Mendelian Principles **No. of Hours: 8**

Mendel's Laws: Dominance, segregation, independent assortment, deviation from Mendelian inheritance, Rediscovery of Mendel's principles, Chromosome theory of inheritance: Allele, multiple alleles, pseudoallele, complementation tests, Extensions of Mendelian genetics: Allelic interactions, concept of dominance, recessiveness, Incomplete dominance and co-dominance, Multiple alleles, Epistasis, penetrance and expressivity

Unit 3 Linkage and Crossing over **No. of Hours: 6**

Linkage and recombination of genes, Cytological basis of crossing over, Crossing over at four-strand stage, Molecular mechanism of crossing over, mapping

Unit 4 Extra-Chromosomal Inheritance **No. of Hours: 7**

Rules of extra nuclear inheritance, Organelle heredity - Chloroplast mutations in *Chlamydomonas*, mitochondrial, mutations in *Saccharomyces*, Maternal effects – Shell coiling in *Limnaeaperegra* Infectious heredity - Kappa particles in *Paramecium*

Unit 5 Characteristics of Chromosomes **No. of Hours: 15**

Structural organization of chromosomes - centromeres, telomeres and repetitive DNA, Packaging DNA molecules into chromosomes, Concept of euchromatin and heterochromatin, Normal and abnormal karyotypes of human chromosomes, Chromosome banding, Giant chromosomes: Polytene and lampbrush chromosomes, Variations in chromosome structure: Deletion, duplication, inversion and translocation, Variation in chromosomal number and structural abnormalities - Klinefelter syndrome, Turner syndrome, Down syndrome

Unit 6 Recombination **No. of Hours: 3**

Homologous and non-homologous recombination, including transposition, site-specific recombination.

Unit 7 Human genetics **No. of Hours: 3**

Pedigree analysis, lod score for linkage testing, karyotypes, genetic disorders.

Unit 8 Quantitative genetics **No. of Hours: 3**

Polygenic inheritance, heritability and its measurements, QTL mapping.

DSE-B:
1. INHERITANCE BIOLOGY (PRACTICAL)
SEMESTER –6
MCB-A-DSE-B-6-1-P

TOTAL HOURS: 60 **CREDITS: 2**

1. Mendelian deviations in dihybrid crosses
2. Studying Barr Body with the temporary mount of human cheek cells
3. Studying *Rhoeo* translocation with the help of photographs
4. Karyotyping with the help of photographs
5. Chi-Square Analysis
6. Study of polytene chromosomes using temporary mounts of salivary glands of *Chiromonas /Drosophila* larvae
7. Study of pedigree analysis
8. Analysis of a representative quantitative trait

SUGGESTED READING

1. Gardner EJ, Simmons MJ, Snustad DP (2008). Principles of Genetics. 8th Ed. Wiley-India
2. Snustad DP, Simmons MJ (2011). Principles of Genetics. 6th Ed. John Wiley and Sons Inc.
3. Weaver RF, Hedrick PW (1997). Genetics. 3rd Ed. McGraw-Hill Education
4. Klug WS, Cummings MR, Spencer CA, Palladino M (2012). Concepts of Genetics. 10th Ed. Benjamin Cummings
5. Griffith AJF, Wessler SR, Lewontin RC, Carroll SB. (2007). Introduction to Genetic Analysis. 9th Ed. W.H.Freeman and Co., New York
6. Hartl DL, Jones EW (2009). Genetics: Analysis of Genes and Genomes. 7th Ed, Jones and Bartlett Publishers
7. Russell PJ. (2009). *i* Genetics - A Molecular Approach. 3rd Ed, Benjamin Cummings

B.Sc (HONOURS) MICROBIOLOGY (CBCS STRUCTURE)

DSE-B:

2. MICROBES IN SUSTAINABLE AGRICULTURE AND DEVELOPMENT (THEORY)

SEMESTER –6

MCB-A-DSE-B-6-2-TH

TOTAL HOURS: 50 **CREDITS: 4**

Unit 1 Soil Microbiology **No of Hours: 6**

Soil as Microbial Habitat, Soil profile and properties, Soil formation, Diversity and distribution of microorganisms in soil

Unit 2 Mineralization of Organic & Inorganic Matter in Soil **No of Hours: 6**

Mineralization of cellulose, hemicelluloses, lignocelluloses, lignin and humus, phosphate, nitrate, silica, potassium

Unit 3 Microbial Activity in Soil and Green House Gases **No of Hours: 5**

Carbon dioxide, methane, nitrous oxide, nitric oxide – production and control

Unit 4 Microbial Control of Soil Borne Plant Pathogens **No of Hours: 7**

Biocontrol mechanisms and ways, Microorganisms used as biocontrol agents against Microbial plant pathogens, Insects, Weeds

Unit 5 Biofertilization, Phytostimulation, Bioinsecticides **No of Hours: 12**

Plant growth promoting bateria, biofertilizers – symbiotic (*Bradyrhizobium, Rhizobium, Frankia*), Non Symbiotic (*Azospirillum, Azotobacter*, Mycorrhizae, MHBs, Phosphate solubilizers, algae), Novel combination of microbes as biofertilizers, PGPRs

Unit 6 Secondary Agriculture Biotechnology **No of Hours: 8**

Biotech feed, Silage, Biomanure, biogas, biofuels – advantages and processing parameters

Unit 7 GM crops **No of Hours: 6**

Advantages, social and environmental aspects, Bt crops, golden rice, transgenic animals.

DSE-B:

2.MICROBES IN SUSTAINABLE AGRICULTURE AND DEVELOPMENT (PRACTICAL)

SEMESTER –6

MCB-A-DSE-B-6-2-P

TOTAL HOURS: 60 **CREDITS: 2**

1. Study soil profile
2. Study microflora of different types of soils
3. *Rhizobium* as soil inoculants characteristics and field application
4. *Azotobacter*as soil inoculants characteristics and field application
5. Design and functioning of a biogas plant
6. Isolation of cellulose degrading organisms

SUGGESTED READINGS

1. Agrios GN. (2006). Plant Pathology.5th edition. Academic press, San Diego,
2. Singh RS. (1998). Plant Diseases Management. 7th edition. Oxford & IBH, New Delhi.
3. Glick BR, Pasternak JJ, and Patten CL (2010) Molecular Biotechnology 4th edition, ASM Press,

4. Atlas RM and Bartha R. (2000). Microbial Ecology: Fundamentals & Applications. 4th edition. Benjamin/Cummings Science Publishing, USA
5. Maier RM, Pepper IL and Gerba CP. (2009). Environmental Microbiology. 2nd edition, Academic Press
6. Barton LL & Northup DE (2011). Microbial Ecology. 1st edition, Wiley Blackwell, USA
7. Campbell RE. (1983). Microbial Ecology. Blackwell Scientific Publication, Oxford, England.
8. Coyne MS. (2001). Soil Microbiology: An Exploratory Approach. Delmar Thomson Learning.
9. Altman A (1998). Agriculture Biotechnology, Ist edition, Marcel decker Inc.
10. Mahendra K. Rai (2005). Hand Book of Microbial Biofertilizers, The Haworth Press, Inc. New York.
11. Reddy, S.M. et. al. (2002). Bioinoculants for Sustainable Agriculture and Forestry, Scientific Publishers.
12. Saleem F and Shakoori AR (2012) Development of Bioinsecticide, Lap Lambert Academic Publishing GmbH KG

B.Sc (HONOURS) MICROBIOLOGY (CBCS STRUCTURE)
DSE-B:
3. INSTRUMENTATION AND BIOTECHNIQUES (THEORY)
SEMESTER-6

MCB-A-DSE-B-6-3-TH

TOTAL HOURS: 50 **CREDITS: 4**

Unit 1 Microscopy **No. of Hours: 10**

Brightfield and darkfield microscopy, Fluorescence Microscopy, Phase contrast Microscopy, Confocal Microscopy, Electron Microscopy (Scanning and Transmission Electron Microscopy) and Micrometry.

Unit 2 Chromatography **No. of Hours: 10**

Principles and applications of paper chromatography (including Descending and 2-D), Thin layer chromatography. Column packing and fraction collection. Gel filtration chromatography, ion-exchange chromatography and affinity chromatography, GLC, HPLC.

Unit 3 Electrophoresis **No. of Hours: 10**

Principle and applications of native polyacrylamide gel electrophoresis, SDS- polyacrylamide gel electrophoresis, 2D gel electrophoresis, Isoelectric focusing, Zymogram preparation and Agarose gel electrophoresis.

Unit 4 Spectrophotometry **No. of Hours: 10**

Principle and use of study of absorption spectra of biomolecules.Analysis of biomolecules using UV and visible range.Colorimetry and turbidometry.

Unit 5 Centrifugation **No. of Hours: 10**

Preparative and analytical centrifugation, fixed angle and swinging bucket rotors.RCF and sedimentation coefficient, differential centrifugation, density gradient centrifugation and ultracentrifugation.

DSE-B:

3. INSTRUMENTATION AND BIOTECHNIQUES (PRACTICAL)

SEMESTER –6

MCB-A-DSE-B-6-3-P

TOTAL HOURS: 60 **CREDITS: 2**

1. Study of fluorescent micrographs to visualize bacterial cells.
2. Ray diagrams of phase contrast microscopy and Electron microscopy.
3. Separation of mixtures by paper / thin layer chromatography.
4. Demonstration of column packing in any form of column chromatography.
5. Separation of protein mixtures by any form of chromatography.
6. Separation of protein mixtures by Polyacrylamide Gel Electrophoresis (PAGE).
7. Determination of λ_{max} for an unknown sample and calculation of extinction coefficient.
8. Separation of components of a given mixture using a laboratory scale centrifuge.
9. Understanding density gradient centrifugation with the help of pictures.

SUGGESTED READINGS

1. Wilson K and Walker J. (2010). Principles and Techniques of Biochemistry and Molecular Biology. 7th Ed., Cambridge University Press.
2. Nelson DL and Cox MM. (2008). Lehninger Principles of Biochemistry, 5th Ed., W.H. Freeman and Company.
3. Willey MJ, Sherwood LM &Woolverton C J. (2013). Prescott, Harley and Klein's Microbiology. 9th Ed., McGraw Hill.
4. Karp G. (2010) Cell and Molecular Biology: Concepts and Experiments. 6th edition. John Wiley & Sons. Inc.
5. De Robertis EDP and De Robertis EMF. (2006). Cell and Molecular Biology. 8th edition. Lipincott Williams and Wilkins, Philadelphia.
6. Cooper G.M. and Hausman R.E. (2009). The Cell: A Molecular Approach. 5th Edition. ASM Press & Sunderland, Washington D.C., Sinauer Associates, MA.
7. Nigam A and Ayyagari A. 2007. Lab Manual in Biochemistry, Immunology and Biotechnology. Tata McGraw Hill.

B.Sc (HONOURS) MICROBIOLOGY (CBCS STRUCTURE)

SEC-A:

1. Microbial Quality Control in Food and Pharmaceutical Industries

SEMESTER – 3

MCB-A-SEC-A-3-1

TOTAL HOURS: 30 **CREDITS: 2**

Unit 1 Microbiological Laboratory and Safe Practices **No. of Hours: 8**

Good laboratory practices - Good laboratory practices, Good microbiological practices
Biosafety cabinets – Working of biosafety cabinets, using protective clothing, specification for BSL-1, BSL-2, BSL-3. Discarding biohazardous waste – Methodology of Disinfection, Autoclaving & Incineration

Unit 2 Determining Microbes in Food / Pharmaceutical Samples **No. of Hours: 10**

Culture and microscopic methods - Standard plate count, Most probable numbers, Direct microscopic counts, Biochemical and immunological methods: Limulus lysate test for endotoxin, gel diffusion, sterility testing for pharmaceutical products
Molecular methods - Nucleic acid probes, PCR based detection, biosensors.

Unit 3 Pathogenic Microorganisms of Importance in Food & Water **No. of Hours: 8**

Enrichment culture technique, Detection of specific microorganisms - on XLD agar, Salmonella Shigella Agar, Manitol salt agar, EMB agar, McConkey Agar, Saboraud Agar
Ascertaining microbial quality of milk by MBRT, Rapid detection methods of microbiological quality of milk at milk collection centres (COB, 10 min Resazurin assay)

Unit 4 HACCP for Food Safety and Microbial Standards **No. of Hours: 4**

Hazard analysis of critical control point (HACCP) - Principles, flow diagrams, limitations
Microbial Standards for Different Foods and Water – BIS standards for common foods and drinking water

SUGGESTED READING

1. Harrigan WF (1998) Laboratory Methods in Food Microbiology, 3rd ed. Academic Press
2. Garg N, Garg KL and Mukerji KG (2010) Laboratory Manual of Food Microbiology I K International Publishing House Pvt. Ltd.
3. Jay JM, Loessner MJ, Golden DA (2005) Modern Food Microbiology, 7th edition. Springer
4. Baird RM, Hodges NA and Denyer SP (2005) Handbook of Microbiological Quality control in Pharmaceutical and Medical Devices, Taylor and Francis Inc.

B.Sc (HONOURS) MICROBIOLOGY (CBCS STRUCTURE)
SEC-A:
2. BIOFERTILIZERS AND BIOPESTICIDES
SEMESTER – 3

MCB-A-SEC-A-3-2

TOTAL HOURS: 30 **CREDITS: 2**

Unit 1 Biofertilizers **No of Hours: 10**

General account of the microbes used as biofertilizers for various crop plants and their advantages over chemical fertilizers.
Symbiotic N2 fixers: *Rhizobium* - Isolation, characteristics, types, inoculum production and field application, legume/pulses plants
Frankia- Isolation, characteristics, Alder, Casurina plants, non-leguminous crop symbiosis.Cyanobacteria, *Azolla* - Isolation, characterization, mass multiplication, Role in rice cultivation, Crop response, field application.

Unit 2 Non - Symbiotic Nitrogen Fixers **No of Hours: 4**

Free living *Azospirillum*, *Azotobacter* - free isolation, characteristics, mass inoculums, production and field application.

Unit 3 Phosphate Solubilizers **No of Hours: 4**

Phosphate solubilizing microbes - Isolation, characterization, mass inoculum production, field application

Unit 4 MycorrhizalBiofertilizers **No of Hours: 5**

Importance of mycorrizal inoculum, types of mycorrhizae and associated plants, Mass inoculum production of VAM, field applications of Ectomycorrhizae and VAM.

Unit 5 Bioinsecticides **No of Hours: 7**

General account of microbes used as bioinsecticides and their advantages over synthetic pesticides, *Bacillus thuringiensis*, production, Field applications, Viruses – cultivation and field applications.

Suggested Readings

1. Kannaiyan, S. (2003). Bioetchnology of Biofertilizers, CHIPS, Texas.
2. Mahendra K. Rai (2005). Hand book of Microbial biofertilizers, The Haworth Press, Inc. New York.
3. Reddy, S.M. et. al. (2002). Bioinoculants for sustainable agriculture and forestry, Scientific Publishers.
4. SubbaRao N.S (1995) Soil microorganisms and plant growth Oxford and IBH publishing co. Pvt. Ltd. NewDelhi.
5. Saleem F and Shakoori AR (2012) Development of Bioinsecticide, Lap Lambert Academic Publishing GmbH KG
6. Aggarwal SK (2005) Advanced Environmental Biotechnology, APH publication

B.Sc (HONOURS) MICROBIOLOGY (CBCS STRUCTURE)
SEC-B:
1. FOOD FERMENTATION TECHNIQUES
SEMESTER – 4

MCB-A-SEC-B-4-1

TOTAL HOURS: 30 **CREDITS: 2**

Unit 1 Fermented Foods **No of Hours: 4**

Definition, types, advantages and health benefits

Unit 2 Milk Based Fermented Foods **No of Hours: 8**

Dahi, Yogurt, Buttermilk (Chach) and cheese: Preparation of inoculums, types of microorganisms and production process

Unit 3 Grain Based Fermented Foods **No of Hours: 6**

Soy sauce, Bread, Idli and Dosa: Microorganisms and production process

Unit 4 Vegetable Based Fermented Foods **No of Hours: 4**

Pickels, Saeurkraut: Microorganisms and production process

Unit 5 Fermented Meat and Fish **No of Hours: 4**

Types, microorganisms involved, fermentation process

Unit 6 Probiotic Foods **No of Hours: 4**

Definition, types, microorganisms and health benefits

Suggested Readings

1. Hui YH, Meunier-Goddik L, Josephsen J, Nip WK, Stanfield PS (2004) Handbook of food and fermentation technology, CRC Press
2. Holzapfel W (2014) Advances in Fermented Foods and Beverages, Woodhead Publishing.
3. Yadav JS, Grover, S and Batish VK (1993) A comprehensive dairy microbiology, Metropolitan
4. Jay JM, Loessner MJ, Golden DA (2005) Modern Food Microbiology, 7th edition. Springer

B.Sc (HONOURS) MICROBIOLOGY (CBCS STRUCTURE)
SEC-B:
2. MICROBIOLOGICAL ANALYSIS OF AIR AND WATER
SEMESTER – 4

MCB-A-SEC-B-4-2

TOTAL HOURS: 30 **CREDITS: 2**

Unit 1 Aeromicrobiology **No of Hours: 4**

Bioaerosols, Air borne microorganisms (bacteria, Viruses, fungi) and their impact on human health and environment, significance in food and pharma industries and operation theatres, allergens

Unit 2 Air Sample Collection and Analysis **No of Hours: 7**
Bioaerosol sampling, air samplers, methods of analysis, CFU, culture media for bacteria and fungi, Identification characteristics

Unit 3 Control Measures **No of Hours: 4**
Fate of bioaerosols, inactivation mechanisms – UV light, HEPA filters, desiccation, Incineration

Unit 4 Water Microbiology **No of Hours: 4**
Water borne pathogens, water borne diseases

Unit 5 Microbiological Analysis of Water **No of Hours: 7**
Sample Collection, Treatment and safety of drinking (potable) water, methods to detect potability ofwater samples: (a) standard qualitative procedure: presumptive/MPN tests, confirmed and completed tests for faecal coliforms (b) Membrane filter technique and (c) Presence/absence tests

Unit 6 Control Measures **No of Hours: 4**
Precipitation, chemical disinfection, filtration, high temperature, UV light

Suggested Reading

1. da Silva N, Taniwaki MH, Junqueira VC, Silveira N, Nascimento MS, Gomes RAR (2012) Microbiological Examination Methods of Food and WaterA Laboratory Manual, CRC Press
2. Atlas RM and Bartha R. (2000). Microbial Ecology: Fundamentals & Applications. 4th edition. Benjamin/Cummings Science Publishing, USA
3. Maier RM, Pepper IL and Gerba CP. (2009). Environmental Microbiology. 2nd edition, Academic Press
4. Hurst CJ, Crawford RL, Garland JL, Lipson DA (2007) Manual of Environmental Microbiology, 3rd edition, ASM press

UNIVERSITY OF CALCUTTA

CBCS SYLLABUS

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THREE-YEAR GENERAL COURSE OF STUDIES IN

MICROBIOLOGY

2018

Structure of B. Sc. General Microbiology under CBCS

Core Course: CC

CC-1/GE1: Introduction and Scope of microbiology, Bacteriology
CC-2/GE2: Bacteriology and Virology
CC-3/GE3: Biomolecules and Microbial metabolism
CC-4/GE4: Microbial Genetics and Molecular Biology

Discipline Specific Elective (DSE)

DSE-A (Any One)

1. Genetic Engineering and Biotechnology
2. Microbes in Environment

DSE-B (Any One)

1. Medical Microbiology and Immunology
2. Industrial Microbiology and Food Microbiology

Skill Enhancement Elective Courses (SEC)

SEC-A

1. Microbial Quality Control in Food and Pharmaceutical Industries
2. Biofertilizers and Biopesticides

SEC-B

1. Food Fermentation Techniques
2. Microbiological Analysis of Air and Water

SUBJECT/PAPER CODE FORMAT

1. **Subject Code: MCB**
2. **Honours Code: A**
3. **Course Code: a) Core Course:CC**
   b) Discipline Specific Elective: DSE-A/DSE-B
   c) Skill Enhancement Course: SEC-A/SEC-B
4. **Semester Code: 1/2/3/4/5/6**
5. **Paper No. Code: 1/2/3…../14**
6. **Paper Component Code: a) Theory:TH, b) Practical: P**

Semester Wise Microbiology General Courses

Semester-1

Core Course

B.Sc (General) MICROBIOLOGY (CBCS STRUCTURE)
CC-1/GE1: INTRODUCTION AND SCOPE OF MICROBIOLOGY
(THEORY)
MCB-G-CC-1-1-TH

TOTAL HOURS: 50 **CREDITS: 4**

Unit 1 History of Development of Microbiology **No. of Hours: 8**

Development of microbiology as a discipline, Spontaneous generation *vs*. biogenesis. Contributions of Anton von Leeuwenhoek, Louis Pasteur, Robert Koch, Joseph Lister, Alexander Fleming
Role of microorganisms in fermentation, Germ theory of disease, Development of various microbiological techniques and golden era of microbiology, Development of the field of soil microbiology: Contributions of Martinus W. Beijerinck, Sergei N. Winogradsky, Selman A.Waksman Establishment of fields of medical microbiology and immunology through the work of Paul Ehrlich, Elie Metchnikoff, Edward Jenner

Unit 2 Diversity of Microorganisms **No. of Hours: 8**

Systems of classification : Binomial nomenclature, Whittaker's five kingdom and Carl Woese's three kingdom classification systems and their utility
General characteristics of different groups: Acellular microorganisms (Viruses, Viroids, Prions) and Cellular microorganisms (Prokarya: Archaea and Bacteria, Eukarya : Algae, Fungi and Protozoa) giving definitions and citing examples
Protozoa : Methods of nutrition, locomotion & reproduction - Amoeba, *Paramecium* and *Plasmodium*

Unit 3 Microscopy No. of Hours: 5

Bright Field Microscope, Dark Field Microscope, Phase Contrast Microscope, FluoresenceMicroscope,Transmission Electron Microscope, Scanning Electron Microscope

Unit 4 Sterilization **No. of Hours: 5**

Moist Heat, Autoclave, Dry Heat, Hot Air Oven, Tyndallization, Filteration.

Unit 5 Microbes in Human Health & Environment **No. of Hours: 8**

Medical microbiology and immunology: List of important human diseases and their causativeagents of various human systems. Definitions of immunity (active/passive), primary and secondary immune response, antigen, antibody and their types
Environmental microbiology: Definitions and examples of important microbial interactions – mutualism, commensalism, parasitism, Definitions and microorganisms used as biopesticides, biofertilizers, in biodegradation, biodeterioration and bioremediation (*e.g.* hydrocarbons in oil spills)

Unit 6 Industrial Microbiology **No. of Hours: 8**

Definition of fermentation, primary and secondary metabolites, types of fermentations and fermenters and microbes producing important industrial products through fermentation.

Unit 7 Food and Dairy Microbiology **No. of Hours: 8**

Microorganisms as food (SCP), microorganisms in food fermentations (dairy and non dairy based fermented food products) and probiotics.Microorganisms in food spoilage and food borne infections.

CC-1/GE1: INTRODUCTION AND SCOPE OF MICROBIOLOGY (PRACTICALS)
SEMESTER –1

MCB-G-CC-1-1-P

TOTAL HOURS: 60 **CREDITS: 2**

1. Microbiology Laboratory Management and Biosafety.
2. To study the principle and applications of important instruments (biological safety cabinets, autoclave, incubator, BOD incubator, hot air oven, light microscope, pH meter) used in the microbiology laboratory
3. Preparation of culture media for bacterial cultivation
4. Sterilization of medium using Autoclave and assessment for sterility
5. Sterilization of glassware using Hot Air Oven and assessment for sterility
6. Sterilization of heat sensitive material by filtration and assessment for sterility
7. Demonstration of presence of microflora in the environment by exposing nutrient agar plates to air.
8. Study of different shapes of bacteria using permanent slides
9. Study of *Rhizopus* and *Penicillium* using permanent mounts
10. Study of *Spirogyra* and *Chlamydomonas* using permanent Mounts
11. Study of the following protozoans using permanent mounts/photographs: *Amoeba*, *Entamoeba*, *Paramecium* and *Plasmodium*

SUGGESTED READING

1. Tortora GJ, Funke BR and Case CL. (2008). Microbiology: An Introduction. 9th edition. Pearson Education
2. Madigan MT, Martinko JM, Dunlap PV and Clark DP. (2014). Brock Biology of Microorganisms. 14th edition. Pearson International Edition
3. Cappucino J and Sherman N. (2010). Microbiology: A Laboratory Manual. 9th edition. Pearson Education Limited
4. Wiley JM, Sherwood LM and Woolverton CJ. (2013) Prescott's Microbiology. 9th Edition. McGraw Hill International.
5. Atlas RM. (1997). Principles of Microbiology. 2nd edition. WM.T.Brown Publishers.
6. Pelczar MJ, Chan ECS and Krieg NR. (1993). Microbiology. 5th edition. McGraw Hill Book Company.
7. Stanier RY, Ingraham JL, Wheelis ML, and Painter PR. (2005). GeneralMicrobiology. 5thedition. McMillan.

Semester-2

Core Course

CC-2/GE2: BACTERIOLOGY AND VIROLOGY (THEORY) MCB-G-CC-2-2-TH

TOTAL HOURS: 50 **CREDITS: 4**

Unit 1 Cell organization **No. of Hours: 10**

Cell size, shape and arrangements, capsule, flagella and pili, Composition and detailed structure of gram- positive and gram- negative cell wall and archaeal cell wall, Structure, chemical composition and functions of bacterial and archaeal cell membranes, Ribosomes, inclusions, nucleoid, plasmids, structure, formation and stages of sporulation

Unit 2 Bacterial growth and control **No. of Hours: 8**

Culture media: Components of media, Synthetic or defined media, Complex media, enriched media, selective media, differential media, enrichment culture media
Pure culture isolation: Streaking, serial dilution and plating methods, cultivation, maintenance and stocking of pure cultures, cultivation of anaerobic bacteria Growth: Binary fission, phases of growth

Unit 3 Bacterial Systematics and Taxonomy **No. of Hours: 8**

Taxonomy, nomenclature, systematics, types of classifications
Morphology, ecological significance and economic importance of the following groups:
Archaea: methanogens, thermophiles and halophiles
Eubacteria: Gram negative and Gram positive
Gram negative:
Non-proteobacteria– *Deinococcus, Chlamydiae,* Spirochetes
Alpha proteobacteria- *Rickettsia, Rhizobium, Agrobacterium*
Gamma proteobacteria –*Escherichia,Shigella,Pseudomonas*
Gram positive: Low G+C: *Mycoplasma, Bacillus, Clostridium, Staphylococcus* High G+C: *Streptomyces, Frankia*

Unit 4 Introduction to Viruses **No. of Hours: 8**

Properties of viruses; general nature and important features
Subviral particles; viroids, prions and their importance
Isolation and cultivation of viruses

Unit 5 Structure, and multiplication of viruses **No. of Hours: 8**

Morphological characters: Capsid symmetry and different shapes of viruses with examples
Viral multiplication in the Cell: Lytic and lysogenic cycle
Description of important viruses: salient features of the viruses infecting different hosts - Bacteriophages (T4 & Lambda); Plant (TMV & Cauliflower Mosaic Virus), Human (HIV & Hepatitis viruses)

Unit 6 Role of Viruses in Disease and its prevention **No. of Hours: 8**

Viruses as pathogens: Role of viruses in causing diseases
Prevention and control of viruses: Viral vaccines, interferons and antiviral compounds

CC-2/GE2: BACTERIOLOGY AND VIROLOGY (PRACTICAL)

MCB-G-CC-2-2-P

TOTAL HOURS: 60 **CREDITS: 2**

1. Preparation of different media: Nutrient agar, Nutrient broth
2. To perform simple staining and Gram's staining of the bacterial smear
3. To perform spore staining
4. Isolation of pure cultures of bacteria by streaking method
5. Enumeration of colony forming units (CFU) count by spread plate method/pour plate
7. Study the morphological structures of viruses (DNA and RNA) and their important characters using electron micrographs

8. Study of the methods of isolation and propagation of plant viruses
9. Study of cytopathic effects of viruses using photographs

SUGGESTED READING

1. Atlas RM. (1997). Principles of Microbiology. 2nd edition. WM.T.Brown Publishers
2. Madigan MT, Martinko JM, Dunlap PV and Clark DP (2014). Brock Biology of Micro-organisms.

14th edition. Pearson Education, Inc.

3. Stanier RY, Ingraham JL, Wheelis ML and Painter PR. (2005). General Microbiology. 5th edition. McMillan

4. Carter J and Saunders V(2007). Virology, principles and Applications. John Wiley and Sons
5. Flint SJ, Enquist, LW, Krug, RM, Racaniello, VR Skalka, AM (2004) Principles of Virology, Molecular Biology, Pathogenesis and Control.2nd edition.ASM Press
6. Shors Teri (2013) Understanding Viruses 2nd edition Jones and Bartlett Learning Burlington USA

7. PelczarJr MJ, Chan ECS, and Krieg NR. (2004). Microbiology. 5th edition Tata McGraw Hill.
8. Tortora GJ, Funke BR, and Case CL. (2008). Microbiology: An Introduction. 9th edition Pearson Education.

9. Willey JM, Sherwood LM, and Woolverton CJ. (2013). Prescott's Microbiology. 9th edition. McGraw Hill Higher Education.
10. Dimmock, NJ, Easton, AL, Leppard, KN (2007). Introduction to Modern Virology. 6th edition, Blackwell Publishing Ltd.

11. Cann AJ (2012) Principles of Molecular Virology, Academic Press Oxford UK

Semester-3

Core Course

CC-3/GE3: MICROBIAL METABOLISM (THEORY)
MCB-G-CC-3-3-TH

TOTAL HOURS: 50 **CREDITS: 4**

Unit 1 Microbial Growth and Effect of Environment on Microbial Growth **No. of Hours: 10**
Definitions of growth, Batch culture, Continuous culture, generation time and specific growth rate
Temperature and temperature ranges of growth
pH and pH ranges of growth
Effect of solute and water activity on growth
Effect of oxygen concentration on growth
Nutritional categories of microorganisms

Unit 2 Nutrient uptake and Transport **No. of Hours: 10**
Passive and facilitated diffusion
Primary and secondary active transport, concept of uniport, symport and antiport
Group translocation
Iron uptake

Unit 3 Chemoheterotrophic Metabolism - Aerobic Respiration **No. of Hours: 8**
Concept of aerobic respiration, anaerobic respiration and fermentation
Sugar degradation pathways i.e. EMP, ED, Pentose phosphate pathway
TCA cycle
Electron transport chain: components of respiratory chain, comparison of mitochondrial and bacterial ETC, electron transport phosphorylation, uncouplers and inhibitors

Unit 4 Chemoheterotrophic Metabolism- Anaerobic respiration and fermentation
No. of Hours: 6
Anaerobic respiration with special reference to dissimilatory nitrate reduction (Denitrification; nitrate /nitrite and nitrate/ammonia respiration; fermentative nitrate reduction)
Fermentation - Alcohol fermentation and Pasteur effect; Lactate fermentation (homofermentative and heterofermentative pathways), concept of linear and branched fermentation pathways

Unit 5 Chemolithotrophic and Phototrophic Metabolism **No. of Hours: 10**
Introduction to aerobic and anaerobic chemolithotrophy with an example each. Hydrogen oxidation (definition and reaction) and methanogenesis (definition and reaction)
Introduction to phototrophic metabolism - groups of phototrophic microorganisms, anoxygenic*vs.* oxygenic photosynthesis with reference to photosynthesis in green bacteria and cyanobacteria

Unit 6 Nitrogen Metabolism - an overview **No. of Hours: 6**
Introduction to biological nitrogen fixation
Ammonia assimilation
Assimilatory nitrate reduction

CC-3/GE3: MICROBIAL METABOLISM (PRACTICAL)

MCB-G-CC-3-3-P

TOTAL HOURS: 60 **CREDITS: 2**

1. Study and plot the growth curve of *E. coli* by tubidiometric and standard plate count methods.
2. Calculations of generation time and specific growth rate of bacteria from the graph plotted with the given data
3. Effect of temperature on growth of *E. coli*
4. Effect of pH on growth of *E. coli*
5. Effect of Nitrogen and Carbon sources on *E. Coli*
6. Effect of salt on growth of *E. coli*
7. Demonstration of alcoholic fermentation
8. Demonstration of the thermal death time and decimal reduction time of *E. coli.*

SUGGESTED READINGS

1. Madigan MT, and Martinko JM (2014). Brock Biology of Microorganisms. 14th edition. Prentice Hall International Inc.
2. Moat AG and Foster JW. (2002). Microbial Physiology. 4th edition. John Wiley & Sons
3. Reddy SR and Reddy SM. (2005). Microbial Physiology. Scientific Publishers India
4. Gottschalk G. (1986). Bacterial Metabolism. 2nd edition. Springer Verlag
5. Stanier RY, Ingrahm JI, Wheelis ML and Painter PR. (1987). General Microbiology. 5th edition, McMillan Press.
6. Willey JM, Sherwood LM, and Woolverton CJ. (2013). Prescott's Microbiology. 9th edition. McGraw Hill Higher Education.

SEMESTER-4
Core Course
CC-4/GE4: MICROBIAL GENETICS AND MOLECULAR BIOLOGY (THEORY)

MCB-G-CC-4-4-TH

TOTAL HOURS: 50 **CREDITS: 4**

Unit 1 Structures of DNA and RNA / Genetic Material **No. of Hours: 6**
DNA structure, Salient features of double helix, Types of DNA, denaturation and renaturation, topoisomerases; Organization of DNA Prokaryotes,Viruses, Eukaryotes. RNA Structure

Unit 2 Replication of DNA **No. of Hours: 5**
Bidirectional and unidirectional replication, semi- conservative, semi- discontinuous replication Mechanism of DNA replication: Enzymes and proteins involved in DNA replication –DNA polymerases, DNA ligase, primase, telomerase – for replication of linear ends

Unit 3 Transcription **No. of Hours: 5**
Transcription: Definition, promoter - concept and strength of promoter. Transcriptional Machinery and Mechanism of transcription.

Unit 4 Translation **No. of Hours: 5**
Genetic code, Translational machinery, Charging of tRNA, aminoacyltRNA synthetases, Mechanisms of initiation, elongation and termination of polypeptides.

Unit 5 Regulation of gene Expression **No. of Hours: 5**
Principles of transcriptional regulation, regulation at initiation with examples from *lac* and *trp* operons

Unit 6 Mutations **No. of Hours: 8**
Mutations and mutagenesis: Definition and types of Mutations; Physical and chemical mutagens; Uses of mutations, DNA repair mechanisms

Unit 7 Mechanisms of Genetic Exchange Transformation - Discovery, mechanism of natural competence Conjugation - Discovery, mechanism, Hfr and F' strains Transduction - Generalized transduction, specialized transduction **No. of Hours: 8**

Unit 8 Plasmids and Transposable Elements **No. of Hours: 8**
Property and function of plasmids, Types of plasmids.Prokaryotic transposable elements – Insertion Sequences, composite and non-composite transposons, Replicative and Non replicative transposition, Uses of transposons and transposition.

CC-4/GE4: MICROBIAL GENETICS AND MOLECULAR BIOLOGY (PRACTICAL)
SEMESTER – 4

MCB-G-CC-4-4-P

TOTAL HOURS: 60 **CREDITS: 2**

1. Study of different types of DNA and RNA using micrographs and model / schematic representations
2. Study of semi-conservative replication of DNA through micrographs / schematic representations
3. Estimation of salmon sperm / calf thymus DNA using colorimeter (diphenylamine reagent) or UV spectrophotometer (A260 measurement)

4. Resolution and visualization of DNA by Agarose Gel Electrophoresis.
5. Resolution and visualization of proteins by Polyacrylamide Gel Electrophoresis (SDS-PAGE).
6. Study the effect of chemical (HNO2) and physical (UV) mutagens on bacterial cells
7. Study survival curve of bacteria after exposure to ultraviolet (UV) light
8. Demonstration of Bacterial Transformation and calculation of transformation efficiency.

SUGGESTED READINGS

1. Watson JD, Baker TA, Bell SP, Gann A, Levine M and Losick R (2008) Molecular Biology of the Gene, 6th edition, Cold Spring Harbour Lab. Press, Pearson Publication

2. Becker WM, Kleinsmith LJ, Hardin J and Bertoni GP (2009) The World of the Cell, 7th edition, Pearson Benjamin Cummings Publishing, San Francisco
3. De Robertis EDP and De Robertis EMF (2006) Cell and Molecular Biology, 8th edition. Lippincott Williams and Wilkins, Philadelphia

4. Karp G (2010) Cell and Molecular Biology: Concepts and Experiments, 6th edition, John Wiley & Sons. Inc.

5. Sambrook J and Russell DW. (2001). Molecular Cloning: A Laboratory Manual. 4th Edition, Cold Spring Harbour Laboratory press.

6. Krebs J, Goldstein E, Kilpatrick S (2013). Lewin's Essential Genes, 3rd Ed., Jones and Bartlett Learning

7. Gardner EJ, Simmons MJ, Snustad DP (2008). Principles of Genetics. 8th Ed. Wiley-India

8. Klug WS, Cummings MR, Spencer, C, Palladino, M (2011). Concepts of Genetics, 10th Ed., Benjamin Cummings
9. Maloy SR, Cronan JE and FriefelderD(2004) Microbial Genetics 2nd EDITION., Jones and Barlett Publishers

10. Russell PJ. (2009). i Genetics- A Molecular Approach. 3rd Ed, Benjamin Cumming

Skill Enhancement Elective Courses (SEC)

SEC-A

(A candidate has to opt any one from SEC-A either in Semester-3 or in Semester-5)

1: BIOFERTILIZERS AND BIOPESTICIDES
MCB-G-SEC-A-3/5-1-TH

TOTAL HOURS: 30 **CREDITS: 2**

Unit 1 Biofertilizers **No of Hours: 10**

General account of the microbes used as biofertilizers for various crop plants and their advantages over chemical fertilizers.
Symbiotic N2 fixers: *Rhizobium* - Isolation, characteristics, types, inoculum production and field application, legume/pulses plants
Frankia- Isolation, characteristics, Alder, Casurina plants, non-leguminous crop symbiosis.Cyanobacteria, *Azolla* - Isolation, characterization, mass multiplication, Role in rice cultivation, Crop response, field application.

Unit 2 Non - Symbiotic Nitrogen Fixers **No of Hours: 4**

Free living *Azospirillum, Azotobacter* - free isolation, characteristics, mass inoculums, production and field application.

Unit 3 Phosphate Solubilizers **No of Hours: 4**

Phosphate solubilizing microbes - Isolation, characterization, mass inoculum production, field application

Unit 4 MycorrhizalBiofertilizers **No of Hours: 5**

Importance of mycorrizal inoculum, types of mycorrhizae and associated plants, Mass inoculum production of VAM, field applications of Ectomycorrhizae and VAM.

Unit 5 Bioinsecticides **No of Hours: 7**

General account of microbes used as bioinsecticides and their advantages over synthetic pesticides, *Bacillus thuringiensis*, production, Field applications, Viruses – cultivation and field applications.

Suggested Readings

1. Kannaiyan, S. (2003). Bioetchnology of Biofertilizers, CHIPS, Texas.
2. Mahendra K. Rai (2005). Hand book of Microbial biofertilizers, The Haworth Press, Inc. New York.
3. Reddy, S.M. et. al. (2002). Bioinoculants for sustainable agriculture and forestry, Scientific Publishers.
4. SubbaRao N.S (1995) Soil microorganisms and plant growth Oxford and IBH publishing co. Pvt. Ltd. NewDelhi.

5. Saleem F and Shakoori AR (2012) Development of Bioinsecticide, Lap Lambert Academic Publishing GmbH KG
6. Aggarwal SK (2005) Advanced Environmental Biotechnology, APH publication.

2.Microbial Quality Control in Food and Pharmaceutical Industries
MCB-G-SEC-A-3/5-3-TH

TOTAL HOURS: 30 **CREDITS: 2**

Unit 1 Microbiological Laboratory and Safe Practices **No. of Hours: 8**

Good laboratory practices - Good laboratory practices, Good microbiological practices
Biosafety cabinets – Working of biosafety cabinets, using protective clothing, specification for BSL-1, BSL-2, BSL-3. Discarding biohazardous waste – Methodology of Disinfection, Autoclaving & Incineration

Unit 2 Determining Microbes in Food / Pharmaceutical Samples **No. of Hours: 10**

Culture and microscopic methods - Standard plate count, Most probable numbers, Direct microscopic counts, Biochemical and immunological methods: Limulus lysate test for endotoxin, gel diffusion, sterility testing for pharmaceutical products
Molecular methods - Nucleic acid probes, PCR based detection, biosensors.

Unit 3 Pathogenic Microorganisms of Importance in Food & Water **No. of Hours: 8**

Enrichment culture technique, Detection of specific microorganisms - on XLD agar, Salmonella Shigella Agar, Manitol salt agar, EMB agar, McConkey Agar, Saboraud Agar
Ascertaining microbial quality of milk by MBRT, Rapid detection methods of microbiological quality of milk at milk collection centres (COB, 10 min Resazurin assay)

Unit 4 HACCP for Food Safety and Microbial Standards **No. of Hours: 4**

Hazard analysis of critical control point (HACCP) - Principles, flow diagrams, limitations
Microbial Standards for Different Foods and Water – BIS standards for common foods and drinking water

SUGGESTED READING

1. Harrigan WF (1998) Laboratory Methods in Food Microbiology, 3rd ed. Academic Press
2. Garg N, Garg KL and Mukerji KG (2010) Laboratory Manual of Food Microbiology I K International Publishing House Pvt. Ltd.
3. Jay JM, Loessner MJ, Golden DA (2005) Modern Food Microbiology, 7th edition. Springer
4. Baird RM, Hodges NA and Denyer SP (2005) Handbook of Microbiological Quality control in Pharmaceutical and Medical Devices, Taylor and Francis Inc.

SEC-B

(A candidate has to opt any one from SEC-B either in Semester-4 or in Semester-6)

1. MICROBIOLOGICAL ANALYSIS OF AIR AND WATER

MCB-G-SEC-B-4/6-2-TH

TOTAL HOURS: 30 **CREDITS: 2**

Unit 1 Aeromicrobiology **No of Hours: 4**

Bioaerosols, Air borne microorganisms (bacteria, Viruses, fungi) and their impact on human health and environment, significance in food and pharma industries and operation theatres, allergens

Unit 2 Air Sample Collection and Analysis **No of Hours: 7**

Bioaerosol sampling, air samplers, methods of analysis, CFU, culture media for bacteria and fungi, Identification characteristics

Unit 3 Control Measures **No of Hours: 4**

Fate of bioaerosols, inactivation mechanisms – UV light, HEPA filters, desiccation, Incineration

Unit 4 Water Microbiology **No of Hours: 4**

Water borne pathogens, water borne diseases

Unit 5 Microbiological Analysis of Water **No of Hours: 7**

Sample Collection, Treatment and safety of drinking (potable) water, methods to detect potability ofwater samples: (a) standard qualitative procedure: presumptive/MPN tests, confirmed and completed tests for faecal coliforms (b) Membrane filter technique and (c) Presence/absence tests

Unit 6 Control Measures **No of Hours: 4**

Precipitation, chemical disinfection, filtration, high temperature, UV light

Suggested Reading

1. da Silva N, Taniwaki MH, Junqueira VC, Silveira N, Nascimento MS, Gomes RAR (2012) Microbiological Examination Methods of Food and WaterA Laboratory Manual, CRC Press
2. Atlas RM and Bartha R. (2000). Microbial Ecology: Fundamentals & Applications. 4th edition. Benjamin/Cummings Science Publishing, USA
3. Maier RM, Pepper IL and Gerba CP. (2009). Environmental Microbiology. 2nd edition, Academic Press
4. Hurst CJ, Crawford RL, Garland JL, Lipson DA (2007) Manual of Environmental Microbiology, 3rd edition, ASM press

2. FOOD FERMENTATION TECHNIQUES

MCB-G-SEC-B-4/6-4-TH

TOTAL HOURS: 30 **CREDITS: 2**

Unit 1 Fermented Foods **No of Hours: 4**

Definition, types, advantages and health benefits

Unit 2 Milk Based Fermented Foods **No of Hours: 8**

Dahi, Yogurt, Buttermilk (Chach) and cheese: Preparation of inoculums, types of microorganisms and production process

Unit 3 Grain Based Fermented Foods **No of Hours: 6**

Soy sauce, Bread, Idli and Dosa: Microorganisms and production process

Unit 4 Vegetable Based Fermented Foods **No of Hours: 4**

Pickels, Saeurkraut: Microorganisms and production process

Unit 5 Fermented Meat and Fish **No of Hours: 4**

Types, microorganisms involved, fermentation process

Unit 6 Probiotic Foods **No of Hours: 4**

Definition, types, microorganisms and health benefits

Suggested Readings

1. Hui YH, Meunier-Goddik L, Josephsen J, Nip WK, Stanfield PS (2004) Handbook of food and fermentation technology, CRC Press
2. Holzapfel W (2014) Advances in Fermented Foods and Beverages, Woodhead Publishing.
3. Yadav JS, Grover, S and Batish VK (1993) A comprehensive dairy microbiology, Metropolitan
4. Jay JM, Loessner MJ, Golden DA (2005) Modern Food Microbiology, 7th edition. Springer

Elective Course (Any One from DSE-A)

Semester-5

DSE-A:
1. GENETIC ENGINEERING AND BIOTECHNOLOGY (THEORY)

MCB-G-DSE-A-5-1-TH

TOTAL HOURS: 50 **CREDITS: 4**

Unit 1 Introduction to genetic engineering **No. of Hours: 12**

Milestones in genetic engineering and biotechnology

Restriction modification systems: Mode of action, applications of Type II restriction enzymes in genetic engineering

DNA modifying enzymes and their applications: DNA polymerases. Terminal deoxynucleotidyl transferase, kinases and phosphatases, and DNA ligases Cloning: Use of linkers and adaptors

Transformation of DNA: Chemical method, Electroporation

Methods of DNA, RNA and Protein analysis: Agarose gel electrophoresis, Southern - and Northern - blotting techniques, dot blot, DNA microarray analysis, SDS-PAGE and Western blotting.

Unit 2 Vectors **No. of Hours: 14**

Cloning Vectors: Definition and Properties

Plasmid vectors: pBR and pUC series

Bacteriophage lambda and M13 based vectors

Cosmids, BACs, YACs

Expression vectors: *E.coli* lac and T7 promoter-based vectors, yeast YIp, YEp and YCp vectors, Baculovirus based vectors, mammalian SV40-based expression vectors

Unit 3 DNA Amplification and DNA sequencing **No. of Hours: 8**

PCR: Basics of PCR, RT-PCR, Real-Time PCR

Genomic and cDNA libraries: Preparation and uses, Genome sequencing

Sanger's method of DNA Sequencing: traditional and automated sequencing

Unit 4 Application of Genetic Engineering and Biotechnology **No. of Hours: 12**

Gene delivery: Microinjection, electroporation, biolistic method (gene gun), liposome and viral-mediated delivery, *Agrobacterium* - mediated delivery

Products of recombinant DNA technology: Products of human therapeutic interest - insulin, hGH, antisense molecules. Bt transgenic - cotton, brinjal, flavosavo tomato, Gene therapy, recombinant vaccine, protein engineering

Unit 5 Intellectual Property Rights **No. of Hours: 4**

Patents, Copyrights, Trademarks

DSE-A:

1. GENETIC ENGINEERING AND BIOTECHNOLOGY (PRACTICAL)

SEMESTER –5

MCB-G-DSE-A-5-1-P

TOTAL HOURS: 60 **CREDITS: 2**

1. Isolation of Plasmid DNA from *E.coli*
2. Digestion of DNA using restriction enzymes and analysis by agarose gel electrophoresis
3. Ligation of DNA fragments
4. Interpretation of sequencing gel electropherograms
5. Designing of primers for DNA amplification
6. Amplification of DNA by PCR
7. Demonstration of Southern blotting

SUGGESTED READING

1. Brown TA. (2010). Gene Cloning and DNA Analysis. 6th edition. Blackwell Publishing, Oxford, U.K.
2. Clark DP and Pasternik NJ. (2009). Biotechnology: Applying the Genetic Revolution. Elsevier Academic Press, USA
3. Primrose SB and Twyman RM. (2006). Principles of Gene Manipulation and Genomics, 7th edition. Blackwell Publishing, Oxford, U.K.
4. Sambrook J and Russell D. (2001). Molecular Cloning-A Laboratory Manual. 3rd edition. Cold Spring Harbor Laboratory Press
5. Wiley JM, Sherwood LM and Woolverton CJ. (2013). Prescott, Harley and Klein's Microbiology. 8th edition, McGraw Hill Higher Education
6. Brown TA. (2007). Genomes-3. Garland Science Publishers
7. Primrose SB and Twyman RM. (2008). Genomics: Applications in human biology. Blackwell Publishing, Oxford, U.K.

DSE-A:
2. MICROBES IN ENVIRONMENT (THEORY)

SEMESTER – 5

MCB-G-DSE-A-5-2-TH

TOTAL HOURS: 50 **CREDITS: 4**

Unit 1 Microorganisms and their Habitats **No. of Hours: 12**

Structure and function of ecosystems
Terrestrial Environment: Soil profile and soil microflora
Aquatic Environment: Microflora of fresh water and marine habitats
Atmosphere: Aeromicroflora and dispersal of microbes
Animal Environment: Microbes in/on human body (Microbiomics) & animal (ruminants) body.
Extreme Habitats: Extremophiles: Microbes thriving at high & low temperatures, pH, high hydrostatic & osmotic pressures, salinity, & low nutrient levels.

Unit 2 Microbial Interactions **No. of Hours: 08**

Microbe interactions: Mutualism, synergism, commensalism, competition, amensalism, parasitism, predation
Microbe-Plant interaction: Symbiotic and non symbiotic interactions
Microbe-animal interaction: Microbes in ruminants, nematophagus fungi and symbiotic luminescent bacteria

Unit 3 Biogeochemical Cycling **No. of Hours: 10**

Carbon cycle: Microbial degradation of cellulose, hemicelluloses, lignin and chitin
Nitrogen cycle: Nitrogen fixation, ammonification, nitrification, denitrification and nitrate reduction
Phosphorus cycle: Phosphate immobilization and solubilisation
Sulphur cycle: Microbes involved in sulphur cycle
Other elemental cycles: Iron and manganese

Unit 4 Waste Management **No. of Hours: 10**

Solid Waste management: Sources and types of solid waste, Methods of solid waste disposal (composting and sanitary landfill)
Liquid waste management: Composition and strength of sewage (BOD and COD), Primary, secondary (oxidation ponds, trickling filter, activated sludge process and septic tank) and tertiary sewage treatment

Unit 5 Microbial Bioremediation **No. of Hours: 5**

Principles and degradation of common pesticides, hydrocarbons (oil spills).

Unit 6 Water Potability **No. of Hours: 5**

Treatment and safety of drinking (potable) water, methods to detect potability of water samples: (a) standard qualitative procedure: presumptive test/MPN test, confirmed and completed tests for faecal coliforms (b) Membrane filter technique and (c) Presence/absence tests

DSE-A:
2. MICROBES IN ENVIRONMENT (PRACTICAL)
SEMESTER –5

MCB-G-DSE-A-5-2-P

TOTAL HOURS: 60 **CREDITS: 2**

1. Analysis of soil - pH, moisture content, water holding capacity, percolation, capillary action.
2. Isolation of microbes (bacteria & fungi) from soil (28ºC & 45ºC).
3. Isolation of microbes (bacteria & fungi) from rhizosphere and rhizoplane.
4. Assessment of microbiological quality of water.
5. Determination of BOD of waste water sample.
6. Study the presence of microbial activity by detecting (qualitatively) enzymes (dehydrogenase, amylase, urease) in soil.
7. Isolation of *Rhizobium* from root nodules.

SUGGESTED READINGS

1. Atlas RM and Bartha R. (2000). Microbial Ecology: Fundamentals & Applications. 4th edition. Benjamin/Cummings Science Publishing, USA
2. Madigan MT, Martinko JM and Parker J. (2014). Brock Biology of Microorganisms. 14th edition. Pearson/ Benjamin Cummings
3. Maier RM, Pepper IL and Gerba CP. (2009). Environmental Microbiology. 2nd edition, Academic Press
4. Okafor, N (2011). Environmental Microbiology of Aquatic & Waste systems. 1st edition, Springer, New York
5. Singh A, Kuhad, RC & Ward OP (2009). Advances in Applied Bioremediation. Volume 17, Springer-Verlag, Berlin Hedeilberg
6. Barton LL & Northup DE (2011). Microbial Ecology. 1st edition, Wiley Blackwell, USA Campbell RE. (1983). Microbial Ecology. Blackwell Scientific Publication, Oxford, England.
7. Coyne MS. (2001). Soil Microbiology: An Exploratory Approach. Delmar Thomson Learning.
8. Lynch JM &Hobbie JE. (1988). Microorganisms in Action: Concepts & Application in Microbial Ecology. Blackwell Scientific Publication, U.K.
9. Martin A. (1977). An Introduction to Soil Microbiology. 2nd edition. John Wiley & Sons Inc. New York & London.
10. Stolp H. (1988). Microbial Ecology: Organisms Habitats Activities. Cambridge University Press, Cambridge, England.
11. SubbaRao NS. (1999). Soil Microbiology. 4th edition. Oxford & IBH Publishing Co. New Delhi.
12. Willey JM, Sherwood LM, and Woolverton CJ. (2013). Prescott's Microbiology. 9th edition. McGraw Hill Higher Education.

Elective Course (Any One from DSE-B)

Semester-6

DSE-B:
1. MEDICAL MICROBIOLOGY AND IMMUNOLOGY (THEORY)

MCB-G-DSE-B-6-1-TH

TOTAL HOURS: 50 **CREDITS: 4**

Unit 1 Normal microflora of the human body and host pathogen interaction
No. of Hours: 5

Normal microflora of the human body: Importance of normal microflora, normal microflora of skin, throat, gastrointestinal tract, urogenital tract
Host pathogen interaction: Definitions - Infection, Invasion, Pathogen, Pathogenicity, Virulence, Toxigenicity, Carriers and their types, Opportunistic infections, Nosocomial infections. Transmission of infection,

Unit 2 Sample collection, transport and diagnosis **No. of Hours: 2**

Collection, transport and culturing of clinical samples and their identification characteristics.

Unit 3 Bacterial diseases **No. of Hours: 3**

List of diseases of various organ systems and their causative agents.

Unit 4 Viral diseases **No. of Hours: 3**

List of diseases of various organ systems and their causative agents.

Unit 5 Protozoan diseases **No. of Hours: 2**

List of diseases of various organ systems and their causative agents.

Unit 6 Fungal diseases **No. of Hours: 2**

Brief description of various types of mycoses.

Unit 7 Antimicrobial agents: General characteristics and mode of action **No. of Hours: 6**

Antibacterial agents: Five modes of action with one example each: Inhibitor of nucleic acid synthesis; Inhibitor of cell wall synthesis; Inhibitor of cell membrane function; Inhibitor of protein synthesis; Inhibitor of metabolism
Antifungal agents: Mechanism of action of Amphotericin B, Griseofulvin
Antiviral agents: Mechanism of action of Amantadine, Acyclovir, Azidothymidine

Unit 8 Immune Cells and Organs **No. of Hours: 5**

Structure, Functions and Properties of: Immune Cells – Stem cell, T cell, B cell, NK cell, Macrophage, Neutrophil, Eosinophil, Basophil, Mast cell, Dendritic cell; and Immune Organs – Bone Marrow, Thymus, Lymph Node, Spleen

Unit 9 Antigens and Antibodies **No. of Hours: 6**

Characteristics of an antigen (Foreignness, Molecular size and Heterogeneity); Haptens; Epitopes (T & B cell epitopes), Adjuvants, Structure, Types and Functions of antibodies.

Unit 10 Generation of Immune Response **No. of Hours: 6**

Primary and Secondary Immune Response; Generation of Humoral Immune Response (Plasma and Memory cells); Generation of Cell Mediated Immune Response

Unit 11 Immunological Disorders and Tumor Immunity **No. of Hours: 5**

Types of Autoimmunity and Hypersensitivity with examples; Immunodeficiencies - Animal models (Nude and SCID mice).

Unit 12 Immunological Techniques No. of Hours: 5
Principles of Precipitation, Agglutination, Immunodiffusion, Immunoelectrophoresis, ELISA, ELISPOT.

DSE-B:
1. MEDICAL MICROBIOLOGY AND IMMUNOLOGY (PRACTICAL)

MCB-G-DSE-B-6-1-P

TOTAL HOURS: 60 **CREDITS: 2**

1. Identify bacteria on the basis of cultural, morphological and biochemical characteristics: IMViC, TSI, nitrate reduction, urease production and catalase tests
2. Study of composition and use of important differential media for identification of bacteria: EMB Agar, McConkey agar, Mannitol salt agar, Deoxycholate citrate agar, TCBS
3. Study of bacterial flora of skin by swab method
4. Perform antibacterial sensitivity by Kirby-Bauer method
5. Identification of human blood groups.
6. To perform Total Leukocyte Count of the given blood sample.
7. To perform Differential Leukocyte Count of the given blood sample.
8. To separate serum from the blood sample (demonstration).
9. To perform immunodiffusion by Ouchterlony method.

SUGGESTED READING

1. Ananthanarayan R. and Paniker C.K.J. (2009) Textbook of Microbiology. 8th edition, University Press Publication
2. Brooks G.F., Carroll K.C., Butel J.S., Morse S.A. and Mietzner, T.A. (2013) Jawetz, Melnick and Adelberg's Medical Microbiology. 26th edition. McGraw Hill Publication
3. Goering R., Dockrell H., Zuckerman M. and Wakelin D. (2007) Mims' Medical Microbiology. 4th edition. Elsevier
4. Willey JM, Sherwood LM, and Woolverton CJ. (2013) Prescott, Harley and Klein's Microbiology. 9th edition. McGraw Hill Higher Education
5. Abbas AK, Lichtman AH, Pillai S. (2007). Cellular and Molecular Immunology. 6th edition Saunders Publication, Philadelphia.
6. Delves P, Martin S, Burton D, Roitt IM. (2006). Roitt's Essential Immunology.11th edition Wiley-Blackwell Scientific Publication, Oxford.
7. Goldsby RA, Kindt TJ, Osborne BA. (2007). Kuby's Immunology. 6th edition W.H. Freeman and Company, New York.
8. Richard C and Geiffrey S. (2009). Immunology. 6th edition. Wiley Blackwell Publication.

DSE-B:
2. INDUSTRIAL AND FOOD MICROBIOLOGY (THEORY)

MCB-G-DSE-B-6-2-TH

TOTAL HOURS: 50 **CREDITS: 4**

Unit 1 Introduction to Industrial microbiology **No. of Hours: 10**
Brief history and developments in industrial microbiology
Types of fermentation processes - solid state, liquid state, batch, fed-batch and continuous
Types of fermenters – laboratory, pilot-scale and production fermenters
Components of a typical continuously stirred tank bioreactor

Unit 2 Isolation of Industrial Strains and Fermentation Medium **No. of Hours: 6**
Primary and secondary screening
Preservation and maintenance of industrial strains
Ingredients used in fermentation medium - molasses, corn steep liquor, whey & Yeast extract

Unit 3 Microbial fermentation processes **No. of Hours: 10**
Downstream processing - filtration, centrifugation, cell disruption, solvent extraction.
Microbial production of industrial products - citric acid, ethanol and penicillin.
Industrial production and uses of the enzymes - amylases, proteases, lipases and cellulases

Unit 4 Food as a substrate for microbial growth **No. of Hours: 6**
Intrinsic and extrinsic parameters that affect microbial growth in food
Microbial spoilage of food - milk, egg, bread and canned foods

Unit 5 Principles and methods of food preservation and food sanitation **No. of Hours: 8**
Physical methods - high temperature, low temperature, irradiation, aseptic packaging
Chemical methods - salt, sugar, benzoates, citric acid, ethylene oxide, nitrate and nitrite
Food sanitation and control – HACCP

Unit 6 Dairy products, probiotics and Food-borne Diseases **No. of Hours: 10**
Fermented dairy products - yogurt, acidophilus milk, kefir, dahi and cheese
Probiotics definition, examples and benefits
Food intoxication by *Clostridium botulinum* and *Staphylococcus aureus*
Food infection by *Salmonella* and *E.coli*

DSE-B:
2.INDUSTRIAL AND FOOD MICROBIOLOGY (PRACTICAL)
MCB-G-DSE-B-6-2-P

TOTAL HOURS: 60 **CREDITS: 2**

1. Microbial fermentation for the production and estimation of amylase
2. Microbial fermentation for the production and estimation of citric acid
3. Microbial fermentation for the production and estimation of ethanol
4. Determination of the microbiological quality of milk sample by MBRT
5. Isolation of fungi from spoilt bread/fruits/vegetables
6. Preparation of Yogurt/Dahi

SUGGESTED READING

1. Crueger W and Crueger A. (2000). Biotechnology: A textbook of Industrial Microbiology. 2nd Edition. Panima Publishing Company, New Delhi

2. Patel AH. (1996). Industrial Microbiology .1st Edition. MacMillan India Limited Publishing Company Ltd. New Delhi, India
3. Tortora GJ, Funke BR, and Case CL. (2008). Microbiology: An introduction.9th Edition. Pearson Education
4. Willey JM, Sherwood LM AND Woolverton CJ (2013), Prescott, Harley and Klein's Microbiology.9th Edition. McGraw Hill Higher education
5. Casida LE. (1991). Industrial Microbiology. 1st edition. Wiley Eastern Limited.
6. Stanbury PF, Whitaker A and Hall SJ. (2006). Principles of Fermentation Technology. 2nd edition, Elsevier Science Ltd.
7. Adams MR and Moss MO. (1995). Food Microbiology. 4th edition, New Age International (P) Limited Publishers, New Delhi, India.
8. Banwart JM. (1987). Basic Food Microbiology. 1st edition. CBS Publishers and Distributors, Delhi, India.
9. Frazier WC and Westhoff DC. (1992). Food Microbiology. 3rd edition. Tata McGraw-Hill Publishing Company Ltd, New Delhi, India.
10. Jay JM, Loessner MJ and Golden DA. (2005). Modern Food Microbiology. 7th edition, CBS Publishers and Distributors, Delhi, India.

UNIVERSITY OF CALCUTTA

Notification No. CSR/ 12 /18

It is notified for information of all concerned that the Syndicate in its meeting held on 28.05.2018 (vide Item No.14) approved the Syllabi of different subjects in Undergraduate Honours / General / Major courses of studies (CBCS) under this University, as laid down in the accompanying pamphlet:

List of the subjects

Sl. No.	Subject	Sl. No.	Subject
1	Anthropology (Honours / General)	29	Mathematics (Honours / General)
2	Arabic (Honours / General)	30	Microbiology (Honours / General)
3	Persian (Honours / General)	31	Mol. Biology (General)
4	Bengali (Honours / General /LCC2 /AECC1)	32	Philosophy (Honours / General)
5	Bio-Chemistry (Honours / General)	33	Physical Education (General)
6	Botany (Honours / General)	34	Physics (Honours / General)
7	Chemistry (Honours / General)	35	Physiology (Honours / General)
8	Computer Science (Honours / General)	36	Political Science (Honours / General)
9	Defence Studies (General)	37	Psychology (Honours / General)
10	Economics (Honours / General)	38	Sanskrit (Honours / General)
11	Education (Honours / General)	39	Social Science (General)
12	Electronics (Honours / General)	40	Sociology (Honours / General)
13	English ((Honours / General/ LCC1/ LCC2/AECC1)	41	Statistics (Honours / General)
14	Environmental Science (Honours / General)	42	Urdu (Honours / General /LCC2 /AECC1)
15	Environmental Studies (AECC2)	43	Women Studies (General)
16	Film Studies (General)	44	Zoology (Honours / General)
17	Food Nutrition (Honours / General)	45	Industrial Fish and Fisheries – IFFV (Major)
18	French (General)	46	Sericulture – SRTV (Major)
19	Geography (Honours / General)	47	Computer Applications – CMAV (Major)
20	Geology (Honours / General)	48	Tourism and Travel Management – TTMV (Major)
21	Hindi (Honours / General /LCC2 /AECC1)	49	Advertising Sales Promotion and Sales Management –ASPV (Major)
22	History (Honours / General)	50	Communicative English –CMEV (Major)
23	Islamic History Culture (Honours / General)	51	Clinical Nutrition and Dietetics CNDV (Major)
24	Home Science Extension Education (General)	52	Bachelor of Business Administration (BBA) (Honours)
25	House Hold Art (General)	53	Bachelor of Fashion and Apparel Design – (B.F.A.D.) (Honours)
26	Human Development (Honours / General)	54	Bachelor of Fine Art (B.F.A.) (Honours)
27	Human Rights (General)	55	B. Music (Honours / General) and Music (General)
28	Journalism and Mass Communication (Honours / General)		

The above shall be effective from the academic session 2018-2019.

SENATE HOUSE
KOLKATA-700073
The 4th June, 2018

Paul 4/6/18
(Dr. Santanu Paul)
Deputy Registrar

MODEL COURSE CURRICULUM FOR UNDERGRADUATE COURSES UNDER CHOICE BASED CREDIT SYSTEM

FINAL SYLLABUS

FOR

BACHELOR IN ENVIRONMENTAL SCIENCE (HONOURS)

UNIVERSITY OF CALCUTTA

Details of course under B.Sc. in Environmental Science (Hons.)

Course	Credits*
	Theory + Practical
I Core Courses (14 Papers)	
Core Courses - Theory (14 Papers) (4 Credits each)	14x4=56
Core Course – Practical (2 Credits Each)	14x2=28
II. Discipline Specific Electives (4 Papers)	
Discipline Specific Electives - Theory (4 Papers) (4 Credits)	4x4=16
Discipline Specific Electives - Practical (4 Papers) (2 Credits Each)	4x2=8
III Generic Electives (4 Papers)	
Generic Electives– Theory (4 Papers) (4 Credits)	4x4=16
Generic Electives – Practical (4 Papers) (2 Credits Each)	4x2=8
III. Ability Enhancement Courses (2 Papers)	
1. Ability Enhancement Compulsory Courses (AECC 1) English Communications. (2 credits) 2. Ability Enhancement Compulsory Courses (AECC 2) Environmental Studies (2 C credits)	2x2=4
IV. Skill Enhancement Courses (SEC)	
Skill Enhancement Courses (SEC) (Theory) (2 Papers of 2 Credits each)	2x2=4
Total Credits	**140**

Bachelor in Environment Science (Hons.)
Courses/Papers Sequence

Semester 1	Semester 2	Semester 3	Semester 4	Semester 5	Semester 6
CC l: Earth and Earth Surface Processes	CC3: Water and Water Resources Management	CC5: Ecology and Ecosystems	CC8: Systematics & Biogeography	CC 11: Biodiversity & Conservation Biology	CC l3: Environmental Pollution and Human Health
CC2: Physics & Chemistry of Environment	CC4: Land management and soil conservation	CC6: Environmental Biotechnology	CC9: Urban Ecosystems	CC l2: Organismal & Evolutionary Biology	CC l4: Natural Resources Management & Sustainability
AECCl: English Communication IMIL	AECC2: Environmental Studies	CC7: Atmosphere & Global Climate Change	CC 10: Environmental Legislation & Policy	DSE A1: Energy & Environment	DSE B1: Natural Hazards & Disaster Management
		SEC A1: Remote Sensing, Geographic Information System & Modelling	SEC B1: Environment Impact & Risk Assessment	DSE B2: Solid Waste Management OR DSE B3: Environmental Health and Toxicology	DSE A2: Environmental Economics and Statistics OR DSE A3: Green Technologies
		SEC A2: Wildlife Management	SEC B2: Analytical methods, instrumentation and Measurement		

CC1 (1ST SEMESTER) ENV-A-CC-1-1-TH: EARTH AND EARTH SURFACE PROCESSES

Theory (50 Lectures)

Unit 1: History of Earth (5 lectures)

Formation of the Earth: formation and composition of core, mantle, crust, atmosphere and hydrosphere; chemical composition of Earth; geological time scale and major changes on the Earth's surface.

Unit 2: Earth system processes (15 lectures)

Movement of lithosphere plates; mantle convection and plate tectonics, major plates and hotspots, plate boundaries; sea floor spread; earthquakes; volcanic activities; orogeny; isostasy; gravitational and magnetic fields of the earth; origin of the main geomagnetic field; continental drift, Pangaea and present-day continents, paleontological evidences of plate tectonics.

Land surface processes: fluvial and glacial processes, rivers and geomorphology; types of glaciers, glacier dynamics, erosional and depositional processes and glaciated landscapes; coastal processes.

Unit 3: Rocks, weathering and minerals (15 lectures)

Minerals and important rock forming minerals; rock cycle: lithification and metamorphism; Three rock laws; rock structure, igneous, sedimentary and metamorphic rocks; weathering: physical, biogeochemical processes; erosion: physical processes of erosion, factors affecting erosion; agents of erosion: rivers and streams, glacial and aeolian transportation and deposition of sediments by running water, wind and glaciers.

Unit 4: Earth atmosphere (6 lectures)

Atmosphere: evolution of earth's atmosphere, composition of atmosphere, physical and optical properties, circulation; interfaces: atmosphere–ocean interface, atmosphere–land interface, ocean–land interface.

Unit 5: Mountain and river systems of India (9 lectures)

Continental collision and mountain formation; Formation of Peninsular Indian mountain systems - Western and Eastern Ghats, Vindhyas, Aravallis, etc.; Formation of the Himalaya; perennial river systems and evolution of monsoon in Indian subcontinent; formation of Indo-Gangetic Plains, progression of agriculture in the Indian subcontinent in Holocene; withdrawing monsoon and lessons to draw.

CC1 (1ST SEMESTER) ENV-A-CC-1-1-P: EARTH AND EARTH SURFACE PROCESSES

l. Identification of rocks & minerals (Hand Specimen)
a) Rocks- Granite, Basalt, Dolerite, Shale, Sandstone, Limestone, Slate, Marble, Quartzite, Gneiss
b) Minerals- Talc, Bauxite, Mica, Quartz, Hematite, Galena (15)

2. Topological sheet interpretation for geomorphology. (10)
3. Viva Voce (5)

CC2 (1ST SEMESTER) ENV-A-CC-1-2-TH: PHYSICS AND CHEMISTRY OF ENVIRONMENT

Theory (50 Lectures)

Unit 1: Fundamentals of environmental physics (10 lectures)

Part A: Basic concepts of light and matter; spectroscopic concepts: Introduction to the concept of absorption and transmission of light, Beer–Lambert law; scattering of light, Rayleigh and Mia scattering.

Part B: Basic concepts of pressure, force, work and energy; types of forces and their relation (pressure gradient, viscous, Coriolis, gravitational, centripetal, and centrifugal force); concept of heat transfer, conduction, convection; concept of temperature, lapse rate (dry and moist adiabatic); laws of thermodynamics; concept of heat and work, Carnot engine.

Unit 2: Fundamentals of environmental chemistry (15 lectures)

Part A: Atomic structure, electronic configuration, periodic properties of elements (ionization potential, electron affinity and electronegativity), types of chemical bonds (ionic, covalent, coordinate and hydrogen bonds); mole concept, molarity and normality, quantitative volumetric analysis.

Part B: Types of chemical reactions; acids, bases and salts, concept of chemical equilibrium, solubility products; solutes and solvents; redox reactions, concepts of pH and pE, electrochemistry, Nernst equation, electrochemical cells.

Part C: Basic concepts of organic chemistry, hydrocarbons, aliphatic and aromatic compounds, organic functional groups, polarity of the functional groups, colloid chemistry. Xenobiotic compounds, chemistry of pesticides and dyes, synthetic polymers.

Unit 3: Atmospheric chemistry (9 lectures)

Composition of atmosphere; photochemical reactions in atmosphere; smog formation, types of smog (sulphur smog and photochemical smog), aerosols; chemistry of acid rain, reactions of NO_X and SO_X; free radicals and ozone layer depletion, role of CFCs in ozone depletion.

Unit 4: Water chemistry (9 lectures)

Chemical and physical properties of water; Gases in water, Henry's Law, alkalinity and acidity of water, hardness of water, calculation of total hardness; solubility of metals, complex formation and chelation; heavy metals in water.

Unit 5: Soil chemistry **(7 lectures)**

Soil composition; relation between organic carbon and organic matter, inorganic and organic components in soil; soil humus; cation and anion exchange reactions in soil; nitrogen, phosphorus and potassium in soil.

CC2 (1ST SEMESTER) ENV-A-CC-1-2-P: PHYSICS AND CHEMISTRY OF ENVIRONMENT

1. Acidity, Alkalinity (PA & TA), Total Hardness of water, Calcium Hardness of Water (10)
2. Soil moisture, Soil pH, Soil electrical conductivity. (10)
3. Viva Voce (5) Laboratory notebook (5)

CC3 (2ND SEMESTER) ENV-A-CC-2-3-TH: WATER AND WATER RESOURCES MANAGEMENT

Theory (50 Lectures)

Unit 1: Water resource **(5 lectures)**

Sources and types of water; hydrological cycle; precipitation, runoff, infiltration, evaporation, evapo-transpiration; classification of water resources (oceans, rivers, lakes and wetlands).

Unit 2: Properties of water **(10 lectures)**

Physical: temperature, colour, odour, total dissolved solids and total suspended solids; Chemical: major inorganic and organic constituents, dissolved gases, DO, COD, BOD, electrical conductivity, sodium adsorption ratio; Biological: phytoplankton, phytobenthos, zooplankton, macro-invertebrates and microbes.

Unit 3: Surface and Groundwater **(14 lectures)**

Introduction to surface and ground water; water table; vertical distribution of water; formation and properties of aquifers; hydraulic potential, Darcy's equation, types of flow, turbulence, techniques for ground water recharge; watershed and drainage basins; importance of watershed and watershed management.

Unit 4: Wetlands and their management **(6 lectures)**

Definition of a wetland; types of wetlands (fresh water and marine); ecological and hydrological functions of wetlands; threats to wetlands; wetland conservation and management; Ramsar Convention, 1971; major wetlands of India.

Unit 5: Water resource in India and Water sharing conflicts **(15 lectures)**

Demand for water (agriculture, industrial, domestic); overuse and depletion of surface and ground water resources; water quality standards in India; hot spots of surface water; role of state in water resources management. Water resources and sharing problems, case studies on Kaveri and Krishna river water disputes; Multi- purpose river valley projects in India and their environmental and social impacts; case studies of dams - Narmada and Tehri dam – social and ecological losses versus economic benefits.

CC 3 (2ND SEMESTER) ENV-A-CC-2-3-P: WATER AND WATER RESOURCES MANAGEMENT

1. pH, Electrical conductivity, Salinity (through Chloride Estimation), Dissolved oxygen, TSS, TDS, Iron. (20)
2. Viva Voce (5), Laboratory Notebook (5)

CC 4 (2ND SEMESTER) ENV-A-CC-2-4-TH: LAND MANAGEMENT AND SOIL CONSERVATION

Theory (50 Lectures)

Unit 1: Introduction to Land Resource **(5 lectures)**

Land as a resource, types and evaluation, soil health; ecological and economic importance of soil; types and causes of soil degradation; impact of soil loss and soil degradation on agriculture and food security; need for soil conservation and restoration of soil fertility.

Unit 2: Fundamentals of soil science **(10 lectures)**

Soil formation; classification of soil; soil architecture; physical properties of soil; soil texture; soil profile; soil water holding capacity; soil temperature; soil colloids; soil acidity and alkalinity; soil salinity and sodicity; soil organic matter; micronutrients of soil; nitrogen, sulphur, potassium and phosphorus economy of soil; soil biodiversity; soil taxonomy maps.

Unit 3: Soil degradation and conservation **(10 lectures)**

Soil resistance and resilience; nature and types of soil erosion; non-erosive and erosive soil degradation; losses of soil moisture and its regulation; nutrient depletion; soil pollution due to mining and mineral extraction, industrial and urban development, toxic organic chemicals, and organic contaminants in soils; fertilizers and fertilizer management; recycling of soil nutrients.

Different techniques of soil conservation (mechanical and biological)

Unit 4: Land use changes **(5 lectures)**

Land use pattern, drivers of land use and land cover change in major geographic zones and biodiverse regions with particular reference to the Himalaya and the Western Ghats.

Unit 5: Land degradation and management **(20 lectures)**

Land degradation: biological and physical phenomena; visual indicators of land degradation; drivers of land degradation - deforestation, desertification; habitat loss, loss of biodiversity; range land degradation; land salinization; human population pressure, poverty, socio-economic and institutional factors, Economic valuation of land degradation; onsite and offsite costs of land degradation; loss of ecosystem services; effects on farming communities; effects on food security; effects on nutrient cycles; future effects of soil degradation; emerging threats of land degradation to developing countries.

Sustainable land use planning; role of databases and data analysis in landuse planning control and management; land tenure and land policy; legal, institutional and sociological factors; participatory land degradation assessment; integrating land degradation assessment into conservation.

CC 4 (2ND SEMESTER) ENV-A-CC-2-4-P: LAND MANAGEMENT AND SOIL CONSERVATION

1. Soil Organic Carbon, Water Holding Capacity, Determination of Soil carbonate and Bicarbonate , Available NPK of Soil (Demonstration only). (20)
2. Viva voce (5), Laboratory Notebook (5)

CC 5 (3RD SEMESTER) ENV-A-CC-3-5-TH: ECOLOGY AND ECOSYSTEMS

Theory (50 Lectures)

Unit1: Introduction to Ecology **(12 lectures)**

Basic concepts and definitions: ecology, landscape, habitat, ecozones, biosphere, ecosystems, ecosystem stability, resistance and resilience; autecology; synecology; major terrestrial biomes. Ecological amplitude; Liebig's Law of the Minimum; Shelford's Law of Tolerance; phenotypic plasticity; ecotypes; ecoclines; acclimation; ecological niche; types of niche: Eltonian niche, Hutchinsonian niche, fundamental niche, realized niche; niche breadth; niche partitioning; niche differentiation.

Unit 2: Population Ecology **(8 lectures)**

Concept of population; characteristics of population: density, dispersion, natality, mortality, life tables, survivorship curves, age structure; population growth: geometric, exponential, logistic, density-dependent; limits to population growth.

Unit 3: Community Ecology **(8 lectures)**

Discrete versus continuum community view; community structure and organization: physiognomy, sociability, species associations, periodicity, biomass, stability, keystone species, ecotone and edge effect; species interactions: mutualism, symbiotic relationships, commensalism, amensalism, protocooperation, predation, competition, parasitism, mimicry, herbivory; ecological succession: primary and secondary successions, models and types of successions, and meta-population; r- and K-selection, climax community concepts, examples of succession, rudreal, competitive and stress-tolerance strategies

Unit 4: Ecosystem ecology **(15 lectures)**

Types of ecosystem: forest, grassland, lentic, lotic, estuarine, marine, desert, wetlands; ecosystem structure and function; abiotic and biotic components of ecosystem; ecosystem boundary; ecosystem. function; ecosystem metabolism; primary production and models of energy flow; secondary production and trophic efficiency; ecosystem connections: food chain, food web; detritus pathway of energy flow and decomposition processes; ecological efficiencies; ecological pyramids: pyramids of number, biomass, and energy.Concept of exotics and invasives; natural spread versus man-induced invasions; characteristics of invaders; stages of invasion; mechanisms of invasions; invasive pathways; impacts of invasion on ecosystem and communities; invasive ecogenomics – role of polyploidy and genome size in determining invasiveness; economic costs of biological invasions.

Unit 5: Biogeochemical cycles and nutrient cycling **(7 lectures)**

Carbon cycle; nitrogen cycle; phosphorus cycle; sulphur cycle; hydrological cycle; nutrient cycle models; ecosystem input of nutrients; biotic accumulation; ecosystem losses; nutrient supply and uptake; role of mycorrhizae; decomposition and nutrient release; nutrient use efficiency; nutrient budget; nutrient conservation strategies.

CC 5 (3RD SEMESTER) ENV-A-CC-3-5-TH: ECOLOGY AND ECOSYSTEMS

1. Field study in ecology using both qualitative and quantitative studies (Checklist/Quadrat /Transect) from any one of the following bio-geographical area (coastal/ forest/ Hills) with report submission. (20)
2. Viva-voce (10)

CC 6 (3RD SEMESTER) ENV-A-CC-3-6-TH: ENVIRONMENTAL BIOTECHNOLOGY

Theory (50 Lectures)

Unit 1: Basic Concepts of Microbiology **(6 lectures)**

Classification of microorganisms, different factors for microbial growth, staining techniques

Unit 2: The Structure and Function of DNA, RNA and Protein **(10 lectures)**

DNA: structural forms and their characteristics (B, A, C, D, T, Z); physical properties: UV absorption spectra, denaturation and renaturation kinetics; biological significance of different forms; Synthesis.

RNA: structural forms and their characteristics (rRNA, mRNA, tRNA; SnRNA, Si RNA, miRNA, hnRNA); biological significance of different types of RNA; synthesis.

Protein: hierarchical structure (primary, secondary, tertiary, quaternary), types of amino acids; post-translational modifications and their significance; synthesis; types and their role: structural, functional (enzymes).

Central dogma of biology; genetic material prokaryotes, viruses, eukaryotes and organelles; mobile DNA; chromosomal organization (euchromatin, heterochromatin - constitutive and facultative heterochromatin).

Unit 3: Recombinant DNA Technology **(10 lectures)**

Recombinant DNA: origin and current status; steps of preparation; toolkit of enzymes for manipulation of DNA: restriction enzymes, polymerases (DNA/RNA polymerases, transferase, reverse transcriptase), other DNA modifying enzymes (nucleases, ligase, phosphatases, polynucleotide kinase); genomic and cDNA libraries: construction, screening and uses; cloning and expression vectors (plasmids, bacteriophage, phagmids, cosmids, artificial chromosomes)

Unit 4: Biotechnology of Solid waste and solid waste treatment **(15 lectures)**

Wastewater treatment: anaerobic, aerobic process, methanogenesis, bioreactors, cell and protein (enzyme) immobilization techniques; solid waste treatment: sources and management (composting, vermiculture and methane production, landfill. hazardous waste treatment); specific bioremediation technologies: land farming, prepared beds, biopiles, composting, bioventing, biosparging, pump and treat method, use of bioreactors for bioremediation; phytoremediation; remediation of degraded ecosystems; degradation of xenobiotics in environment

Unit 4: Ecologically safe products and processes **(7 lectures)**

PGPR bacteria: biofertilizers, microbial insecticides and pesticides, bio-control ofplant pathogen, Integrated pest management; development of stress tolerant plants, biofuel; mining and metal biotechnology: microbial transformation, accumulation and concentration of metals, metal leaching.

Unit 5: GMs and GMOs **(2 lectures)**

Concept of GM and GMOs, case studies, biosafety protocol

CC 6 (3RD SEMESTER) ENV-A-CC-3-6-P: ENVIRONMENTAL BIOTECHNOLOGY

1. Gram Staining, Total coliform count (MPN), ABO Blood grouping. (10)
2. Review paper preparation/ presentation on topics related to Environmental Biotechnology. (15)
3. Viva-voce. (5)

CC 7 (3RD SEMESTER) ENV-A-CC-3-7-TH:ATMOSPHERE AND GLOBAL CLIMATE CHANGE

Theory (50 Lectures)

Unit 1: Global energy balance **(4 lectures)**

Earth's energy balance; energy transfers in atmosphere; Earth's radiation budget; green house gases (GHGs); greenhouse effect; global conveyor belt.

Unit 2: Atmospheric circulation **(12 lectures)**

Movement of air masses; atmosphere and climate; air and sea interaction; southern oscillation; western disturbances; *EI Nina* and *La Nina*; tropical cyclone; Indian monsoon and its development, effect of urbanization on micro climate; Asian brown clouds.

Unit 3: Meteorology and atmospheric stability **(14 lectures)**

Meteorological parameters (temperature, relative humidity, wind speed and direction, precipitation); atmospheric stability and mixing heights; temperature inversion; plume behavior; Gaussian plume model.

Unit 4: Global warming and climate change **(12 lectures)**

Earth's climate through ages; trends of global warming and climate change; drivers of global warming and the potential of different green house gases (GHGs) causing the climate change; atmospheric windows; impact of climate change on atmosphere, weather patterns, sea level rise, agricultural productivity and biological responses - range shift of species, CO_2 fertilization and agriculture; impact on economy and spread of human diseases.

Environmental policy debate; International agreements; Kyoto protocol 1997; Convention on Climate Change; carbon credit and carbon trading; clean development mechanism.

Unit 5: Ozone layer depletion **(8 lectures)**

Ozone layer or ozone shield; importance of ozone layer; ozone layer depletion and causes; Chapman cycle; process of spring time ozone depletion over Antarctica; ozone depleting substances (ODS); effects of ozone depletion; mitigation measures and international protocols - Montreal protocol 1987.

CC 7 (3RD SEMESTER) ENV-A-CC-3-7-P:ATMOSPHERE AND GLOBAL CLIMATE CHANGE

1. Estimation of atmospheric pressure, relative humidity, rainfall, insolation, wind speed, light intensity (Lux meter) (20)
2. Viva-voce. (5), Laboratory notebook (5)

SKILL ENHANCEMENT COURSE (SEC)

SEC-A (Anyone from SEC A1 OR SEC A2 IN 3RD SEMESTER)

ENV-A-SEC-A-3-X-TH

SEC A 1: REMOTE SENSING, GEOGRAPHIC INFORMATION SYSTEM & MODELLING

Theory (Lectures: 30)

Unit 1: Remote Sensing: definitions and principles; electromagnetic (EME) spectrum; interaction of EMR with Earth's surface; spectral signature; satellites and sensors; aerial photography and image interpretation.

Unit 2: Geographical Information Systems: definitions and components; spatial and non-spatial data; raster and vector data; database generation; database management system; land use! land cover mapping; overview of GIS software packages; GPS survey, data import, processing, and mapping.

Unit 3: Applications and case studies of remote sensing and GIS in geosciences, water resource management, land use planning, forest resources, agriculture, marine and atmospheric studies.

SEC A 2: WILDLIFE MANAGEMENT

Theory (Lectures: 30)

Unit 1: Need of wildlife management; role of stakeholders in managing wildlife. Journey of mankind from predator to conservator; prehistoric association between wildlife and humans: records from Bhimbetka wall paintings; conservation of wildlife in the reign of king Ashoka: excerpts from rock edicts; understanding wildlife management, conservation and policies regarding protected areas in 21st century; positive values provided by wildlife conservation (monetary, recreational, scientific and ecological benefits).

Unit 2: Principles and practices of wildlife management, Course and fine filter approaches for wildlife Management. Analysis of wild life management problems. Species conservation projects in India (Tiger, Rhino, Lion)

Unit 3: Capture and handling techniques, Identification and marking techniques, Measuring animal abundance, radio telemetry**,**

CC 8 (4TH SEMESTER) ENV-A-CC-4-8-TH: SYSTEMATICS AND BIOGEOGRAPHY

Theory (Lectures: 50)

Unit 1: Concept and systematics approaches (12 lectures)

Definition of systematics; taxonomic identification; keys; field inventory; herbarium; museum; botanical gardens; taxonomic literature; nomenclature; evidence from anatomy, ultrastructure, cytology, phyto-chemistry, numerical and molecular methods.Concept of taxa (species, genus, family, order, class, phylum, kingdom); concept of species (taxonomic, typological, biological, evolutionary, phylogenetic); categories and taxonomic hierarchy.

Unit 2: Nomenclature and systems of classification (6 lectures)

Principles and rules (International Code of Botanical and Zoological Nomenclature); ranks and names; types and typification; author citation; valid publication; rejection of names; principle of priority and its limitations; names of hybrids.

Unit 4: Biogeography (6 lectures)

Biogeographical rules – Gloger's rule, Bergmann's rule, Allen's rule, Geist rule; biogeographical realms and their fauna; endemic, rare, exotic, and cosmopolitan species.

Part-A: Historical Biogeography (6 lectures)

Earth's history; paleo-records of diversity and diversification; continental drift and plate tectonics and their role in biogeographic patterns – past and present; biogeographical dynamics of climate change and Ice Age.

Part-B: Ecological Biogeography (10 lectures)

Species, habitats; environment and niche concepts; biotic and abiotic determinants of communities; species-area relationships; concept of rarity and commonness; Island Biogeography theory; Equilibrium Theory of Insular Biogeography; geography of diversification and invasion; phylogeography.

Part-C: Conservation Biogeography (2 lectures)

Application of biogeographical rules in design of protected area and biosphere reserves; use of remote sensing in conservational planning.

Unit 5: Speciation and extinction **(8 lectures)**

Types and processes of speciation – allopatric, parapatric, sympatric; ecological diversification; adaptive radiation, convergent and parallel evolution; dispersal and immigration; means of dispersal and barriers to dispersal; extinction.

CC 8 (4TH SEMESTER) ENV-A-CC-4-8-P: SYSTEMATICS AND BIOGEOGRAPHY

1. Identification of suitable flora and fauna (Definite list of specimens of ecological and economic significance). (20)

Specimens for Identification	Specimens for Identification
Agaricus sp.	*Hirudinea* sp.
Crustose Lichen	*Physalia* sp.
Azolla sp.	*Taenia solium*
Pteris sp.	*Ascaris lumbricoides*
Ceratophyllum sp.	*Entamoeba histolytica*
Andrographis paniculata	*Coccinella septempunctata*
Eichhornia crassipes	*Tryporyza incertulas*
Lemna minor	Spider
Parthenium hysterophorus	*Lamellidens marginalis*
Lantana camara	*Octopus* sp.
Jatropha sp.	*Pila* sp.
Rauvolfia serpentina/canescens	*Asterias* sp.
Acanthus ilicifolius	*Carcharodon carcharias*
Pisum sativum	*Tilapia* sp.
Opuntia dillenii	*Exocetus* sp.
Solanum lycopersicum	*Rhacophorus* sp.
Ficus benghalensis	*Naja* sp.
Datura metel	*Chamaeleo* sp.
Vanda roxburghii	*Columba livia*
Aloe vera	*Culex* sp.

2. Identification Key Preparation. (5)
3. Laboratory notebook and Viva voce (5)

CC 9 (4TH SEMESTER) ENV-A-CC-4-9-TH: URBAN ECOSYSTEMS

Theory (50 Lectures)

Unit 1: Environment in an urban setting (8 lectures)

Man as the driver of urban ecosystem; commodification of nature; metros, cities and towns as sources and sinks of resources; resource consumption and its social, cultural, economic and ecological perspectives; urban transformation; increasing challenges posed by modernity for the environment.

Unit 2: Urban dwelling (12 lectures)

Urban Sprawl; Housing scenario across a range of large-medium-small cities; poverty and slums in an urban context; Town planning Acts and their environmental aspects; energy consumption and waste disposal as well as accumulation; environmental costs of urban infrastructure.

Unit 3: Urban interface with the environment (10 lectures)

Definition and concepts: green technology, green energy, green infrastructure, green economy, and, green chemistry; sustainable consumption of resources; individual and community level participation such as small-scale composting pits for biodegradable waste, energy conservation; Green technologies in historical and contemporary perspectives; successful green technologies: wind turbines, solar panels; 3R's of green technology: recycle, renew and reduce.

Unit 4: Natural spaces in a city (8 lectures)

Concept of 'controlled nature'; scope, importance and threats to nature in the city; organization and planning of green spaces such as parks, gardens and public spaces; concept of green belts; urban natural forest ecosystem as green lungs.

Unit 5: Planning and environmental management (12 lectures)

Green buildings; history of green buildings, need and relevance of green buildings over conventional buildings, construction of green buildings; associated costs and benefits; outlined examples of green buildings; LEED certified building; Eco-mark certification, establishment of Eco-mark in India, its importance and implementation; Green planning: role of governmental bodies, land use planning, concept of green cities, waste reduction and recycling in cities, role of informal sector in waste management, public transportation for sustainable development, green belts.; rainwater harvesting (Corporation and Municipal areas)

CC 9 (4TH SEMESTER) ENV-A-CC-4-9-P: URBAN ECOSYSTEMS

1. Urban survey in group of maximum five students (Corporations and Municipal areas) with field report submission and field viva (20)
2. Viva-voce (10)

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CC 10 (4TH SEMESTER) ENV-A-CC-4-10-TH: ENVIRONMENTAL LEGISLATION AND POLICY

Theory (50 lectures)

Unit 1: Introduction **(4 lectures)**

Constitution of India; fundamental rights; fundamental duties; Union of India; union list, state list, concurrent list; legislature; state assemblies; judiciary; panchayats and municipal bodies.

Unit 2: History of environmental legislation and policy **(8 lectures)**

Provision of Environmental Conservation - British India: Indian Penal Code 1860, Forest Act 1865, Fisheries Act 1897; Independent India: Van Mahotsava 1950, National Forest Policy 1952, National Forest Policy 1988.

Unit 3: Environmental legislation **(25 lectures)**

Legal definitions (environmental pollution, natural resource, biodiversity, forest, sustainable development); Article 48A (The protection and improvement of environment and safeguarding of forests and wildlife); Article 51 A (Fundamental duties).

The Indian Forest Act 1927; The Wildlife (Protection) Act 1972; The Water (Prevention and Control of Pollution) Act 1974; The Water (Prevention and Control of Pollution) Cess Act 1977; The Forests (Conservation) Act 1980; The Air (Prevention and Control of Pollution) Act 1981; The Environment (Protection) Act 1986; Motor Vehicle Act 1988; The Public Liability Insurance Act 1991; Noise Pollution (Regulation and Control) Rules 2000; The Biological Diversity Act 2002; The Schedule Tribes and other Traditional Dwellers (Recognition of Forests Rights) Act 2006; The National Green Tribunal Act 2010; scheme and labeling of environment friendly products, Ecomarks.

Unit 4: Role of Government institutions and National Policies **(5 lectures)**

Role of Ministry of Environment, Forests & Climate Change in environmental law and policy making; role of central and state pollution control boards in environmental law and policy making; National Green Tribunal; National Environment Policy, 2006.

Unit 5: International laws and policy **(8 lectures)**

Stockholm Conference 1972; United Nations Conference on Environment and Development 1992; Rio de Janeiro (Rio Declaration, Agenda 21); Montreal Protocol 1987; Kyoto Protocol 1997; Copenhagen and Paris summits; Ramsar convention.

CC 10 (4TH SEMESTER) ENV-A-CC-4-10-P : ENVIRONMENTAL LEGISLATION AND POLICY

1. Review of different Case studies on Environmental Issues and power point presentation. (30)

SKILL ENHANCEMENT COURSE (SEC)

SEC-B (Anyone from SEC B1 OR SEC B2 IN 4TH SEMESTER)

ENV-A-SEC-A-4-X-TH

SEC B1 : ENVIRONMENTAL IMPACT AND RISK ASSESSMENT

Theory (30 Lectures)

Unit 1: Environmental impact assessment (EIA): definitions, introduction and concepts; rationale and historical development of EIA; scope and methodologies of EIA; role of project proponents, project developers and consultants; Terms of Reference; impact identification and prediction; baseline data collection; Environmental Impact Statement (EIS), Environmental Management Plan (EMP)

Unit 2: Rapid EIA; Strategic Environmental Assessment; Social Impact Assessment; Cost-Benefit analysis; Life cycle assessment; environmental appraisal; environmental management - principles, problems and strategies; environmental planning; environmental audit; introduction to ISO and ISO 14000; sustainable development.

Unit 3: EIA regulations in India; status of EIA in India; current issues in EIA; case study of hydropower projects! thermal projects.

Unit 4: Risk assessment: introduction and scope; project planning; exposure assessment; toxicity assessment; hazard identification and assessment; risk characterization; risk communication; environmental monitoring; community involvement; legal and regulatory framework; human and ecological risk assessment.

SEC B 2: ANALYTICAL METHODS, INSTRUMENTATION AND MEASUREMENT

Theory (30 Lectures)

Unit 1: Sampling, preservation, storage techniques; Principles and applications of titrimetry (Acidimetry, Alkalimetry, Complexometry, Argentometry, Iodometry) gravimetry, potentiometry, conductimetry.

Unit 2: Principles and application of UV-VIS Spectrophotometry, Atomic absorbtion spectrophometry flame photometry, electrophoresis Chromatography, X-Ray fluorescence and Microscopy- Properties, Types

and applications.

Unit 3: Date Information Knowledge Wisdom Loop, data analysis, errors in data representation.

CC 11 (5TH SEMESTER) ENV-A-CC-5-11-TH: BIODIVERSITY AND CONSERVATION BIOLOGY

Theory (50 Lectures)

Unit 1: Biodiversity patterns and estimation (12 lectures)

Definition; Types; Spatial patterns: latitudinal and elevational trends in biodiversity; temporal patterns: seasonal fluctuations in biodiversity patterns.

Sampling strategies and surveys: floristic, faunal, and aquatic; qualitative and quantitative methods: scoring, habitat assessment, richness, density, frequency, abundance, evenness, diversity, biomass estimation; community diversity estimation: alpha, beta and gamma diversity.

Unit 2: Importance of biodiversity (8 lectures)

Economic values – medicinal plants, drugs, fisheries and livelihoods; ecological services – primary productivity, role in hydrological cycle, biogeochemical cycling; ecosystem services – purification of water and air, nutrient cycling, climate control, pest control, pollination, and formation and protection of soil; social, aesthetic, consumptive, and ethical values of biodiversity.

Unit 3: Threats to biodiversity (10 lectures)

Natural and anthropogenic disturbances; habitat loss, habitat degradation, and habitat fragmentation; climate change; pollution; hunting; over-exploitation; deforestation; hydropower development; invasive species; land use changes; overgrazing; man wildlife conflicts; consequences of biodiversity loss; Intermediate Disturbance Hypothesis.

Unit 4: Conservation of biodiversity (10 lectures)

Importance of biodiversity patterns in conservation; In-situ conservation (Biosphere Reserves, National Parks, Wildlife Sanctuaries); Ex-situ conservation (botanical gardens, zoological gardens, gene banks, seed and seedling banks, pollen culture, tissue culture and DNA banks), role of local communities and traditional knowledge in conservation; biodiversity hotspots; IUCN Red List categorization – guidelines, practice and application; Red Data book; ecological restoration; afforestation; social forestry; agro forestry; joint forest management; role of remote sensing in management of natural resources.

Unit 5: Biodiversity in India (10 lectures)

India as a mega diversity nation; phytogeographic and zoogeographic zones of the country; forest types and forest cover in India; fish and fisheries of India; impact of hydropower development on biological diversity; status of protected areas and biosphere reserves in the country; National Biodiversity Action Plan.

CC 11 (5TH SEMESTER) ENV-A-CC-5-11-P

1. Biodiversity assessment in local field work (Calculation of parameters (Frequency, density, abundance, relative density) and indices (Shannon wiener diversity index, Simpson's index, Simpson's index of diversity, evenness index) and report submission. (20)
2. Viva voce (10)

CC 12 (5TH SEMESTER) ENV-A-CC-5-12-TH: ORGANISMAL AND EVOLUTIONARY BIOLOGY

Theory (50 Lectures)

Unit 1: History of life on Earth **(17 lectures)**

Part-A : Paleontology and evolutionary History; evolutionary time scale; eras, periods and epoch; major events in the evolutionary time scale; stages in primate evolution including Homo.

Part B: Lamarck's concept of evolution; Darwin's Evolutionary Theory: variation, adaptation, struggle, fitness and natural selection; Mendelism; spontaneity of mutations; The Evolutionary Synthesis.

Unit 2: Evolution of unicellular life **(8 lectures)**

Origin of cells and unicellular evolution and basic biological molecules; abiotic synthesis of organic monomers and polymers; Oparin-Haldane hypothesis; study of Miller; the first cell;

Unit 3: Geography of evolution **(5 lectures)**

Biogeographic evidence of evolution; patterns of distribution.

Unit 4: Molecular evolution **(7 lectures)**

Introduction to biomolecules: Protein, Lipids, Carbohydrates (General characteristics and classification) Neutral evolution; molecular divergence and molecular clocks; molecular tools in phylogeny, classification and identification; protein and nucleotide sequence analysis.

Unit 5: Fundamentals of population genetics **(13 lectures)**

Concepts of populations, gene pool, gene frequency; concepts and rate of change in gene frequency through natural selection, migration and genetic drift; adaptive radiation; isolating mechanisms; speciation (allopatric, sympatric, peripatric and parapatric); convergent evolution; sexual selection; co-evolution; Hardy-Weinberg Law.

CC 12 (5TH SEMESTER) ENV-A-CC-5-12-P: ORGANISMAL AND EVOLUTIONARY BIOLOGY

1. Numerical problems on pedigree and population genetics. (10)
2. Estimation of protein using BSA (Lowry method), Glucose (Anthrone Method) (10)
3. Viva-voce (5), Laboratory Notebooks (5)

DISCIPLINE SPECIFIC ELECTIVE

5TH SEMESTER

ENV-A-DSE-A-5-1-TH+P AND ANY ONE FROM ENV-A-DSE-B-5-2-TH+P OR ENV-A-DSE-B-5-3-TH+P

ENV-A-DSE-A-5-1-TH : ENERGY AND ENVIRONMENT

Theory (50 Lectures)

Unit 1: Energy resources **(12 lectures)**

Defining energy; forms and importance; Global energy resources; renewable and non-renewable resources: distribution and availability; sources and sinks of energy; past, present, and future technologies for capturing and integrating these resources into our energy infrastructure.

Unit 2: Energy demand **(7 lectures)**

Global energy demand: historical and current perspective; energy demand and use in domestic, industrial, agriculture and transportation sector; generation and utilization in rural and urban environments; changes in demand in major world economies; energy subsidies; environmental costs.

Unit 3: Energy, environment and society **(15 lectures)**

Energy production as driver of environmental change; nature, scope and analysis of local and global impacts of energy use on the environment; fossil fuel burning and related issues of air pollution, nuclear energy and related issues such as radioactive waste, spent fuel; energy production, transformation and utilization associated environmental impacts (Chernobyl and Fukushima nuclear accidents, construction of dams, environmental pollution); energy over-consumption and its impact on the environment, economy, and global change; social inequalities related to energy production, distribution, and use; energy conservation.

Unit 4: Our energy future **(16 lectures)**

Current and future energy use patterns in the world and in India; evolution of energy use over time; alternative sources as green energy (biofuels, wind energy, solar energy, geothermal energy; tidal energy, ocean energy; nuclear energy); need for energy efficiency; energy conservation and sustainability; action strategies for sustainable energy management from a future perspective

DSE A1: ENV-A-DSE-A-5-1-P

1. Calculation of energy efficiency from given data. (10)
2. Preparation of energy audit of a domestic unit and report submission. (10)
3. Viva-voce (10)

DSE B2 ENV-A-DSE-B-5-2-TH : SOLID WASTE MANAGEMENT

Theory (50 Lectures)

Unit 1: Introduction **(3 lectures)**

Sources and generation of solid waste, their classification and chemical composition; characterization of municipal solid waste; hazardous waste and biomedical waste.

Unit 2: Effect of solid waste disposal on environment **(5 lectures)**

Impact of solid waste on environment, human and plant health; effect of solid waste and industrial effluent discharge on water quality and aquatic life; mining waste and land degradation; effect of land fill leachate on soil characteristics and ground water pollution.

Unit 3: Solid waste Management **(12 lectures)**

Different techniques used in collection, storage, transportation and disposal of solid waste (municipal, hazardous and biomedical waste); landfill (traditional and sanitary landfill design); thermal treatment (pyrolysis and incineration) of waste material; drawbacks in waste management techniques.

Unit 4: Industrial waste management **(6 lectures)**

Types of industrial waste: hazardous and non-hazardous; effect of industrial waste on air, water and soil; industrial waste management and its importance; stack emission control and emission monitoring; effluent treatment plant and sewage treatment plant.

Unit 5: Resource Recovery **(6 lectures)**

4R - reduce, reuse, recycle and recover; biological processing - composting, anaerobic digestion, aerobic treatment; reductive dehalogenation; mechanical biological treatment; green techniques for waste treatment.

Unit 6: Waste-to-energy (WTE) **(4 lectures)**

Concept of energy recovery from waste; refuse derived fuel (RDF); different WTE processes: combustion, pyrolysis, landfill gas (LFG) recovery; anaerobic digestion; gasification.

Unit 7: Integrated waste management **(4 lectures)**

Concept of Integrated waste management; waste management hierarchy; methods and importance of Integrated waste management.

Unit 8: Policies for solid waste management **(10 lectures)**

Municipal Solid Wastes (Management and Handling) Rules 2000; Hazardous Wastes Management and Handling Rules 1989; Bio-Medical Waste (Management and Handling) Rules 1998; Plastic Waste (Management and Handling) Rules, 2011; E-Waste (Management) Rules, 2016

DSE B2: ENV-A-DSE-B-5-2-P

1. Visit to a Solid Waste Management site and Report submission. (20)
2. Viva-voce (10)

DSE B3: ENV-A-DSE-B-5-3-TH: ENVIRONMENTAL HEALTH AND TOXICOLOGY

Theory (50 Lectures)

Unit 1: Epidemiology and Health **(6 lectures)**

Concept of Health and Disease, principles of epidemiology and epidemiological methods, aims of epidemiology, measurement of mortality, measurement of morbidity.

Unit 2: Concept of Disease **(10 lectures)**

Concept of screening the diseases, some communicable diseases like small pox, cholera, acute diarrheal disease, viral hepatitis, water borne pathogens, vector borne diseases, diseases caused by contaminated food and water, soil borne infections, insect borne diseases.

Unit 3: Concept of Immunology **(12 lectures)**

Elementary idea about antigens and antibody, hyper sensitivity, allergic reactions, pollens and their allergens. Immunological techniques.

Unit4: Community and Health **(2 lectures)**

Communication for health education, health care of the country.

Unit 5: Basic Concept of Toxicology **(20 lectures)**

Different types of toxicant, toxicity test, toxicity by different factors, exposure effect relationship, different route of exposure, synergistic and antagonistic effect, Bioaccumulation and Biomagnification. Detoxification, toxico-dynamics.

DSE B3: ENV-A-DSE-B-5-3-P

1. LC_{50} calculation by probit analysis with data provided. (10)
2. Study of Nuclear abnormalities in the erythrocytes of fish/ from root tip of *Allium cepa* (10)
3. Viva-voce (5), Laboratory notebooks (5)

CC 13 (6TH SEMESTER) ENV-A-CC-6-13-TH: ENVIRONMENTAL POLLUTION AND HUMAN HEALTH

Theory (50 Lectures)

Unit 1: Introduction (9 lecture)

Definition of pollution; pollutants; classification of pollutants. Solubility of pollutants (hydrophilic and lipophilic pollutants), transfer of pollutants within different mediums, role of chelating agents in transferring pollutants, concept of biotransformation and bioaccumulation, concept of radioactivity, radioactive decay and half-life of pollutants, organometallic compounds, acid mine drainage.

Unit 2: Air pollution (8 lectures)

Ambient air quality: monitoring and standards (National Ambient Air Quality Standards of India); air quality index; sources and types of pollutants (primary and secondary); smog (case study); effects of different pollutants on human health (NO_x, SO_x, PM, CO, CO_2, hydrocarbons and VOCs) and control measures; indoor air pollution: sources and effects on human health.

Unit 3: Water pollution (8 lectures)

Sources of surface and ground water pollution; water quality parameters and standards; organic waste and water pollution; eutrophication; COD, BOD, DO; effect of water contaminants on human health (nitrate, fluoride, arsenic, chlorine, cadmium, mercury, pesticides); water borne diseases; concept and working of effluent treatment plants (ETPs).

Unit 4: Soil pollution (4 lectures)

Causes of soil pollution and degradation; effect of soil pollution on environment, vegetation and other life forms; control strategies.

Unit 5: Noise pollution (3 lectures)

Noise pollution–sources; frequency, intensity and permissible ambient noise levels; effect on communication, impacts on life forms and humans - working efficiency, physical and mental health; control measures.

Unit 6: Radioactive and thermal pollution (4 lectures)

Radioactive material and sources of radioactive pollution; effect of radiation on human health (somatic and genetic effects); thermal pollution and its effects.

Unit 7: Marine pollution **(4 lectures)**

Marine resources and their importance; sources of marine pollution; oil spill and its effects; coral reefs and their demise; coastal area management; existing challenges and management techniques (planning, construction, environmental monitoring of coastal zones).

Unit 8: Pollution control **(10 lectures)**

Activated Sludge Process (ASP) – Trickling Filters – oxidation ponds, fluidized bed reactors, membrane bioreactor neutralization, ETP sludge management; digesters, up flow anaerobic sludge blanket reactor, fixed film reactors, sequencing batch reactors, hybrid reactors, bioscrubbers, biotrickling filters; regulatory framework for pollution monitoring and control; case study: Ganga Action Plan; Yamuna Action Plan; implementation of CNG in NCT of Delhi.

CC 13 (6TH SEMESTER) ENV-A-CC-6-13-P: ENVIRONMENTAL POLLUTION AND HUMAN HEALTH

1. BOD, COD, Noise (dB(A), SPM, RSPM, Dust fall rate, Soil respiration. (20)

2. Viva Voce (5), Laboratory notebook (5)

CC 14 (6TH SEMESTER) ENV-A-CC-6-14-TH: NATURAL RESOURCE MANAGEMENT AND SUSTAINABILITY

Theory (50 Lectures)

Unit 1: Introduction **(7 lectures)**

Resource and reserves; classification of natural resources; renewable and non-renewable resources; resource degradation; resource conservation; resource availability and factors influencing its availability; land resources; water resources; fisheries and other marine resources; energy resources; mineral resources; human impact on natural resources; ecological, social and economic dimension of resource management.

Unit 2: Natural resources and conservation **(7 lectures)**

Forest resources: economic and ecological importance of forests, forest management strategies, sustainable forestry; water resources: supply, renewal, and use of water resources, freshwater shortages, strategies of water conservation; soil resources: importance of soil, soil conservation strategies; food resources: world foodproblem, techniques to increase world food production, green revolution.

Unit 3: Mineral resources **(8 lectures)**

Mineral resources and the rock cycle; identified resources; undiscovered resources; reserves; types of mining: surface, subsurface, open-pit, dredging, strip; reserve-to-production ratio; global consumption patterns of mineral resources techniques to increase mineral resource supplies; ocean mining for mineral resources; environmental effects of extracting and using mineral resources.

Unit 4: Energy resources **(20 lectures)**

Part A: Oil: formation, exploration, extraction and processing, oil shale, tar sands; natural gas: exploration, liquefied petroleum gas, liquefied natural gas; coal: reserves, classification, formation, extraction, processing, coal gasification; environmental impacts of non-renewable energy consumption; impact of energy consumption on global economy; application of green technology; future energy options and challenges.

Part B: Energy efficiency; life cycle cost; cogeneration; solar energy: technology, advantages, passive and active solar heating system, solar thermal systems, solar cells, 1NN solar mission; hydropower: technology, potential, operational costs, benefits ofhydropower development; nuclear power: nuclear fission, fusion, reactors, pros and cons of nuclear power, storage of radioactive waste, radioactive contamination; tidal energy; wave energy; ocean thermal energy conversion (OTEC); geothermal energy; energy from biomass; bio-diesel.

Unit 5: Resource management **(8 lectures)**

Approaches in resource management: ecological approach; economic approach; ethnological approach; implications of the approaches; integrated resource management strategies; concept of sustainability science: different approach towards sustainable development and its different constituents; sustainability of society, resources and framework; sustainable energy strategy; principles of energy conservation; Indian renewable energy programme.

CC 14 (6TH SEMESTER) ENV-A-CC-6-14-P: : NATURAL RESOURCE MANAGEMENT AND SUSTAINABILITY

1. Project Work: Submission of report & presentation (30)

DISCIPLINE SPECIFIC ELECTIVE

6TH SEMESTER

ENV-A-DSE-B-6-1-TH+P AND ANY ONE FROM ENV-A-DSE-A-6-2-TH+P OR ENV-A-DSE-A-6--3-TH+P

DSE B1: ENV-A-DSE-B-6-1-TH: NATURAL HAZARDS AND DISASTER MANAGEMENT

Theory (50 Lectures)

Unit 1: Introduction **(3 lectures)**

Definition of hazard; natural, technological, and context hazards; concept of risk and vulnerability; reasons of vulnerability - rapid population growth, urban expansion, environmental pollution, epidemics, industrial accidents, inadequate government policies.

Unit 2: Natural hazards **(16 lectures)**

Natural hazards: hydrological, atmospheric & geological hazards; earthquake: seismic waves, epicenter; volcanoes: causes of volcanism, geographic distribution; floods: types and nature, frequency of flooding; landslides: causes and types of landslides, landslide analysis; drought: types of drought-meteorological, agricultural, hydrological, and famine; Glacial Lake Outburst Floods (GLOF); tornadoes, cyclone & hurricanes; tsunamis: causes and location of tsunamis; coastal erosion, sea level changes and its impact on coastal areas and coastal zone management.

Unit 3: Anthropogenic hazards **(15 lectures)**

Impacts of anthropogenic activities such as rapid urbanization, injudicious ground water extraction, sand mining from river bank, deforestation, mangroves destruction; role of construction along river banks in elevating flood hazard; disturbing flood plains. deforestation and landslide hazards associated with it; large scale developmental projects, like dams and nuclear reactors in hazard prone zones; nature and impact of accidents, wildfires and biophysical hazards. Case studies of Bhopal, Minamata and Chernobyl disaster.

Unit 4: Risk and vulnerability assessment **(4 lectures)**

Two components of risk: likelihood and consequences, qualitative likelihood measurement index; categories of consequences (direct losses, indirect losses, tangible losses, and intangible losses); application of geoinformatics in hazard, risk & vulnerability assessment.

Unit 5: Mitigation and preparedness **(6 lectures)**

Concept of mitigation; types of mitigation: structural and non-structural mitigation, use of technologies in mitigations such as barrier, deflection and retention systems; concept of preparedness; importance of planning, exercise, and training in preparedness; role of public, education and media in hazard preparedness.

Unit 6: Disaster management in India **(6 lectures)**

Lessons from the past considering the examples of Bhuj earthquake, tsunami disaster, and Bhopal tragedy; National Disaster Management Framework, national response mechanism, role of government bodies such as NDMC and IMD; role of armed forces and media in disaster management; role of space technology in disaster management; case study of efficient disaster management during cyclone **'***Phailin***'** in 2013.

DSE B1 ENV-A-DSE-B-6-1-P

1. Prepartion of disaster management plan for any of the following disaster flood, earthquake, cyclone, fire outbreak and report submission. (20)
2. Viva-voce (10)

DSE **A2:**

ENV-A-DSE-A-6-2-TH: ENVIRONMENTAL ECONOMICS AND STATISTICS

Theory (50 Lectures)

Unit 1: Economic solutions to environmental problems **(15 lectures)**

Social costs and benefits of environmental programmes: marginal social benefit of abatement, marginal social cost of abatement; pollution control: policies for controlling air and water pollution, disposal of toxic and hazardous waste- standards vs. emissions charges, environmental subsidies, modelling and emission charges; polluter pay principles; pollution permit trading system.

Unit 2: Natural resource economics **(5 lectures)**

Economics of non-renewable resources; economics of fuels and minerals; Hotelling's rule and extensions; taxation; economics of renewable resources; economics of water use, management of fisheries and forests; introduction to natural resource accounting.

Unit 3: Tools for environmental economic policy **(10 lectures)**

Growth and environment; environmental audit and accounting, Kuznets curve, environmental risk analysis, assessing benefits and cost for environmental decision making; cost benefit analysis and

valuation: discounting, principles of Cost-Benefit Analysis, estimation of costs and benefits, techniques of valuation, adjusting and comparing environmental benefits and costs.

Unit 4: Statistical techniques applied to Environmental systems (20 lectures)

Variables, population and Sampling, sampling methods, sampling error, frequency distribution, bar diagram, pie diagram, arithmetic and geometric mean, mode, median, measures of deviation, null and alternative hypothesis, probability distribution, t-test, χ^2 Test, correlation and regression.

DSE A2

ENV-A-DSE-A-6-2-P

1. Numerical problems on biostatistics Chi-Square test (Goodness of fit, Contingency) Student's t test (Paired and Unpaired) (20)
2. Viva-voce (5), Laboratory Notebooks (5)

D SE A3:

ENV-A-DSE-A-6-3-TH: GREEN TECHNOLOGIES

Unit 1: **Green infrastructure, planning and economy (14 lectures)**

Green buildings; history of green buildings, need and relevance of green buildings over conventional buildings, construction of green buildings; associated costs and benefits; outlined examples of green buildings; LEED certified building; Eco-mark certification, establishment of Eco-mark in India, its importance and implementation; Green planning: role of governmental bodies, land use planning, concept of green cities, waste reduction and recycling in cities, role of informal sector in waste management, public transportation for sustainable development, green belts.

Unit 2: Applications of green technologies (14 lectures)

Increase in energy efficiency: cogeneration, motor system optimization, oxy-fuel firing, isothermal melting process, energy efficient fume hoods, compact fluorescent lights (CFLs), motion detection lighting, or programmable thermostats). Green House Gas (GHG) emissions reduction: carbon capture and storage (CCS) technologies, purchase and use of carbon offsets, promotion and/ or subsidy of alternative forms of transportation for employees, such as carpools, fuel efficient vehicles, and mass transit, methane emissions reduction and!or reuse).

Pollution reduction and removal (Flue Gas Desulfurization (FGD) methods, catalytic or thermal destruction of NO_X, Fluidized Bed Combustion, Dioxins reduction and removal methods, Thermal Oxidizers or Wet Scrubbers to neutralize chemicals or heavy metals, solvent recovery systems, Low Volatile Organic Compound (VOC) paints and sealers).

Unit 3: **Green chemistry** **(12 lectures)**

Introduction to green chemistry; principles and recognition of green criteria in chemistry; bio- degradable and bio-accumulative products in environment; green nanotechnology; reagents, reactions and technologies that should be and realistically could be replaced by green alternatives; photodegradable plastic bags.

Unit 5: Green future **(10 lectures)**

Agenda of green development; reduction of ecological footprint; role of green technologies towards a sustainable future; major challenges and their resolution for implementation of green technologies; green practices to conserve natural resources (organic agriculture, agroforestry, reducing paper usage and consumption, etc.); emphasis on waste reduction instead of recycling, emphasis on innovation for green future; role of advancement in science in developing environmental friendly technologies.

DSE A3: ENV-A-DSE-A-6-3-P

1. Analysis of stability of vermicompost by compost respiration method. (10)
2. Analysis of rainwater harvesting potential in uraban/rural catchments (10)
3. Viva-voce (5), Laboratory Notebooks (5)

Suggested Readings:

1. Abbasi T. and Abbasi S.A., 2010. *Renewable Energy Resources: Their Imapct on Global warming and Pollution.* PHI.
2. Abraham, C.M. 1999. *Environmental Jurisprudence in India*. Kluwer Law International.
3. APHA, 2012. *Standard Methods for the Examination of Water and Waste water (21st ed).* APHA.
4. Anastas, P.T. & Warner, J.C. 1998. *Green Chemistry: Theary & Practice*. Oxford University Press
5. Asnani, P.U. 2006. Solid waste management. *India Infrastructure Repart 570*.
6. Bagchi,A.2004. *Design of Landfills and Integrated Solid Waste Management*. John Wiley & Sons.
7. Baird C., and Cann M., 2005. *Environmental Chemistry (3rd Ed.)*. W H Freeman and Co.
8. Banejee P.K., 2006. *Textbook of Geology*, World Press.
9. Banerjee P.K., 2011. *Introduction to Biostatistics.* S,Chand.
10. Bansil, P.C. 2004.*WaterManagement in India*. Concept Publishing Company, India.
11. Barrow, C.J.2000. *Social Impact Assessment: An Introduction.* Oxford University Press.
12. Barry, R. G. 2003. *Atmasphere, Weather and Climate*. Routledge Press, UK.
13. Bawa K.S., Primack R.B, Oommen M.A. 2004. *Conservation Biology: A Primer for South Asia.* University Press.
14. Blackman, W.C. 2001. *Basic Hazardaus Waste Management*. CRC Press.
15. Bluman, 2007. *Elementary Statistics: A step by Step Approach*. Mc Grawhill.
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MODEL COURSE CURRICULUM FOR UNDERGRADUATE COURSES UNDER CHOICE BASED CREDIT SYSTEM

FINAL SYLLABUS FOR

BACHELOR IN

ENVIRONMENTAL SCIENCE

(GENERAL)

UNIVERSITY OF CALCUTTA

SEMESTER	COURSES	DETAILS OF THE COURSE	CREDIT
I	**CORE COURSE ENV-G-CC/GE-1-1-TH**	Fundamentals of Environmental Science	**4**
	CORE COURSE ENV-G-CC/GE-1-1- P	Fundamentals of Environmental Science	**2**
	ABILITY ENHACEMENT COURSE AECC 1	English Communications/MIL	**2**
II	**CORE COURSE ENV-G-CC/GE-2-2-TH**	Ecology and Biodiversity	**4**
	CORE COURSE ENV-G-CC/GE-2-2-P	Ecology and Biodiversity	**2**
	ABILITY ENHACEMENT COURSE AECC 2	Environmental Studies	**2**
III	**CORE COURSE ENV-G-CC/GE-3-3-TH**	Chemistry of Environment	**4**
	CORE COURSE ENV-G-CC/GE-3-3-P	Chemistry of Environment	**2**
	SKILL ENHANCEMENT COURSE ENV-G-SEC-3-A1-TH	Environmental Laws and policy, Environmental Audit and EIA	**2**
IV	**CORE COURSE ENV-G-CC/GE-4-4-TH**	Environmental Physics and Meteorology	**4**
	CORE COURSE ENV-G-CC/GE-4-4-P	Environmental Physics and Meteorology	**2**
	SKILL ENHANCEMENT COURSE ENV-G-SEC-4-B1-TH	Applications of Environmental Biotechnology	**2**
V	**DISCIPLINE SPECIFIC ELECTIVES ENV-G-DSE-A--5-X-TH**	**A1)** Energy and Environment **A2)** Environmental Economics and Statistics **(Any one Paper)**	**4**
	DISCIPLINE SPECIFIC ELECTIVES ENV-G-DSE-A-5-X-P	**A1)** Energy and Environment **A2)** Environmental Economics and Statistics **(Any one Paper)**	**2**
	SKILL ENHANCEMENT COURSE ENV-G-SEC-5-A2-TH	Environmental Pollution and Green Technologies	**2**
VI	**DISCIPLINE SPECIFIC ELECTIVES ENV-G-DSE-B-6-X-TH**	**B1)** Natural Hazard and Disaster Management **B2)** Solid Waste Management **(Any one Paper)**	**4**
	DISCIPLINE SPECIFIC ELECTIVES ENV-G-DSE-B-6-X-P	Natural Hazard and Disaster Management! Solid Waste Management **(Any one Paper)**	**2**
	SKILL ENHANCEMENT COURSE ENV-G-SEC-6-B2-TH	Remote sensing, GIS and its applications	**2**

	THEORY	PRACTICAL
CORE COURSE (CC): THEORY (CREDIT 4), PRACTICAL (CREDIT 2) **(CC: 12*)**	**12X4 =48,**	**12X2=24**
DISCIPLINE SPECIFIC ELECTIVE (DSE):TH (CREDIT 4), PRAC. (CREDIT 2) **(DSE: 6**)**	**6X4 =24,**	**6X2= 12**
SKILL ENHACEMENT COURSE (SEC): THEORY (CREDIT 2) **(SEC: 4**)**	**4X2 = 8**	

[**Any one Paper either in 3rd or 5th Semester from SEC A Any one Paper either in 4th or 6th Semester from SEC B]**

ABILITY ENHACEMENT COMPULSORY COURSE (AECC) THEORY (CREDIT 2) **2X2 = 4**

*Covering three subjects; *Covering two subjects

TOTAL COURSE = 42 (24 THEORY+18 PRACTICAL)

TOTAL CREDITS = 120 (86 THEORY+ 36 PRACTICAL)

Semester Wise Environmental Science General Courses

Semester-I

ENV-G-CC/GE-1-1-TH: Fundamentals of Environmental Science

Theory: 50 Lectures

Unit 1: Concept of Environment and Environmental Science: **(15 Lectures)**

Definition, Types and Components of Environment (Atmosphere, Hydrosphere, Lithosphere and Biosphere); Environmental Science: An overview; Scopes and Objective of Environmental and Ecological Science; Man – Environment relationships; Growth of Environmental and Ecological science in India.

Unit 2: Environmental Literacy: **(5 Lectures)**

Environmental literacy (formal and non-formal education)

Unit3: Environmental Problems and Global Environmental Issues: **(15 Lectures)**

Classifying environmental problems, Green House effect, Climate change, Acid deposition, Desertification, Ozone layer depletion.

Unit 4: Important atmospheric events: **(8 Lectures)**

Western disturbance, Tropical cyclones, Monsoon, El-nino phenomenon.

Unit 5: Climatic zone of the world: **(7 Lectures)**

Equatorial, Tropical, Sub-Tropical, Tundra.

ENV-G-CC/GE-1-1-P: Fundamentals of Environmental Science (Practical)

1. Study of Laboratory safety rules. (5)
2. To study the principle and applications of following instruments
   (autoclave, incubator, BODincubator, hot air oven, light microscope, pH meter, conductivity meter, spectrophotometer) (10)
3. Assignment on Environmental Education and global environmental issues. (10)
4. Viva Voce. (5)

Semester-II

ENV-G-CC/GE-2-2-TH: Ecology and Biodiversity

Theory: 50 Lectures

Unit 1: Ecological Concepts: (6 Lectures)

Subdivisions and development phases of ecology, Autecology – definition, distribution, phenological studies; Synecology – basic ideas, definition; food chains, food webs and trophic levels.

Unit 2. Population and Community Ecology: (7 Lectures)

Definition; Population characteristics, growth mortality, survivorship and dynamics; Community structures and characters; Predation; Competition; Symbiosis; Defensive Mechanism; Resilience and stability; Basic concept of ecological succession.

Unit 3: Ecosystem ecology: (10 Lectures)

Basic concept of ecosystem, structural and functional aspects of ecosystems; Raymond Lindeman – Trophic level dynamics, Ecological pyramids; Productivity concept of ecosystem; Concept of limiting factors – Liebig's law of minimum, Shelford's law of tolerance; Cycling of nutrients.

Unit 4: Concept and Importance of Biodiversity: (4 Lectures)

Definition; Types; India as megadiverse country; Values (Direct and indirect) and Services of Biodiversity.

Unit 5: Threats to Biodiversity: (**5Lectures)**

Natural and Anthropogenic disturbances; Habitat loss, Habitat degradation, and Habitat fragmentation; Climate change; pollution; hunting; over-exploitation; deforestation; invasive species; land use changes; overgrazing etc.

Unit 6: Measurement of Biodiversity: (6 Lectures)

Different types of biodiversity measurement indices viz. Shannon Wiener biodiversity index, Simpson index, Evenness index, frequency, abundance, density, relative density.

Unit 7: Conservation of Biodiversity: (12 Lectures)

Importance of biodiversity patterns in conservation; In-situ conservation (Biosphere Reserves, National Parks, Wildlife Sanctuaries); Ex-situ conservation (botanical gardens, zoological gardens, gene banks, seed and seedling banks, pollen culture, tissue culture and DNA banks),role of local communities and traditional knowledge in conservation; Biodiversity Hotspots; IUCN Red List categorization - guidelines, practice and application; Red Data book; Joint forest management, Sanctuary and Biosphere reserve – difference and location in India. People's biodiversity register (PBR); Importance of Wetland, its conservation, Ramsar Convention.

ENV-G-CC/GE-2-2-P: Ecology and Biodiversity (Practical)

1. Field study on ecology and biodiversity of flora and fauna of a local area/ex-situ conservation site and field report submission. **(10)**
2.. Identification of environmentally important flora and fauna with characteristics features. (Herbarium/specimens) (15)
3. Viva Voce. (5)

Semester-III

ENV-G-CC/GE-3-3-TH: Chemistry of the Environment

Theory: 50 Lectures

Unit 1: Basics of General Chemistry: (**8 Lectures**)

Molecular weight, Equivalent Weight, Molarity, Normality, Oxidation and Reduction Reactions; Brief idea of Metals and Nonmetals; Aromatic & Aliphatic compounds, Saturated and unsaturated hydrocarbons.

Unit 2: Basics of Chemical Equilibrium and Kinetics: (**4 Lectures**)

Stoichiometry; Chemical equilibrium; Acid-base reactions (acidity, alkalinity, buffer and buffer capacity).

Unit 3: Water Chemistry: (**10 Lectures**)

Fundamentals of water quality; Concept of DO, BOD, COD, Hardness; Principles of sedimentation, coagulation, filtration.

Unit 4: Air Chemistry: (**12 Lectures**)

Classification of elements, particles, ions and radicals in the atmosphere; Chemical process for formation of inorganic and organic particulate matters in air; PM-lO, PM-2.5, Sulphur Oxides Chemistry, Nitrogen Oxides Chemistry, Carbon Oxides Chemistry, VOCs (Volatile Organic Compounds), PAHs (Polycyclic Aromatic Hydrocarbons), Peroxyacetyl nitrate (PAN) and Photochemical smog; Ozone chemistry.

Unit 5: Soil Chemistry: (**8 Lectures**)

Soil composition; relation between organic carbon and organic matter; inorganic and organic components in soil; soil humus; cation and anion exchange reactions in soil; nitrogen, phosphorus and potassium pathways in soil.

Unit 6: Chemistry of Heavy metals: (**8 Lectures**)

Pb, Hg, Cd and As - Physical and chemical properties; Behavior of heavy metals and their compounds in environment.

ENV-G-CC/GE-3-3-P: Chemistry of the Environment (Practical)

1. Estimation of water quality parameters – pH, conductivity, free CO_2, hardness, alkalinity, chloride, Dissolved oxygen. (10)
2. Estimation of Soil quality parameters - pH, conductivity, organic carbon. (10)
3. Viva Voce. (10)

Semester-IV

ENV-G-CC/GE-4-4-TH: Environmental Physics and Meteorology

Theory 50 Lectures

Unit 1: Thermodynamics: **(12 Lectures)**

Concept of System; First and second law of thermodynamics; Entropy; Enthalpy, Free energy; Chemical potential; Heat transfer process; Mass and energy transfer across the various interfaces; Material balance.

Unit 2: Energy Interactions: **(8 Lectures)**

Energy budget concept: Radiation fluxes, metabolism of latent heat exchange; Energy equilibrium between biotic and abiotic environmental component.

Unit 3: Concept of Radiation Physics: **(8 Lectures)**

Types of Electromagnetic radioactivity and its units, characterizations of various rays, application of radio isotopes; Biological effects of radiation.

Unit 4: **Techniques related to environmental physics:** **(10 Lectures)**

Acoustic radar; Application of LASER radiations; Electrical detection of airborne particles using surface ionization techniques; Biosensor: Concept and application.

Unit 5: Concept of Meteorology: **(12 Lectures)**

Basic knowledge of climatological parameters for environmental study; Weather and climate; Classification of Climate; Fundamentals of temperature, pressure, relative humidity, rainfall and wind speed; Concept of atmospheric stability; Mixing height, temperature inversion.

ENV-G-CC/GE-4-4-P: Environmental Physics and Meteorology (Practical)

1. Recording of wind speed, relative humidity, atmospheric pressure, rainfall, insolation and light intensity. (10)
2. Visit to a Weather Station (one day) (10)
3. Viva-Voce (10)

SKILL ENHANCEMENT COURSE (SEC)

SEC-A [Any one Paper either in 3rd or 5th Semester]

ENV-G-SEC-3-A1-TH: Environmental Laws and policy, Environmental Audit and EIA

Theory: 30 Lectures

Unit 1: Fundamental rights and duties in Indian Constitution; Policies related to Environment (8 Lectures)

National Forest Policy 1952, National Forest Policy 1988; National Environment Policy, 2006

Unit 2: Environmental legislation (10 Lectures)

Legal definitions (environmental pollution, natural resource, biodiversity, forest, sustainable development); Article 48A (The protection and improvement of environment and safeguarding of forests and wildlife); Article 51 A (Fundamental duties).

The Indian Forest Act 1927; The Wildlife (Protection) Act 1972; The Water (Prevention and Control of Pollution) Act 1974; The Water (Prevention and Control of Pollution) Cess Act 1977; The Forests (Conservation) Act 1980; The Air (Prevention and Control of Pollution) Act 1981; The Environment (Protection) Act 1986; Motor Vehicle Act 1988; The Public Liability Insurance Act 1991; Noise Pollution (Regulation and Control) Rules 2000; The Biological Diversity Act 2002.

Unit 3: Environmental Audit (6 Lectures)

Overview of Environmental Audit, Basic steps of Environmental Audit, Benefits of Environmental Audit.

Unit 4: Environmental Impact Assessment (6 Lectures)

Definitions, introduction concepts and types; scope and methodologies of EIA, EIA regulations in Ind

ENV-G-SEC-5-A2-TH: Environmental Pollution and Green Technologies

Theory: 30 Lectures

Unit 1: Introduction: **(2 Lectures)**

Definition of pollution; pollutants; classification of pollutants (Physical, chemical and biological).

Unit 2: Air and Noise Pollution: **(8 Lectures)**

Air borne particles and particulate matters, Temperature inversion, SO_X, NO_X, Hydrocarbons, Lead & other pollutants; Temperature inversion; photochemical Smog; Health effects of Air pollution; Adverse health effects of tobacco.

Measurement of Noise, Health effects of Noise pollution, Control of noise pollution.

Unit 3: Water pollution: **(6 Lectures)**

Sources of surface and ground water pollution; Water quality parameters: COD, BOD, DO, hardness, alkalinity; Biological aspects of water pollution: MPN, Eutrophication; Biological indicator; Arsenic pollution of drinking water and its consequence: An overview.

Unit 4: Pesticide pollution: **(2 Lectures)**

Classification of pesticide, Biological magnification of persistent organic pollutants.

Unit 5: Pollution control: **(2 Lectures)**

Activated Sludge Process (ASP) - Trickling Filters - oxidation ponds, fluidized bed reactors, concept and working of effluent treatment plants (ETPs).

Unit 6: Green technologies and its applications: **(10 Lectures)**

Definition and concepts: green technology, Green House Gas (GHG) emissions reduction: carbon capture and storage (CCS) technologies, fuel efficient vehicles, and mass transit, methane emissions reduction and/or reuse; Pollution reduction and removal (Flue Gas Desulfurization (FGD) methods; Rainwater Harvesting; Successful green technologies: wind turbines, solar panels; 3R's of green technology: recycle, renew and reduce.

SEC-B [Any one Paper either in 4th or 6th Semester]

ENV-G-SEC-4-B1-TH: Applications of Environmental Biotechnology

Theory: 30 Lectures

Unit 1: Principles of different biotechnological methods: **(10 Lectures)**

Plasmid preparation, restriction digestion, DNA ligation, PCR, RAPD and RFLP.

Unit 2: Biotechnological applications: **(3 Lectures)**

Biotechnological applications in medicine and industry.

Unit 3: Application of Biotechnology in waste treatment: **(7 Lectures)**

Wastewater treatment; solid waste treatment: sources and management (composting, vermiculture and methane production); Bioremediation; Phytoremediation.

Unit 4: Ecologically safe products and processes: **(7 Lectures)**

PGPR bacteria: biofertilizers, microbial insecticides and pesticides; Integrated pest management.

Unit 5: GMs and GMOs: **(3 Lectures)**

Concept of GM and GMOs; Biosafety protocol.

ENV-G-SEC-6-B2-TH: Remote sensing, GIS and its applications

Theory: 30 Lectures

Unit 1: Remote Sensing: **(8 Lectures)**

Definitions and principles; electromagnetic (EME) spectrum; spectral signature; satellites and sensors; aerial photography and image interpretation.

Unit 2: Geographical Information Systems: **(12 Lectures)**

Definitions and components; spatial and non-spatial data; raster and vector data; database generation; database management system; land use/ land cover mapping; GPS survey, data import, processing, and mapping.

Unit 3: Applications of remote sensing and GIS: **(8 Lectures)**

Water resource management, land use planning, forest and wildlife resources, agriculture, and atmospheric studies.

Semester-V

DISCIPLINE SPECIFIC ELECTIVES

DSE-A [Elective Course (Any One from DSE-A1 and DSE-A2)]

ENV-G-DSE-A--5-X-TH

(DSE) A1: Energy and Environment

Theory: 50 Lectures

Unit 1: Energy resources: **(10 Lectures)**

Defining energy; forms and importance; Global energy resources; renewable and non-renewable resources: distribution and availability.

Unit 2: Energy demand: **(10 Lectures)**

Global energy demand: historical and current perspective; energy demand and use in domestic, industrial, agriculture and transportation sector.

Unit 3: Energy Resource Management: **(20 Lectures)**

Conventional and non-conventional energy resources; Brief idea of energy production and environmental consequences involved (*viz*. Thermal, Hydel, Solar, Wind, Geothermal, Energy from oceans and Bio-energy); Need for energy efficiency; Energy conservation and sustainability; Action strategies for sustainable energy management from a future perspective.

Unit 4: Energy Audit: **(10 Lectures)**

Concept, purpose and methodology**.**

ENV-G-DSE-A--5-X-P
(DSE) A 1: Energy and Environment (Practical)

1. To determine energy efficiencies from the given data. (5)
3. Preparation of Energy audit of a domestic unit/office. (10)
4. Demonstration of water conservation techniques.
5. Demonstration of use of solar devices, photo-cells, wind-mills.
6. Demonstration of Biogas plant (S No. 4,5,6 =5)
7. Preparation of report on Energy Plantation /Visit to a water shed management project and field report preparation. (10)

ENV-G-DSE-A--5-X-TH

(DSE) A2: Environmental Economics and Statistics

Theory: 50 Lectures

Unit 1: Concept of environmental economics: **(4 Lectures)**

Economy and the environment.

Unit 2: National resource economics: **(10 Lectures)**

Economics of non-renewable resources; economics of fuels and minerals; Introduction to natural resource accounting.

Unit 3: Tools for environmental economic policy: **(12 Lectures)**

Growth and environment; environmental accounting, Kuznets curve, assessing benefits and cost for environmental decision making; cost benefit analysis; Economic valuation techniques of environmental benefits - various methods; Policies for controlling air and water pollution; polluter pay principles.

Unit 4: Carbon trading: **(9 Lectures)**

Carbon tax, carbon trading; clean development mechanism; clean production and technology and ecomark - concept only.

Unit 5: Basic Statistics: **(15 Lectures)**

Statistical Sampling, sampling units, estimation of sample size; Mean, mode, median, standard error and deviation, probability, correlation and regression; Testing of hypothesis: Null and alternative, chi-square and student's 't' test.

ENV-G-DSE-A--5-X-P

DSEA2: Environmental Economics and Statistics (Practical)

1. Numerical problems on biostatistics Chi-Square test and Student's t test). (20)
2. Viva -voce. (10)

Semester-VI

DISCIPLINE SPECIFIC ELECTIVES

DSE-B [Elective Course (Any One from DSE-B1 and DSE-B2)]

ENV-G-DSE-B-6-X-TH

(DSE) B1: Natural Hazard and Disaster Management

Theory: 50 Lectures

Unit 1: Introduction: **(12 Lectures)**

Definition of hazard and disaster; Natural, technological and context hazards; Concept of risk and vulnerability.

Unit 2: Natural hazards: **(16 Lectures)**

Natural hazards – earthquake; volcanoes - cause and effects; floods: types and nature, effects; landslides: causes and types of landslides, effects; drought: types of drought - meteorological, agricultural, hydrological and effects; tornadoes, cyclone & hurricanes; tsunamis: causes and location of tsunamis, effects.

Unit 3: Anthropogenic hazards: **(16 Lectures)**

Impacts of anthropogenic activities such as rapid urbanization, injudicious ground water extraction, deforestation; large scale developmental projects, like dams and nuclear reactors in hazard prone zones; Nature and impact of accidents; Case studies of Bhopal, Minamata and Chernobyl disaster.

Unit 5: Disaster management: **(6 Lectures)**

Disaster management cycle; Disaster management plan.

ENV-G-DSE-B-6-X-P

(DSE) B1: Natural Hazard and Disaster Management (Practical)

1. Project Report based on any two field-based case studies among following disasters and one disaster preparedness plan of respective college or locality: -Flood and waterlogging, Cyclone, Earthquake, Human Induced Disasters: Fire Hazards, Chemical, Industrial accidents. (15)
2. Poster preparation and presentation on topic related to national and international disaster and disaster management. (5)
3. Viva -voce (10)

ENV-G-DSE-B-6-X-TH

(DSE) B2: Solid Waste Management

Theory: 50 Lectures

Unit 1: Solid Waste: **(8 Lectures)**

Sources and generation of solid waste; their classification and chemical composition; characterization of municipal solid waste; hazardous waste and biomedical waste.

Unit 2: Effect of solid waste disposal on environment: **(8 Lectures)**

Impact of solid waste on environment, human and plant health; water quality and aquatic life; mining waste and land degradation; effect of land fill leachate on soil characteristics and ground water pollution.

Unit 3: Solid waste Management: **(12 Lectures)**

Different techniques used in collection, storage, transportation and disposal of solid waste (municipal, hazardous and biomedical waste); landfill (traditional and sanitary landfill design); thermal treatment (pyrolysis and incineration) of waste material; drawbacks in waste management techniques; Concept of Integrated waste management.

Unit 5: Resource Recovery: **(10 Lectures)**

4R - reduce, reuse, recycle and recover; biological processing - composting, anaerobic digestion, aerobic treatment; reductive dehalogenation; mechanical biological treatment; green techniques for waste treatment.

Unit 5: Policies for solid waste management: **(12 Lectures)**

Municipal Solid Wastes (Management and Handling) Rules 2000; Hazardous Wastes Management and Handling Rules 1989; Bio-Medical Waste (Management and Handling) Rules 1998; Plastic Waste (Management and Handling) Rules, 2011; E-Waste (Management) Rules, 2016.

ENV-G-DSE-B-6-X-P

(DSE) B 2: Solid Waste Management (Practical)

1. Demonstration of composting techniques including vermicomposting (5)
2. Study of soil microbial activity- Soil respiration (for stability and maturity of compost) (5)

3. Visit to sewage treatment plants/ Visit to waste water treatment plants/ Solid waste management site with field report preparation. (15)
4. Viva-Voce. (5)

Suggested Readings:

1. Agarwal KM., Sikdar PK., Deb SC. A textbook of Environment. Mc millan India Ltd.
2. Anjaneyulu Y. Introduction to Environmental Science. B.S Publication.
3. Enger E, Smith B. Environmental Science. A Study of Interrelationships. McGraw-Hill Higher Education
4. Chapman, Reiss. Ecology: Principles and Applications. Cambridge University Press.
5. Kormondy EJ. Concept of Ecology. Prentice hall of India.
6. Kumar HD. Modern concepts in Ecology
7. Odum EP. Fundamentals of Ecology
8. Sharma PD. Ecology and Environment. Rastogi Publication.
9. Das MC. Fundamental of Ecology. Tata Mcgraw Hill Publication.
10. Gaston, KJ. & Spicer, J.I. 1998. *Biodiversity: An Introduction.* Blackwell Science,
11. London,
12. UK. Krishnamurthy, K.V. 2004. *An Advanced Text Book of Biodiversity - Principles and Practices*. Oxford and IBH Publications Co. Pvt. Ltd. New Delhi
13. Maiti, Maiti. Biodiversity: Perception, Peril and Preservation. PHI Learning Pvt. Ltd.
14. Banerjee SK. Environmental Chemistry.
15. Dara SS. A text book of Environmental Chemistry and Pollution Control.
16. De AK. Environmental Chemistry. New Age (P) Ltd.
17. Gupta PK. 2004. Methods in Environmental analysis - water, soil and air. Agrobios (India), Jodhpur
18. Jadhav HV. Elements of Environmental Chemistry
19. Moore JW, Moore EA. Environmental Chemistry
20. Peavy HS, Rowe DR. Environmental Engineering. McGraw Hill.
21. Glasson, J., Therivel, R., Chadwick, A. 1994. Introduction to Environmental Impact Assessment. London, Research Press, UK.
22. Judith, P. 1999. Handbook of Environmental Impact Assessment. Blackwell Science.
23. Marriott, B. 1997. Environmental Impact Assessment: A Practical Guide. McGraw-Hill, New York, USA.
24. Naseem, M. 2011. Environmental Law in India Mohammad. Kluwer Law International.
25. Venkat, A. 2011. Environmental Law and Policy. PHI Learning Private Ltd.
26. Rosencranz A, Divan S, Noble ML. 2001. Environmental law and policy in India. Tripathi.
27. Barry, R. G. 2003. Atmosphere, Weather and Climate. Routledge Press, UK.
28. Boeker, E. & Grondelle, R. 2011. Environmental Physics: Sustainable Energy and Climate Change. Wiley.
29. Forinash, K. 2010. Foundation of Environmental Physics. Island Press.
30. Singh, Savindra Climatology, Prayag Pustak Publication.
31. Rittman, B.E. & McCarty, P.L. 2001. Environmental Biotechnology. Principles and Applications. McGraw-Hill, New York.
32. Scagg, A.H. 2005. Environmental Biotechnology. Oxford University Press.
    World Commission on Environment and Development. Our Common Future. Oxford University Press.
33. Elliott, D. 1997. Sustainable Technology. Energy, Society and Environment (Chapter 3). New York, Routledge Press
34. Shastri M.N.1995, Energy Options : Himalaya Publishing House, New Delhi.
35. Das. NG. Statistical Methods.

36. Hanley N, Jason FS, White B. Environmental Economics in Theory and Practice. 1997. New Delhi. Macmillan – India.
37. Sankar U. (ed.) Environmental Economics. New Delhi. Oxford University Press, 2001.
38. Wayne RO Environmental Statistics and Data Analysis. 1995. CRC Press.
39. Arceivala. Waste water treatment for pollution control. Tata Mc Graw Hill
40. Chatwal, Anand. Instrumental Methods of Analysis.
Schneid, T.D. & Collins, L. 2001. Disaster Management and Preparedness. Lewis Publishers, New York, NY.
41. Smith, K. 2001. Environmental Hazards: Assessing Risk and Reducing Disaster.Routledge Press.
42. Singh Savindra and Jeetendra, Disaster Management, Pravalika publication, Allahabad.
43. Khopkar. Environmental Pollution Analysis
44. Mastters GM. Introduction to Environmental Engineering & Science. Prentice Hall of India.
45. Rossetti, B.B Prospects and perspective of solid waste management., New age International.
46. Singh, J and Ramanathan, AL 2009. Solid Waste Management: Present and Future Challenges
47. Remote sensing and GIS (2nd Edition) Basudev Bhatta, Oxford University Press
48. Sabins, F.F. 1996. Remote Sensing: Principles an Interpretation. W.R. Freeman.

UNIVERSITY OF CALCUTTA

Notification No. CSR/ 12 /18

It is notified for information of all concerned that the Syndicate in its meeting held on 28.05.2018 (vide Item No.14) approved the Syllabi of different subjects in Undergraduate Honours / General / Major courses of studies (CBCS) under this University, as laid down in the accompanying pamphlet:

List of the subjects

Sl. No.	Subject	Sl. No.	Subject
1	Anthropology (Honours / General)	29	Mathematics (Honours / General)
2	Arabic (Honours / General)	30	Microbiology (Honours / General)
3	Persian (Honours / General)	31	Mol. Biology (General)
4	Bengali (Honours / General /LCC2 /AECC1)	32	Philosophy (Honours / General)
5	Bio-Chemistry (Honours / General)	33	Physical Education (General)
6	Botany (Honours / General)	34	Physics (Honours / General)
7	Chemistry (Honours / General)	35	Physiology (Honours / General)
8	Computer Science (Honours / General)	36	Political Science (Honours / General)
9	Defence Studies (General)	37	Psychology (Honours / General)
10	Economics (Honours / General)	38	Sanskrit (Honours / General)
11	Education (Honours / General)	39	Social Science (General)
12	Electronics (Honours / General)	40	Sociology (Honours / General)
13	English ((Honours / General/ LCC1/ LCC2/AECC1)	41	Statistics (Honours / General)
14	Environmental Science (Honours / General)	42	Urdu (Honours / General /LCC2 /AECC1)
15	Environmental Studies (AECC2)	43	Women Studies (General)
16	Film Studies (General)	44	Zoology (Honours / General)
17	Food Nutrition (Honours / General)	45	Industrial Fish and Fisheries – IFFV (Major)
18	French (General)	46	Sericulture – SRTV (Major)
19	Geography (Honours / General)	47	Computer Applications – CMAV (Major)
20	Geology (Honours / General)	48	Tourism and Travel Management – TTMV (Major)
21	Hindi (Honours / General /LCC2 /AECC1)	49	Advertising Sales Promotion and Sales Management –ASPV (Major)
22	History (Honours / General)	50	Communicative English –CMEV (Major)
23	Islamic History Culture (Honours / General)	51	Clinical Nutrition and Dietetics CNDV (Major)
24	Home Science Extension Education (General)	52	Bachelor of Business Administration (BBA) (Honours)
25	House Hold Art (General)	53	Bachelor of Fashion and Apparel Design – (B.F.A.D.) (Honours)
26	Human Development (Honours / General)	54	Bachelor of Fine Art (B.F.A.) (Honours)
27	Human Rights (General)	55	B. Music (Honours / General) and Music (General)
28	Journalism and Mass Communication (Honours / General)		

The above shall be effective from the academic session 2018-2019.

SENATE HOUSE
KOLKATA-700073
The 4th June, 2018

Paul 4/6/18
(Dr. Santanu Paul)
Deputy Registrar

UNIVERSITY OF CALCUTTA

CBCS SYLLABUS OF ZOOLOGY

2018

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THREE-YEAR HONOURS

DEGREE COURSE OF STUDIES

Outline Structure of CBCS Curriculum for Zoology (Hons), C.U.

PART I; SEM I				
Subject Code	Name of Paper	Theory	Practical	Internal assessment
CC 1	Non Chordata – I (Protists to Pseudocoelomates)	50	30	20
CC 2	Molecular Biology	50	30	20
PART I; SEM II				
CC 3	Non Chordata – II (All Coelomate Phyla)	50	30	20
CC 4	Cell Biology	50	30	20
PART II; SEM III				
CC 5	Chordata	50	30	20
CC 6	Animal Physiology: Controlling & Co-ordinating System	50	30	20
CC 7	Fundamentals of Biochemistry	50	30	20
SEC-A (1/2)	Apiculture / Sericulture	80	NA	20
PART II; SEM IV				
CC 8	Comparative Anatomy of Vertebrate	50	30	20
CC 9	Animal Physiology: Life sustaining system	50	30	20
CC 10	Immunology	50	30	20
SEC- B(1/2)	Aquarium Fisheries/ Medical Diagnosis	80	NA	20
PART III; SEM V				
CC 11	Ecology	50	30	20
CC 12	Principle of Genetics	50	30	20
DSE A(1/2)	Parasitology/Biology of Insect	50	30	20
DSE B (1/2)	Endocrinology/Reproductive Biology	50	30	20
PART III; SEM VI				
CC 13	Developmental Biology	50	30	20
CC 14	Evolutionary Biology	50	30	20
DSE A (1/2)	Animal Biotechnology/Animal Cell Biotechnology	50	30	20
DSE B (1/2)	Animal Behaviour & Chronology/Fish & Fisheries	50	30	20

Abbreviations:

CC: Core Course; DSE A/B: Discipline Specific Elective A/B; SEC A/B: Skill Enhancement Course.

SUBJECT/PAPER CODE FORMAT

1. **Subject Code: ZOO**
2. **Honours Code: A**
3. **Course Code: a) Core Course: CC**

   b) Discipline Specific Elective: DSE-A/DSE-B

   c) Skill Enhancement Course: SEC-A/SEC-B
4. **Semester Code: 1/2/3/4/5/6**
5. **Paper No. Code: 1/2/3…../14**
6. **Paper Component Code: a) Theory: TH, b) Practical: P**

INDEX

CBCS ZOOLOGY (HONOURS), Papers & Their Codes

PART I: SEMESTER 1

CORE COURSE 1. Non-Chordates I

ZOOA-CC1-1-TH

Full Marks 50	**4 Credits**	**50 Hours**
Non-Chordates I: Protists to Pseudocoelomates		
Unit 1: Basics of Animal Classification		4
Definitions: Classification, Systematics and Taxonomy; Taxonomic Hierarchy, Taxonomic types Codes of Zoological Nomenclature; Principle of priority; Synonymy and Homonymy; Concept of classification – three kingdom concept of Carl Woese, 1977 and five kingdom concept of Whittaker, 1969		
Unit 2: Protista and Metazoa		15
Protozoa General characteristics and Classification up to phylum (according to Levine *et. al.*, 1980) Locomotion in *Euglena*, *Paramoecium* and *Amoeba*; Conjugation in *Paramoecium*. Life cycle and pathogenicity of *Plasmodium vivax* and *Entamoeba histolytica* **Metazoa** Evolution of symmetry and segmentation of Metazoa		
Unit 3: Porifera		6
General characteristics and Classification up to classes (Ruppert and Barnes, 1994, 6th Ed.); Canal system and spicules in sponges		
Unit 4: Cnidaria		10
General characteristics and Classification up to classes (Ruppert and Barnes, 1994, 6th Ed.), Metagenesis in *Obelia*; Polymorphism in Cnidaria; Corals and coral reef diversity, Role of symbiotic algae in reef formation. Conservation of coral and coral reefs.		
Unit 5: Ctenophora		2
General characteristics		
Unit 6: Platyhelminthes		6
General characteristics and Classification up to classes (Ruppert and Barnes, 1994, 6th Ed.) Life cycle and pathogenicity and control measures of *Fasciola hepatica* and *Taenia solium*		
Unit 7: Nematoda		7
General characteristics and Classification up to classes (Ruppert and Barnes, 1994, 6th Ed.) Life cycle, and pathogenicity and control measures of *Ascaris lumbricoides* and *Wuchereria bancrofti* Parasitic adaptations in helminthes		

Non-Chordates I Lab; ZOOA-CC-1-1-P

Non-Chordates I: Protists to Pseudocoelomates

Full Marks 30	**60 Hours**	2 credits
List of Practical		
Study of whole mount of *Euglena*, *Amoeba* and *Paramoecium* Identification with reason & Systematic position of *Amoeba*, *Euglena*, *Entamoeba*, *Paramecium*, *Plasmodium*, *Balantidium*, *Vorticella* (from the prepared slides) Identification with reason & Systematic position of *Sycon*, *Poterion* (Neptune's Cup), *Obelia*, *Physalia*, *Aurelia*, *Gorgonia*, *Metridium*, *Pennatula*, *Madrepora*, *Fasciola hepatica*, *Taenia solium* and *Ascaris lumbricoides.* Staining/mounting of any protozoa/helminth from gut of *Periplaneta* sp.		

CORE COURSE 2: Molecular Biology

ZOOA-CC1-2-TH

Full Marks 50	4 Credits	50 Hours
Unit 1: Nucleic Acids		3
Salient features of DNA, Chargaff's Rule, Hypo and Hyperchromic shift. Watson and Crick Model of DNA. RNA types & Function.		
Unit 2: DNA Replication		9
Mechanism of DNA Replication in Prokaryotes, Prove that replication is Semi-conservative, bidirectional and discontinuous, RNA priming, Replication of telomeres.		
Unit 3: Transcription		9
Mechanism of Transcription in prokaryotes and eukaryotes, Transcription factors, Difference between prokaryotic and eukaryotic transcription.		
Unit 4: Translation		9
Genetic code, Degeneracy of the genetic code and Wobble Hypothesis. Mechanism of protein synthesis in prokaryotes.		
Unit 5: Post Transcriptional Modifications and Processing of Eukaryotic RNA		8
Capping and Poly A tail formation in mRNA; Split genes: concept of introns and exons, splicing mechanism, alternative splicing and RNA editing		

Unit 6: Gene Regulation	7
Regulation of Transcription in prokaryotes: *lac* operon and *trp* operon; Regulation of Transcription in eukaryotes: Activators, enhancers, silencer, repressors, miRNA mediated gene silencing. Epigenetic Regulation: DNA Methylation, Histone Methylation & Acetylation.	
Unit 7: DNA Repair Mechanisms	2
Types of DNA repair mechanisms, RecBCD model in prokaryotes, nucleotide and base excision repair, SOS repair	
Unit 8: Molecular Techniques	3
PCR, Western and Southern blot, Northern Blot	

Molecular Biology Lab; ZOOA-CC-1-2-P

Full Marks 30	**60 Hours**	2 Credits
List of Practical		
1. Demonstration of polytene and lampbrush chromosome from photograph 2. Isolation and quantification of genomic DNA from goat liver. 3. Agarose gel electrophoresis for DNA. 4. Histological staining of DNA and RNA in prepared slides		

PART I: SEMESTER 2

CORE COURSE 3: Non-Chordates II – Coelomates

ZOOA-CC2-3-TH

Full Marks 50	4 Credits	50 Hours
Unit 1: Introduction		2
Evolution of coelom		
Unit 2: Annelida		10
General characteristics and Classification up to classes (Ruppert and Barnes, 1994) Excretion in Annelida through nephridia; Metamerism in Annelida.		
Unit 3: Arthropoda		16
General characteristics and Classification up to classes (Ruppert and Barnes, 1994); Insect Eye (Cockroach only). Respiration in Prawn and Cockroach; Metamorphosis in Lepidopteran Insects; Social life in Termite		
Unit 4: Onychophora		2
General characteristics and Evolutionary significance		

Unit 5: Mollusca	10
General characteristics and Classification up to classes (Ruppert and Barnes, 1994); Nervous system in *Pila sp*. Torsion in Gastropoda. Feeding and respiration in *Pila* sp.	
Unit 6: Echinodermata	8
General characteristics and Classification up to classes (Ruppert and Barnes, 1994); Water-vascular system in *Asterias*. Echinoderm larva and affinities with chordates	
Unit 7: Hemichordata	2
General characteristics of phylum Hemichordata. Relationship with non-chordates and chordates	

Non-Chordates II Lab, ZOOA-CC-2-3-P

Full Marks 30	**2 Credits**
List of Practical	

1. Study of following specimens:
   - **a.** Annelids - *Aphrodite, Nereis, Chaetopterus,* Earthworm, *Hirudinaria*
   - **b.** Arthropods - *Limulus, Palaemon, Balanus, Eupagurus, Scolopendra, Peripatus,* Silkworm – life history stages, Termite – members of a colony and Honey bee – members of the colony
   - **c.** Molluscs - *Dentalium, Patella, Chiton, Pila, Achatina, Pinctada, Sepia, Octopus, Nautilus*
   - **d.** Echinoderms - *Asterias, Ophiura, Clypeaster, Echinus, Cucumaria* and *Antedon*
2. Anatomy study: Nervours system, Reproductive system (Male & female), Mouth parts & Salivary apparatus in *Periplaneta* sp.

PART I: SEMESTER 2

CORE COURSE 4: Cell Biology

ZOOA-CC2-4-TH

Full Marks 50	**4 Credits**	**50 Hours**
Unit 1: Plasma Membrane		7
Ultra-structure and composition of Plasma membrane: Fluid mosaic model, Transport across membrane - Active and Passive transport, Facilitated transport, Cell junctions: Tight junctions, Gap junctions, Desmosomes		
Unit 2: Cytoplasmic organelles I		5
Structure and Functions: Endoplasmic Reticulum, Golgi Apparatus, Lysosomes; Protein sorting and mechanisms of vesicular transport		
Unit 3: Cytoplasmic organelles II		7
Mitochondria: Structure, Semi-autonomous nature, Endosymbiotic hypothesis Mitochondrial Respiratory Chain, Chemiosmotic hypothesis; Peroxisomes: Structure and Functions		

Centrosome (Kinetochore and centromeric DNA): Structure and Functions	
Unit 4: Cytoskeleton	5
Type, structure and functions of cytoskeleton; Accessory proteins of microfilament & microtubule	
Unit 5: Nucleus	8
Nuclear envelope, Nuclear pore complex, Nucleolus; Chromatin: Euchromatin and Heterochromatin and packaging (nucleosome),	
Unit 6: Cell Cycle	10
Cell cycle and its regulation, Cancer (Concept of oncogenes and tumor suppressor genes with special reference to p53, Retinoblastoma and Ras. Process of Proto-oncogene activation	
Unit 7: Cell Signalling	8
Cell signalling transduction pathways; Types of signalling molecules and receptors (Classification and Example only): RTK & JAK/STAT. Apoptosis	

Cell Biology Lab; ZOOA-CC-2-4-P

Full Marks 30	**60 Hours**	2 Credits
List of Practical		

1. Preparation of temporary stained squash of onion/arum root tip to study various stages of mitosis
2. Study of various stages of meiosis from grasshopper testis
3. Preparation of permanent slide to show the presence of Barr body in human female blood cells/cheek cells.
4. Preparation of permanent slide to demonstrate:
    a. DNA by Feulgen reaction
    b. Cell viability study by Trypan Blue staining

PART II: SEMESTER 3.

CORE COURSE 5 : Chordata

ZOOA-CC3-5-TH

Full Marks 50	4 Credits	50 Hours
Unit 1: Introduction to Chordates		2
General characteristics and outline classification of Phylum Chordata (Young, 1981)		
Unit 2: Protochordata		7
General characteristics and classification of sub-phylum Urochordata and Cephalochordata up to Classes (Young, 1981). Metamorphosis in *Ascidia*. Chordate Features, structure of pharynx and feeding in *Branchiostoma*		

Unit 3: Agnatha	2
General characteristics and classification of cyclostomes up to order (Young, 1981)	
Unit 4: Pisces	7
General characteristics and classification up to living sub classes (Young, 1981); Accessory respiratory organ, Migration in fishes; Parental care in fishes; Swim bladder in fishes.	
Unit 5: Amphibia	7
General characteristics and classification up to living Orders (Young, 1981); Metamorphosis, Paedomorphosis, Parental care in Amphibia	
Unit 6: Reptilia	8
General characteristics and classification up to living Orders (Young, 1981); Poison apparatus and Biting mechanism in Snake. Poisonous & Non-Poisonous snake.	
Unit 7: Aves	8
General characteristics and classification up to living Sub-Classes (Young, 1981); Exoskeleton and migration in Birds; Principles and aerodynamics of flight	
Unit 8: Mammals	9
General characters and classification up to living sub classes (Young, 1981); Exoskeleton derivatives of mammals; Adaptive radiation in mammals with reference to locomotory appendages; Echolocation in Micro chiropterans	

Chordata Lab; ZOOA-CC-3-5-P

Full Marks 30	**60 Hours**	2 Credits
List of Practical		

Identification with Reasons

a) **Protochordata**: *Balanoglossus*, *Branchiostoma*
b) **Agnatha**: *Petromyzon*
c) **Fishes**: *Scoliodon, Sphyrna, Pristis, Torpedo, Mystus, Heteropneustes, Labeo rohita, Exocoetus, Hippocampus, Anabas,* Flat fish
d) **Amphibia**: *Necturus, Bufo (Duttaphrynus) melanostictus, Rana (Hoplobatrachus) tigerinus, Hyla, Tylototriton,* Axolotl larva
e) **Reptilia**: Chelone, Trionyx, Hemidactylus, Varanus, *Calotes*, *Chamaeleon, Draco, Vipera, Naja, Hydrophis,*
f) **Mammalia**: Bat (Insectivorous and Frugivorous), *Funambulus* (Indian Palm squirrel)

Dissection of brain and pituitary – *ex situ*, digestive and Urino-genital system of *Tilapia*

Pecten from Fowl head

Power point presentation on study of habit, habitat or behaviour of any one animal by student – for internal assessment only

PART II: SEMESTER 3.

CORE COURSE 6: Animal Physiology: Controlling and Co-ordinating System

ZOOA-CC3-6-TH

Full Marks 50	4 Credits	50 Hours
Unit 1: Tissues		4
Structure, location, classification and functions of epithelial tissue, connective tissue, muscular tissue and nervous tissue		
Unit 2: Bone and Cartilage		4
Structure and types of bones and cartilages, Ossification		
Unit 3: Nervous System		10
Structure of neuron, resting membrane potential, Origin of action potential and its propagation across the myelinated and non-myelinated nerve fibres; Types of synapse, Synaptic transmission and Neuromuscular junction		
Unit 4: Muscular system		10
Histology of different types of muscle; Ultra-structure of skeletal muscle; Molecular and chemical basis of muscle contraction; Characteristics of muscle fibre		
Unit 5: Reproductive System		6
Histology of mammalian testis and ovary; physiology of mammalian reproduction – menstrual and oestrous cycle		
Unit 6: Endocrine System		16
Histology and function of thyroid, pancreas and adrenal. Function of pituitary Classification of hormones; Mechanism of Hormone action; Signal transduction pathways for Steroidal and Non- steroidal hormones; Hypothalamus (neuroendocrine gland) - principal nuclei involved in neuroendocrine control of anterior pituitary; Placental hormones		

Animal Physiology: Controlling & Coordinating Systems, Lab;

ZOOA-CC3-6-P

Full Marks 30	**60 Hours**	2 Credits
List of Practical		
1. Recording of cardiac and simple muscle twitch with electrical stimulation 2. Preparation of temporary mounts: Squamous epithelium, Striated muscle fibres and nerve cells 3. Study of permanent slides of Mammalian Skin, Spinal cord, Pancreas, Testis, Ovary, Adrenal, Lung, pyloric stomach, cardiac stomach, Thyroid, small intestine and large intestine of mammal (white rat) 4. Microtomy: Preparation of permanent slide of any five mammalian (Goat/white rat) tissues		

PART II: SEMESTER 3

CORE COURSE 7: Fundamentals of Biochemistry

ZOOA-CC3-7-TH

Full Marks 50	4 Credits	50 Hours
Unit 1: Carbohydrates		8
Structure and Biological importance: Monosaccharides, Disaccharides, Polysaccharides; Derivatives of Monosaccharides; Carbohydrate metabolism: Glycolysis, Citric acid cycle, Pentose phosphate pathway, Gluconeogenesis		
Unit 2: Lipids		7
Structure and Significance: Physiologically important saturated and unsaturated fatty acids, Tri-acylglycerols, Phospholipids, Sphingolipid, Glycolipids, Steroids, Eicosanoids and terpinoids. Lipid metabolism: β-oxidation of fatty acids - a. Palmitic acid {saturated (C 16:0)}, b. Linoleic acid {unsaturated (C 18:2)}; Fatty acid biosynthesis		
Unit 3: Proteins		10
Amino acids: Structure, Classification, General and Electro chemical properties of α-amino acids; Physiological importance of essential and non-essential amino acids, Proteins Bonds stabilizing protein structure; Levels of organization; Protein metabolism: Transamination, Deamination, Urea cycle, Fate of C-skeleton of Glucogenic and Ketogenic amino acids		
Unit 4: Nucleic Acids		10
Structure of Purines, Pyrimidines, Nucleosides and Nucleotides; Nucleic Acid Metabolism: Catabolism of adenosine, Guanosine, cytosine and thymine.		
Unit 5: Enzymes		13
Nomenclature and classification; Cofactors; Specificity of enzyme action; Isozymes; Mechanism of enzyme action; Enzyme kinetics; Derivation of Michaelis-Menten equation, Lineweaver-Burk plot; Factors affecting rate of enzyme-catalyzed reactions; Enzyme inhibition.		
Unit 5: Oxidative Phosphorylation		**2**
Redox systems; Mitochondrial respiratory chain, Inhibitors and un-couplers of Electron Transport System		

Fundamentals of Biochemistry Lab; ZOOA-CC-7-3-P

Fundamentals of Biochemistry		
Full Marks 30	**60 Hours**	**2 Credits**
List of Practical		
1. Qualitative tests for carbohydrates, proteins and lipids 2. Qualitative estimation of Urea & Uric acid 3. Paper chromatography of amino acids. 4. Quantitative estimation of water soluble proteins following Lowry Method		

PART II: SEMESTER 4

CORE COURSE 8.Comparative Anatomy of Vertebrates

ZOOA-CC4-8-TH

Full Marks 50	4 Credits	50 Hours
Unit 1: Integumentary System		10
Structure, function and derivatives of integument in amphibian, birds and mammals		
Unit 2: Digestive System		6
Comparative anatomy of stomach; dentition in mammals		
Unit 3: Respiratory System		6
Respiratory organs in fish, birds and mammals		
Unit 4: Circulatory System		7
General plan of circulation, Comparative account of heart and aortic arches		
Unit 5: Urinogenital System		5
Succession of kidney in different vertebrate groups; evolution of urino-genital ducts		
Unit 6: Nervous system and sense organs		**8**
Comparative account of brain in vertebrates; cranial nerves; olfactory and auditory receptors in vertebrates		
Unit 7: Skeletal system		**8**
Overview of axial and appendicular skeleton – limbs, girdles of pigeon; jaw suspension in mammals		

Comparative Anatomy of Vertebrates Lab; ZOOA-CC4-8-P

Full Marks 30	60 Hours	2 Credits
List of Practical		
1. Study of placoid, cycloid and ctenoid scales through permanent slides/photographs 2. Study of disarticulated skeleton of toad, Pigeon, Guineapig (limb bones, vertebrae, limb and girdle) 3. Comparative study of heart and brain, with the help of model/picture 4. Identification of skulls: Pigeon, one herbivore (Guineapig) and one carnivore (Dog) animal		

PART II: SEMESTER 4

CORE COURSE 9: Animal Physiology: Life Sustaining Systems

ZOOA-CC4-9-TH

Full Marks 50	4 Credits	50 Hours
Unit 1: Physiology of Digestion		10
Structural organisation and function of gastro-intestinal tract; Mechanical and chemical digestion of food, absorption of Carbohydrates, Lipids and Proteins in Human		
Unit 2: Physiology of Respiration		10
Mechanism of Respiration, Respiratory volumes and capacities, transport of Oxygen and Carbon dioxide in blood, Dissociation curves and the factors influencing it, respiratory pigments; Carbon monoxide poisoning		
Unit 3: Physiology of Circulation		8
Structure and functions of haemoglobin; Blood clotting system; Haematopoiesis; Basic steps and its regulation; Blood groups; ABO and Rh factor		
Unit 4: Physiology of Heart		**8**
Coronary Circulation, Structure and working of conducting myocardial fibres, Origin and conduction of cardiac impulses; Cardiac Cycle and cardiac output		
Unit 5: Thermoregulation & Osmoregulation		6
Thermal regulation in camel and polar bear, Osmoregulation in aquatic vertebrates		
Unit 6: Renal Physiology		8
Structure of Kidney and its functional unit, Mechanism of urine formation, Regulation of acid-base balance		

Animal Physiology: Life Sustaining Systems Lab; ZOOA-CC4-9-P

Full Marks 30	60 Hours	2 Credits
List of Practical		
1. Determination of ABO Blood group 2. Estimation of haemoglobin using Sahli's haemoglobin meter 3. Identification of blood cells from human blood 4. Preparation of haemin crystals and haemochromogen crystals 5. Identification of blood cells from cockroach haemolymph 6. Demonstration of blood pressure by digital meter		

PART II: SEMESTER 4

CORE COURSE 10: Immunology

ZOOA-CC4-10-TH

Full Marks 50	4 Credits	50 Hours
Unit 1: Overview of Immune System		3
Introduction – concept of health and disease; Cells and organs of the Immune system		
Unit 2: Innate and Adaptive Immunity		9
Anatomical barriers, Inflammation, Cell and molecules involved in innate immunity, Adaptive immunity (Cell mediated and humoral).		
Unit 3: Antigens		6
Antigenicity and immunogenicity, Immunogens, Adjuvants and haptens, Factors influencing immunogenicity, B and T-Cell epitopes		
Unit 4: Immunoglobulins		10
Structure and functions of different classes of immunoglobulins, Antigen-antibody interactions, Immunoassays (ELISA and RIA), Monoclonal antibody production		
Unit 5: Major Histocompatibility Complex		6
Structure and functions of MHC molecules. Structure of T cell Receptor and its signalling, T cell development & selection		
Unit 6: Cytokines		3
Types, properties and functions of cytokines.		

Unit 7: Complement System	5
Components and pathways of complement activation.	
Unit 8: Hypersensitivity	4
Gell and Coombs' classification and brief description of various types of hypersensitivities.	
Unit 9: Vaccines	4
Various types of vaccines. Active & passive immunization (Artificial and natural).	

Immunology Lab; ZOOA-CC4-10-P

Full Marks 30	**60 Hours**	2 Credits
List of Practical		
1. Demonstration of lymphoid organs (by picture). 2. Histological study of Bursa fabricius, spleen, thymus and lymph nodes through slides/ photographs 3. Demonstration of ELISA		

PART III: SEMESTER 5

CORE COURSE 11.Ecology

ZOOA-CC5-11-TH

Full Marks 50	4 Credits	50 Hours
Unit 1: Introduction to Ecology		4
Autecology and synecology, Levels of organization, Laws of limiting factors, Study of Physical factors, The Biosphere.		
Unit 2: Population		20
Unitary and Modular populations Unique and group attributes of population: Demographic factors, life tables, fecundity tables, survivorship curves, dispersal and dispersion. Geometric, exponential and logistic growth, equation and patterns, r and K strategies Population regulation - density-dependent and independent factors, Population Interactions, Gause's Principle with laboratory and field examples, Lotka-Volterra equation for competition.		
Unit 3: Community		11
Community characteristics: species diversity, abundance, dominance, richness, Vertical stratification, Ecotone and edge effect; Ecological succession with one example.		

Unit 4: Ecosystem	8
Types of ecosystem with an example in detail, Food chain: Detritus and grazing food chains, Linear and Y-shaped food chains, Food web, Energy flow, Ecological pyramids and Ecological efficiencies; Nitrogen cycle.	
Unit 5: Applied Ecology	7
Types & level of biodiversity Mega-diversity countries, Biodiversity Hot spot, Flagship species, Keystone species, Wildlife Conservation (*in situ* and *ex situ* conservation), concept of protected areas. Red data book, Indian wild life act & Schedule. Concept of corridor, advantages and problem of corridor. Threats to survival and conservation strategies for Tiger, Olive ridley, White Rumped Vulture.	

Ecology Lab, ZOOA-CC5-11-P

Full Marks 30	**60 Hours**	2 Credits
List of Practical		
1. Determination of population density in a natural/hypothetical community by quadrate method and calculation of Shannon-Weiner diversity index for the same community 2. Study of an aquatic ecosystem: Phytoplankton and zooplankton, Measurement of area, temperature, salinity, determination of pH, and Dissolved Oxygen content (Winkler's method), Chemical Oxygen Demand and free CO_2 3. Report on a visit to National Park/Biodiversity Park/Wild life sanctuary/ any place of ecological interest/ ecological uniqueness/ Zoological garden		

PART III: SEMESTER 5

CORE COURSE 12.Principle of Genetics

ZOOA-CC5-12-TH

Full Marks 50	4 Credits	Class
Unit 1: Mendelian Genetics and its Extension		12
Principles of inheritance, Incomplete dominance and co-dominance, Epistasis, Multiple alleles, Isoallele (White eye mutations), Pseudoallele (Lozenge Locus) & Cis-trans test for allelism, Lethal alleles, Pleiotropy, Penetrance & Expressivity		
Unit 2: Linkage, Crossing Over and Linkage Mapping		8
Linkage and Crossing, Complete & Incomplete Linkage, Measuring Recombination frequency and linkage map construction using three factor crosses, Interference and coincidence Sex linkage in *Drosophila* (White eye locus) & Human (Haemophilia).		

Unit 3: Mutations	12
Types of gene mutations (Classification), Types of chromosomal aberrations (Classification with one suitable example from *Drosophila* and Human of each), variation in chromosome number; Non-disjunction of X chromosome in *Drosophila*; Non-disjunction of Human Chromosome 21. Molecular basis of mutations in relation to UV light and chemical mutagens. Mutation detection in *Drosophila* by attached X method. Biochemical mutation detection in *Neurospora*.	
Unit 4: Sex Determination	8
Mechanisms of sex determination in *Drosophila* and in man; Dosage compensation in *Drosophila* & Human	
Unit 5: Extra-chromosomal Inheritance	2
Kappa particle in *Paramoecium*, Shell spiralling in snail	
Unit 6: Genetic Fine Structure	2
Complementation test in Bacteriophage (Benzer's experiment on rII locus)	
Unit 7: Transposable Genetic Elements	6
IS element in bacteria, Ac-Ds elements in maize and P elements in *Drosophila*, LINE, SINE, Alu elements in humans	

Principles of Genetics Lab, ZooA-CC5-12-P

Full marks 30	**60 Hours**	2 Credits
List of Practical		
1. Chi-square analyses for genetic ratio test 2. Identification of chromosomal aberration in *Drosophila* and man from photograph 3. Pedigree analysis of some inherited traits in animals		

PART III: SEMESTER 6

CORE COURSE 13: Developmental Biology

ZOOA-CC6-13-TH

Full Marks 50	4 Credits	50 Hours
Unit 1: Early Embryonic Development		20
Gametogenesis: Spermatogenesis, Oogenesis (sea urchin & mammal); Types of eggs, Egg membranes; Fertilization in sea urchin and mammal; Planes and patterns of cleavage; Types of Blastula [frog and chick]; Fate map in chick embryo, fate mapping using vital dye and radioactive technique; Gastrulation in frog and chick; Embryonic induction and organizers in *Xenopus* (Spemann & Mangold's experiment)		

Unit 2: Late Embryonic Development	10
Extra-embryonic membranes in Chick; Implantation of embryo in humans, Placenta (Structure, types and functions of placenta)	
Unit 3: Post Embryonic Development	8
Development of brain and Eye in Chick. Molecular Induction in Brain and Eye development.	
Unit 4: Implications of Developmental Biology	12
In vitro fertilization (IVF), Stem cell: Concept of potency, types, markers and applications of stem cell therapy in bone marrow transplantation and cartilage regeneration	

Developmental Biology Lab; ZOOA-ZooA-CC6-13-P

Full Marks 30	**60 Hours**	2 Credits
List of Practical		
1. Study of whole mounts of developmental stages of chick embryo through permanent slides: 24, 48, and 96 hours of incubation 2. Study of the developmental stages and life cycle of *Drosophila* 3. Study of different sections of placenta (photomicropgraph/ slides) 4. Identification of Invertebrate larva through slides/ photographs of Phylum Annelida, Arthropoda, Mollusca and Echinodermata		

PART III: SEMESTER 6

CORE COURSE 14.Evolutionary Biology

ZOOA-CC6-14-TH

Full Marks 50	4 Credits	50 Hours
Unit 1		**5**
Origin of Life (Chemical basis), RNA world hypothesis		
Unit 2		5
Historical review of Evolutionary concepts: Lamarkism, Darwinism and Neo Darwinism		
Unit 3		6
Geological time scale, Fossil: types and age determination by Carbon dating, Evolution of horse		
Unit 4		6
Natural Selection: Modes with Examples;		

Unit 5	10
Species concept, Isolating mechanisms, modes of speciation; Speciation by chromosome rearrangement in *Drosophila*. Adaptive radiation/macroevolution (exemplified by Galapagos finches).	
Unit 6	2
Origin and Evolution of Man, Unique Hominid characteristics contrasted with primate characteristic	
Unit 7	10
Population genetics: Hardy-Weinberg Law; factors disrupting H-W equilibrium (Genetic Drift, Migration and Mutation and Selection in changing allele frequencies (only derivations required). Simple problems related to estimation of allelic and gene frequencies.	
Unit 8	**3**
Extinction, back ground and mass extinctions, detailed example of K-T extinction	
Unit 9	**5**
Phylogenetic trees, construction and interpretation of Phylogenetic tree using parsimony, convergent and divergent evolution.	

Evolutionary Biology Lab, ZooA-CC6-14-P

Full Marks 30	**60 Hours**	2 Credits
List of Practical		
1. Study of fossils from models/ pictures: Dickinsonia, Paradoxides (Trilobita), Asteroceras (Ammonoid), Pentremites (Blastoid Echinoderm), Ichthyosaur, Archaeopteryx, Cynodont. 2. Study of homology and analogy from suitable specimens. 3. Phylogenetic trees, Construction & interpretation of Phylogenetic tree using parsimony, Construction of dendrogram following principles of phenetics & cladistics from a data table.		

Discipline Specific Elective

[Students will choice either of ZOOA-DSE(A)-5-1-TH or ZOOA-DSE(A)-5-2-TH]

PART III: SEMESTER 5

DSE1. Parasitology

ZOOA-DSE(A)-5-1-TH

Full Marks 50	**4 Credits**	**50 hours**
Unit 1: Introduction to Parasitology		2
Brief introduction of Parasitism, Parasite, Parasitoid and Vectors (mechanical and biological vector); Host parasite relationship		
Unit 2: Parasitic Protists		12
Study of Morphology, Life Cycle, Prevalence, Epidemiology, Pathogenicity, Diagnosis, Prophylaxis and Treatment of *Giardia intestinalis*, *Trypanosoma gambiense*, *Leishmania donovani*		
Unit 3: Parasitic Platyhelminthes		12
Study of Morphology, Life Cycle, Prevalence, Epidemiology, Pathogenicity, Diagnosis, Prophylaxis and Treatment of *Schistosoma haematobium*, *Taenia solium*		
Unit 4: Parasitic Nematodes		12
Study of Morphology, Life Cycle, Prevalence, Epidemiology, Pathogenicity, Diagnosis, Prophylaxis and Treatment of *Ascaris lumbricoides*, *Ancylostoma duodenale*, *Wuchereria bancrofti*, Nematode plant interaction.		
Unit 5: Parasitic Arthropods		10
Biology, importance and control of ticks: Soft tick (*Ornithodoros)*, Hard tick (*Ixodes*), mites (*Sarcoptes*), Lice (*Pediculus*), Flea (*Xenopsylla*) and Bug (*Cimex*). Parasitoid.		
Unit 6: Parasite Vertebrates		**2**
Cookicutter Shark, Hood Mocking bird, Vampire bats their parasitic behaviour and effect on host.		

Parasitology Lab, ZOOA-DSE(A)-5-1-P

Full Marks 30	**60 Hours**	2 Credits
List of Practical		

1. Study of life stages of *Giardia intestinalis*, *Trypanosoma gambiense*, *Leishmania donovani*, *Plasmodium vivax*, *Plasmodium falciparum* through permanent slides/micro photographs
2. Study of adult and life stages of *Schistosoma haematobium*, *Taenia solium* through permanent slides/micro photographs
3. Study of adult and life stages of *Ancylostoma duodenale* through permanent slides/micro photographs.

4. Study of monogenea from the gills of fresh/marine fish [Gills can be procured from fish market as by product of the industry]
5. Study of nematode/cestode parasites from the intestines of Poultry bird [Intestine can be procured from poultry/market as a by-product] & Goat.

Submission of a brief report on parasitic vertebrates

PART III: SEMESTER 5

DSE2. Biology of Insects

ZOOA-DSE(A)-5-2-TH

Full Marks 50	4 Credits	50 Hours
Unit 1: Insect Taxonomy		4
Basis of insect classification; Classification of insects up to orders (Ruppert and Barnes, 1994)		
Unit 2: General Morphology of Insects		6
External Features; Head – Eyes, Types of antennae, Mouth parts with respect to feeding habits Thorax: Wings and wing articulation, Types of Legs adapted to diverse habitat Abdominal appendages and genitalia		
Unit 3: Physiology of Insects		20
Structure and physiology of Insect body systems - Digestive, respiratory, endocrine and nervous system Photoreceptors: Types, Structure and Function Metamorphosis: Types and Neuroendocrine control of metamorphosis		
Unit 4: Insect Society		7
Social insects with special reference to termites Trophallaxis in social insects such as ants, termites and bees		
Unit 5: Insect Plant Interaction		4
Theory of co-evolution, role of allelochemicals in host plant mediation Host-plant selection by phytophagous insects, Major insect pests in paddy		
Unit 6: Insects as Vectors		**9**
Insects as mechanical and biological vectors, Brief discussion on houseflies and mosquitoes as important vectors		

Biology of Insect Lab, ZOOA-DSE(A)-5-2-P

Full Marks 30	**60 Hours**	2 Credits
List of Practical		

1. Study of life cycle of Mosquito
2. Study of different kinds of antennae, legs and mouth parts of insects
3. Mounting of insect wings any insects
4. Methodology of collection, preservation and identification of insects.
5. Morphological studies of various castes of *Apis*, Ant-*Camponotus*, Termite-*Odontotermes*
6. Study of major insect pests of paddy and their damages
7. Study of Mulberry silk moth as beneficial insect

Students will choice either of ZOOA-DSE(B)-5-1-TH or ZOOA-DSE(B)-5-2-TH

PART III: SEMESTER 5

DSE1. Endocrinology

ZOOA-DSE(B)-5-1-TH

Full Marks 50	4 Credits	50 Hours
Unit 1: Introduction to Endocrinology		**6**
General idea of Endocrine systems, Classification, Characteristic and Transport of Hormones, Neuro-secretions and Neuro-hormones: Examples and Functions		
Unit 2: Hypothalamo-Hypophyseal Axis		12
Structure and functions of hypothalamus and Hypothalamic nuclei, Regulation of neuroendocrine glands, Feedback mechanisms, Hypothalamo-Hypophyseal-Gonadal Axis. Structure of pituitary gland, Hormones and their functions, Hypothalamo-hypophyseal portal system		
Unit 3: Peripheral Endocrine Glands		12
Structure, Hormones and Functions of Thyroid gland, Parathyroid, Adrenal, Pancreas, Ovary and Testis. Disorders of endocrine glands (*Diabetes mellitus* type I & Type II; Graves' Disease).		
Unit 4: Regulation of Hormone Action		12
Mechanism of action of steroidal, non-steroidal hormones with receptors (cAMP, IP3-DAG), Calcium and Glucose homeostasis in mammals. Bioassays of hormones using RIA & ELISA, Estrous cycle in rat and menstrual cycle in human.		

Unit 5. Non Mammalian Vertebrate Hormone	8
Functions of Prolactin in Fishes, Amphibia & Birds Function of Melanotropin in Teleost fishes, Amphibians and Reptiles.	

Endocrinology Lab, ZOOA-DSE(B)-5-1-P

Full Marks 30	60 Hours	2 Credits
List of Practical		

1. Dissect and display of Endocrine glands in laboratory bred rat.
2. Study of the permanent slides of all the endocrine glands
3. Tissue fixation, embedding in paraffin, microtomy and slide preparation of any endocrine gland.
4. H-E staining of Histological slides.

PART III: SEMESTER 5

DSE2. Reproductive Biology

ZOOA-DSE(B)-5-2-TH

Full Marks 50	4 Credits	50 Hours
Unit 1: Reproductive Endocrinology		**10**
Mechanism of action of steroid and glycoprotein hormones. Hypothalamo – Hypophyseal – gonadal axis, regulation of gonadotrophin secretion in human (male and female); Reproductive system: Development and differentiation of gonads, genital ducts and external genitalia		
Unit 2: Functional anatomy of male reproduction		14
Histoarchitechture of testis in human; Spermatogenesis and its hormonal regulation; Androgen synthesis and metabolism; Accessory glands functions		
Unit 3: Functional anatomy of female reproduction		18
Histoarchitechture of ovary in human; Oogenesis and its hormonal regulation; Steroidogenesis and secretion of ovarian hormones; Reproductive cycles (human) and their regulation, Fertilization; Hormonal control of implantation; Hormonal regulation of gestation, pregnancy diagnosis, feto-maternal relationship; Mechanism of parturition and its hormonal regulation; Lactation and its regulation		
Unit 4: Reproductive Health		8
Infertility in male and female: causes, diagnosis and management, Assisted Reproductive Technology: Sex selection, sperm banks, frozen embryos, *in vitro* fertilization IVF & IUI Modern contraceptive technologies		

Reproductive Biology Lab, ZOOA-DSE(B)-5-2-P

Full Marks 50	**60 Hours**	2 Credits
List of Practical		
1. Study of animal house: set up and maintenance of animal house, breeding techniques, care of normal and experimental animals (only demonstration through chart). 2. Tissue fixation, embedding in paraffin, microtomy and slide preparation of any endocrine gland. 3. H-E staining of histological slides. 4. Examination of histological sections from photomicrographs/ permanent slides of rat/human: testis, epididymis and accessory glands of male reproductive systems; ovary, fallopian tube, uterus (proliferative and secretory stages), cervix and vagina.		

Students will choice either of ZOOA-DSE(A)-6-1-TH or ZOOA-DSE(A)-6-2-TH

PART III: SEMESTER 6

DSE1. Animal Cell Biotechnology

ZOOA-DSE(A)-6-1-TH

Full Marks 50	4 Credits	50 Hours
Unit 1: Introduction		2
Concept and Scope of Biotechnology		
Unit 2: Techniques in Gene manipulation		15
Recombinant DNA technology, Restriction endonucleases. Cloning Vectors & their features: Plasmids, Phage vectors, Cosmids, Phagemids, BAC, YAC, and HAC. Shuttle and Expression Vectors. Construction of Genomic libraries and cDNA libraries Transformation techniques: Cloning in bacteria and detection technique of clone		
Unit 3: Animal cell Culture		15
Basic techniques in animal cell culture and organ culture, Primary Culture and Cell lines, Culture media – Natural and Synthetic, Stem cells, Cryopreservation of cultures. Agarose and Polyacrylamide Gel Electrophoresis, Southern, Northern and Western blotting, Polymerase chain reaction: Allele specific, RAPD & RT PCR.		
Unit 4: Fermentation		10
Different types of Fermentation: Submerged & Solid state; batch, Fed batch & Continuous; Stirred tank, Air Lift, Fixed Bed and Fluidized. Downstream Processing: Filtration, centrifugation, extraction, chromatography, spray drying and lyophilization.		

Unit 5: Application in Health	8
Hybridoma technology, Production of recombinant Proteins: Insulin and growth hormones.	

Animal Cell Biotechnology Lab, ZOOA-DSE(A)-6-1-P

Full Marks 50	**60 Hours**	2 Credits
List of Practical		

1. Packing and sterilization of glass and plastic wares for cell culture.
2. Preparation of culture media.
3. Preparation of genomic DNA from E. coli/animals/ human.
4. Plasmid DNA isolation (pUC 18/19) and DNA quantitation using agarose gel electrophoresis (by using lambda DNA as standard).
5. Techniques: Western Blot, Southern Hybridization, DNA Fingerprinting, PCR, DNA Microarrays (By Photograph).

PART III: SEMESTER 6

DSE2. Animal Biotechnology

ZOOA-DSE(A)-6-2-TH

Full Marks 50	4 Credits	Class
Unit 1: Introduction		5
Organization of *E.coli* and *Drosophila* genome.		
Unit 2: Molecular Techniques in Gene manipulation		23
Recombinant DNA technology, Restriction endonucleases. Cloning Vectors & their features: Plasmids, Phage vectors, Cosmids, Phagemids, BAC, YAC, and HAC. Shuttle and Expression Vectors. Construction of Genomic libraries and cDNA libraries Transformation techniques: Cloning in bacteria and detection technique of clone Agarose and Polyacrylamide Gel Electrophoresis, Southern, Northern and Western blotting, Polymerase chain reaction: Allele specific, RAPD & RT PCR, DNA Fingerprinting		
Unit 3: Genetically Modified Organisms		12
Production of cloned and transgenic animals: Nuclear Transplantation, Retroviral Method, DNA microinjection. Applications of transgenic animals: Production of pharmaceuticals, production of donor organs, knock-out mice.		
Unit 4: Culture Techniques and Applications		10
Animal cell culture, Expressing cloned genes in mammalian cells, Molecular diagnosis of		

genetic diseases (Cystic fibrosis, Sickle cell anaemia, Thalassemia). Dolly &Polly cloning Genetically modified economically important animal Gene Therapy	

Animal Biotechnology Lab, ZOOA-DSE(A)-6-2-P

Full Marks 30	**60 Hours**	2 Credits
List of Practical		

1. Genomic DNA isolation from *E. coli* and Plasmid DNA isolation (pUC 18/19) from *E. coli*
2. To study following techniques through photographs - Southern Blotting, Northern Blotting, Western Blotting, PCR, DNA fingerprinting
3. Project report on animal cloning & Application & ethical Issues.

Students will choice either of ZOOA-DSE(B)-6-1-TH or ZOOA-DSE(B)-6-2-TH

PART III: SEMESTER 6

DSE1. Animal Behaviour and Chronobiology

ZOOA-DSE(B)-6-1-TH

Full Marks 50	4 Credits	50 Hours
Unit 1: Patterns of Behaviour		10
Stereotyped Behaviours (Orientation, Reflex); Individual Behavioural patterns; Instinct vs. Learned Behaviour; FAP, Associative learning, classical and operant conditioning, Habituation, Imprinting.		
Unit 2: Social and Sexual Behaviour		20
Social organisation in termites; Communication (dance & pheromones in Bees) Social behaviour: Altruism (Hamilton's rule and concept of haplodiploidy), Cooperation and Selfishness Sexual Behaviour: Sexual dimorphism, Mate choice in peacock, Intra-sexual selection (male rivalry in red deer) Kinship theory: Relatedness & inclusive fitness; parental care in fishes (Nest Building & coast benefit), conflict within families: parent offspring conflict and sibling rivalry		
Unit 3: Chronobiology & Biological Rhythm		20
Types and characteristics of biological rhythms: Short- and Long- term rhythms; Circadian rhythms; Tidal rhythms and Lunar rhythms, Circannual rhythms; Photic and non-photic zeitgebers; Role of melatonin. Biological clock and its adaptive significance. Circannual rhythm in bird migration.		

Animal Behaviour and Chronobiology Lab, ZOOA-DSE(B)-6-1-P

Full Marks 50	**60 Hours**	2 Credits
List of Practical		

1. To study nests and nesting habits of the birds and social insects.
2. To study the behavioural responses of wood lice to dry and humid conditions(demonstration only).
3. To study geotaxis behaviour in earthworm.
4. To study the phototaxis behaviour in insect larvae.
5. Visit to Forest/ Wild life Sanctuary/Biodiversity Park/Zoological Park to study behavioural activities of animals and prepare a short report.
6. Study of circadian functions in humans (daily eating, sleep and temperature patterns).

PART III: SEMESTER 6

DSE2. Fish and Fisheries

ZOOA-DSE(B)-6-2-TH

Full Marks 50	4 Credits	50 Hours
Unit 1: Introduction and Classification		**4**
Feeding habit, habitat and manner of reproduction. Classification of fish (upto Subclasses) (Romar, 1959)		
Unit 2: Morphology and Physiology		14
Types of fins and their modifications; Locomotion in fish; Hydrodynamics; Types of Scales, Use of scales in Classification and determination of age of fish; Gills and gas exchange; Swim Bladder: Types and role in Respiration, buoyancy; Electric organ, Bioluminescence		
Unit 3: Fisheries		10
Inland Fisheries; Marine Fisheries; Fishing crafts and Gears; Depletion of fisheries resources; Application of remote sensing and GIS in fisheries; Fisheries law and regulations		
Unit 4: Aquaculture		16
Extensive, semi-intensive and intensive culture of fish; Pen and cage culture; Polyculture; Composite fish culture; Brood stock management; Induced breeding of fish; Management of finfish hatcheries; Preparation and maintenance of fish aquarium; Preparation of compound diets for fish; Role of water quality in aquaculture; Fish diseases: Bacterial, viral and parasitic; Preservation and processing of harvested fish, Fishery by-products		
Unit 5: Fish in research		6
Transgenic fish Zebra fish as a model organism in research		

Fish and Fisheries Lab, ZOOA-DSE(B)-6-2-P

Full Marks 30	**60 Hours**	2 Credits

List of Practical

1. Morphometric and meristic characters of fishes
2. Identification of *Petromyzon, Myxine, Pristis, Exocoetus, Hippocampus, Gambusia, Labeo, Heteropneustes, Anabas*
3. Study of different types of scales (through permanent slides/ photographs).
4. Study of crafts and gears used in Fisheries (Photoghaphs)
5. Water quality criteria for Aquaculture: Assessment of pH, alkalinity, Salinity.
6. Study of air breathing organs in *Channa, Heteropneustes, Anabas* and *Clarias*
7. Project Report on a visit to any fish farm/ pisciculture unit/Zebrafish rearing Lab.

Skill Enhancement courses (SEC)

[A student will choice either ZOOA-SEC(A)-3-1 or ZOOA-SEC(A)3-2]

PART II: SEMESTER 3

SEC-1 Apiculture

ZOOA-SEC(A)-3-1-TH

Full Marks 80	2 Credits	30 Hours
Unit 1: Biology of Bees		**2**
Apis and Non-*Apis* Bee species and their identification. General Morphology of *Apis* Honey Bees Social Organization of Bee Colony		
Unit 2: Rearing of Bees		14
Artificial Bee rearing (Apiary), Beehives – Newton and Langstroth box Bee Pasturage Selection of Bee Species for Apiculture Modern Bee Keeping Equipment Methods of Extraction of Honey (Indigenous and Modern)		
Unit 3: Diseases and Enemies		6
Bee Diseases and Enemies Control and Preventive measures		
Unit 4: Bee Economy		2
Products of Apiculture Industry and its Uses – Honey, Bees Wax, Propolis, Pollen etc.		
Unit 5: Entrepreneurship in Apiculture		6
Bee Keeping Industry – Recent Efforts, Modern Methods in employing artificial Beehives for cross pollination in horticultural gardens		

PART II: SEMESTER 3

SEC-2.Sericulture

ZOOA-SEC(A)-3-2-TH

Full Marks 80	2 Credits	30 Hours
Unit 1: Introduction		**6**
Sericulture: Definition, history and present status; Silk route Types of silkworms, Distribution and Races Exotic and indigenous races Mulberry and non-mulberry Sericulture		
Unit 2: Biology of Silkworm		4
Life cycle of *Bombyx mori* Structure of silk gland and secretion of silk		
Unit 3: Rearing of Silkworms		10
Selection of mulberry variety and establishment of mulberry garden Rearing house and rearing appliances. Disinfectants: Formalin, bleaching powder, RKO Silkworm rearing technology: Early age and Late age rearing Types of mountages Spinning, harvesting and storage of cocoons		
Unit 4: Pests and Diseases		7
Pests of silkworm: Uzi fly, dermestid beetles and vertebrates Pathogenesis of silkworm diseases: Protozoan, viral, fungal and bacterial Control and prevention of pests and diseases		
Unit 5: Entrepreneurship in Sericulture		3
Prospectus of Sericulture in India: Sericulture industry in different states, employment, potential in mulberry and non-mulberry sericulture Visit to various sericulture centres.		

[A student has to choice either ZOOA-SEC(B)-4-1 or ZOOA-SEC(B)4-2]

PART II: SEMESTER 4

SEC-1.Aquarium Fish Keeping

ZOOA-SEC(B)-4-1-TH

Full Marks 80	2 Credits	30 Hours
Unit 1: Introduction to Aquarium Fish Keeping		**2**
The potential scope of Aquarium Fish Industry as a Cottage Industry, Exotic and Endemic species of Aquarium Fishes		
Unit 2: Biology of Aquarium Fishes		10
Common characters and sexual dimorphism of Fresh water and Marine Aquarium fishes such as Guppy, Molly, Sword tail, Gold fish, Angel fish, Blue morph, Anemone fish and Butterfly fish		
Unit 3: Food and feeding of Aquarium fishes		8
Use of live fish feed organisms. Preparation and composition of formulated fish feeds, Aquarium fish as larval predator		
Unit 4: Fish Transportation		5
Live fish transport - Fish handling, packing and forwarding techniques.		
Unit 5: Maintenance of Aquarium		5
General Aquarium maintenance – budget for setting up an Aquarium Fish Farm as a Cottage Industry		

PART II: SEMESTER 4

SEC-2.Medical Diagnostic Technique

ZOOA-SEC(B)-4-2-TH

Full Marks 80	2 Credits	30 Hours
Unit 1: Diagnostics Methods Used for Analysis of Blood		**8**
Blood composition, Differential Leucocyte Count (DLC) using Leishman's stain, Platelet count using haemocytometer, Erythrocyte Sedimentary Rate (ESR), Packed Cell Volume (PCV)		
Unit 2: Diagnostic Methods Used for Urine Analysis		**4**
Urine Analysis: Physical characteristics; Abnormal constituents, Urine culture		
Unit 3: Non-infectious Diseases		**6**
Causes, types, symptoms, complications, diagnosis and prevention of Diabetes (Type I and Type		

II), Hypertension (Primary and secondary), Testing of blood glucose using Glucometer/Kit	
Unit 4: Infectious Diseases	**3**
Causes, types, symptoms, diagnosis and prevention of Tuberculosis and Hepatitis, Malarial parasite (Microscope based and ELISA based)	
Unit 5: Clinical Biochemistry	**1**
Lipid profiling, Liver function test. PSA test	
Unit 6: Clinical Microbiology	**1**
Antibiotic Sensitivity Test	
Unit 7: Tumours	**2**
Types (Benign/Malignant), Detection and metastasis; Medical imaging: X-Ray of Bone fracture, PET, MRI and CT Scan (using photographs).	
Unit 8: Visit to Pathological Laboratory and Submission of Project	**6**

UNIVERSITY OF CALCUTTA

CBCS SYLLABUS FOR ZOOLOGY

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THREE-YEAR GENERAL
DEGREE COURSE OF STUDIES

ZOOLOGY

2018

Outline Structure of CBCS Curriculum For Zoology (General), C.U.

PART I; SEM I				
Subject Code	**Name of Paper**	**Theory**	**Practical**	**Internal assessment**
CC1/GE1	**Animal Diversity**	**50**	**30**	**20**
PART I; SEM II				
CC2/GE2	**Comparative Anatomy & Developmental Biology**	**50**	**30**	**20**
PART II; SEM III				
CC 3/GE3	**Physiology and Biochemistry**	**50**	**30**	**20**
SEC-A (1)	**Apiculture**	**80**	**NA**	**20**
PART II; SEM IV				
CC 4/GE4	**Genetics and Evolutionary Biology**	**50**	**30**	**20**
SEC- B(1)	**Aquarium Fish Keeping**	**80**	**NA**	**20**
PART III; SEM V				
DSE A(1)	**Applied Zoology**	**50**	**30**	**20**
DSE B (1)	**Aquatic biology**	**50**	**30**	**20**
SEC-A (1)	**Sericulture**	**80**	**NA**	**20**
PART III; SEM VI				
DSE A (1)	**Biology of Insect**	**50**	**30**	**20**
DSE B (2)	**Ecology & Wild life Biology**	**50**	**30**	**20**
SEC-B (1)	**Medical diagnosis**	**80**	**NA**	**20**

Abbreviations:

CC: Core Course; DSE A/B: Discipline Specific Elective A/B; SEC A/B: Skill Enhancement Course.

SUBJECT/PAPER CODE FORMAT

4. **Subject Code: ZOO**
5. **Honours Code: G**
6. **Course Code: a) Core Course:CC**
   b) Discipline Specific Elective: DSE-A/DSE-B
   c) Skill Enhancement Course: SEC-A/SEC-B

4. **Semester Code: 1/2/3/4/5/6**
5. **Paper No. Code: 1/2/3…../14**
6. **Paper Component Code: a) Theory:TH, b) Practical: P**

INDEX

CBCS ZOOLOGY (GENERAL), Papers & Their Codes

PART I: SEMESTER 1.

CORE COURSE 1.Animal Diversity

ZOOG-CC1-1-TH

Full Marks 50	4 Credits	50 Hours
Unit 1: Kingdom Protista		2
General characters and classification up to classes (Levine et. al., 1980); Locomotory Organelles and locomotion in *Amoeba* and *Paramecium*		
Unit 2: Phylum Porifera		2
General characters and classification up to classes (Ruppert and Barnes, 1994, 6th Ed.); Canal System in *Sycon*		
Unit 3: Phylum Cnidaria		2
General characters and classification up to classes (Ruppert and Barnes, 1994, 6th Ed.); Metagenesis in *Obelia*		
Unit 4: Phylum Platyhelminthes		2
General characters and classification up to classes (Ruppert and Barnes, 1994, 6th Ed.); Life history of *Taenia solium*		
Unit 5: Phylum Nemathelminthes		2
General characters and classification up to classes (Ruppert and Barnes, 1994, 6th Ed.); Life history of *Ascaris lumbricoides* and its adaptation		
Unit 6: Phylum Annelida		4
General characters and classification up to classes (Rupert and Barnes, 1994, 6th Ed.); Metamerism in Annelida		
Unit 7: Phylum Arthropoda		4
General characters and classification up to classes (Ruppert and Barnes, 1994, 6th Ed.); Eye in Cockroach, Metamorphosis in Lepidoptera		
Unit 8: Phylum Mollusca		2
General characters and classification up to classes (Ruppert and Barnes, 1994, 6th Ed.); Respiration in *Pila*		
Unit 9: Phylum Echinodermata		4
General characters and classification up to classes (Ruppert and Barnes, 1994, 6th Ed.); Water-vascular system in Asteroidea		
Unit 10: Protochordates		2
General Characters ; Pharynx and feeding mechanism in *Amphioxus*		
Unit 11: Agnatha		2
General features of Agnatha and classification of cyclostomes up to classes (Young, 1981)		

Unit 12: Pisces	4
General features and Classification up to orders (Young, 1981); Osmoregulation in Fishes	
Unit 13: Amphibia	4
General features and Classification up to orders (Young, 1981); Parental care	
Unit 14: Reptiles	4
General features and Classification up to orders (Young, 1981); Poisonous and non-poisonous snakes, Biting mechanism	
Unit 15: Aves	4
General features and Classification up to orders (Young, 1981); Flight adaptations in birds	
Unit 17: Mammals	4
Classification up to orders (Young, 1981); Hair, Horn & Antler, Nail & claw	

Animal Diversity, ZOOG-CC1-1-P

Full Marks: 30	60 Hours	2 Credits

List of Practicals

1. Identification with reasons of the following specimens:

   Amoeba, Euglena, Paramecium, Sycon, Obelia, Aurelia, Metridium, Taenia solium, Ascaris lumbricoides (Male and female), *Aphrodite, Nereis, Hirudinaria, Palaemon, Cancer, Limulus, Apis, Chiton, Dentalium, Unio, Sepia, Octopus, Echinus, Cucumaria* and *Antedon, Balanoglossus, Branchiostoma, Petromyzon, Torpedo, Labeo rohita, Exocoetus, Salamandra, Hyla, Chelone, Hemidactylus, Chamaeleon, Draco, Vipera, Naja*, Bat, *Funambulus*
2. Key for Identification of poisonous and non-poisonous snakes
3. Study of anatomy of digestive system, salivary gland, mouth parts of *Periplaneta*, Study of reproductive system of female cockroach

   An "animal album" containing photographs, cut outs, with appropriate write up about the above mentioned taxa. Different taxa/ topics may be given to different sets of students for this purpose

PART I: SEMESTER 2.

CORE COURSE 2.Comparative Anatomy & Developmental Biology

ZOOG-CC2-2-TH

Full Marks 50	4 Credits	50 Hours
Unit 1: Integumentary System		4
Derivatives of integument with respect to glands in Birds & Mammals		
Unit 2: Digestive System		4
Stomach and Dentition		
Unit 3: Respiratory System		6

Brief account of Gills, lungs, air sacs and swim bladder	
Unit 4: Circulatory System	6
Evolution of heart and aortic arches	
Unit 5: Urino-genital System	6
Succession of kidney, Evolution of urino-genital ducts	
Unit 6: Early Embryonic Development	14
Gametogenesis: Spermatogenesis and oogenesis with respect to mammals. Fertilization: Sea-Urchin; Early development of frog; structure of mature egg and its membranes, patterns of cleavage, fate map, up to formation of gastrula; types of morphogenetic movements; Fate of germ layers	
Unit 7: Late Embryonic Development	10
Placenta types and function; Metamorphic events in frog life cycle and its hormonal regulation	

Comparative Anatomy & Developmental Biology Lab, ZOOG-CC2-2-P

Full marks 30	**60 hours**	**2 Credits**
List of Practical:		
1. Osteology: Limb bones, girdle and vertebra of Pigeon & Guineapig, Mammalian skulls: One herbivorous; Guinea pig and one carnivorous; Dog. 2. Larval stages: Veliger, Nauplius, Trochophore, Mysis. 3. Study of the different types of placenta- histological sections through photomicrographs. 4. Developmental stages of chick embryo: 24 Hrs., 48 Hrs, 72 Hrs., 96 Hrs.		

PART II: SEMESTER 3.

CORE COURSE 3. PHYSIOLOGY AND BIOCHEMISTRY

ZOOG-CC3-3-TH

Full Marks 50	4 Credits	50 Hours
Unit 1: Nerve and muscle		**8**
Structure of a neuron, resting membrane potential, Origin of Action potential and its propagation in myelinated and non-myelinated nerve fibres, Ultra-structure of skeletal muscle, Molecular and chemical basis of muscle contraction		
Unit 2: Digestion		6
Physiology of digestion in the alimentary canal; Absorption of carbohydrates, proteins, lipids		
Unit 3: Respiration		6
Pulmonary ventilation, Transport of Oxygen and carbon		
Unit 4: Cardio-vascular system		6

Composition of blood, Structure of Heart, Origin and conduction of the cardiac impulse, cardiac cycle	
Unit 5: Excretion	6
Structure of nephron, Mechanism of Urine formation; Counter-current Mechanism	
Unit 6:Reproduction and Endocrine Glands	10
Physiology of male reproduction: Histology of testis, hormonal control of spermatogenesis; Physiology of female, reproduction: Histology of ovary, hormonal control of menstrual cycle. Structure and function of pituitary, thyroid, pancreas and adrenal.	
Unit 7: Carbohydrate Metabolism	4
Glycolysis, Kreb's cycle, Glycogenesis, Electron Transport Chain.	
Unit 8: Lipid metabolism	
Beta oxidation of Palmitic acid {saturated (C 16:0)} and Linoleic acid {unsaturated (C 18:2)}	
Unit 9: Protein Metabolism	4
Transamination, Deamination, Urea cycle	
Unit 10. Enzyme	2
Enzyme Classification, factors affecting enzyme action, Inhibition.	

PHYSIOLOGY AND BIOCHEMISTRY Lab; ZOOG-CC3-3-P

Full Marks 30	**60 Hours**	2 Credits
List of Practical		
1. Study of permanent histological sections of mammalian pituitary, thyroid, pancreas, adrenal gland. 2. Study of permanent histological sections of mammalian duodenum, liver, lung, kidney. 3. Qualitative test for carbohydrate samples.		

PART II: SEMESTER 4.

CORE-COURSE 4.Genetics & Evolutionary Biology

ZOOG-CC4-4-TH

Full Marks 50	4 Credits	50 Hours
Unit 1:Mendelian Genetics and its Extension		10
Principles of Inheritance, Chromosome theory of inheritance, Incomplete dominance and co-dominance, Multiple alleles, lethal alleles, sex linked inheritance in *Drosophila* (White eye locus) & Human (Thalassemia).		
Unit 2: Linkage, Crossing Over		8
Linkage and crossing over, Complete & Incomplete Linkage, Recombination frequency as a measure of linkage intensity. Holiday Model		
Unit 3: Mutation		

Chromosomal mutation, Deletion, duplication, inversion, translocation, aneuploidy, gene mutation, induced mutation, types & example	8
Unit 4: Sex determination	8
Genic Balance theory and dosage compensation in *Drosophila*.	
Unit 5: Origin of Life	2
Chemical Origin of life	
Unit 6: Evolutionary Theories	6
Lamarckism, Darwinism, Neo-Darwinism.	
Unit 7: Process of Evolutionary changes	4
Isolating mechanism, Natural Selection.	
Unit 8: Speciation	4
Sympatric, Allopatric, Parapatric	

Genetics and Evolutionary Biology Lab ZOOG-CC4-4-P

Full marks 30	**2 Credits**
List of Practical:	
Verification of Mendelian Ratio using Chi square test. Identification of Human Aneuploidy using photo graph of karyotype. Phylogeny of horse with diagram of limb and skull. Study and identification of Darwin Finches from photographs. Visit to natural history museum and submission of report.	

Discipline specific courses

Elective Course (Any One from DSE-A)

Semester-5

DSE-A

Applied Zoology.ZOOG-DSE-A-5-1-TH

Full Marks 50	Credits 4	50 Hours
Unit I: Host & Parasite Relationship		2
Type of Host, Types of Parasites, Other types of Relations.		
Unit 2: Epidemiology of Diseases		5

Transmission, Prevention and Control of Tuberculosis and Typhoid.	
Unit 3: Parasitic Protozoa	7
Life History and pathogenicity of *Entamoeba histolytica*, *Plasmodium vivax* and *Trypanosoma gambiense.*	
Unit 4: Parasitic Helminthes	8
Life History and pathogenicity of *Alcylostoma duodenale, Wuchereria bancrofti*.	
Unit 5: Insect of Economic Importance	8
Biology, Control and Damage caused by *Heliocoverpa armigera, Pyrilla perpusilla, Sytophilus oryzae* and *Tribolium casteneum*.	
Unit 6: Insect of Medical Importance	2
Medical Importance and control of *Anopheles*	
Unit 8: Animal Husbandry	6
Preservation and artificial insemination in cattle; Induction of early puberty and synchronization of estrus in cattle	
Unit 9: Poultry Farming	6
Principles of poultry breeding, Management of breeding stock and broilers, Processing and preservation of eggs	
Unit 10: Fish Technology	6
Genetic improvements in aquaculture industry; Induced breeding and transportation of fish seed	

Applied Zoology. ZOOG-DSE-A-5-1-P

Full marks 30	**60 Hours**	2 Credits

List of Practical:

1. Study of *Plasmodium vivax, Entamoeba histolytica, Trypanosoma gambiense, Ancylostoma duodenale* and *Wuchereria bancrofti* and their life stages through permanent slides/photomicrographs or specimens.
2. Study of arthropod vectors associated with human diseases: *Pediculus, Culex, Anopheles, Aedes*
3. Study of insect damage to different plant parts/stored grains through damaged products/photographs.
4. Identifying feature and economic importance of *Helicoperva; Heliothis armigera,Papilio demoleus, Pyrilla perpusilla, Callosobruchus chinensis, Sitophilus oryzae* and *Tribolium castaneum*
5. Visit to poultry farm or animal breeding centre. Submission of visit report
6. Maintenance of freshwater aquarium(demonstration only)

Discipline specific courses

Elective Course (Any One from DSE-A)

Semester-5

DSE-A

AQUATIC-BIOLOGY. ZOOG-DSE-A-5-2-TH

Full Marks 50	**Credits 4**	**Class 60**
Unit 1: Aquatic Bionics		15
Brief introduction of the aquatic biomes: Freshwater ecosystem; lakes, wetlands, streams and rivers, estuaries, intertidal zones, oceanic pelagic zone, marine benthic zone and coral reefs.		
Unit 2: Freshwater Biology lakes		15
Origin and classification, Lake as an Ecosystem, Lake morphometry, Physico-chemical Characteristics: Light, Temperature, Thermal stratification, Dissolved Solids, Carbonate, Bicarbonates, Phosphates and Nitrates, Turbidity; dissolved gases; Oxygen, Carbon dioxide. Nutrient Cycles in Lakes-Nitrogen, Sulphur and Phosphorous. **Streams:** Different stages of stream development, Physico-chemical environment, Adaptation of hill-stream fishes.		
Unit 3: Marine Biology		15
Salinity and density of Sea water, Continental shelf, Adaptations of deep sea organisms, Coral reefs, Sea weeds.		
Unit 4: Management of Aquatic Resources		15
Causes of pollution: Agricultural, Industrial, Sewage, Thermal and Oil spills, Eutrophication, Management and conservation ;legislations, Sewage treatment Water quality assessment - BOD and COD		

AQUATIC BIOLOGY. ZOOG-DSE-A-5-2-P

Full Marks 30	60 Hours	2 Credits

1. Determine the area of a lake using graphimetric and gravimetric method.
2. Identify the important macrophytes, phytoplanktons and zooplanktons present in a lake ecosystem.
3. Determine the amount of dissolved Oxygen, and free Carbon dioxide, in water collected from a nearby lake / water body.
4. Visit to any aquatic Ecosystem and preparation and submission of report.

Discipline specific courses

Elective Course (Any One from DSE-B)

Semester-6

DSE-B

Biology of Insect. ZOOG-DSE-B-6-1-TH

Full Marks 50	Credits 4	50 Hours
Unit I: Introduction to Insects		6
General Features of Insects, Morphological features, Head, Eyes, Types of antennae, Mouth parts with respect to feeding habits		
Unit II: Concept of Vectors		6
Brief introduction of Carrier and Vectors; mechanical and biological vector, Reservoirs, Host-vector relationship, Adaptations as vectors, Host Specificity		
Unit III: Insects as Vectors		8
Classification of insects up to orders, detailed features of orders with insects as vectors - Diptera, Siphonaptera, Siphunculata, Hemiptera		
Unit IV: Dipteran as Disease Vectors		14
Dipterans, as important insect vectors - Mosquitoes, Sand fly, Houseflies; Study of mosquito-borne diseases - Dengue, Viral encephalitis, Filariasis; Control of mosquitoes.		
Unit V: Siphonaptera as Disease Vectors		6
Fleas as important insect vectors; Host-specificity, Study of Flea-borne diseases - Plague, Typhus fever; Control of fleas		
Unit VI: Siphunculata as Disease Vectors		4
Human louse; Head, Body and Pubic louse as important insect vectors; Study of louse-borne diseases -Typhus fever, Relapsing fever, Trench fever; Control of human louse		
Unit VII: Hempitera as Disease Vectors		6
Bugs as insect vectors; Blood-sucking bugs; Chagas disease, Bed bugs as mechanical vectors,Control and prevention measures		

Biology of Insect. ZOOG-DSE-B-6-1-P

Full marks 25	**60 Hours**	2 Credits
List of Practical		

1. Study of different kinds of mouth parts of insects
2. Study of following insect vectors through permanent slides/photographs: *Aedes, Culex, Anopheles, Pediculus humanuscapitis, Pediculus humanuscorporis, Phlebotomus argentipes, Musca domestica,*
3. Submission of a project report on any one of the insect vectors and disease transmitted by the insect.

Ecology& Wild life Biology;ZOOG-DSE-B-6-2-TH

Full Marks 50	Credits 4	Class 60
Unit 1: Introduction to Ecology		4
Ecosystem, Autecology and synecology, Levels of organization, Laws of limiting factors, Study of Physical factors, The Biosphere.		
Unit 2: Population		20
Attributes of population: Life tables, fecundity tables, survivorship curves, dispersal and dispersion. Geometric, exponential and logistic growth, equation and patterns, Population regulation: density-dependent and independent factors,		
Unit 3: Community		11
Community characteristics: species diversity, abundance, dominance, richness, Vertical stratification, Ecotone and edge effect.		
Unit 4: Ecosystem		10
Types of ecosystem with an example in detail, Food chain: Detritus and grazing food chains, Linear and Y-shaped food chains, Food web, Energy flow through the ecosystem, Ecological pyramids and Ecological efficiencies		
Unit 5: Wild Life		5
Wildlife Conservation (in-situ and ex-situ conservation)**:** Necessity for wildlife conservation; National parks & sanctuaries, Tiger conservation - Tiger reserves in India; Management challenges in Tiger reserve		

Ecology& Wild life Biology;ZOOG-DSE-B-6-2-P

Full marks 30	**60 Hours**	2 Credits
List of Practical		
1. Identification of flora, mammalian fauna, avian fauna 2. Demonstration of basic equipment needed in wildlife studies use, care and maintenance (Compass, Binoculars, Spotting scope, Range Finders, Global Positioning System, Various types of Cameras and lenses) 3. Familiarization and study of animal evidences in the field; Identification of animals through pug marks, hoof marks, scats, pellet groups, nest, antlers, etc. 4. Study of an aquatic ecosystem: Phytoplankton and zooplankton, Measurement of area, temperature, salinity, determination of pH, and Dissolved Oxygen content (Winkler's method), Chemical Oxygen Demand and free CO_2		

Skill Enhancement Elective Courses (SEC)

SEMESTER –3

SEC-A

APICULTURE; ZOOG-SEC-A-3-1-TH

Full Marks 80	Credits 2	30 Hours
Unit 1: Biology of Bees		2
Classification and Biology of Honey Bees Social Organization of Bee Colony		
Unit 2: Rearing of Bees		14
Artificial Bee rearing; Apiary, Beehives - Newton and Langstroth, Bee Pasturage; Selection of Bee Species for Apiculture; Bee Keeping Equipment; Methods of Extraction of Honey; Indigenous and Modern		
Unit 3: Diseases and Enemies		6
Bee Diseases and Enemies Control and Preventive measures		
Unit 4: Bee Economy		2
Products of Apiculture Industry and its Uses ;Honey, Bees Wax, Propolis, Pollen etc		
Unit 5: Entrepreneurship in Apiculture		6
Bee Keeping Industry - Recent Efforts, Modern Methods in employing artificial Beehives for cross		

Skill Enhancement Elective Courses (SEC)

SEMESTER – 4

AQUARIUM FISH KEEPING; ZOOG-SEC-B-4-2-TH

Full Marks 80	Credits 2	30 Hours
Unit l: Introduction to Aquarium Fish Keeping		2
The potential scope of Aquarium Fish Industry as a Cottage Industry, Exotic and Endemic species of Aquarium Fishes		
Unit 2: Biology of Aquarium Fishes		10
Common characters and sexual dimorphism of Fresh water and Marine Aquarium fishes such as Guppy, Molly, Sword tail, Gold fish, Angel fish, Blue morph, Anemone fish and Butterfly fish		
Unit 3: Food and feeding of Aquarium fishes		8
Use of live fish feed organisms. Preparation and composition of formulated fish feeds		
Unit 4: Fish Transportation		5
Live fish transport - Fish handling, packing and forwarding techniques.		
Unit 5: Maintenance of Aquarium		5
General Aquarium maintenance - budget for setting up an Aquarium Fish Farm as a Cottage		

Skill Enhancement Elective Courses (SEC)

SEMESTER –5

SEC-A

Sericulture; ZOOG-SEC-A-5-3-TH

Full Marks 80	Credits 2	30 Hours
Unit 1: Introduction		6
Sericulture: Definition, history and present status; Silk route; Types of silkworms, Distribution and Races Exotic and indigenous races Mulberry and non-mulberry Sericulture		
Unit 2: Biology of Silkworm		4
Life cycle of *Bombyx mori;* Structure of silk gland and secretion of silk		
Unit 3: Rearing of Silkworms		10
Selection of mulberry variety and establishment of mulberry garden Rearing house and rearing appliances Disinfectants: Formalin, bleaching powder, RKO Silkworm rearing technology: Early age and Late age rearing Types of mountages; Spinning and harvesting and storage of cocoons.		
Unit 4: Pests and Diseases		7
Pests of silkworm: Uzi fly, dermestid beetles and vertebrates Pathogenesis of silkworm diseases: Protozoan, viral, fungal and bacterial Control and prevention of pests and diseases		
Unit 5: Entrepreneurship in Sericulture		3
Prospectus of Sericulture in India: Sericulture industry in different states, employment, potential in mulberry and non-mulberry sericulture. Visit to various sericulture centres.		

Skill Enhancement Elective Courses (SEC)

SEMESTER –6

SEC-B

Medical diagnosis; ZOOG-SEC-B-6-4-TH

Full Marks 80	Credits 2	Class 30
Unit 1: Diagnostics Methods Used for Analysis of Blood		8
Blood composition, Preparation of blood smear and Differential Leucocyte Count (D.L.C) using Leishman's stain, Platelet count using haemocytometer, Erythrocyte Sedimentation Rate (E.S.R)		
Unit 2: Diagnostic Methods Used for Urine Analysis		4
Urine Analysis: Physical characteristics; Abnormal constituents, Urine culture		
Unit 3: Non-infectious Diseases		6
Causes, types, symptoms, complications, diagnosis and prevention of Diabetes (Type I and Type II), Hypertension (Primary and secondary), Testing of blood glucose using Glucometer/Kit		
Unit 4: Infectious Diseases		3
Causes, types, symptoms, diagnosis and prevention of Tuberculosis and Hepatitis, Malarial parasite		

(Microscope based and ELISA based)	
Unit 5: Clinical Biochemistry	1
Lipid profiling, Liver function test. PSA test	
Unit 6: Clinical Microbiology	1
Antibiotic Sensitivity Test	
Unit 8: Tumours	2
Types (Benign/Malignant), Detection and metastasis; Medical imaging: X-Ray of Bone fracture,	
Unit 9: Visit to Pathological Laboratory and Submission of Project	5

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UNIVERSITY OF CALCUTTA

Notification No. CSR/ 12 /18

It is notified for information of all concerned that the Syllabi of different subjects in Undergraduate Honours / General / Major courses of studies (CBCS) under this University, as laid down in the accompanying pamphlet:

List of the subjects

Sl. No.	Subject	Sl. No.	Subject
1	Anthropology (Honours / General)	29	Mathematics (Honours / General)
2	Arabic (Honours / General)	30	Microbiology (Honours / General)
3	Persian (Honours / General)	31	Mol. Biology (General)
4	Bengali (Honours / General /LCC2 /AECC1)	32	Philosophy (Honours / General)
5	Bio-Chemistry (Honours / General)	33	Physical Education (General)
6	Botany (Honours / General)	34	Physics (Honours / General)
7	Chemistry (Honours / General)	35	Physiology (Honours / General)
8	Computer Science (Honours / General)	36	Political Science (Honours / General)
9	Defence Studies (General)	37	Psychology (Honours / General)
10	Economics (Honours / General)	38	Sanskrit (Honours / General)
11	Education (Honours / General)	39	Social Science (General)
12	Electronics (Honours / General)	40	Sociology (Honours / General)
13	English ((Honours / General/ LCC1/ LCC2/AECC1)	41	Statistics (Honours / General)
14	Environmental Science (Honours / General)	42	Urdu (Honours / General /LCC2 /AECC1)
15	Environmental Studies (AECC2)	43	Women Studies (General)
16	Film Studies (General)	44	Zoology (Honours / General)
17	Food Nutrition (Honours / General)	45	Industrial Fish and Fisheries – IFFV (Major)
18	French (General)	46	Sericulture – SRTV (Major)
19	Geography (Honours / General)	47	Computer Applications – CMAV (Major)
20	Geology (Honours / General)	48	Tourism and Travel Management – TTMV (Major)
21	Hindi (Honours / General /LCC2 /AECC1)	49	Advertising Sales Promotion and Sales Management –ASPV (Major)
22	History (Honours / General)	50	Communicative English –CMEV (Major)
23	Islamic History Culture (Honours / General)	51	Clinical Nutrition and Dietetics CNDV (Major)
24	Home Science Extension Education (General)	52	Bachelor of Business Administration (BBA) (Honours)
25	House Hold Art (General)	53	Bachelor of Fashion and Apparel Design – (B.F.A.D.) (Honours)
26	Human Development (Honours / General)	54	Bachelor of Fine Art (B.F.A.) (Honours)
27	Human Rights (General)	55	B. Music (Honours / General) and Music (General)
28	Journalism and Mass Communication (Honours / General)		

The above shall be effective from the academic session 2018-2019.

SENATE HOUSE
KOLKATA-700073
The 4th June, 2018

Paul 4/6/18
(Dr. Santanu Paul)
Deputy Registrar

COURSE CURRICULUM UNDER CHOICE BASED CREDIT SYSTEM

SYLLABUS

FOR

BACHELOR
IN CHEMISTRY (HONOURS)

UNIVERSITY OF CALCUTTA

Course Structure

Course Credits

	Theory+ Practical
Core Course (CC)	
Theory (14 Papers of 4 credits each)	14×4= 56
Practical (14 Papers of 2 credits each)	14×2=28
Discipline Specific ElectiveCourse*(DSE)	
Theory (4 Papers of 4 credits each)	4×4=16
Practical(4 Papers of 2 credits each)	4×2=8
Generic Elective (GE)	
Theory (4 Papers of 4 credits each)	4×4=16
Practical(4 Papers of 2 credits each)	4×2=8
Ability Enhancement Compulsory Course (AECC)	
(2 Papers of 2 credits each)	2×2=4
Environmental Science	
English/MIL Communication	
SkillEnhancement Elective Course(SEC)	
(2 Papers of 2 credits each)	2×2=4
Total credit	**140**

***Optional Dissertation or project work in place of one Discipline Specific Elective paper (6 credits) in 6th Semester**

CORE COURSES FOR B. SC. HONOURS (CHEMISTRY)

SEM	CODE*	PAPER	BRIEF DESCRIPTION
1	CEMA-CC-1-1-TH	INORGANIC CHEMISTRY-1 ORGANIC CHEMISTRY -1A	Acid-base and redox reactions Basics of Organic Chemistry
	CEMA-CC-1-1- P	PRACTICALS**	
	CEMA-CC-1-2-TH	PHYSICAL CHEMISTRY-1 ORGANIC CHEMISTRY -1B	Kinetic theory, Chemical kinetics Stereochemistry
	CEMA-CC-1-2-P	PRACTICALS	
2	CEMA-CC-2-3-TH	ORGANIC CHEMISTRY -2	Reaction Mechanism
	CEMA-CC-2-3-P	PRACTICALS	
	CEMA-CC-2-4-TH	INORGANIC CHEMISTRY-2	Chemical Bonding
	CEMA-CC-2-4-P	PRACTICALS	
3	CEMA-CC-3-5-TH	PHYSICAL CHEMISTRY-2	Chemical Thermodynamics
	CEMA-CC-3-5-P	PRACTICALS	
	CEMA-CC-3-6-TH	INORGANIC CHEMISTRY-3	s and p Block Elements
	CEMA-CC-3-6-P	PRACTICALS	
	CEMA-CC-3-7-TH	ORGANIC CHEMISTRY -3	Alkenes, Alkynes, Carbonyls
	CEMA-CC-3-7-P	PRACTICALS	
4	CEMA-CC-4-8-TH	ORGANIC CHEMISTRY - 4	Organic Synthesis, Spectroscopy
	CEMA-CC-4-8-P	PRACTICALS	
	CEMA-CC-4-9-TH	PHYSICAL CHEMISTRY- 3	Applications of Thermodynamics, Quantum Mechanics
	CEMA-CC-4-9-P	PRACTICALS	
	CEMA-CC-4-10-TH	INORGANIC CHEMISTRY-4	Coordination Chemistry, d & f elements
	CEMA-CC-4-10-P	PRACTICALS	
5	CEMA-CC-5-11-TH	PHYSICAL CHEMISTRY -4	Quantum Chemistry, Statistical Thermodynamics
	CEMA-CC-5-11-P	PRACTICALS	
	CEMA-CC-5-12-TH	ORGANIC CHEMISTRY -5	Cyclic Compounds, Biomolecules
	CEMA-CC-5-12-P	PRACTICALS	
6	CEMA-CC-6-13-TH	INORGANIC CHEMISTRY-5	Bioinorganic and Organometallic Chemistry
	CEMA-CC-6-13-P	PRACTICALS	
	CEMA-CC-6-14-TH	PHYSICAL CHEMISTRY -5	Molecular Spectroscopy, Photochemistry
	CEMA-CC-6-14-P	PRACTICALS	

*** The Course code indicates subject-type of course-semester number-paper number-theory /practical [e.g. CEMA-CC-1-1-TH/P stands for Chemistry HonoursCore Course- First Semester- Paper 1- Theoretical /Practical]**

**** Practicals are based on the corresponding theoretical papers.**

Discipline Specific Courses (DSE)
For Semester 5

Any One from the following

DSE-A1:MOLECULAR MODELLING & DRUG DESIGN

DSE-A2: APPLICATIONS OF COMPUTERS IN CHEMISTRY

Any One from the following

DSE-B1: INORGANIC MATERIALS OF INDUSTRIALIMPORTANCE

DSE-B2: NOVEL INORGANIC SOLIDS

For Semester 6

Any One from the following

DSE-A3: GREEN CHEMISTRY AND CHEMISTRY OF NATURAL PRODUCTS

DSE-A4: ANALYTICAL METHODS IN CHEMISTRY

Any One from the following

DSE-B3:POLYMER CHEMISTRY

DSE-B4: DISSERTATION

SKILL ENHANCEMENT COURSES (SEC)

SEC-A For Semester 3 [Any one]

SEC 1 – MATHEMATICS AND STATISTICS FOR CHEMISTS
SEC 2 – ANALYTICAL CLINICAL BIOCHEMISTRY

SEC-B For Semester 4 [Any one]

SEC 3 – PHARMACEUTICALS CHEMISTRY
SEC4 - PESTICIDE CHEMISTRY

Important Guidelines

- **General Electives (GE) are to be taken preferably from Physics and Mathematics disciplines.**
- **All graphs for Physical / Inorganic Courses must be done using standard Spreadsheet Software**
- **Each college should take necessary measures to ensure they should have the following facilities:**

  1. UV-VIS Spectrophotometer with printer.
  2. FT-IR spectrophotometer with printer.
  3. Internet facility.
  4. Requisite number of computers (One computer for 3-4 students).

For proper maintenance of above mentioned facilities, clean & dry AC rooms are mandatory.

- **Each lecture is of 1 hr duration for both theory and practical classes.**

CORE COURSES (HONOURS) IN CHEMISTRY[CEM-A]

SEMESTER-1

CEMA-CC-1-1-TH :

(Credits: Theory-04, Practicals-02)

INORGANIC CHEMISTRY-1

Theory: 40 Lectures

Extra nuclear Structure of atom **(14 Lectures)**

Quantum numbers and their significance, Schrödinger's wave equation, significance of ψ and ψ^2. Radial and angular wave functions for hydrogen atom. Radial and angular distribution curves. Shapes of *s*, *p*, *d* and *f* orbitals. Pauli's Exclusion Principle, Hund's rules and multiplicity, Exchange energy, Aufbau principle and its limitations, Ground state Term symbols of atoms and ions for atomic number upto 30.

Acid-Base reactions **(12 Lectures)**

Acid-Base concept: Arrhenius concept, theory of solvent system (in H_2O, NH_3, SO_2 and HF), Bronsted-Lowry's concept, relative strength of acids, Pauling's rules. Lux-Flood concept, Lewis concept, group characteristics of Lewis acids, solvent levelling and differentiating effects.Thermodynamic acidity parameters, Drago-Wayland equation.Superacids, Gas phase acidity and proton affinity; HSAB principle.Acid-base equilibria in aqueous solution (Proton transfer equilibria in water), pH, buffer.Acid-base neutralisation curves; indicator, choice of indicators.

Redox Reactions **(14 Lectures)**

Ion-electron method of balancing equation of redox reaction.Elementary idea on standard redox potentials with sign conventions, Nernst equation (without derivation).Influence of complex formation, precipitation and change of pH on redox potentials; formal potential.Feasibility of a redox titration, redox potential at the equivalence point, redox indicators.Redox potential diagram (Latimer and Frost diagrams) of common elements and their applications.Disproportionation and comproportionation reactions (typical examples).

Electroanalytical methods: Basic principle of pH metric, potentiometric and conductometric titrations. Techniques used for the determination of equivalence points. Techniques used for the determination of pKa values

Solubility and solubility effect – common ion effect and their applications to the precipitation and separation of common metallic ions as hydroxides, sulfides, phosphates, carbonates, sulfates and halides.

Reference Books

1. Lee, J. D. *Concise Inorganic Chemistry*,5th Ed., Wiley India Pvt. Ltd., 2008.
2. Douglas, B.E. and McDaniel, D.H. *Concepts & Models of Inorganic Chemistry* Oxford, 1970.
3. Day, M.C. and Selbin, J. *Theoretical Inorganic Chemistry*, ACS Publications, 1962.
4. Atkin, P. *Shriver & Atkins' Inorganic Chemistry*, 5th Ed., Oxford University Press (2010).
5. Cotton, F.A., Wilkinson, G. and Gaus, P.L., *Basic Inorganic Chemistry 3rd Ed.;* Wiley India.
6. Sharpe, A.G., *Inorganic Chemistry*, 4th Indian Reprint (Pearson Education) 2005.
7. Huheey, J. E.; Keiter, E.A, & Keiter, R.L. *Inorganic Chemistry, Principles ofStructure and Reactivity 4th Ed.*, Harper Collins 1993, Pearson,2006.
8. Atkins, P.W. & Paula, J. *Physical Chemistry*, Oxford Press, 2006.
9. Mingos, D.M.P., *Essential trends in inorganic chemistry*. Oxford University Press (1998).
10. Winter, M. J., The Orbitron, http://winter.group.shef.ac.uk/orbitron/ (2002). An illustrated gallery of atomic and molecular orbitals.
11. Burgess, J., *Ions in solution: basic principles of chemical interactions.* Ellis Horwood (1999).

ORGANIC CHEMISTRY-1A

Theory: 20 Lectures

Basics of Organic Chemistry

Bonding and Physical Properties **(18 Lectures)**

Valence Bond Theory: concept of hybridisation, shapes of molecules, resonance (including hyperconjugation); calculation of formal charges and double bond equivalent (DBE); orbital pictures of bonding (sp^3, sp^2, sp: C-C, C-N & C-O systems and *s-cis* and *s-trans* geometry for suitable cases).

Electronic displacements: inductive effect, field effect, mesomeric effect, resonance energy; bond polarization and bond polarizability; electromeric effect; steric effect, steric inhibition of resonance.

MO theory: qualitative idea about molecular orbitals, bonding and antibonding interactions, idea about σ, σ^*, π, π^*, n – MOs; concept of HOMO, LUMO and SOMO; sketch and energy levels of π MOs of i) acyclic p orbital system (C=C, conjugated diene, triene, allyl and pentadienyl systems) ii) cyclic p orbital system (neutral systems: [4], [6] annulenes; charged systems: 3-,4-,5-membered ring systems); Hückel's rules for aromaticity up to [8] annulene (including mononuclear heterocyclic compounds up to 6-membered ring); concept of antiaromaticity and homoaromaticity; non-aromatic molecules; Frost diagram (qualitative drawing).

Physical properties: influence of hybridization on bond properties: bond dissociation energy (BDE) and bond energy; bond distances, bond angles; concept of bond angle strain; melting point/boiling point and solubility of common organic compounds in terms of covalent & non-covalent intermolecular forces; polarity of molecules and

dipole moments; relative stabilities of isomeric hydrocarbons in terms of heat of hydrogenation and heat of combustion data.

General Treatment of Reaction Mechanism I **(02 Lectures)**

Mechanistic classification: ionic, radical and pericyclic (definition and example); reaction type: addition, elimination and substitution reactions (definition and example); nature of bond cleavage and bond formation: homolytic and heterolytic bond fission, homogenic and heterogenic bond formation; curly arrow rules in representation of mechanistic steps; reagent type: electrophiles and nucleophiles (elementary idea).

Reference Books

1. Finar, I. L. *Organic Chemistry (Volume 1),* Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
2. Morrison, R. N. & Boyd, R. N. *Organic Chemistry*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
3. Sykes, P. *A guidebook to Mechanism in Organic Chemistry*, Pearson Education, 2003.
4. Carey, F. A., Guiliano, R. M.*Organic Chemistry*, Eighth edition, McGraw Hill Education, 2012.

CEMA-CC-1-1-P(45 Lectures)

**** During examination marks of the experiments will be set in 2:1 ratio for Inorganic and Organic experiments respectively.**

1) INORGANIC CHEMISTRY: I (1) LAB (30 Lectures)

Acid and Base Titrations: (DEMO ONLY)

1. Estimation of carbonate and hydroxide present together in mixture
2. Estimation of carbonate and bicarbonate present together in a mixture.
3. Estimation of free alkali present in different soaps/detergents.

Oxidation-Reduction Titrations:

1. Estimation of Fe(II) using standardized $KMnO_4$ solution
2. Estimation of oxalic acid OR sodium oxalate in a given mixture
3. Estimation of Fe(II) and Fe(III) in a given mixture using $K_2Cr_2O_7$ solution.
4. Estimation of Fe(III) and Mn(II) in a mixture using standardized $KMnO_4$ solution
5. Estimation of Fe(III) and Cu(II) in a mixture using $K_2Cr_2O_7$.

6. Estimation of Fe(III) and Cr(III) in a mixture using $K_2Cr_2O_7$.

Reference Books

1. Mendham, J., *A. I. Vogel's Quantitative Chemical Analysis* 6th Ed., Pearson, 2009.
2. *Practical Workbook Chemistry (Honours), UGBS, Chemistry*, University of Calcutta, 2015

2) ORGANIC CHEMISTRY: O (1A) LAB (15 Lectures)

Separation based upon solubility, by using common laboratory reagents like water (cold,hot), dil. HCl, dil. NaOH, dil. $NaHCO_3$, *etc*., of components of a binary solid mixture; purification of **any one** of the separated components by crystallization and determination of its melting point. The composition of the mixture should be of the following types **[ANY THREE]**: *p*-Nitrobenzoic acid/*p*-Aminobenzoic acid; *p*-Nitrotolune/*p*-Anisidine; benzoic acid/naphthalene; urea/phenyl benzoate; *p*-toluidine/benzophenone; *p*-chlorobenzoic acid/ benzophenone, Benzoic acid/Anthracene; Glucose/Biphenyl; Benzoic acid/Benzophenone; Urea/Benzophenone. **Use of pH paper** is recommended.

Reference Books

1. Bhattacharyya, R. C, *A Manual of Practical Chemistry.*
2. Vogel, A. I. *Elementary Practical Organic Chemistry*, Part 2: *Qualitative Organic Analysis*, CBS Publishers and Distributors.
3. Mann, F.G. & Saunders, B.C. *Practical Organic Chemistry*, Pearson Education (2009).
4. Furniss, B.S., Hannaford, A.J., Smith, P.W.G., Tatchell, A.R. *Practical Organic Chemistry*,*5th Ed*., Pearson (2012).
5. Dutta, S, *B. Sc. Honours Practical Chemistry*, Bharati Book Stall.

CEMA-CC-1-2-TH :

(Credits: Theory-04, Practicals-02)

PHYSICAL CHEMISTRY-1

Theory(40 Lectures)

Kinetic Theory and Gaseous state (20 Lectures)

Kinetic Theory of gases: Concept of pressure and temperature; Collision of gas molecules; Collision diameter; Collision number and mean free path; Frequency of binary collisions (similar and different molecules); Wall collision and rate of effusion

Maxwell's distribution of speed and energy: Nature of distribution of velocities, Maxwell's distribution of speeds in one, two and three dimensions; Kinetic energy distribution in one, two and three dimensions, calculations of average, root mean square and most probable values in each case; Calculation of number of molecules having energy $\geq \varepsilon$, Principle of equipartition of energy and its application to calculate the classical limit of molar heat capacity of gases

Real gas and virial equation: Deviation of gases from ideal behavior; compressibility factor; Boyle temperature; Andrew's and Amagat's plots; van der Waals equation and its features; its derivation and application in explaining real gas behaviour, other equations of state (Berthelot, Dietrici); Existence of critical state, Critical constants in terms of van der Waals constants; Law of corresponding states; virial equation of state; van der Waals equation expressed in virial form and significance of second virial coefficient; Intermolecular forces (Debye, Keesom and London interactions; Lennard-Jones potential - elementary idea)

Transport processes **(08 Lectures)**

Diffusion : Fick's law, Flux, force, phenomenological coefficients & their inter-relationship (general form), different examples of transport properties

Viscosity: General features of fluid flow (streamline flow and turbulent flow); Newton's equation, viscosity coefficient; Poiseuille's equation (with derivation); principle of determination of viscosity coefficient of liquids by falling sphere method and using Ostwald's viscometer. Temperature variation of viscosity of liquids and comparison with that of gases.Relation between viscosity coefficient of a gas and mean free path.

Chemical kinetics **(12 Lectures)**

Rate law, order and molecularity: Introduction of rate law, Extent of reaction; rate constants, order; Forms of rates of First, second and nth order reactions; Pseudo first order reactions (example using acid catalyzed hydrolysis of methyl acetate); Determination of order of a reaction by half-life and differential method; Rate-determining step and steady-state approximation – explanation with suitable examples;) Opposing reactions, consecutive reactions and parallel reactions (with explanation of kinetic and thermodynamic control of products; all steps first order)

Role of Temperature : Temperature dependence of rate constant; Arrhenius equation, energy of activation;

Homogeneous catalysis: Homogeneous catalysis with reference to acid-base catalysis; Enzyme catalysis; Michaelis-Menten equation, Lineweaver-Burk plot, turn-over number.

Reference Books

1. **Levine, I. N. *Physical Chemistry*, 6th Edition McGraw-Hill India**
2. **Castellan, G. W. *Physical Chemistry*, Narosa**
3. **McQuarrie, D. A. & Simons, J. D. *Physical Chemistry: A Molecular Approach*, Viva Press**
4. **Kapoor K.L, A Text Book Of Physical Chemistry , McGraw Hill India**

5. Engel, T. & Reid, P. *Physical Chemistry*, 3rd Edition Pearson India
6. Atkins, P. W. & Paula, J. de *Atkins' Physical Chemistry*, 10th Edition Oxford University Press
7. Maron, S. & Prutton *Physical Chemistry*
8. Ball, D. W. *Physical Chemistry*, Thomson Press
9. Mortimer, R. G. *Physical Chemistry*, Elsevier
10. Laidler, K. J. *Chemical Kinetics*, Pearson
11. Glasstone, S. & Lewis, G.N. *Elements of Physical Chemistry*
12. Rakshit, P.C., *Physical Chemistry* Sarat Book House
13. Moore, W. J. *Physical Chemistry*, Orient Longman

ORGANIC CHEMISTRY-IB

Theory (20 Lectures)

Stereochemistry I (17 Lectures)

Bonding geometries of carbon compounds and representation of molecules: tetrahedral nature of carbon and concept of asymmetry; Fischer, sawhorse, flying wedge and Newman projection formulae and their inter translations.

Concept of chirality and symmetry: symmetry elements, molecular chirality and centre of chirality; asymmetric and dissymmetric molecules; enantiomers and diastereomers; concept of stereogenicity, chirotopicity and pseudoasymmetry; chiral centres and number of stereoisomerism: systems involving 1/2/3-chiral centre(s) (AA, AB, ABA and ABC types).

Relative and absolute configuration: D/L and *R/S* descriptors; *erythro/threo* and *meso* nomenclature of compounds; *syn/anti* nomenclatures for aldols; *E/Z* descriptors for C=C, conjugated diene, triene, C=N and N=N systems; combination of *R/S*- and *E/ Z*-isomerisms.

Optical activity of chiral compounds: optical rotation, specific rotation and molar rotation; racemic compounds, racemisation (through cationic, anionic, radical intermediates and through reversible formation of stable achiral intermediates); resolution of acids, bases and alcohols *via* diastereomeric salt formation; optical purity and enantiomeric excess; invertomerism of chiral trialkylamines.

General Treatment of Reaction Mechanism II (03 Lectures)

Reactive intermediates: carbocations (carbenium and carbonium ions), non-classical cabocations, carbanions, carbon radicals, carbenes: generation and stability, structure using orbital picture and electrophilic/nucleophilic behavior of reactive intermediates (elementary idea).

Reference Books

1. Finar, I. L. *Organic Chemistry (Volume 1)*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
2. Morrison, R. N. & Boyd, R. N. *Organic Chemistry*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).

3. Sykes, P. *A guidebook to Mechanism in Organic Chemistry*, Pearson Education, 2003.
4. Carey, F. A., Guiliano, R. M. *Organic Chemistry*, Eighth edition, McGraw Hill Education, 2012.
5. Eliel, E. L. & Wilen, S. H. *Stereochemistry of Organic Compounds*, Wiley: London, 1994.
6. Nasipuri, D. *Stereochemistry of Organic Compounds*, Wiley Eastern Limited.
7. Clayden, J., Greeves, N. & Warren, S. *Organic Chemistry*, Second edition, Oxford University Press, 2012.
8. Keeler, J., Wothers, P. *Chemical Structure and Reactivity – An Integrated approach*, Oxford University Press.
9. Smith, J. G. *Organic Chemistry*, Tata McGraw-Hill Publishing Company Limited.
10.Fleming, I. *Molecular Orbitals and Organic Chemical Reactions*, Reference/Student Edition, Wiley, 2009.
11. James, J., Peach, J. M. *Stereochemistry at a Glance*, Blackwell Publishing, 2003.
12. Robinson, M. J. T., *Stereochemistry*, Oxford Chemistry Primer, OxfordUniversity Press, 2005.

CEMA-CC-1-2-P:

(45 Lectures)

**** During examination marks of the experiments will be set in 2:1 ratio for Physical and Organic experiments respectively.**

1) PHYSICAL CHEMISTRY: P (1) LAB (30 Lectures)

Experiment 1: Study of kinetics of decomposition of H_2O_2

Experiment 2: Study of kinetics of acid-catalyzed hydrolysis of methyl acetate

Experiment 3: Study of viscosity of unknown liquid (glycerol, sugar) with respect to water.

Experiment 4: Study of the variation of viscosity with the concentration of the solution

Experiment 5: Determination of solubility of sparingly soluble salt in water, in electrolyte with common ions and in neutral electrolyte (using common indicator)

Reference Books

1. Viswanathan, B., Raghavan, P.S. *Practical Physical Chemistry* Viva Books (2009)
2. Mendham, J., A. I. Vogel's Quantitative Chemical Analysis 6th Ed., Pearson
3. Harris, D. C. *Quantitative Chemical Analysis*. 9th Ed., Freeman (2016)
4. Palit, S.R., De, S. K. *Practical Physical Chemistry* Science Book Agency
5. Levitt, B. P. edited *Findlay's Practical Physical Chemistry* Longman Group Ltd.

6. Gurtu, J. N., Kapoor, R., *Advanced Experimental Chemistry* S. Chand & Co. Ltd.
7. *Practical Workbook Chemistry (Honours), UGBS, Chemistry*, University of Calcutta, 2015

2) ORGANIC CHEMISTRY: O (1B) LAB (15 Lectures)

Determination of boiling point of common organic liquid compounds [**ANY FIVE**]*n*-butyl alcohol, cyclohexanol, ethyl methyl ketone, cyclohexanone, acetylacetone,isobutyl methyl ketone, isobutyl alcohol, acetonitrile, benzaldehyde and acetophenone. [Boiling points of the chosen organic compounds should preferably be within 180^0C].

SEMESTER-2

CEMA-CC-2-3-TH :

(Credits: Theory-04, Practicals-02)

ORGANIC CHEMISTRY-2

Theory: 60 Lectures

StereochemistryII (20 Lectures)

Chirality arising out of stereoaxis: stereoisomerism of substituted cumulenes with even and odd number of double bonds; chiral axis in allenes, spiro compounds, alkylidenecycloalkanes and biphenyls;related configurational descriptors ($R_a/S_{a)}$; atropisomerism; racemisation of chiral biphenyls.

Concept of prostereoisomerism: prostereogenic centre; concept of (*pro*)^n-*chirality*: topicity of ligands and faces (elementary idea); *pro-R/pro-S*, *pro-E/pro-Z* and *Re/Si* descriptors;*pro-r* and *pro-s* descriptors of ligands on propseudoasymmetric centre.

Conformation*:* conformational nomenclature: eclipsed, staggered, *gauche*, *syn*and *anti*; dihedral angle, torsion angle;Klyne-Prelog terminology; *P/M* descriptors; energy barrier of rotation, concept of torsional and steric strains; relative stability of conformers on the basis of steric effect, dipole-dipole interaction and H-bonding; *butane gauche* interaction; conformational analysis of ethane, propane, *n*-butane, 2-methylbutane and 2,3-dimethylbutane; haloalkane, 1,2-dihaloalkanes and 1,2-diols (up to four carbons); 1,2-halohydrin; conformation of conjugated systems (*s-cis* and*s-trans*).

General Treatment of Reaction Mechanism III (20 lectures)

Reaction thermodynamics*:*free energy and equilibrium, enthalpy and entropy factor, calculation of enthalpy change *via* BDE, intermolecular & intramolecular reactions.

*Concept of organic acids and bases:*effect of structure, substituent and solvent on acidityand basicity; proton sponge; comparison between nucleophilicity and basicity; application of thermodynamic principles in acid-base equilibria.

Tautomerism*:*prototropy (keto-enol, nitro - *aci*-nitro, nitroso-oximino, diazo-amino and enamine-imine systems); valence tautomerism and ring-chain tautomerism; composition of the equilibrium in different systems (simple carbonyl; 1,2- and 1,3-dicarbonyl systems, phenols and related systems), factors affecting keto-enol tautomerism; application of thermodynamic principles in tautomeric equilibria.

Reaction kinetics*:* rate constant and free energy of activation; free energy profiles for one-step, two-step and three-step reactions; catalyzed reactions: electrophilic and nucleophilic catalysis; kinetic control and thermodynamic control of reactions; isotope effect: primary and β-secondary kinetic isotopic effect (k_H /k_D); principle of microscopic reversibility; Hammond's postulate.

Substitution and Elimination Reactions (20 Lectures)

Free-radical substitution reaction*:* halogentaion of alkanes, mechanism (with evidence) and stereochemical features; reactivity-selectivity principle in the light of Hammond's postulate.

Nucleophilic substitution reactions*:* substitution at sp^3 centre[systems: alkyl halides, allyl halides, benzyl halides, alcohols, ethers, epoxides, α-halocarbonyls]:mechanisms (with evidence),relative rates& stereochemical features: S_N1, S_N2, S_N2', S_N1' (allylic rearrangement) and S_Ni; effectsof solvent, substrate structure, leaving group and nucleophiles (including ambident nucleophiles, cyanide & nitrite); substitutions involving NGP (with hetero atoms and aryl groups); role of crown ethers and phase transfer catalysts.

Elimination reactions*:* E1, E2, E1cB and Ei (pyrolytic *syn* eliminations); formation of alkenes and alkynes; mechanisms (with evidence), reactivity, regioselectivity (Saytzeff/Hofmann)and stereoselectivity; comparison between substitution and elimination.

Reference Books

1. Finar, I. L. *Organic Chemistry (Volume 1)*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
2. Morrison, R. N. & Boyd, R. N. *Organic Chemistry*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
3. Sykes, P. *A guidebook to Mechanism in Organic Chemistry*, Pearson Education, 2003.
4. Carey, F. A., Guiliano, R. M.*Organic Chemistry*, Eighth edition, McGraw Hill Education, 2012.
5. Eliel, E. L. &Wilen, S. H. *Stereochemistry of Organic Compounds*, Wiley: London, 1994.
6**.** Nasipuri, D.*Stereochemistry of Organic Compounds,* Wiley Eastern Limited.
7. Clayden, J., Greeves, N. &Warren, S. *Organic Chemistry*, Second edition, Oxford UniversityPress, 2012.
8. Keeler, J., Wothers, P.*Chemical Structure and Reactivity – An Integrated approach*, Oxford University Press.
9. Smith, J. G. *Organic Chemistry*, Tata McGraw-Hill Publishing Company Limited.
10.Fleming, I. *Molecular Orbitals and Organic Chemical Reactions*, Reference/StudentEdition,Wiley, 2009.
11. James, J., Peach, J. M. *Stereochemistry at a Glance*, Blackwell Publishing, 2003.
12. Robinson, M. J. T., *Stereochemistry*, Oxford Chemistry Primer, OxfordUniversity Press, 2005.
13. Maskill, H., *Mechanisms of Organic Reactions*, Oxford Chemistry Primer, OxfordUniversity Press.

CEMA-CC-2-3-P:

(45Lectures)

Organic Preparations

A.The following reactions **(any eight)**are to be performed, noting the yield of the crude product:

1. Nitration of aromatic compounds
2. Condensation reactions
3. Hydrolysis of amides/imides/esters
4. Acetylation of phenols/aromatic amines
5. Brine mediated benzoylation of amines/amino acids.
6. Side chain oxidation of aromatic compounds
7. Diazo coupling reactions of aromatic amines
8. Bromination of anilides using green approach (Bromate-Bromide method)
9. Redox reaction including solid-phase method
10. Green 'multi-component-coupling' reaction
11. Selective reduction of *m*-dinitrobenzene to *m*-nitroaniline

Students must also calculate percentage yield, based upon isolated yield (crude) and theoretical yield.

B. Purification of the crude product is to be made by crystallisation from water/alcohol, crystallizationafter charcoal treatment, or sublimation, whichever is applicable.

C. Melting point of the purified product is to be noted.

Reference Books

1. Vogel, A. I. *Elementary Practical Organic Chemistry*, Part 1: *Small scale Preparations*, CBS Publishers and Distributors.
2. Mann, F.G. & Saunders, B.C. *Practical Organic Chemistry*, Pearson Education(2009).
3. Furniss, B.S., Hannaford, A.J., Smith, P.W.G. & Tatchell, A.R. *Practical Organic Chemistry, 5th Ed.* Pearson (2012).
4. Ahluwalia, V.K. & Aggarwal, R. *Comprehensive Practical Organic Chemistry: Preparation and Quantitative Analysis*, University Press (2000).
5. *Practical Workbook Chemistry (Honours), UGBS, Chemistry*, University of Calcutta, 2015.

CEMA-CC-2-4-TH :

(Credits: Theory-04, Practicals-02)

INORGANIC CHEMISTRY-2

Theory: 60 Lectures

Chemical Bonding-I **(20 Lectures)**

(i) *Ionic bond:* General characteristics, types of ions, size effects, radius ratio rule and its application and limitations. Packing of ions in crystals.Born-Landé equation with derivation and importance of Kapustinskii expression for lattice energy.Madelung constant, Born-Haber cycle and its application, Solvation energy.Defects in solids (elementary idea). Solubility energetics of dissolution process

(ii) *Covalent bond:* Polarizing power and polarizability, ionic potential,Fazan's rules. Lewis structures, formal charge. Valence Bond Theory. The hydrogen molecule (Heitler-London approach), directional character of covalent bonds, hybridizations, equivalent and non-equivalent hybrid orbitals, Bent's rule, Dipole moments, VSEPR theory, shapes of molecules and ions containing lone pairs and bond pairs (examples from main groups chemistry) and multiple bonding (σ and π bond approach).

Chemical Bonding-II **(30 Lectures)**

(i) Molecular orbital concept of bonding (The approximations of the theory, Linear combination of atomic orbitals (LCAO)) (elementary pictorial approach): sigma and pi-bonds and delta interaction, multiple bonding. Orbital designations: *gerade*, *ungerade*, HOMO, LUMO. Orbital mixing,. MO diagrams of H_2, Li_2, Be_2, B_2, C_2, N_2, O_2, F_2, and their ions wherever possible; Heteronuclear molecular orbitals: CO, NO, NO^+, CN^-, HF, BeH_2, CO_2 and H_2O. Bond properties: bond orders, bond lengths.
(ii) *Metallic Bond:* Qualitative idea of valence bond and band theories. Semiconductors and insulators, defects in solids.
(iii) *Weak Chemical Forces:* Hydrogen bonding (theories of hydrogen bonding, valence bond treatment), receptor-guest interactions, Halogen bonds. Effects of chemical force, melting and boiling points.

Radioactivity **(10 Lectures)**

Nuclear stability and nuclear binding energy. Nuclear forces: meson exchange theory. Nuclear models (elementary idea): Concept of nuclear quantum number, magic numbers. Nuclear Reactions: Artificial radioactivity, transmutation of elements, fission, fusion and spallation. Nuclear energy and power generation.Separation and uses of isotopes. Radio chemical methods: principles of determination of age of rocks and minerals, radio carbon dating, hazards of radiation and safety measures.

Reference Books

1. Lee, J. D. *Concise Inorganic Chemistry, 5th Ed.*, Wiley India Pvt. Ltd., 2008.
2. Huheey, J. E.; Keiter, E.A. & Keiter, R.L. *Inorganic Chemistry, Principles ofStructure and Reactivity 4th Ed.*, Harper Collins 1993, Pearson, 2006.
3. Douglas, B.E. and McDaniel, D.H. *Concepts & Models of Inorganic Chemistry* Oxford, 1970.
4. Porterfield, H. W., *Inorganic Chemistry,* Second Edition, Academic Press, 2005.
5. Purecell, K.F. and Kotz, J.C., *An Introduction toInorganic Chemistry*, Saunders: Philadelphia, 1980.
6. Cotton, F.A., Wilkinson, G., & Gaus, P.L. *Basic Inorganic Chemistry 3rd Ed.;* Wiley India.
7. Gillespie, R. J. and Hargittai, I., The VSEPR Model of Molecular Geometry, Prentice Hall (1992).
8. Albright, T., *Orbital interactions in chemistry*, John Wiley and Sons (2005).
9. Mingos, D.M.P., *Essential trends in inorganic chemistry*. Oxford University Press (1998).
10. Miessler, G. L., Fischer, P. J., Tarr, D. A., *Inorganic Chemistry*, Pearson, 5th Edition.
11. Kaplan, I., *Nuclear Physics*, Addison-Wesley Publishing Company Inc. London, 1964.
12. Friedlander, G., Kennedy, J. W., Macias, E. S. And Miller, J. M., *Nuclear and Radiochemistry*, Wiley, 1981.

CEMA-CC-2-4-P:(45 Lectures)

Iodo-/ Iodimetric Titrations

1. Estimation of Vitamin C
2. Estimation of (i) arsenite and (ii) antimony iodimetrically
3. Estimation of available chlorine in bleaching powder.

Estimation of metal content in some selective samples

1. Estimation of Cu in brass.
2. Estimation of Cr and Mn in Steel.
3. Estimation of Fe in cement.

Reference Books

1. Mendham, J., *A. I. Vogel's Quantitative Chemical Analysis* 6th Ed., Pearson, 2009.
2. *Practical Workbook Chemistry (Honours), UGBS, Chemistry*, University of Calcutta, 2015

SEMESTER-3

CEMA-CC-3-5-TH :

(Credits: Theory-04, Practicals-02)

PHYSICAL CHEMISTRY-2

Theory: 60 Lectures

Chemical Thermodynamics I (10 Lectures)

1st law of Thermodynamics: Intensive and extensive variables; state and path functions; isolated, closed and open systems; zeroth law of thermodynamics;Concept of heat, work, internal energy and statement of first law; enthalpy, *H*; relation between heat capacities, calculations of *q*, *w*, Δ*U* and Δ*H* for reversible, irreversible and free expansion of gases (ideal and van der Waals) under isothermal and adiabatic conditions; Joule's experiment and its consequence

Thermochemistry:Standard states; Heats of reaction; enthalpy of formation of molecules and ions and enthalpy of combustion and its applications; Laws of thermochemistry; bond energy, bond dissociation energy and resonance energy from thermochemical data, Kirchhoff's equations ; Adiabatic flame temperature.

Chemical Thermodynamics II (20 Lectures)

Second Law:Need for a Second law; statement of the second law of thermodynamics; Concept of heat reservoirs and heat engines; Carnot cycle; Carnot engine and refrigerator; Kelvin – Planck and Clausius statements and equivalence of the two statements with entropic formulation; Carnot's theorem; Values of §dQ/T and Clausius inequality;Physical concept of Entropy; Entropy is a measure of the microscopic disorder of the system. Entropy change of systems and surroundings for various processes and transformations; Entropy and unavailable work; Auxiliary state functions (G and A) and their variation with T, P and V. Criteria for spontaneity and equilibrium.

Thermodynamic relations: Maxwell's relations; Gibbs- Helmholtz equation, Joule-Thomson experiment and its consequences; inversion temperature; Joule-Thomson coefficient for a van der Waals gas; General heat capacity relations

Systems of Variable Composition:

Partial molar quantities, dependence of thermodynamic parameters on composition; Gibbs-Duhem equation, chemical potential of ideal mixtures, change in thermodynamic functions inmixing of ideal gases. Activities and activity coefficients.Fugacity and fugacity coefficient.

Applications of Thermodynamics – I (06 Lectures)

Chemical Equilibrium:

Thermodynamic conditions for equilibrium, degree of advancement; van't Hoff's reaction isotherm (deduction from chemical potential); Variation of free energy with degree of advancement; Equilibrium constant and standard Gibbs free energy change; Van't Hoff's reaction isobar and isochore from different standard states; Le Chatelier's principle and its derivation, variation of equilibrium constant under different conditions Nernst's distribution law; Application- (eg. dimerization of benzene in benzoic acid). Solvent Extraction.

ELECTROCHEMISTRY: (24 Lectures)

(i) Conductance and transport number

Ion conductance; Conductance and measurement of conductance, cell constant, specific conductance and molar conductance; Variation of specific and equivalent conductance with dilution for strong and weak electrolytes; Kohlrausch's law of independent migration of ions; Equivalent and molar conductance at infinite dilution and their determination for strong and weak electrolytes; Debye –Huckel theory of Ion atmosphere (qualitative)-asymmetric effect, relaxation effect and electrophoretic effect; Debye-Huckel limiting law-brief qualitative description. Estimation of activity coefficient for electrolytes using Debye-Huckel limiting law. Ostwald's dilution law; Ionic mobility; Application of conductance measurement (determination of solubility product and ionic product of water); Conductometric titrations.Transport number, Principles of Hittorf's and Moving-boundary method; Wien effect, Debye-Falkenhagen effect, Walden's rule

(ii) Ionic equilibrium:

Strong, moderate and weak electrolytes, degree of ionization, factors affecting degree of ionization, ionization constant and ionic product of water. Ionization of weak acids and bases, pH scale, common ion effect; dissociation constants of mono-, di-and triprotic acids (exact treatment).

Salt hydrolysis- calculation of hydrolysis constant, degree of hydrolysis and pH for different salts (exact Treatment).Determination of hydrolysis constant conductometrically. Buffer solutions; derivation of Henderson equation and its applications; buffer capacity, buffer range, buffer action . Qualitative treatment of acid – base titration curves (calculation of pH at various stages). Theory of acid–base indicators; selection of indicators and their limitations.

Multistage equilibrium in polyelectrolyte systems; hydrolysis and hydrolysis constants

(iii) Electromotive Force: Rules of oxidation/reduction of ions based on half-cell potentials,; Chemical cells, reversible and irreversible cells with examples; Electromotive force of a cell and its measurement, Thermodynamic derivation of Nernst equation; Standard electrode (reduction) potential and its application to different kinds of half-cells. Application of EMF measurements in determining (i) free energy, enthalpy and entropy of a cell reaction, (ii) equilibrium constants, and (iii) pH values, using hydrogen, quinone-hydroquinone and glass electrodes

Concentration cells with and without transference, liquid junction potential; determination of activity coefficients and transference numbers; Potentiometric titrations (acid-base, redox, precipitation)

Reference Books

1. **Levine, I. N. *Physical Chemistry*, 6th Edition , McGraw-Hill India**
2. **Castellan, G. W. *Physical Chemistry*, Narosa**
3. **McQuarrie, D. A. & Simons, J. D. *Physical Chemistry: A Molecular Approach*, Viva Press**
4. **Kapoor K.L, A Text Book Of Physical Chemistry , McGraw Hill India**
5. Engel, T. & Reid, P. *Physical Chemistry*, 3rd Edition ,Pearson India
6. Atkins, P. W. & Paula, J. de *Atkins' Physical Chemistry*, 10th Edition, Oxford University Press
7. Maron, S. & Prutton , *Physical Chemistry*
8. Ball, D. W. *Physical Chemistry*, Thomson Press
9. Mortimer, R. G. *Physical Chemistry*, 2nd Edition, Elsevier
10. Glasstone, S. & Lewis, G.N. *Elements of Physical Chemistry*
11. Rakshit, P.C., *Physical Chemistry*,Sarat Book House
12. Moore, W. J. *Physical Chemistry*, Orient Longman
14. Denbigh, K. *The Principles of Chemical Equilibrium* ,Cambridge
15. Zemansky, M. W. & Dittman, R.H. *Heat and Thermodynamics*, Tata-McGraw-Hil
16. Glasstone, S. An Introduction to Electrochemistry, East-West Press .
17. Klotz, I.M., Rosenberg, R. M.*Chemical Thermodynamics:Basic Concepts and Methods* , 7th Edition, Wiley

CEMA-CC-3-5-P: (45 Lectures)

Experiment 1: Conductometric titration of an acid (strong, weak/ monobasic, dibasic, and acid mixture) against strong base.
Experiment 2: Study of saponification reaction conductometrically
Experiment 3: Verification of Ostwald's dilution law and determination of K_a of weak acid
Experiment 4: Potentiometric titration of Mohr's salt solution against standard $K_2Cr_2O_7$ and $KMnO_4$solution
Experiment 5: Determination of K_{sp} for AgCl by potentiometric titration of $AgNO_3$ solution against standard KCl solution
Experiment 6: Determination of heat of neutralization of a strong acid by a strong base

Reference Books

1. Viswanathan, B., Raghavan, P.S. *Practical Physical Chemistry* Viva Books (2009)
2. Mendham, J., A. I. Vogel's Quantitative Chemical Analysis 6th Ed., Pearson
3. Harris, D. C. *Quantitative Chemical Analysis*. 9th Ed., Freeman (2016)

4. Palit, S.R., De, S. K. *Practical Physical Chemistry* Science Book Agency
5. Levitt, B. P. edited *Findlay's Practical Physical Chemistry* Longman Group Ltd.
6. Gurtu, J. N., Kapoor, R., *Advanced Experimental Chemistry* S. Chand & Co. Ltd.
7. *Practical Workbook Chemistry (Honours), UGBS, Chemistry*, University of Calcutta, 2015

CEMA-CC-3-6-TH :

(Credits: Theory-04, Practicals-02)

INORGANIC CHEMISTRY-3

Theory: 60 Lectures

Chemical periodicity **(15 Lectures)**

Modern IUPAC Periodic table, Effective nuclear charge, screening effects and penetration, Slater's rules, atomic radii, ionic radii (Pauling's univalent), covalent radii, lanthanide contraction. Ionization potential, electron affinity and electronegativity (Pauling's, Mulliken's and Allred-Rochow's scales) and factors influencing these properties, group electronegativities.Group trends and periodic trends in these properties in respect of s-, p- and d-block elements.Secondary periodicity, Relativistic Effect, Inert pair effect.

Chemistry of *s* and *p* Block Elements **(30 Lectures)**

Relative stability of different oxidation states, diagonal relationship and anomalous behaviour of first member of each group. Allotropy and catenation.Hydrides and their classification ionic, covalent and interstitial.Basic beryllium acetate and nitrate.Study of the following compounds with emphasis on structure, bonding, preparation, properties and uses.Beryllium hydrides and halides.Boric acid and borates, boron nitrides, borohydrides (diborane) and graphitic compounds, silanes, Oxides and oxoacids of nitrogen, phosphorus, sulphur and chlorine.Peroxo acids of sulphur, sulphur-nitrogen compounds, interhalogen compounds, polyhalide ions, pseudohalogens, fluorocarbons and basic properties of halogens.

Noble Gases:
Occurrence and uses, rationalization of inertness of noble gases, Clathrates; preparation and properties of XeF_2, XeF_4 and XeF_6; Nature of bonding in noble gas compounds (Valence bond treatment and MO treatment for XeF_2 and XeF_4). Xenon-oxygen compounds. Molecular shapes of noble gas compounds (VSEPR theory).

Inorganic Polymers:
Types of inorganic polymers, comparison with organic polymers, synthesis, structural aspects and applications of silicones and siloxanes.Borazines, silicates and phosphazenes.

Coordination Chemistry-I **(15 Lectures)**

Coordinate bonding: double and complex salts. Werner's theory of coordination complexes, Classification of ligands, Ambidentate ligands, chelates, Coordination numbers, IUPAC nomenclature of coordination complexes (up to two metal centers), Isomerism in coordination compounds, constitutional and stereo isomerism, Geometrical and optical isomerism in square planar and octahedral complexes.

Reference Books

1. Lee, J. D. *Concise Inorganic Chemistry, 5th Ed.*, Wiley India Pvt. Ltd., 2008.
2. Huheey, J. E.; Keiter, E.A, & Keiter, R.L. *Inorganic Chemistry, Principles ofStructure and Reactivity 4th Ed.*, Harper Collins 1993, Pearson, 2006.
3. Douglas, B.E. and McDaniel, D.H. *Concepts & Models of Inorganic Chemistry* Oxford, 1970.
4. Porterfield, H. W., *Inorganic Chemistry*, Second Edition, Academic Press, 2005.
5. Purecell, K.F. and Kotz, J.C., *An Introduction toInorganic Chemistry*, Saunders: Philadelphia, 1980.
6. Cotton, F.A., Wilkinson, G., & Gaus, P.L. *Basic Inorganic Chemistry 3rd Ed.;* Wiley India.
7. Gillespie, R. J. and Hargittai, I., The VSEPR Model of Molecular Geometry, Prentice Hall (1992).
8. Albright, T., *Orbital interactions in chemistry*, John Wiley and Sons (2005).
9. Mingos, D.M.P., *Essential trends in inorganic chemistry*. Oxford University Press (1998).
10. Miessler, G. L., Fischer, P. J., Tarr, D. A., *Inorganic Chemistry*, Pearson, 5th Edition.
11. Kaplan, I., *Nuclear Physics*, Addison-Wesley Publishing Company Inc. London, 1964.
12. Friedlander, G., Kennedy, J. W., Macias, E. S. And Miller, J. M., *Nuclear and Radiochemistry*, Wiley, 1981.

CEMA-CC-3-6-P:(45 Lectures)

Complexometric titration

1. Zn(II)
2. Zn(II) in a Zn(II) and Cu(II) mixture.
3. Ca(II) and Mg(II) in a mixture.
4. Hardness of water.
5. Al(III) in Fe(III) and Al(III) in a mixture

Chromatography of metal ions

Principles involved in chromatographic separations. Paper chromatographic separation of following metal ions:

1. Ni (II) and Co (II)
2. Fe (III) and Al (III)

Gravimetry

1. Estimation of Ni(II) using Dimethylglyoxime (DMG).
2. Estimation of copper as CuSCN.
3. Estimation of Al(III) by precipitating with oxine and weighing as $Al(oxine)_3$ (aluminiumoxinate).
4. Estimation of chloride.

Reference Books

3. Mendham, J., *A. I. Vogel's Quantitative Chemical Analysis* 6th Ed., Pearson, 2009.
4. *Practical Workbook Chemistry (Honours), UGBS, Chemistry*, University of Calcutta, 2015

CEMA-CC-3-7-TH :

(Credits: Theory-04, Practicals-02)

ORGANIC CHEMISTRY-3

Theory: 60 Lectures

Chemistry of alkenes and alkynes (15 Lectures)

Addition to C=C:mechanism (with evidence wherever applicable), reactivity, regioselectivity (Markownikoff and anti-Markownikoff additions) and stereoselectivity; reactions: hydrogenation, halogenation, hydrohalogenation, hydration, oxymercuration-demercuration, hydroboration-oxidation, epoxidation, *syn* and *anti*-hydroxylation, ozonolysis, addition of singlet and triplet carbenes; Simmons-Smith cyclopropanation reaction; electrophilic addition to diene (conjugated dienes and allene); radical addition: HBr addition; mechanism of allylic and benzylic bromination in competition with brominations across C=C; use of NBS; Birch reduction of benzenoid aromatics; interconversion of *E*- and *Z*- alkenes; contra-thermodynamic isomerization of internal alkenes.

Addition to C≡C (in comparison to C=C*):*mechanism, reactivity, regioselectivity(Markownikoff and anti-Markownikoff addition) and stereoselectivity; reactions:hydrogenation, halogenations, hydrohalogenation, hydration, oxymercuration-demercuration, hydroboration-oxidation, dissolving metal reduction of alkynes (Birch); reactions of terminal alkynes by exploring its acidity; interconversion of terminal and non-terminal alkynes.

Aromatic Substitution (10 Lectures)

Electrophilic aromatic substitution*:*mechanisms and evidences in favour of it; orientation and reactivity; reactions: nitration, nitrosation, sulfonation, halogenation, Friedel-Crafts reaction; one-carbonelectrophiles (reactions: chloromethylation,

Gatterman-Koch, Gatterman, Houben-Hoesch,Vilsmeier-Haack, Reimer-Tiemann, Kolbe-Schmitt); *Ipso* substitituion.

Nucleophilic aromatic substitution*:*addition-elimination mechanism and evidences in favour of it; S_N1 mechanism; cine substitution (benzyne mechanism), structure of benzyne.

Carbonyl and Related Compounds (30 Lectures)

Addition to C=O: structure, reactivity and preparation of carbonyl compounds; mechanism (with evidence), reactivity, equilibrium and kinetic control; formation of hydrates, cyanohydrins and bisulphite adduct; nucleophilic addition-elimination reactions with alcohols, thiolsand nitrogen- based nucleophiles;reactions: benzoin condensation, Cannizzaro and Tischenko reactions, reactions with ylides: Wittig and Corey-Chaykovsky reaction; Rupe rearrangement, oxidations and reductions: Clemmensen, Wolff-Kishner, $LiAlH_4$, $NaBH_4$, MPV, Oppenauer, Bouveault-Blanc, acyloin condensation; oxidation of alcohols with PDC and PCC; periodic acid and lead tetraacetate oxidation of 1,2-diols.

Exploitation of acidity of α-H of C=O*:* formation of enols and enolates; kinetic and thermodynamic enolates; reactions (mechanism with evidence):halogenation of carbonyl compounds under acidic and basic conditions, Hell-Volhard-Zelinsky (H. V. Z.) reaction, nitrosation, SeO_2 (Riley) oxidation; condensations (mechanism with evidence): Aldol,Tollens', Knoevenagel, Claisen-Schmidt, Claisen ester including Dieckmann, Stobbe; Mannich reaction,Perkin reaction, Favorskii rearrangement; alkylation of active methylene compounds; preparation and synthetic applications of diethyl malonate and ethyl acetoacetate; specific enol equivalents (lithium enolates, enamines and silyl enol ethers) in connection with alkylation, acylation and aldol type reaction.

Nucleophilic addition to α,β-unsaturated carbonyl system*:*general principle and mechanism (with evidence); direct and conjugate addition, addition of enolates (Michael reaction), Stetter reaction, Robinson annulation.

Substitution at sp^2 carbon (C=O system): mechanism (with evidence): $B_{AC}2$, $A_{AC}2$, $A_{AC}1$, $A_{AL}1$ (inconnection to acid and ester); acid derivatives: amides, anhydrides & acyl halides (formation and hydrolysis including comparison).

Organometallics(5 Lectures)

Grignard reagent*; Organolithiums; Gilman cuprates:* preparation and reactions (mechanism with evidence); addition of Grignard and organolithium to carbonyl compounds; substitution on -COX; directed ortho metalation of arenes using organolithiums, conjugate addition by Gilman cuprates; Corey-House synthesis; abnormal behaviour of Grignard reagents; comparison of reactivity among Grignard, organolithiums and organocopper reagents; Reformatsky reaction; Blaise reaction; concept of *umpolung.*

Reference Books

1. Finar, I. L. *Organic Chemistry (Volume 1)*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).

2. Morrison, R. N. & Boyd, R. N. *Organic Chemistry*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
3. Sykes, P. *A guidebook to Mechanism in Organic Chemistry*, Pearson Education, 2003.
4. Carey, F. A., Guiliano, R. M.*Organic Chemistry*, Eighth edition, McGraw Hill Education, 2012.
5. Loudon, G. M. *Organic Chemistry*, Fourth edition, Oxford University Press, 2008.
6. Norman, R.O. C., Coxon, J. M. *Principles of Organic Synthesis*, Third Edition, Nelson Thornes, 2003.
7. Clayden, J., Greeves, N. &Warren, S. *Organic Chemistry*, Second edition, Oxford UniversityPress, 2012.
8. Graham Solomons, T.W., Fryhle, C. B. *Organic Chemistry*, John Wiley & Sons, Inc.
9. Smith, J. G. *Organic Chemistry*, Tata McGraw-Hill Publishing Company Limited.
10. March, J. *Advanced Organic Chemistry*, Fourth edition, Wiley.
11. Jenkins, P. R., *Organometallic Reagents in Synthesis*, Oxford Chemistry Primer, Oxford University Press.
12. Ward, R. S., *Bifunctional Compounds*, Oxford Chemistry Primer, Oxford University Press.

CEMA-CC-3-7-P:(45 Lectures)

A. Identification of a Pure Organic Compound

Solid compounds: oxalic acid, tartaric acid, citric acid, succinic acid, resorcinol, urea, glucose, cane sugar, benzoic acid and salicylic acid

Liquid Compounds: formic acid, acetic acid, methyl alcohol, ethyl alcohol, acetone, aniline, dimethylaniline, benzaldehyde, chloroform and nitrobenzene

B. Quantitative Estimations:

Each student is required to perform all the experiments [Any**FIVE** will be set in the examination]
1. Estimation of glycine by Sörensen's formol method
2. Estimation of glucose by titration using Fehling's solution
3. Estimation of sucrose by titration using Fehling's solution
4. Estimation of aromatic amine (aniline) by bromination (Bromate-Bromide) method
5. Estimation of acetic acid in commercial vinegar
6. Estimation of urea (hypobromite method)
7. Estimation of saponification value of oil/fat/ester

Reference Books

1. Bhattacharyya, R. C, *A Manual of Practical Chemistry.*
2. Vogel, A. I. *Elementary Practical Organic Chemistry*, Part 2: *Qualitative Organic Analysis*, CBS Publishers and Distributors.
3. Mann, F.G. & Saunders, B.C. *Practical Organic Chemistry*, Pearson Education (2009).

4. Furniss, B.S., Hannaford, A.J., Smith, P.W.G., Tatchell, A.R. *Practical Organic Chemistry,5th Ed.*, Pearson (2012).
5. Dutta, S, *B. Sc. Honours Practical Chemistry*, Bharati Book Stall.
6. Arthur, I. Vogel, *Quantitative Organic Analysis*, Pearson
7. *Practical Workbook Chemistry (Honours), UGBS, Chemistry*, University of Calcutta, 2015

SEMESTER-4

CEMA-CC-4-8-TH :

(Credits: Theory-04, Practicals-02)

ORGANIC CHEMISTRY-4

Theory: 60 Lectures

Nitrogen compounds(12 Lectures)

Amines: Aliphatic & Aromatic:preparation, separation (Hinsberg's method) and identification of primary, secondary and tertiary amines; reaction (with mechanism): Eschweiler–Clarke methylation,diazo coupling reaction, formation and reactions of phenylenediamines, diazomethane and diazoacetic ester.

Nitro compounds (aliphatic and aromatic): preparation and reaction (with mechanism): reduction under different conditions; Nef carbonyl synthesis, Henry reaction and conjugate addition of nitroalkane anion.

Alkylnitrile and isonitrile: preparation and reaction (with mechanism): Thorpe nitrile condensation, von Richter reaction.

Diazonium salts and their related compounds: reactions (with mechanism) involving replacement of diazo group; reactions: Gomberg, Meerwein, Japp-Klingermann.

Rearrangements(14 Lectures)

Mechanism with evidence and stereochemical features for the following:

Rearrangement to electron-deficient carbon: Wagner-Meerwein rearrangement, pinacol rearrangement, dienone-phenol; Wolff rearrangement in Arndt-Eistert synthesis, benzil-benzilic acid rearrangement, Demjanov rearrangement, Tiffeneau–Demjanov rearrangement.

Rearrangement to electron-deficient nitrogen: rearrangements: Hofmann, Curtius, Lossen, Schmidt and Beckmann.

Rearrangement to electron-deficient oxygen: Baeyer-Villiger oxidation, cumene hydroperoxide-phenol rearrangement and Dakin reaction.

Aromatic rearrangements:Migration from oxygen to ring carbon: Fries rearrangement and Claisen rearrangement.

Migration from nitrogen to ring carbon: Hofmann-Martius rearrangement**,** Sommelet Hauser rearrangement, Fischer-Hepp rearrangement, *N*-azo to *C*-azo rearrangement, Bamberger rearrangement, Orton rearrangement and benzidine rearrangement.

The Logic of Organic Synthesis(14 Lectures)

*Retrosynthetic analysis:*disconnections; synthons, donor and acceptor synthons; natural reactivity and *umpolung*; latent polarity in bifunctional compounds: illogical electrophiles and nucleophiles; synthetic equivalents; functional group interconversion and addition (FGI and FGA); C-C disconnections and synthesis: one-group and two-group (1,2- to 1,5-dioxygenated compounds), reconnection (1,6-dicarbonyl);protection-deprotection strategy (alcohol, amine, carbonyl, acid).
*Strategy of ring synthesis:*thermodynamic and kinetic factors; synthesis of large rings, application of high dilution technique.
Asymmetric synthesis: stereoselective and stereospecific reactions; diastereoselectivity and enantioselectivity (only definition); diastereoselectivity: addition of nucleophiles to C=O adjacent to a stereogenic centre: Felkin-Anh model.

Organic Spectroscopy **(20 Lectures)**

UV Spectroscopy: introduction;types of electronic transitions, end absorption; transition dipole moment and allowed/forbidden transitions; chromophores and auxochromes; Bathochromic andHypsochromic shifts; intensity of absorptions (Hyper-/Hypochromic effects); application of Woodward's Rules for calculation of λ_{max} for the following systems: conjugated diene, *α,β*-unsaturated aldehydes and ketones(alicyclic, homoannular and heteroannular); extended conjugated systems (dienes, aldehydes and ketones); relative positions of λ_{max} considering conjugative effect, steric effect, solvent effect, effect of pH; effective chromophore concentration: keto-enol systems; benzenoid transitions.
IR Spectroscopy: introduction;modes of molecular vibrations(fundamental and non-fundamental);IR active molecules; application of Hooke's law, force constant; *fingerprint region* and its significance; effect of deuteration; overtone bands; vibrational coupling in IR; characteristic and diagnostic stretching frequencies of C-H, N-H, O-H, C-O, C-N, C-X, C=C (including skeletal vibrations of aromatic compounds), C=O, C=N, N=O, C≡C, C≡N; characteristic/diagnostic bending vibrations are included; factors affecting stretching frequencies: effect of conjugation, electronic effects, mass effect, bond multiplicity, ring-size, solvent effect, H-bonding on IR absorptions; application in functional group analysis.
*NMR Spectroscopy:*introduction;nuclear spin;NMR active molecules;basic principles of Proton Magnetic Resonance; choice of solvent and internal standard; equivalent and non-equivalent protons; chemical shift and factors influencing it; ring current effect;significance of the terms: up-/downfield, shielded and deshielded protons; spin coupling and coupling constant (1st order spectra); relative intensities of *first-order* multiplets: Pascal's triangle; chemical and magnetic equivalence in NMR ; anisotropic effects in alkene, alkyne, aldehydes and aromatics; NMR peak area, integration; relative peak positions with coupling patterns of common organic compounds (both aliphatic and benzenoid-aromatic); rapid proton exchange; interpretation of NMR spectra of simple compounds.
Applications of IR, UV and NMR spectroscopy for identification of simple organic molecules.

Reference Books

1. Finar, I. L. *Organic Chemistry (Volume 1)*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
2. Finar, I. L. *Organic Chemistry* (*Volume 2: Stereochemistry and the Chemistry of Natural Products*), Dorling Kindersley (India) Pvt. Ltd.(Pearson Education).
3. Norman, R.O. C., Coxon, J. M. *Principles of Organic Synthesis*, Third Edition, Nelson Thornes, 2003.
4. Clayden, J., Greeves, N., Warren, S., *Organic Chemistry*, Second edition, Oxford University Press 2012.
5. Silverstein, R. M., Bassler, G. C., Morrill, T. C. *Spectrometric Identification of Organic Compounds*, John Wiley and Sons, INC, Fifth edition.
6. Kemp, W. *Organic Spectroscopy*, Palgrave.
7. Pavia, D. L. *et al. Introduction to Spectroscopy*, 5th Ed. Cengage Learning India Ed. (2015). 8. Dyer, J. *Application of Absorption Spectroscopy of Organic Compounds*, PHI Private Limited
9. March, J. *Advanced Organic Chemistry*, Fourth edition, Wiley.
10. Harwood, L. M., *Polar Rearrangements*, Oxford Chemistry Primer, Oxford University Press.
11. Bailey, Morgan, Organonitrogen Chemistry, Oxford Chemistry Primer, Oxford University Press.
12. Warren, S. *Organic Synthesis the Disconnection Approach*, John Wiley and Sons.
13. Warren, S., *Designing Organic Synthesis*, Wiley India, 2009.
14. Carruthers, W. *Modern methods of Organic Synthesis*, Cambridge University Press.
15. Willis, C. A., Wills, M., *Organic Synthesis*, Oxford Chemistry Primer, Oxford University Press

CEMA-CC-4-8-P: (45 Lectures)

Experiment: Qualitative Analysis of Single Solid Organic Compounds

1. Detection of special elements (N, S, Cl, Br) by Lassaigne's test
2. Solubility and classification (solvents: H_2O, 5% HCl, 5% NaOH and 5% $NaHCO_3$)
3. Detection of the following functional groups by systematic chemical tests: aromatic amino ($-NH_2$), aromatic nitro ($-NO_2$), amido ($-CONH_2$, including imide), phenolic –OH, carboxylic acid (-COOH), carbonyl (distinguish between -CHO and >C=O); only one test for each functional group is to be reported.
4. Melting point of the given compound
5. Preparation, purification and melting point determination of a crystalline derivative of the given compound.
6. Identification of the compound through literature survey.

Each student, during laboratory session, is required to carry out qualitative chemical tests for all the special elements and the functional groups with relevant derivatisation in known and unknown (**at least six)** organic compounds.

Reference Books

1. Vogel, A. I. *Elementary Practical Organic Chemistry*, Part 2: *Qualitative Organic Analysis*, CBS Publishers and Distributors.

2. Mann, F.G. & Saunders, B.C. *Practical Organic Chemistry*, Pearson Education (2009).
3. Furniss, B.S., Hannaford, A.J., Smith, P.W.G., Tatchell, A.R. *Practical Organic Chemistry*, 5th Ed., Pearson (2012).
4. Clarke, H. T., *A Handbook of Organic Analysis (Qualitative and Quantitative)*, Fourth Edition, CBS Publishers and Distributors (2007). 5. *Practical Workbook Chemistry (Honours), UGBS, Chemistry*, University of Calcutta, 2015.

CEMA-CC-4-9-TH :

(Credits: Theory-04, Practicals-02)

PHYSICAL CHEMISTRY 3

Theory: 60 Lectures

Application of Thermodynamics – II (20 lectures)

Colligative properties: Vapour pressure of solution; Ideal solutions, ideally diluted solutions and colligative properties; Raoult's law; Thermodynamic derivation using chemical potential to derive relations between the four colligative properties [(i) relative lowering of vapour pressure, (ii) elevation of boiling point, (iii) Depression of freezing point, (iv) Osmotic pressure] and amount of solute. Applications in calculating molar masses of normal, dissociated and associated solutes in solution;Abnormal colligative properties.

Phase Equilibrium: Definitions of phase, component and degrees of freedom; Phase rule and its derivations; Definition of phase diagram; Phase diagram for water, CO_2, Sulphur.
First order phase transition and Clapeyron equation; Clausius-Clapeyron equation - derivation and use; Ehrenfest Classification of phase transition.
Binary solutions: Liquid vapour equilibrium for two component systems Ideal solution at fixed temperature and pressure; Principle of fractional distillation; Duhem-Margules equation; Henry's law; Konowaloff's rule; Positive and negative deviations from ideal behaviour; Azeotropic solution; Liquid-liquid phase diagram using phenol- water system; Solid-liquid phase diagram; Eutectic mixture
Three component systems, water-chloroform-acetic acid system, triangular plots

Foundation of Quantum Mechanics (25 Lectures)

Beginning of Quantum Mechanics: Black body radiation (Concept only) Wave-particle duality, light as particles: photoelectric and Compton effects; electrons as waves and the de Broglie hypothesis; Uncertainty relations (without proof)
Wave function: Postulates of Quantum Mechanics, Schrodinger time-independent equation; nature of the equation, acceptability conditions for the wave functions and probability interpretations of wave function Vector representation of wave function. Orthonormality of wave function.

Concept of Operators: Elementary concepts of operators, eigenfunctions and eigenvalues; Linear operators; Commutation of operators, commutator and uncertainty relation; Expectation value; Properties of Hermitian operator; Complete set of Eigenfunctions.Expansion of Eigenfunctions.

Particle in a box: Setting up of Schrodinger equation for one-dimensional box and its solution; Comparison with free particle eigenfunctions and eigenvalues. Properties of PB wave functions (normalisation, orthogonality, probability distribution); Expectation values of x, x^2, p_x and p_x^2 and their significance in relation to the uncertainty principle; Extension of the problem to two and three dimensions and the concept of degenerate energy levels.

Crystal Structure ***(15 Lectures)***

Bravais Lattice and Laws of Crystallography: Types of solid, Bragg's law of diffraction; Laws of crystallography (Haüy's law and Steno's law); Permissible symmetry axes in crystals; Lattice, space lattice, unit cell, crystal planes, Bravais lattice. Packing of uniform hard sphere, close packed arrangements (fcc and hcp); Tetrahedral and octahedral voids. Void space in p-type, F-type and I-type cubic systems

Crystal planes: Distance between consecutive planes [cubic, tetragonal and orthorhombic lattices]; Indexing of planes, Miller indices; calculation of d_{hkl}; Relation between molar mass and unit cell dimension for cubic system; Bragg's law (derivation).Determination of crystal structure: Powder method; Structure of NaCl and KCl crystals.

Specific heat of solid: Coefficient of thermal expansion, thermal compressibility of solids; Dulong –Petit's law; Perfect Crystal model, Einstein's theory – derivation from partition function, limitations; Debye's T^3 law – analysis at the two extremes

Reference Books

1. **Levine, I. N. *Physical Chemistry*, 6th Edition , McGraw-Hill India**
2. **Castellan, G. W. *Physical Chemistry*, Narosa**
3. **McQuarrie, D. A. & Simons, J. D. *Physical Chemistry: A Molecular Approach*, Viva Press**
4. **Kapoor K.L, A Text Book Of Physical Chemistry , McGraw Hill India**
5. Engel, T. & Reid, P. *Physical Chemistry*, 3rd Edition ,Pearson India
6. Atkins, P. W. & Paula, J. de *Atkins' Physical Chemistry*, 10th Edition, Oxford University Press
7. Maron, S. & Prutton , *Physical Chemistry*
8. Ball, D. W. *Physical Chemistry*, Thomson Press
9. Mortimer, R. G. *Physical Chemistry*, 2nd Edition, Elsevier
10. Atkins, P. W. *Molecular Quantum Mechanics*, 5th edition ,Oxford
11. Levine, I. N. *Quantum Chemistry*, 7th Edition, Pearson India
12. Sannigrahi A.B, Quantum Chemistry,2nd Edition, Books and Allied Pvt Ltd.
13. Denbigh, K. *The Principles of Chemical Equilibrium* Cambridge University Press
14. Zemansky, M. W. & Dittman, R.H. *Heat and Thermodynamics*, Tata-McGraw-Hil

CEMA-CC-4-9-P :(45 Lectures)

Experiment 1: Kinetic study of inversion of cane sugar using a Polarimeter (Preferably Digital)

Experiment 2: Study of Phase diagram of Phenol-Water system.

Experiment 3: Determination of partition coefficient for the distribution of I_2 between water and CCl_4

Experiment 4: Determination of pH of unknown solution (buffer), by colour matching method

Experiment 5: pH-metric titration of acid (mono- and di-basic) against strong base

Experiment 6 : pH-metric titration of a tribasic acidagainst strong base.

Reference Books

1. Viswanathan, B., Raghavan, P.S. *Practical Physical Chemistry* Viva Books (2009)
2. Mendham, J., A. I. Vogel's Quantitative Chemical Analysis 6th Ed., Pearson
3. Harris, D. C. *Quantitative Chemical Analysis*. 9th Ed., Freeman (2016)
4. Palit, S.R., De, S. K. *Practical Physical Chemistry* Science Book Agency
5. Levitt, B. P. edited *Findlay's Practical Physical Chemistry* Longman Group Ltd.
6. Gurtu, J. N., Kapoor, R., *Advanced Experimental Chemistry* S. Chand & Co. Ltd.
7. *Practical Workbook Chemistry (Honours), UGBS, Chemistry,* University of Calcutta, 2015

CEMA-CC-4-10-TH

(Credits: Theory-04, Practicals-02)

INORGANIC CHEMISTRY-4

Theory: 60 Lectures

Coordination Chemistry-II

(30 Lectures)

VB description and its limitations. Elementary Crystal Field Theory: splitting of d^n configurations in octahedral, square planar and tetrahedral fields, crystal field stabilization energy (CFSE) in weak and strong fields; pairing energy. Spectrochemical series.Jahn- Teller distortion.Octahedral site stabilization energy (OSSE).Metal-ligand bonding (MO concept, elementary idea), sigma- and pi-bonding in octahedral complexes (qualitative pictorial approach) and their effects on the oxidation states of transitional metals (examples). Magnetism and Colour: Orbital and spin magnetic moments, spin only moments of d^n ions and their correlation with effective magnetic

moments, including orbital contribution; quenching of magnetic moment: super exchange and antiferromagnetic interactions (elementary idea with examples only); d-d transitions; L-S coupling; qualitative Orgel diagrams for $3d^1$ to $3d^9$ ions. Racah parameter. Selection rules for electronic spectral transitions; spectrochemical series of ligands; charge transfer spectra (elementary idea).

Chemistry of d- and f- block elements (15 Lectures)

Transition Elements:
General comparison of 3d, 4d and 5d elements in term of electronic configuration, oxidation states, redox properties, coordination chemistry.

Lanthanoids and Actinoids:
General Comparison on Electronic configuration, oxidation states, colour, spectral and magnetic properties; lanthanide contraction, separation of lanthanides (ion-exchange method only).

Reaction Kinetics and Mechanism (15 Lectures)

Introduction to inorganic reaction mechanisms. Substitution reactions in square planar complexes, Trans- effect and its application in complex synthesis, theories of trans effect, Mechanism of nucleophilic substitution in square planar complexes, Thermodynamic and Kinetic stability, Kinetics of octahedral substitution, Ligand field effects and reaction rates, Mechanism of substitution in octahedral complexes.

Reference Books

1. Huheey, J. E.; Keiter, E.A. & Keiter, R.L. *Inorganic Chemistry, Principles ofStructure and Reactivity 4th Ed.*, Harper Collins 1993, Pearson,2006.
2. Greenwood, N.N. & Earnshaw A. *Chemistry of the Elements*, Butterworth-Heinemann, 1997.
3. Cotton, F.A., Wilkinson, G., Murrillo, C. A., Bochmann, M., *Advanced Inorganic Chemistry 6th Ed. 1999.*,Wiley.
4. Miessler, G. L. & Donald, A. Tarr. *Inorganic Chemistry* 4th Ed., Pearson, 2010.
5. Purecell, K.F. and Kotz, J.C., *An Introduction toInorganic Chemistry*, Saunders: Philadelphia, 1980.
6. Mingos, D.M.P., *Essential trends in inorganic chemistry*. Oxford University Press (1998).

CEMA-CC-4-10-P (45 Lectures)

Inorganic preparations

1. $[Cu(CH_3CN)_4]PF_6/ClO_4$
2. *Cis* and *trans* $K[Cr(C_2O_4)_2\ (H_2O)_2]$

3. Potassium diaquadioxalatochromate(III)
4. Tetraamminecarbonatocobalt (III) ion
5. Potassium tris(oxalato)ferrate(III)
6. Tris-(ethylenediamine) nickel(II) chloride.
7. $[Mn(acac)_3]$ and $Fe(acac)_3]$ (acac= acetylacetonate)

Instrumental Techniques

1. Measurement of 10Dq by spectrophotometric method.
2. Determination of λ_{max} of $[Mn(acac)_3]$ and $[Fe(acac)_3]$ complexes.

Reference Books

1. Mendham, J., *A. I. Vogel's Quantitative Chemical Analysis* 6th Ed., Pearson, 2009.
2. *Inorganic Synthesis*, Vol. 1-10.

SEMESTER-5

CEMA-CC-5-11-TH :

(Credits: Theory-04, Practicals-02)

PHYSICAL CHEMISTRY - 4

Theory: 60 Lectures

Quantum Chemistry II **(30 Lectures)**

Simple Harmonic Oscillator:Setting up of One dimensional Schrödinger equation and discussion of solution and wave functions. Classical turning points, Expectation values of x, x^2, p_x and p_x^2 .

Angular momentum: Commutation rules, quantization of square of total angular momentum and z-component; Rigid rotator model of rotation of diatomic molecule; Schrödinger equation, transformation to spherical polar coordinates; Separation of variables. Spherical harmonics; Discussion of solution

Hydrogen atom and hydrogen-like ions: Setting up of Schrödinger equation in spherical polar coordinates, Separation of variables, Solution of angular Part (φ part only), quantization of energy (only final energy expression); Real wave functions. Average and most probable distances of electron from nucleus; Setting up of Schrödinger equation for many-electron atoms (He, Li)Need for approximation methods. Statement of variation theorem and application to simple systems(particle-in-a-box, harmonic oscillator, hydrogen atom).

LCAO :Born-Oppenheimer approximation. Covalent bonding, valence bond and molecular orbital approaches, LCAO-MO treatment of H_2^+; Bonding and antibonding orbitals; Qualitative extension to H_2; Comparison of LCAO-MO and VB treatments of H_2 and their limitations.(only wavefunctions, detailed solutionnot required) and their limitations.

Statistical Thermodynamics **(20 Lectures)**

Configuration: Macrostates, microstates and configuration; calculation with harmonic oscillator; variation of W with E; equilibrium configuration

Boltzmann distribution: Thermodynamic probability, entropy and probability, Boltzmann distribution formula (with derivation); Applications to barometric distribution; Partition function, concept of ensemble - canonical ensemble and grand canonical ensembles

Partition function: molecular partition function and thermodynamic properties,

3^{rd} law: Absolute entropy, Plank's law, Calculation of entropy, Nernst heat theorem

Adiabatic demagnetization: Approach to zero Kelvin, adiabatic cooling, demagnetization, adiabatic demagnetization – involved curves

Numerical Analysis **(10 Lectures)**

Roots of Equation:Numerical methods for finding the roots of equations: Quadratic Formula, Iterative Methods (e.g., Newton Raphson Method).
Least-Squares Fitting.Numerical Differentiation.Numerical Integration(Trapezoidal and Simpson's Rule)

Reference Books

1. **Levine, I. N. *Physical Chemistry*, 6th Edition McGraw-Hill India**
2. **Castellan, G. W. *Physical Chemistry*, Narosa**
3. **McQuarrie, D. A. & Simons, J. D. *Physical Chemistry: A Molecular Approach*, Viva Press**
4. **Kapoor K.L, A Text Book Of Physical Chemistry , McGraw Hill India**
5. Engel, T. & Reid, P. *Physical Chemistry*, 3rd Edition Pearson India
6. Atkins, P. W. & Paula, J. de *Atkins' Physical Chemistry*, 10th Edition Oxford University Press
7. Levine, I. N. *Quantum Chemistry*, 7th Edition,Pearson India
8. Maron, S. & Prutton *Physical Chemistry*
9. Ball, D. W. *Physical Chemistry*, Thomson Press
10. Mortimer, R. G. *Physical Chemistry*, Elsevier
11. Glasstone, S. & Lewis, G.N. *Elements of Physical Chemistry*
12. Rakshit, P.C., *Physical Chemistry* Sarat Book House
14. Klotz, I.M., Rosenberg, R. M. *Chemical Thermodynamics:Basic Concepts and Methods* , Wiley
15. Sannigrahi A.B, Quantum Chemistry,2nd Edition, Books and Allied Pvt Ltd.
16. Atkins, P. W. *Molecular Quantum Mechanics*, 5th edition ,Oxford
17. Moore, W. J. *Physical Chemistry*, Orient Longman
18. Nash, L. K. *Elements of Statistical Thermodynamics*, Dover
19. V. Rajaraman, Computer Oriented Numerical Methods, PHI Learning, 2013
20. V. Rajaraman, Computer Programming in FORTRAN 77, Prentice Hall, 1997
21. Martin Cwiakala, Schaum's Outline of Programming with FORTRAN 77, 1995

CEMA-CC-5-11-P :(45 Lectures)

Computer programs(Using FORTRAN or C or C ++) based on numerical methods :

Programming 1: Roots of equations: (e.g. volume of van der Waals gas and comparison with ideal gas, pH of a weak acid)

Programming 2: Numerical differentiation (e.g., change in pressure for small change in volume of a van der Waals gas, Potentiometric titrations)

Programming 3: Numerical integration (e.g. entropy/ enthalpy change from heat capacity data), probability distributions (gas kinetic theory) and mean values

Reference Books

1. McQuarrie, D. A. *Mathematics for PhysicalChemistry*. University Science Books (2008)

2. Mortimer, R. *Mathematics for Physical Chemistry*. 3rd Ed. Elsevier (2005)
3. Yates, P. *Chemical Calculations*. 2nd Ed. CRC Press (2007)
4. Harris, D. C. *Quantitative Chemical Analysis*. 6th Ed., Freeman (2007) Chapters 3-5
5. Let us C, Yashvant Kanetkar, BPB Publication, 15th Edition, 2016

CEMA-CC-5-12-TH :

(Credits: Theory-04, Practicals-02)

ORGANIC CHEMISTRY - 5

Theory: 60 Lectures

Carbocyles and Heterocycles **(16 lectures)**

*Polynuclear hydrocarbonsand their derivatives:*synthetic methods include Haworth, Bardhan-Sengupta, Bogert-Cook and other useful syntheses (with mechanistic details);fixation of double bonds and Fries rule;reactions (with mechanism) of naphthalene, anthraceneand phenanthrene and their derivatives.
*Heterocyclic compounds:*Biological importance of heterocycles referred in the syllabus; 5- and 6-membered rings with one heteroatom; reactivity, orientation and important reactions (with mechanism) of furan, pyrrole,thiophene and pyridine; synthesis (including retrosynthetic approach and mechanistic details): pyrrole: Knorr synthesis, Paal-Knorr synthesis, Hantzsch; furan: Paal-Knorr synthesis, Feist-Benary synthesis and its variation; thiophenes: Paal-Knorr synthesis, Hinsberg synthesis; pyridine: Hantzsch synthesis;benzo-fused 5-and 6-membered rings with one heteroatom: reactivity, orientation and important reactions (with mechanistic details) of indole, quinoline and isoquinoline; synthesis (including retrosynthetic approachand mechanistic details): indole: Fischer,quinoline: Skraup, isoquinoline: Bischler-Napieralski synthesis.

Cyclic Stereochemistry **(10 Lectures)**

*Alicyclic compounds:*concept of I-strain (Baeyer's strain theory); conformational analysis: cyclohexane, mono and disubstituted cyclohexane; symmetry properties and optical activity; topomerisation; ring size and ease of cyclisation; conformation & reactivity in cyclohexane system: consideration of steric and stereoelectronic requirements; elimination (E2, E1), nucleophilic substitution (S_N1, S_N2, S_Ni, NGP), merged substitution-elimination; rearrangements; oxidation of cyclohexanol, esterification, saponification, lactonisation, epoxidation, pyrolytic *syn* elimination and fragmentation reactions.

Pericyclic reactions **(08 Lectures)**

Mechanism, stereochemistry, regioselectivity in case of

Electrocyclic reactions: FMO approach involving 4π- and 6π-electrons (thermal and photochemical) and corresponding cycloreversion reactions.
Cycloaddition reactions: FMOapproach, Diels-Alder reaction, photochemical [2+2] cycloadditions.
*Sigmatropic reactions:*FMO approach,sigmatropic shifts and their order; [1,3] and [1,5] H shifts and [3,3] shifts with reference to Claisen and Cope rearrangements.

Carbohydrates **(14 Lectures)**

Monosaccharides: Aldoses up to 6 carbons; structure of D-glucose & D-fructose (configuration & conformation); ring structure of monosaccharides (furanose and pyranose forms): Haworth representations and non-planar conformations; anomeric effect (including stereoelectronic explanation); mutarotation; epimerization; reactions (mechanisms in relevant cases): Fischer glycosidation, osazone formation, bromine-water oxidation, HNO_3 oxidation, selective oxidation of terminal –CH_2OH of aldoses, reduction to alditols, Lobry de Bruyn-van Ekenstein rearrangement; stepping–up (Kiliani-Fischer method) and stepping–down (Ruff's &Wohl's methods) of aldoses; end-group-interchange of aldoses; acetonide (isopropylidene and benzylidene protections; ring size determination; Fischer's proof of configuration of (+)-glucose.
Disaccharides: Glycosidic linkages, concept of glycosidic bond formation by glycosyl donor-acceptor, structure of sucrose, inversion of cane sugar.

Biomolecules **(12 Lectures)**

*Aminoacids:*synthesis with mechanistic details: Strecker, Gabriel; acetamido malonic ester, azlactone, Bücherer hydantoin synthesis, synthesis involving diketopiperizine, isoelectric point, zwitterions; electrophoresis, reaction (with mechanism): ninhydrin reaction, Dakin-West reaction; resolution of racemic amino acids.
*Peptides:*peptide linkage and its geometry; syntheses (with mechanistic details) of peptides using *N*-protection & C-protection, solid-phase (Merrifield) synthesis; peptide sequence: *C*-terminal and *N*-terminal unit determination (Edman, Sanger and 'dansyl'methods); partial hydrolysis; specific cleavage of peptides; use of CNBr.
*Nucleic acids:*pyrimidine and purine bases (only structure & nomenclature); nucleosides and nucleotides corresponding to DNA and RNA;mechanism for acid catalysed hydrolysis of nucleosides (both pyrimidine and purine types); comparison of alkaline hydrolysis of DNA and RNA; elementary idea of double helical structure of DNA (Watson-Crick model); complimentary base–pairing in DNA.

Reference Books

1. Clayden, J., Greeves, N., Warren, S. *Organic Chemistry*, Second edition, Oxford University Press 2012.
2. Eliel, E. L. & Wilen, S. H. *Stereochemistry of Organic Compounds*, Wiley: London.
3. Nasipuri, D. *Stereochemistry of Organic Compounds*, Wiley Eastern Limited.
4. Fleming, I. *Molecular Orbitals and Organic Chemical reactions*, Reference/Student Edition, Wiley, 2009.
5. Fleming, I. *Pericyclic Reactions*, Oxford Chemistry Primer, Oxford University Press.

6. Gilchrist, T. L. & Storr, R. C. *Organic Reactions and Orbital symmetry*, Cambridge University Press.
7. Finar, I. L. *Organic Chemistry (Volume 1),* Dorling Kindersley (India) Pvt. Ltd.(Pearson Education).
8. Finar, I. L. *Organic Chemistry* (*Volume 2: Stereochemistry and the Chemistry of Natural Products*), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
9. Morrison, R. T. & Boyd, R. N. *Organic Chemistry*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
10. Loudon, G. M. *Organic Chemistry*, Fourth edition, Oxford University Press.
11. James, J., Peach, J. M. *Stereochemistry at a Glance*, Blackwell Publishing, 2003.
12. Robinson, M. J. T., *Stereochemistry*, Oxford Chemistry Primer, Oxford University Press, 2005.
13. Davis, B. G., Fairbanks, A. J., *Carbohydrate Chemistry*, Oxford Chemistry Primer, Oxford University Press.
14. Joule, J. A. Mills, K. *Heterocyclic Chemistry*, Blackwell Science.
15. Acheson, R.M. *Introduction to the Chemistry of Heterocyclic compounds*, John Wiely & Sons (1976).
16. Gilchrist, T. L. *Heterocyclic Chemistry*, 3rd edition, Pearson.
17. Davies, D. T., *Heterocyclic Chemistry*, Oxford Chemistry Primer, Oxford University Press

CEMA-CC-5-12-P:(45 Lectures)

A. Chromatographic Separations

1. TLC separation of a mixture containing 2/3 amino acids
2. TLC separation of a mixture of dyes (fluorescein and methylene blue)
3.Column chromatographic separation of mixture of dyes
4.Paper chromatographic separation of a mixture containing 2/3 amino acids
5. Paper chromatographic separation of a mixture containing 2/3 sugars

B. **Spectroscopic Analysis of Organic Compounds**

1. Assignment of labelled peaks in the ^{1}H NMR spectra of the known organic compounds explaining the relative δ-values and splitting pattern.
2. Assignment of labelled peaks in the IR spectrum of the same compound explaining the relative frequencies of the absorptions (C-H, O-H, N-H, C-O, C-N, C-X, C=C, C=O, N=O, C≡C, C≡N stretching frequencies; **characteristic bending vibrations are included**).
3. The students must record full spectral analysis of **at least 15 (fifteen)** compounds from the following list:

(i) 4′-Bromoacetanilide (ii) 2-Bromo-4'-methylacetophenone (iii) Vanillin (iv) 2′-Methoxyacetophenone (v) 4-Aminobenzoic acid (vi) Salicylamide (vii) 2′-Hydroxyacetophenone (viii) 1,3-Dinitrobenzene (ix) *trans*-Cinnamic acid (x) Diethyl fumarate (xi) 4-Nitrobenzaldehyde (xii) 4′-Methylacetanilide (xiii) Mesityl oxide (xiv) 2-Hydroxybenzaldehyde (xv) 4-Nitroaniline (xvi) 2,3-Dimethylbenzonitrile (xvii) Pent-

1-yn-3-ol (xviii) 3-Nitrobenzaldehyde (xix) 3-Aminobenzoic acid (xx) Ethyl 3-aminobenzoate (xxi) Ethyl 4-aminobenzoate (xxii) 3-nitroanisole.

Reference Books

1. *Practical Workbook Chemistry (Honours), UGBS, Chemistry*, University of Calcutta, 2015

2. Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. *Practical Organic Chemistry, 5th Ed.*, Pearson (2012).

3. Mann, F.G. & Saunders, B.C. *Practical Organic Chemistry*, Pearson Education.

SEMESTER- 6

CEMA-CC-6-13-TH:

(Credits: Theory-04, Practicals-02)

INORGANIC CHEMISTRY-5

Theory: 60 Lectures

Theoretical Principles in Qualitative Analysis (10 Lectures)

Basic principles involved in analysis of cations and anions and solubility products, commonion effect. Principles involved in separation of cations into groups and choice of group reagents. Interfering anions (fluoride, borate, oxalate and phosphate) and need to remove them after Group II.

Bioinorganic Chemistry **(25 Lectures)**

Elements of life: essential and beneficial elements, major, trace and ultratrace elements. Basic chemical reactions in the biological systems and the role of metal ions (specially Na^+, K^+, Mg^{2+}, Ca^{2+}, $Fe^{3+}/^{2+}$, $Cu^{2+}/^{+}$, and Zn^{2+}). Metal ion transport across biological membrane Na^+/ K^+-ion pump. Dioxygen molecule in life. Dioxygen management proteins: Haemoglobin, Myoglobin, Hemocyanine and Hemerythrin. Hydrolytic enzymes: carbonate bicarbonate buffering system and carbonic anhydrase and carboxyanhydrase A. Toxic metal ions and their effects, chelation therapy (examples only), Pt and Au complexes as drugs (examples only), metal dependent diseases (examples only)

Organometallic Chemistry **(25 Lectures)**

Definition and classification of organometallic compounds on the basis of bond type.Concept of hapticity of organic ligands.18-electron and 16-electron rules (pictorial MO approach).Applications of 18-electron rule to metal carbonyls, nitrosyls, cyanides. General methods of preparation of mono and binuclear carbonyls of 3d series. Structures of mononuclear and binuclear carbonyls.pi-acceptor behaviour of CO, synergic effect and use of IR data to explain extent of back bonding. Zeise's salt: Preparation, structure, evidences of synergic effect. Ferrocene: Preparation and reactions (acetylation, alkylation, metallation, Mannich Condensation). Reactions of organometallic complexes: substitution, oxidative addition, reductive elimination and insertion reactions.

Catalysis by Organometallic Compounds

Study of the following industrial processes

1. Alkene hydrogenation (Wilkinson's Catalyst)
2. Hydroformylation
3. Wacker Process
4. Synthetic gasoline (Fischer Tropsch reaction)

5. Ziegler-Natta catalysis for olefin polymerization.

Reference Books

1. Lippard, S.J. & Berg, J.M. *Principles of Bioinorganic Chemistry* Panima Publishing Company 1994.
2. Huheey, J. E.; Keiter, E.A. & Keiter, R.L. *Inorganic Chemistry, Principles ofStructure and Reactivity 4th Ed.*, Harper Collins 1993, Pearson,2006.
3. Greenwood, N.N. & Earnshaw A. *Chemistry of the Elements*, Butterworth-Heinemann, 1997.
4. Cotton, F.A., Wilkinson, G., Murrillo, C. A., Bochmann, M., *Advanced Inorganic Chemistry 6th Ed. 1999.*,Wiley.
5. Bertini, I., Gray, H. B., Lippard, S.J., Valentine, J. S., Viva, 2007.
6. Basolo, F, and Pearson, R.C. *Mechanisms of Inorganic Chemistry*, John Wiley & Sons, NY, 1967.
7. Purecell, K.F. and Kotz, J.C., *An Introduction toInorganic Chemistry*, Saunders: Philadelphia, 1980.
8. Powell, P. *Principles of Organometallic Chemistry*, Chapman and Hall, 1988.
9. Collman, J. P. *et al. Principles and Applications of Organotransition MetalChemistry*. Mill Valley, CA: University Science Books, 1987.
10. Crabtree, R. H. *The Organometallic Chemistry of the Transition Metals*. New York, NY: John Wiley, 2000.

CEMA-CC-6-13-P: (45 Lectures)

Qualitative semimicro analysis of mixtures containing not more than three radicals. Emphasis should be given to the understanding of the chemistry of different reactions.

Cation Radicals: Na^+,K^+, Ca^{2+}, Sr^{2+}, Ba^{2+}, Al^{3+}, Cr^{3+}, Mn^{2+}/Mn^{4+}, Fe^{3+}, Co^{2+}/Co^{3+}, Ni^{2+}, Cu^{2+}, Zn^{2+}, Pb^{2+}, Cd^{2+} (Demo), Bi^{3+} (Demo), Sn^{2+}/Sn^{4+}, As^{3+}/As^{5+}, $Sb^{3+/5+}$ (Demo), NH_4^+, Mg^{2+} (Demo).

Anion Radicals: F^-, Cl^-, Br^-, BrO_3^-, I^-, IO_3^-, SCN^-, S^{2-}, SO_4^{2-}, NO_3^-, NO_2^-, PO_4^{3-}, AsO_4^{3--}, BO_3^{3-}, CrO_4^{2-} / $Cr_2O_7^{2-}$, $Fe(CN)_6^{4-}$, $Fe(CN)_6^{3-}$.

Insoluble Materials: Al_2O_3(ig), Fe_2O_3(ig), Cr_2O_3(ig), SnO_2, $SrSO_4$, $BaSO_4$, CaF_2, $PbSO_4$.

Reference Books

1. Svehla, G., *Vogel's Qualitative Inorganic Analysis*, Pearson Education, 2012.*2. Practical Workbook Chemistry (Honours), UGBS, Chemistry*, University of Calcutta, 2015

CEMA-CC-6-14-TH:

(Credits: Theory-04, Practicals-02)

PHYSICAL CHEMISTRY-5

Theory: 60 Lectures

Molecular Spectroscopy (25 Lectures)

Interaction of electromagnetic radiation with molecules and various types of spectra;
Rotation spectroscopy: Selection rules, intensities of spectral lines, determination of bond lengths of diatomic and linear triatomic molecules, isotopic substitution
Vibrational spectroscopy: Classical equation of vibration, computation of force constant, amplitude of diatomic molecular vibrations, anharmonicity, Morse potential, dissociation energies, fundamental frequencies, overtones, hot bands, degrees of freedom for polyatomic molecules, modes of vibration, Diatomic vibrating rotator, P, Q, R branches
Electronic Spectroscopy: Potential energy curves (diatomic molecules), Frank-Condon principle and vibrational structure of electronic spectra; Frank Condon factor. Bond dissociation and principle of determination of dissociation energy (ground state); Decay of excited states by radiative and non-radiative paths; Pre-dissociation; Fluorescence and phosphorescence, Jablonskii diagram;

Raman spectroscopy: Classical Treatment. Rotational Raman effect; Vibrational Raman spectra, Stokes and anti-Stokes lines; their intensity difference, rule of mutual exclusion

Photochemistry and Theory of reaction rate: (15 Lectures)

Lambert-Beer's law: Characteristics of electromagnetic radiation, Lambert-Beer's law and its limitations, physical significance of absorption coefficients; Laws of photochemistry, Stark-Einstein law of photochemical equivalence quantum yield, actinometry, examples of low and high quantum yields
Rate of Photochemical processes: Photochemical equilibrium and the differential rate of photochemical reactions, Photostationary state; HI decomposition, H_2-Br_2 reaction, dimerisation of anthracene; photosensitised reactions, quenching; Role of photochemical reactions in biochemical processes, chemiluminescence

Collision theory of reaction rate (detailed treatment). Lindemann theory of unimolecular reaction; Outline of Transition State theory (classical treatment) . Primary Kinetic Salt Effect.

Surface phenomenon (15 Lectures)

Surface tension and energy:

Surface tension, surface energy, excess pressure, capillary rise and surface tension; Work of cohesion and adhesion, spreading of liquid over other surface; Vapour pressure over curved surface; Temperature dependence of surface tension

Adsorption:

Physical and chemical adsorption; Freundlich and Langmuir adsorption isotherms; multilayer adsorption and BET isotherm (no derivation required); Gibbs adsorption isotherm and surface excess; Heterogenous catalysis (single reactant);

Colloids:

Lyophobic and lyophilic sols, Origin of charge and stability of lyophobic colloids, Coagulation and Schultz-Hardy rule, Zeta potential and Stern double layer (qualitative idea), Tyndall effect; Electrokinetic phenomena (qualitative idea only); Stability of colloids and zeta potential; Micelle formation

Dipole moment and polarizability: **(05 Lectures)**

Polarizability of atoms and molecules, dielectric constant and polarisation, molar polarisation for polar and non-polar molecules; Clausius-Mosotti equation and Debye equation (both without derivation) and their application; Determination of dipole moments

Reference Books

1. **Levine, I. N. *Physical Chemistry*, 6th Edition , McGraw-Hill India**
2. **Castellan, G. W. *Physical Chemistry*, Narosa**
3. **McQuarrie, D. A. & Simons, J. D. *Physical Chemistry: A Molecular Approach*, Viva Press**
4. **Kapoor K.L, A Text Book Of Physical Chemistry , McGraw Hill India**
5. Engel, T. & Reid, P. *Physical Chemistry*, 3rd Edition ,Pearson India
6. Atkins, P. W. & Paula, J. de *Atkins' Physical Chemistry*, 10th Edition, Oxford University Press
7. Maron, S. & Prutton , *Physical Chemistry*
8. Ball, D. W. *Physical Chemistry*, Thomson Press
9. Mortimer, R. G. *Physical Chemistry*, 2nd Edition, Elsevier
10. Banwell, C. N. Fundamentals of Molecular Spectroscopy, Tata-McGraw-Hill
11. Barrow, G. M. Molecular Spectroscopy, McGraw-Hill
12. Hollas, J.M. Modern Spectroscopy, Wiley India
13. McHale, J. L. Molecular Spectroscopy, Pearson Education
14. Wayne, C. E. & Wayne, R. P. Photochemistry, OUP
15. Brown, J. M. Molecular Spectroscopy, OUP

CEMA-CC-6-14-P: (45 Lectures)

Experiment 1: Determination of surface tension of a liquid using Stalagmometer
Experiment 2: Determination of the indicator constant of an acid base indicator spectrophotometrically
Experiment 3: Verification of Beer and Lambert's Law for $KMnO_4$ and $K_2Cr_2O_7$ solution
Experiment 4: Study of kinetics of $K_2S_2O_8$ + KI reaction, spectrophotometrically
Experiment 5: Determination of pH of unknown buffer, spectrophotometrically
Experiment 6: Determination of CMC of a micelle from Surface Tension Measurement.

Reference Books

1. Viswanathan, B., Raghavan, P.S. *Practical Physical Chemistry* Viva Books (2009)
2. Mendham, J., A. I. Vogel's Quantitative Chemical Analysis 6th Ed., Pearson
3. Harris, D. C. *Quantitative Chemical Analysis*. 6th Ed., Freeman (2007)
4. Palit, S.R., De, S. K. *Practical Physical Chemistry* Science Book Agency
5. Levitt, B. P. edited *Findlay's Practical Physical Chemistry* Longman Group Ltd.
6. Gurtu, J. N., Kapoor, R., *Advanced Experimental Chemistry* S. Chand & Co. Ltd.

DISCIPLINE SPECIFIC ELECTIVE COURSES

Semester 5

1. Any one from DSEA-1 and DSEA-2
2. Any one from DSEB-1 and DSEB-2

Semester 6

3. Any one from DSEA-3 and DSEA-4
4. Any one from DSEB-3 and DSEB-4

DSE-A

DSE A-1: MOLECULAR MODELLING AND DRUG DESIGN

(Credits: Theory-04, Practicals-02)
Theory: 60 Lectures

Introduction to Molecular Modelling: (8 Lectures)
Introduction. Useful Concepts in Molecular Modelling: Coordinate Systems. Potential Energy Surfaces. Molecular Graphics Surfaces.

Force Fields: (12 Lectures)
Bond Stretching.Angle Bending.Introduction to nonbonded interactions. Electrostatic interactions.van der Waals Interactions. Hydrogen bonding in Molecular Mechanics.Force Field Models for the Simulation of Liquid Water.

Energy Minimization and Computer Simulation: (12 Lectures)
Minimization and related methods for exploring the energy surface. Non-derivative method, First and second order minimization methods. Computer simulation methods.Simple thermodynamic properties and Phase Space Boundaries. Analyzing the results of a simulation and estimating Errors

Molecular Dynamics & Monte Carlo Simulation: (16 Lectures)
Molecular Dynamics Simulation Methods.Molecular Dynamics using simple models. Molecular Dynamics with continuous potentials. Molecular Dynamics at constant temperature and pressure. Metropolis method.Monte Carlo simulation of molecules.

Structure Prediction and Drug Design: (12 Lectures)
Structure prediction - Introduction to comparative Modeling.Sequence alignment. Constructing and evaluating a comparative model. Predicting protein structures by 'Threading', Molecular docking. Structure based de novo ligand design, QSAR.

Reference Books:

1. A.R. Leach, Molecular Modelling Principles and Application, Longman, 2001.
2. J.M. Haile, Molecular Dynamics Simulation Elementary Methods, John Wiley and Sons, 1997.
3. Satya Prakash Gupta, QSAR and Molecular Modeling, Springer - Anamaya Publishers, 2008.

PRACTICAL- DSE A-1: MOLECULAR MODELLING & DRUG DESIGN

(45 Lectures)

i. Compare the optimized C-C bond lengths in ethane, ethene, ethyne and benzene. Visualize the molecular orbitals of the ethane σ bonds and ethene, ethyne, benzene and pyridine π bonds.
ii. (a) Perform a conformational analysis of butane. (b) Determine the enthalpy of isomerization of *cis* and *trans* 2-butene.
iii. Visualize the electron density and electrostatic potential maps for LiH, HF, N2, NO and CO and comment. Relate to the dipole moments. Animate the vibrations of these molecules.
iv. (a) Relate the charge on the hydrogen atom in hydrogen halides with their acid character. (b) Compare the basicities of the nitrogen atoms in ammonia, methylamine, dimethylamine and trimethylamine.
v. (a) Compare the shapes of the molecules: 1-butanol, 2-butanol, 2-methyl-1-propanol, and 2-methyl-2-propanol. Note the dipole moment of each molecule. (b) Show how the shapes affect the trend in boiling points: (118 ºC, 100 ºC, 108 ºC, 82 ºC, respectively).
vi. Build and minimize organic compounds of your choice containing the following functional groups. Note the dipole moment of each compound: (a) alkyl halide (b) aldehyde (c) ketone (d) amine (e) ether (f) nitrile (g) thiol (h) carboxylic acid (i) ester (j) amide.
vii. (a) Determine the heat of hydration of ethylene. (b) Compute the resonance energy of
benzene by comparison of its enthalpy of hydrogenation with that of cyclohexene.
viii. Arrange 1-hexene, 2-methyl-2-pentene, (*E*)-3-methyl-2-pentene, (*Z*)-3-methyl-2-pentene, and 2,3-dimethyl-2-butene in order of increasing stability.
ix. (a) Compare the optimized bond angles H2O, H2S, H2Se. (b) Compare the HAH bond
angles for the second row dihydrides and compare with the results from qualitative MO theory.
Note: Software: ChemSketch, ArgusLab (www.planaria-software.com), TINKER 6.2 (dasher.wustl.edu/ffe), WebLab Viewer, Hyperchem, VMD, or any similar software.

Reference Books:

1) A.R. Leach, Molecular Modelling Principles and Application, Longman, 2001.
2) J.M. Haile, Molecular Dynamics Simulation Elementary Methods, John Wiley and Sons, 1997.

3) Satya Prakash Gupta, QSAR and Molecular Modeling, Springer - Anamaya Publishers, 2008.

DSE-A-2: APPLICATIONS OF COMPUTERS IN CHEMISTRY

(Credits: Theory-04, Practicals-02)

Theory: 60 Lectures

Computer Programming Basics (FORTRAN): (Lectures: 20)

Elements ofFORTRAN Language.FORTRAN Keywords and commands, Logical and Relational Operators, iteration, Array variables, Matrix addition and multiplication.Function and Subroutine.

Introduction to Spreadsheet Software(MS Excel): (Lectures 25)

Creating a Spreadsheet, entering and formatting information, basic functions and formulae, creating charts, tables and graphs. Incorporating tables and graphs into word processing documents, simple calculations.

Solution of simultaneous equations(for eg: in chemical Equilibrium problems) using Excel **SOLVER** Functions. Use of Excel **Goal Seek** function.

Numerical Modelling: Simulation of pH metric titration curves, Excel functions **LINEST** and Least Squares. Numerical Curve Fitting, Regression, Numerical Differentiation and Integration

Statistical Analysis: (Lectures: 15)

Gaussian Distribution and Errors in Measurement and their effect on data sets. Descriptive Statistics using Excel, Statistical Significance Testing, the T test and the F test.

Reference Books

1. McQuarrie, D. A. Mathematics for Physical Chemistry University Science Books (2008).
2. Mortimer, R. Mathematics for Physical Chemistry. 3rd Ed. Elsevier (2005).
3. Steiner, E. The Chemical Maths Book Oxford University Press (1996).
4. Yates, P. Chemical calculations. 2nd Ed. CRC Press (2007).
5. Harris, D. C. Quantitative Chemical Analysis. 6th Ed., Freeman (2007) Chapters 3-5.

6. Levie, R. de, How to use Excel in analytical chemistry and in general scientific data analysis, Cambridge Univ. Press (2001)
7. Noggle, J. H. Physical chemistry on a Microcomputer. Little Brown & Co. (1985).
8. S. R. Crouch, F. J. Holler, Applications of MS Excel in Analytical Chemistry, Thomson, 2004.
9. V. Rajaraman, Computer Programming in FORTRAN 77, Prentice Hall, 1997
10. Martin Cwiakala, Schaum's Outline of Programming with FORTRAN 77, 1995

PRACTICALS DSE-A-2: APPLICATIONS OF COMPUTERS IN CHEMISTRY

(45 Lectures)

(At least 10 experiments are to be performed.)

1. Plotting of Graphs using a spreadsheet. (Planck's Distribution Law, Maxwell Boltzmann Distribution Curves as a function of temperature and molecular weight)
2. Determination of vapour pressure from Van der Waals Equation of State.
3. Determination of rate constant from Concentration-time data using **LINEST** function.
4. Determination of Molar Extinction Coefficient from Absorbent's data using **LINEST** function.
5. Determination of concentration simultaneously using Excel **SOLVER** Function.(For eg: Determination of $[OH^-]$, $[Mg^{2+}]$ and $[H_3O^+]$ from K_{sp} and K_w data of $Mg(OH)_2$.)
6. Simultaneous Solution of Chemical Equilibrium Problems to determine the equilibrium compositions from the Equilibrium Constant data at a given Pressure and Temperature.
7. Determination of Molar Enthalpy of Vaporization using Linear and Non Linear Least squares fit.
8. Calculation and Plotting of a Precipitation Titration Curve with MS Excel.
9. Acid-Base Titration Curve using Excel **Goal Seek** Function.
10. Plotting of First and Second Derivative Curve for pH metric and Potentiometric titrations .
11. Use of spreadsheet to solve the 1D Schrodinger Equation(Numerov Method).
12. Michaelis-Menten Kinetics for Enzyme Catalysis using Linear and Non - Linear Regression

Reference Books

1. Levie, R. de, How to use Excel in analytical chemistry and in general scientific data analysis, Cambridge Univ. Press (2001)
2. S. R. Crouch, F. J. Holler, Applications of MS Excel in Analytical Chemistry, Thomson, 2004.
3. Levine, I. N. Physical Chemistry, Tata McGraw-Hill ,6th Edition

DSE-A-3: GREEN CHEMISTRY AND CHEMISTRY OF NATURAL PRODUCTS

(Credits: Theory-04, Practicals-02)

Theory: 60 Lectures

Introduction to Green Chemistry: (04 Lectures)

What is Green Chemistry? Need for Green Chemistry.Goals of Green Chemistry. Limitations/ Obstacles in the pursuit of the goals of Green Chemistry

Principles of Green Chemistry and Designing a Chemical synthesis: (16 Lectures)

Twelve principles of Green Chemistry with their explanations and examples and special emphasis on the following:

- Designing a Green Synthesis using these principles; Prevention of Waste/ byproducts; maximum incorporation of the materials used in the process into the final products , Atom Economy, calculation of atom economy of the rearrangement, addition, substitution and elimination reactions.
- Prevention/ minimization of hazardous/toxic products reducingtoxicity.

- Green solvents–supercritical fluids, water as a solvent for organic reactions, ionic liquids, PEG, solventless processes.
- Energy requirements for reactions – alternative sources of energy: use of microwaves and ultrasonic energy.
- Use of catalytic reagents (wherever possible) in preference to stoichiometric reagents; catalysis and green chemistry.

Examples of Green Synthesis/ Reactions and some real world cases: (20lectures)

1. Green Synthesis of the following compounds: adipic acid, catechol, disodium iminodiacetate (alternative to Strecker synthesis)
2. Microwave assisted reactions in water: Hofmann Elimination, methyl benzoate to benzoic acid, oxidation of toluene and alcohols; microwave assisted reactions in organic solvents: Diels-Alder reaction and Decarboxylation reaction
3. Ultrasound assisted reactions: sonochemical Simmons-Smith Reaction (Ultrasonic alternative to Iodine)
4. Green counterpart of common organic reactions: Aldol, Friedel-Crafts, Michael, Knoevenagel, Cannizzaro, benzoin condensation and Dieckmann condensation.
5. Rearrangement reactions by green approach: Fries rearrangement, Claisen rearrangement, Beckmann rearrangement, Baeyer-Villiger oxidation.

Future Trends in Green Chemistry: (12 Lectures)

Oxidation reagents and catalysts; Biomimetic, multifunctional reagents; Combinatorial green chemistry; Proliferation of solventless reactions.Green chemistry in sustainable development.

Alkaloids **(5 Lectures)**

Hoffmann's exhaustive methylation, Emde's modification, Structure elucidation Natural occurrence, General structural features, Isolation and their physiological action.Synthesis of Hygrine.Medicinal importance of Nicotine, Hygrine, Quinine, Morphine, Cocaine and Reserpine.

Terpenes **(3 Lectures)**

Occurrence, classification, isoprene rule; Elucidation of stucture and synthesis of Citral.

Reference Books

1. Anastas, P.T. & Warner, J.K.: *Green Chemistry - Theory and Practical*, Oxford University Press (1998).
2. Matlack, A.S. *Introduction to Green Chemistry*, Marcel Dekker (2001).
3. Cann, M.C. & Connely, M.E. *Real-World cases in Green Chemistry*, American Chemical Society, Washington (2000).
4.Ryan, M.A. & Tinnesand, M. *Introduction to Green Chemistry*, American Chemical Society, Washington (2002).
5. Lancaster, M. *Green Chemistry: An Introductory Text* RSC Publishing, 2nd Edition, 2010.
6. Ahluwalia, V. K & Kidwai, M. R. New Trends in Green Chemistry, Anamalaya Publishers, 2005.
7. Finar, I. L. *Organic Chemistry* (*Volume 2*), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).

PRACTICALS-DSE-A-3: GREEN CHEMISTRY

(45 Lectures)

(Any **SIX** of the following list)

1. Acetylation of primary amine (preparation of acetanilide).
2. [4+2] Cycloaddition reaction (Diels-Alder reaction between furan and maleic anhydride).
3. Preparation of biodiesel from vegetable/waste cooking oil.
4. Photoreduction of benzophenone to benzopinacol in the presence of sunlight.
5. Pinacol-pinacolone rearrangement reaction (preparation of benzopinacolone).
6. Solid state synthesis of benzilic acid from benzil.
7. Benzoin condensation using thiamine hydrochloride as a catalyst instead of potassium cyanide.
8. Green multicomponent synthesis (three component coupling).
9. Base catalysed aldol condensation (synthesis of dibenzal propanone from benzaldehyde and acetone).
10. Bromination of *trans*-stilbene using bromide/bromate mixture.
11. Preparation and characterization of gold nanoparticles using tea leaves.
12. Extraction of D-limonene from orange peel using liquid carbon dioxide.

13. Electrophilic aromatic substitution reaction (nitration of salicylic acid).
14. Green radical coupling reaction.

Reference Books

1. Anastas, P.T & Warner, J.C. *Green Chemistry: Theory and Practice,*OxfordUniversity Press (1998).
2. Kirchoff, M. & Ryan, M.A. *Greener approaches to undergraduate chemistryexperiment*. American Chemical Society, WashingtonDC (2002).
3. Ryan, M.A. *Introduction to Green Chemistry*, Tinnesand; (Ed), American Chemical Society, WashingtonDC (2002).
4. Sharma, R.K.; Sidhwani, I.T. & Chaudhari, M.K. I.K. *Green Chemistry Experiment:A monograph International Publishing House Pvt Ltd. New Delhi*. Bangalore CISBN978-93-81141-55-7 (2013).
5. Cann, M.C. & Connelly, M. E. *Real world cases in Green Chemistry*, American Chemical Society (2008).
6. Cann, M. C. & Thomas, P. *Real world cases in Green Chemistry*, American Chemical Society (2008).
7. Lancaster, M. *Green Chemistry: An Introductory Text* RSC Publishing, 2nd Edition, 2010.
8. Pavia, D.L., Lampman, G.M., Kriz, G.S. & Engel, R.G. *Introduction to OrganicLaboratory Techniques: A Microscale and Macro Scale Approach*, W.B.Saunders,1995.

DSE-A4: ANALYTICAL METHODS IN CHEMISTRY

(Credits: Theory-04, Practicals-02)

Theory: 60 Lectures

Optical methods of analysis: (30 Lectures)

Origin of spectra, interaction of radiation with matter, fundamental laws of spectroscopy and selection rules, validity of Beer-Lambert's law.

UV-Visible Spectrometry: Basic principles of instrumentation (choice of source,monochromator and detector) for single and double beam instrument;
Basic principles of quantitative analysis: estimation of metal ions from aqueous solution,geometrical isomers, keto-enol tautomers. Determination of composition of metal complexes using Job's method of continuous variation and mole ratio method.
Infrared Spectrometry: Basic principles of instrumentation (choice of source, monochromator& detector) for single and double beam instrument; sampling techniques.

Structural illustration through interpretation of data, Effect and importance of isotope substitution.

Flame Atomic Absorption and Emission Spectrometry: Basic principles of instrumentation(choice of source, monochromator, detector, choice of flame and Burner designs. Techniques of atomization and sample introduction; Method of background correction, sources of chemical interferences and their method of removal. Techniques for the quantitative estimation of trace level of metal ions from water samples.

Thermal methods of analysis: (8 Lectures)

Theory of thermogravimetry (TG), basic principle of instrumentation.
Techniques for quantitative estimation of Ca and Mg from their mixture.

Electroanalytical methods: (7 Lectures)

Classification of electroanalytical methods, basic principle of pH metric, potentiometric and conductometric titrations. Techniques used for the determination of equivalence points. Techniques used for the determination of pKa values.

Separation techniques: (15 Lectures)

Solvent extraction: Classification, principle and efficiency of the technique.

Mechanism of extraction: extraction by solvation and chelation.
Technique of extraction: batch, continuous and counter current extractions.

Qualitative and quantitative aspects of solvent extraction: extraction of metal ions from aqueous solution, extraction of organic species from the aqueous and nonaqueous media.

Chromatography: Classification, principle and efficiency of the technique.
Mechanism of separation: adsorption, partition & ion exchange.
Development of chromatograms: frontal, elution and displacement methods.

Qualitative and quantitative aspects of chromatographic methods of analysis: IC, GLC, GPC, TLC and HPLC.

Stereoisomeric separation and analysis: Measurement of optical rotation, calculation of Enantiomeric excess (ee)/ diastereomeric excess (de) ratios and determination of enantiomeric composition using NMR, Chiral solvents and chiral shift reagents. Chiral chromatographic techniques using chiral columns (GC and HPLC).

Role of computers in instrumental methods of analysis.

Reference Books

1. Mendham, J., *A. I. Vogel's Quantitative Chemical Analysis 6thEd.,* Pearson, 2009.
2. Willard, H.H. *et al.*: *Instrumental Methods of Analysis*, 7th Ed. Wardsworth Publishing Company, Belmont, California, USA, 1988.

3. Christian, G.D. *Analytical Chemistry*, 6th Ed. John Wiley & Sons, New York, 2004.
4. Harris, D.C.: *Exploring Chemical Analysis*, 9th Ed. New York, W.H. Freeman, 2016.
5. Khopkar, S.M. *Basic Concepts of Analytical Chemistry*. New Age International Publisher, 2009.
6. Skoog, D.A. Holler F.J. & Nieman, T.A. *Principles of Instrumental Analysis*, Cengage Learning India Ed.
7. Mikes, O. *Laboratory Hand Book of Chromatographic & Allied Methods*, Elles Harwood Series on Analytical Chemistry, John Wiley & Sons, 1979.
8. Ditts, R.V. Analytical Chemistry; Methods of separation, van Nostrand, 1974.

PRACTICALS-DSE-A-4: ANALYTICAL METHODS IN CHEMISTRY

(45 Lectures)

I. Separation Techniques by:

Chromatography:

(a) Separation and identification of the monosaccharides present in the given mixture (glucose & fructose) by paper chromatography. Reporting the R_f values.

(b)Separate a mixture of Sudan yellow and Sudan Red by TLC technique and identify them on the basis of their R_f values.

(c) Chromatographic separation of the active ingredients of plants, flowers and juices by TLC

Solvent Extractions:

To separate a mixture of Ni^{2+} & Fe^{2+} by complexation with DMG and extracting the Ni^{2+}-DMG complex in chloroform, and determine its concentration by spectrophotometry.

II. Analysis of soil:

(i) Determination of pH of soil.
(ii) Estimation of calcium, magnesium, phosphate

III. Ion exchange:

Determination of exchange capacity of cation exchange resins and anion exchange resins.

IV. Spectrophotometry

1. Determination of pKa values of indicator using spectrophotometry.
2. Determination of chemical oxygen demand (COD).
3. Determination of Biological oxygen demand (BOD).

Reference Books

1. Mendham, J., *A. I. Vogel's Quantitative Chemical Analysis 6thEd.*, Pearson, 2009.
2. Willard, H.H. *et al.*: *Instrumental Methods of Analysis*, 7th Ed. Wardsworth Publishing Company, Belmont, California, USA, 1988.
3. Christian, G.D. *Analytical Chemistry*, 6th Ed. John Wiley & Sons, New York, 2004.
4. Harris, D.C.*Exploring Chemical Analysis*, 9th Ed. New York, W.H. Freeman, 2016.
5. Khopkar, S.M. *Basic Concepts of Analytical Chemistry*. New Age International Publisher, 2009.
6. Skoog, D.A. Holler F.J. and Nieman, T.A. *Principles of Instrumental Analysis*, Cengage Learning India Edition.
7. Mikes, O. & Chalmes, R.A. *Laboratory Handbook of Chromatographic & AlliedMethods*, Elles Harwood Ltd. London.
8. Ditts, R.V. *Analytical Chemistry: Methods of separation.*Van Nostrand, New York, 1974.

DSE-B

DSE-B-1: INORGANIC MATERIALS OF INDUSTRIALIMPORTANCE

(Credits: Theory-04, Practicals-02)

Theory: 60 Lectures

Silicate Industries: (16 Lectures)

Glass: Glassy state and its properties, classification (silicate and non-silicate glasses).Manufacture and processing of glass. Composition and properties of the following types of glasses: Soda lime glass, lead glass, armoured glass, safety glass, borosilicate glass, fluorosilicate, coloured glass, photosensitive glass.

Ceramics: Important clays and feldspar, ceramic, their types and manufacture. Hightechnology ceramics and their applications, superconducting and semiconducting oxides, fullerenes carbon nanotubes and carbon fibre.

Cements: Classification of cement, ingredients and their role, Manufacture of cement and thesetting process, quick setting cements.

Fertilizers: (8 Lectures)

Different types of fertilizers. Manufacture of the following fertilizers: Urea, ammonium nitrate, calcium ammonium nitrate, ammonium phosphates; polyphosphate, superphosphate, compound and mixed fertilizers, potassium chloride, potassium sulphate.

Surface Coatings: (10 Lectures)

Objectives of coatings surfaces, preliminary treatment of surface, classification of surface coatings.Paints and pigments-formulation, composition and related properties. Oil paint, Vehicle, modified oils, Pigments, toners and lakes pigments, Fillers, Thinners, Enamels, emulsifying agents. Special paints (Heat retardant, Fire retardant, Eco-friendly paint, Plastic paint), Dyes, Wax polishing, Water and Oil paints, additives, Metallic coatings (electrolytic and electroless), metal spraying and anodizing.

Batteries: (6 Lectures)

Primary and secondary batteries, battery components and their role, Characteristics of Battery.Working of following batteries: Pb acid, Li-Battery, Solid state electrolyte battery.Fuel cells, Solar cell and polymer cell.

Alloys: **(10 Lectures)**

Classification of alloys, ferrous and non-ferrous alloys, Specific properties of elements in alloys. Manufacture of Steel (removal of silicon decarbonization, demanganization, desulphurization dephosphorisation) and surface treatment (Arand heat treatment, nitriding, carburizing). Composition and properties of different types of steels.

Catalysis: **(6 Lectures)**

General principles and properties of catalysts, homogenous catalysis (catalytic steps and examples) and heterogenous catalysis (catalytic steps and examples) and their industrial applications, Deactivation or regeneration of catalysts.

Phase transfer catalysts, application of zeolites as catalysts.

Chemical explosives: **(4 Lectures)**

Origin of explosive properties in organic compounds, preparation and explosive properties of lead azide, PETN, cyclonite (RDX).Introduction to rocket propellants.

Reference Books

1. E. Stocchi: *Industrial Chemistry*, Vol-I, Ellis Horwood Ltd. UK.
2. R. M. Felder, R. W. Rousseau: *Elementary Principles of Chemical Processes*, Wiley Publishers, New Delhi.
3. W. D. Kingery, H. K. Bowen, D. R. Uhlmann: *Introduction to Ceramics*, Wiley Publishers, New Delhi.
4. J. A. Kent: Riegel's *Handbook of Industrial Chemistry*, CBS Publishers, New Delhi.
5. P. C. Jain, M. Jain: *Engineering Chemistry*, Dhanpat Rai & Sons, Delhi.
6. R. Gopalan, D. Venkappayya, S. Nagarajan: *Engineering Chemistry*, Vikas Publications, New Delhi.
7. Sharma, B.K. & Gaur, H. *Industrial Chemistry*, Goel Publishing House, Meerut (1996).

PRACTICALS-DSE B-1: INORGANIC MATERIALS OF INDUSTRIAL IMPORTANCE

(45 Lectures)

1. Determination of free acidity in ammonium sulphate fertilizer.
2. Estimation of Calcium in Calcium ammonium nitrate fertilizer.
3. Estimation of phosphoric acid in superphosphate fertilizer.
4. Electroless metallic coatings on ceramic and plastic material.
5. Determination of composition of dolomite (by complexometric titration).
6. Analysis of (Cu, Ni); (Cu, Zn) in alloy or synthetic samples.
7. Analysis of Cement.

8. Preparation of pigment (zinc oxide).

Reference Books

1. E. Stocchi: *Industrial Chemistry*, Vol-I, Ellis Horwood Ltd. UK.
2. R. M. Felder, R. W. Rousseau: *Elementary Principles of Chemical Processes*, Wiley Publishers, New Delhi.
3. W. D. Kingery, H. K. Bowen, D. R. Uhlmann: *Introduction to Ceramics*, Wiley Publishers, New Delhi.
4. J. A. Kent: Riegel's *Handbook of Industrial Chemistry*, CBS Publishers, New Delhi.
5. P. C. Jain, M. Jain: *Engineering Chemistry*, Dhanpat Rai & Sons, Delhi.
6. R. Gopalan, D. Venkappayya, S. Nagarajan: *Engineering Chemistry*, Vikas
7. Publications, New Delhi.
8. Sharma, B.K. & Gaur, H. *Industrial Chemistry*, Goel Publishing House, Meerut (1996).

DSE B-2: NOVEL INORGANIC SOLIDS

(Credits: Theory-04, Practicals-02)

Theory: 60 Lectures

Synthesis and modification of inorganic solids: (10 Lectures)

Conventional heat and beat methods, Co-precipitation method, Sol-gel methods,Hydrothermal method, Ion-exchange and Intercalation methods.

Inorganic solids of technological importance: (10 Lectures)

Solid electrolytes – Cationic, anionic, mixed Inorganic pigments – coloured solids, white and
black pigments.
Molecular material and fullerides, molecular materials & chemistry – one-dimensionalmetals, molecular magnets, inorganic liquid crystals.

Nanomaterials: (10 Lectures)

Overview of nanostructures and nanomaterials: classification.
Preparation of gold and silver metallic nanoparticles, self-assembled nanostructures-control
of nanoarchitecture-one dimensional control. Carbon nanotubes and inorganic nanowires.Bio-inorganic nanomaterials, DNA and nanomaterials, natural and antisical nanomaterials,
bionano composites.

Introduction to engineering materials for mechanical construction: (10 Lectures)

Composition, mechanical and fabricating characteristics and applications of various types of
cast irons, plain carbon and alloy steels, copper, aluminum and their alloys like duralumin,
brasses and bronzes cutting tool materials, super alloys thermoplastics, thermosets andcomposite materials.

Composite materials(10 Lectures)

Introduction, limitations of conventional engineering materials, role of matrix in composites,classification, matrix materials, reinforcements, metal-matrix composites, polymer-matrixcomposites, fibre-reinforced composites, environmental effects on composites, applicationsof composites.

Speciality polymers: **(10 Lectures)**

Conducting polymers - Introduction, conduction mechanism, polyacetylene,
polyparaphenylene and polypyrole, applications of conducting polymers, Ion-exchange resins
and their applications. Ceramic & Refractory: Introduction, classification, properties, raw
materials, manufacturing and applications.

Reference Books:

• Shriver & Atkins. Inorganic Chemistry, Peter Alkins, Tina Overton, Jonathan Rourke, Mark Weller and Fraser Armstrong, 5th Edition, Oxford University Press (2011-2012)
• Adam, D.M. Inorganic Solids: An introduction to concepts in solid-state structural chemistry.
• Frank J. Ovens, Introduction to Nanotechnology

PRACTICAL – DSEB-2: NOVEL INORGANIC SOLIDS

(45 Lectures)

1. Determination of cation exchange method
2. Determination of total difference of solids.
3. Synthesis of hydrogel by co-precipitation method.
4. Synthesis of silver and gold metal nanoparticle

Reference Book

• Fahan, *Materials Chemistry*, Springer (2004).

DSE-B-3: POLYMER CHEMISTRY

(Credits: Theory-04, Practicals-02)

Theory: 60 Lectures

Introduction and history of polymeric materials: (04 Lectures)

Different schemes of classification of polymers, Polymer nomenclature, Molecular forces and chemical bonding in polymers, Texture of Polymers.

Functionality and its importance: (08 Lectures)
Criteria for synthetic polymer formation, classification of polymerization processes, Relationships between functionality, extent of reaction and degree of polymerization.Bi-functional systems, Poly-functional systems.

Kinetics of Polymerization: (08 Lectures)

Mechanism and kinetics of step growth, radical chain growth, ionic chain (both cationic and anionic) and coordination polymerizations, Mechanism and kinetics of copolymerization, polymerization techniques.

Crystallization and crystallinity: (04 Lectures)

Determination of crystalline melting point and degree of crystallinity, Morphology of crystalline polymers, Factors affecting crystalline melting point.

Nature and structure of polymers: **(04 Lectures)**

Structure Property relationships.

Determination of molecular weight of polymers: (08 Lectures)
(*Mn*,*Mw*, etc) by end group analysis,viscometry, light scattering and osmotic pressure methods. Molecular weight distribution and its significance.Polydispersity index.

Glass transition temperature (Tg) and determination of Tg: **(08 Lectures)**
Free volume theory, WLFequation, Factors affecting glass transition temperature (Tg).

Polymer Solution: (08 Lectures)
Criteria for polymer solubility, Solubility parameter, Thermodynamicsof polymer solutions, entropy, enthalpy, and free energy change of mixing of polymers solutions, Flory- Huggins theory, Lower and Upper critical solution temperatures.

Properties of Polymer: **(08 Lectures)**
(Physical, thermal, Flow & Mechanical Properties).

Brief introduction to preparation, structure, properties and application of the following

polymers: polyolefins, polystyrene and styrene copolymers, poly(vinyl chloride) and related polymers, poly(vinyl acetate) and related polymers, acrylic polymers, fluoro polymers,
polyamides and related polymers. Phenol formaldehyde resins (Bakelite, Novalac), polyurethanes, silicone polymers, polydienes,

Polycarbonates, Conducting Polymers, [polyacetylene, polyaniline, poly(p-phenylene sulphide polypyrrole, polythiophene)].

Reference Books

1. R.B. Seymour & C.E. Carraher: *Polymer Chemistry: An Introduction*, Marcel Dekker, Inc. New York, 1981.
2. G. Odian: *Principles of Polymerization*, 4th Ed. Wiley, 2004.
3. F.W. Billmeyer: *Textbook of Polymer Science*, 2nd Ed. Wiley Interscience, 1971.
4. P. Ghosh: Polymer Science & Technology, Tata McGraw-Hill Education, 1991.
5. R.W. Lenz: *Organic Chemistry of Synthetic High Polymers.* Interscience Publishers, New York, 1967.

PRACTICALS – DSE- B-3: POLYMER CHEMISTRY

(45 Lectures)

Polymer synthesis

1. Free radical solution polymerization of styrene (St) / Methyl Methacrylate (MMA) / Methyl Acrylate (MA) / Acrylic acid (AA).
   a) Purification of monomer
   b) Polymerization using benzoyl peroxide (BPO) / 2,2'-azo-bis-isobutylonitrile (AIBN)
2. Preparation of nylon 66/6
3. Interfacial polymerization, preparation of polyester from isophthaloyl chloride (IPC) and phenolphthalein
4. Redox polymerization of acrylamide
5. Precipitation polymerization of acrylonitrile
6. Preparation of urea-formaldehyde resin
7. Preparations of novalac resin/ resold resin.
8. Microscale Emulsion Polymerization of Poly(methylacrylate).

Polymer characterization

1. Determination of molecular weight by viscometry:
   (a) Polyacrylamide-aq.$NaNO_2$ solution
   (b) (Poly vinyl proplylidine (PVP) in water
2. Determination of the viscosity-average molecular weight of poly(vinyl alcohol) (PVOH) and the fraction of "head-to-head" monomer linkages in the polymer.
3. Determination of molecular weight by end group analysis: Polyethylene glycol (PEG) (OH group).
4. Testing of mechanical properties of polymers.
5. Determination of hydroxyl number of a polymer using colorimetric method.

Polymer analysis

1. Estimation of the amount of HCHO in the given solution by sodium sulphite method
2. Instrumental Techniques
3. IR studies of polymers
4. DSC analysis of polymers
5. Preparation of polyacrylamide and its electrophoresis

*at least 7 experiments to be carried out.

Reference Books

1. M.P. Stevens, *Polymer Chemistry: An Introduction*, 3rd Ed., OxfordUniversity Press, 1999.
2. H.R. Allcock, F.W. Lampe & J.E. Mark, *Contemporary Polymer Chemistry*, 3rd ed. Prentice-Hall (2003)
3. F.W. Billmeyer, *Textbook of Polymer Science*, 3rd ed. Wiley-Interscience (1984)
4. J.R. Fried, *Polymer Science and Technology*, 2nd ed. Prentice-Hall (2003)
5. P. Munk & T.M. Aminabhavi, *Introduction to Macromolecular Science*, 2nd ed. John Wiley & Sons (2002)
6. L. H. Sperling, *Introduction to Physical Polymer Science*, 4th ed. John Wiley & Sons (2005)
7. M.P. Stevens, *Polymer Chemistry: An Introduction* 3rd ed. OxfordUniversity Press (2005).
8. Seymour/ Carraher's Polymer Chemistry, 9th ed. by Charles E. Carraher, Jr. (2013).

DSE B-4 : Dissertation

(Credits: 06)

In a total of 105 lecture hours, a student has to carry out research /review on a topic as assigned by the respective college. A project report and digital presentation will be required for the assessment of the student at the end of the semester.

SKILL ENHANCEMENT COURSES

SEC-A [SEMESTER 3]

SEC 1 – Mathematics and Statistics for Chemists

(Credits: 2 Lectures: 30)

1.Functions, limits, derivative, physical significance, basic rules of differentiation, maxima and minima, applications in chemistry,Error function, Gamma function, exact and inexact differential, Taylor and McLaurin series, Fourier series and Fourier Transform, Laplace transform, partial differentiation, rules of integration, definite and indefinite integrals. **(08 Lectures)**

2.**Differential equations**: Separation of variables, homogeneous, exact, linearequations, equations of second order, series solution method.

(04 Lectures)

3**. Probability**:Permutations, combinations and theory of probability**(03 Lectures)**

4.**Vectors, matrices and determinants:** Vectors, dot, cross and triple products, introduction to matrix algebra, addition and multiplication of matrices, inverse, adjoint and transpose of matrices, unit and diagonal matrices.

(04 Lectures)

5. **Qualitative and quantitative aspects of analysis:**
Sampling, evaluation of analytical data, errors, accuracy and precision, methods of their expression, normal law of distribution if indeterminate errors, statistical test of data; F, Q and t test, rejection of data, and confidence intervals. **(03 Lectures)**

6. **Analysis and Presentation of Data***:* Descriptive statistics. Choosing and using statistical tests.Chemometrics. Analysis of variance (ANOVA), Correlation and regression, fitting of linear equations, simple linear cases, weighted linear case, analysis

of residuals, general polynomial fitting, linearizing transformations, exponential function fit. Basic aspects of multiple linear regression analysis. **(08 Lectures)**

Reference Books

1.The Chemical Maths Book, E. Steiner, Oxford University Press (1996).
2. Hibbert, D. B. & Gooding, J. J. (2006) *Data analysis for chemistry*.
OxfordUniversity Press.
3. Higher Engineering Mathematics, Grewal B.S., Khanna Publishers, 43rd Edition.
4. Advanced Engineering Mathematics, Kreyszig Erwin, Wiley, 10th Edition

SEC 2 – ANALYTICAL CLINICAL BIOCHEMISTRY

(Credits: 2 Lectures:30)

Carbohydrates: Biological importance of carbohydrates, Metabolism, Cellular currency of energy (ATP), Glycolysis, Alcoholic and Lactic acid fermentations, Krebs cycle.
Isolation and characterization of polysachharides.
Proteins: Classification, biological importance; Primary and secondary and tertiary structures of proteins: α-helix and β- pleated sheets, Isolation, characterization, denaturation of proteins.
Enzymes: Nomenclature, Characteristics (mention of Ribozymes), and Classification; Active site, Mechanism of enzyme action, Stereospecificity of enzymes, Coenzymes and cofactors, Enzyme inhibitors, Introduction to Biocatalysis: Importance in "Green Chemistry" and Chemical Industry.
Lipids: Classification. Biological importance of triglycerides and phosphoglycerides and cholesterol; Lipid membrane, Liposomes and their biological functions and underlying applications.
Lipoproteins: Properties, functions and biochemical functions of steroid hormones. Biochemistry of peptide hormones.
Structure of DNA (Watson-Crick model) and RNA, Genetic Code, Biological roles of DNA and RNA: Replication, Transcription and Translation, Introduction to Gene therapy.
Biochemistry of disease: A diagnostic approach by blood/ urine analysis.
Blood: Composition and functions of blood, blood coagulation. Blood collection and preservation of samples.Anaemia, Regulation, estimation and interpretation of data for blood sugar, urea, creatinine, cholesterol and bilirubin.
Urine: Collection and preservation of samples. Formation of urine.Composition and estimation of constituents of normal and pathological urine.

Hands On Practical
Identification and estimation of the following:
1. Carbohydrates – qualitative and quantitative.
2. Lipids – qualitative.
3. Determination of the iodine number of oil.
4. Determination of the saponification number of oil.
5. Determination of cholesterol using Liebermann- Burchard reaction.

6. Proteins – qualitative.
7. Isolation of protein.
8. Determination of protein by the Biuret reaction.
9. Determination of nucleic acids

Reference Books

1. Cooper, T.G. Tool of Biochemistry. Wiley-Blackwell (1977).
2. Wilson, K. & Walker, J. Practical Biochemistry. Cambridge University Press (2009).
3. Varley, H., Gowenlock, A.H & Bell, M.: Practical Clinical Biochemistry, Heinemann, London (1980).
4. Devlin, T.M., Textbook of Biochemistry with Clinical Correlations, John Wiley & Sons, 2010.
5. Berg, J.M., Tymoczko, J.L. & Stryer, L. Biochemistry, W.H. Freeman, 2002.
6. Talwar, G.P. & Srivastava, M. Textbook of Biochemistry and Human Biology, 3rd Ed. PHI Learning.
7. Nelson, D.L. & Cox, M.M. Lehninger Principles of Biochemistry, W.H. Freeman, 2013.
8. O. Mikes, R.A. Chalmers: Laboratory Handbook of Chromatographic Methods, D. Van Nostrand & Co., 1961.

SEC-B [SEMESTER 4]

SEC 3 – PHARMACEUTICALS CHEMISTRY

(Credits: 2 Lectures: 30)

Drugs & Pharmaceuticals

Drug discovery, design and development; Basic Retrosynthetic approach. Synthesis of the representative drugs of the following classes: analgesics agents, antipyretic agents, anti-inflammatory agents (Aspirin, paracetamol, lbuprofen); antibiotics (Chloramphenicol); antibacterial and antifungal agents (Sulphonamides; Sulphanethoxazol, Sulphacetamide, Trimethoprim); antiviral agents (Acyclovir), Central Nervous System agents (Phenobarbital, Diazepam),Cardiovascular (Glyceryl trinitrate), antilaprosy (Dapsone), HIV-AIDS related drugs (AZT- Zidovudine).

Fermentation

Aerobic and anaerobic fermentation. Production of (i) Ethyl alcohol and citric acid, (ii) Antibiotics; Penicillin, Cephalosporin, Chloromycetin and Streptomycin, (iii) Lysine, Glutamic acid, Vitamin B2, Vitamin B12 and Vitamin C.

Hands On Practical

1. Preparation of Aspirin and its analysis.
2. Preparation of magnesium bisilicate (Antacid).

Reference Books

1. Patrick, G. L. Introduction to Medicinal Chemistry, Oxford University Press, UK, 2013.
2. Singh, H. & Kapoor, V.K. Medicinal and Pharmaceutical Chemistry, Vallabh Prakashan, Pitampura, New Delhi, 2012.
3. Foye, W.O., Lemke, T.L. & William, D.A.: Principles of Medicinal Chemistry, 4th ed., B..I. Waverly Pvt. Ltd. New Delhi.

SEC-4 PESTICIDE CHEMISTRY

(Credits: 02, 30 Lectures)

General introduction to pesticides (natural and synthetic), benefits and adverse effects, changing concepts of pesticides, structure activity relationship, synthesis and technical manufacture and uses of representative pesticides in the following classes:Organochlorines(DDT, Gammexene,); Organophosphates (Malathion, Parathion); Carbamates (Carbofuranand carbaryl); Quinones (Chloranil), Anilides (Alachlor and Butachlor).

Hands on Practicals

1 To calculate acidity/alkalinity in given sample of pesticide formulations as per BIS specifications.

2 Preparation of simple organophosphates, phosphonates and thiophosphates

Reference Book:

• R. Cremlyn: *Pesticides*, John Wiley.

GENERAL ELECTIVE COURSE IN CHEMISTRY

Course Structure (B.Sc. General)

Course Credits

	Theory+ Practical
Core Course (CC)	
Theory (12 Papers of 4 credits each)	12×4=48
Practical (12 Papers of 2 credits each)	12×2=24
Discipline Specific Elective Course*(DSE)	
Theory (6 Papers of 4 credits each)	6×4=24
Practical(6 Papers of 2 credits each)	6×2=12
Ability Enhancement Compulsory Course (AECC)	
(2 Papers of 2 credits)	2×2=4
Environmental Science	
English/MIL Communication	
Skill Enhancement Elective Course (SEC)	
(4 Papers of 2 credits)	4×2=8
Total credit	**120**

B.SC. (GENERAL) CHEMISTRY [CEM-G]

CORE /GENERIC COURSES

SEM	COURSE CODE [CEM-G]	PAPER
1	CC1/GE1	PAPER 1
2	CC2/GE2	PAPER 2
3	CC3/GE3	PAPER 3
4	CC4/GE4	PAPER 4

DISCIPLINE SPECIFIC ELECTIVE [DSE] COURSES

DSE- A

DSEA-1 : Novel Inorganic Solids
DSEA-2: Inorganic Materials of Industrial Importance

DSE-B

DSEB-1 : Green Chemistry and Chemistry of Natural Products
DSEB-2: Analytical Methods in Chemistry

SKILL ENHANCEMENT COURSES [SEC]

SEC(A): (Any one either in semester III or V)
SEC1 : Basic Analytical Chemistry
SEC2– Analytical Clinical Biochemistry

SEC(B) (Any one either in semester IV or VI)

SEC 3 – PHARMACEUTICALS CHEMISTRY
SEC 4 - PESTICIDE CHEMISTRY

CC1/ GE 1:

(Credits: Theory-04, Practicals-02)
Theory: 60 Lectures

Kinetic Theory of Gases and Real gases
Concept of pressure and temperature; Collision of gas molecules; Collision number and mean free path. Nature of distribution of velocities, Maxwell's distribution of speed and kinetic energy; Average velocity, root mean square velocity and most probable velocity; Principle of equipartition of energy Deviation of real gases from ideal behavior; compressibility factor; Boyle temperature; Andrew's and Amagat's plots; van der Waals equation and its features; Existence of critical state, Critical constants in terms of van der Waals constants; Law of corresponding states.

Liquids
Definition of Surface tension, its dimension and principle of its determination using stalagmometer; Viscosity of a liquid and principle of determination of coefficient of viscosity using Ostwald viscometer; Effect of temperature on surface tension and coefficient of viscosity of a liquid (qualitative treatment only)

Chemical Kinetics
Introduction of rate law, Order and molecularity; Extent of reaction; rate constants; Rates of First, second and nth order reactions and their Differential and integrated forms (with derivation); Pseudo first order reactions; Determination of order of a reaction by halfhalf-life and differential method. Temperature dependence of rate constant; Arrhenius equation, energy of activation;

Atomic Structure
Bohr's theory for hydrogen atom (simple mathematical treatment), atomic spectra of hydrogen and Bohr's model, Sommerfeld's model, quantum numbers and their significance, Pauli's exclusion principle, Hund's rule, electronic configuration of many-electron atoms, *Aufbau* principle and its limitations.

Chemical Periodicity
Classification of elements on the basis of electronic configuration: general characteristics of s-, p-, d- and f-block elements. Positions of hydrogen and noble gases. Atomic and ionic radii, ionization potential, electron affinity, and electronegativity; periodic and group-wise variation of above properties in respect of s- and p- block elements.

Acids and bases
Brönsted–Lowry concept, conjugate acids and bases, relative strengths of acids and bases, effects of substituent and solvent, differentiating and leveling solvents. Lewis acid-base concept, classification of Lewis acids and bases, Lux-Flood concept and solvent system concept. Hard and soft acids and bases (HSAB concept), applications of HSAB process.

Fundamentalsof Organic Chemistry
Electronic displacements: inductive effect, resonance and hyperconjugation; nucleophiles and electrophiles; reactive intermediates: carbocations, carbanions and free radicals.

Stereochemistry
Different types of isomerism; geometrical and optical isomerism; concept of chirality and optical activity (upto two carbon atoms); asymmetric carbon atom; interconversion of Fischer and Newman representations; enantiomerism and diastereomerism, *meso* compounds; *threo* and

erythro, D and L, *cis* and *trans* nomenclature; CIP Rules: *R/S* (only one chiral carbon atoms) and *E/Z* nomenclature.

Nucleophilic Substitution and Elimination Reactions
Nucleophilic substitutions: S_N1 and S_N2 reactions; eliminations: E1 and E2 reactions (elementary mechanistic aspects); Saytzeff and Hofmann eliminations.

CC1/GE 1 Practical: 45 Lectures

1. Estimation of sodium carbonate and sodium hydrogen carbonate present in a mixture.

2. Estimation of oxalic acid by titrating it with $KMnO_4$.

3. Estimation of water of crystallization in Mohr's salt by titrating with $KMnO_4$.

4. Estimation of Fe (II) ions by titrating it with $K_2Cr_2O_7$ using internal indicator.

5. Estimation of Cu (II) ions iodometrically using $Na_2S_2O_3$.

6.Estimation of Fe(II) and Fe(III) in a given mixture using $K_2Cr_2O_7$ solution.

CC2/GE 2:

(Credits: Theory-04, Practicals-02)
Theory: 60 Lectures

Chemical Thermodynamics:
Intensive and extensive variables; state and path functions; isolated, closed and open systems; zeroth law of thermodynamics; Concept of heat, work, internal energy and statement of first law; enthalpy, H; relation between heat capacities, calculations of q, w, ΔU and ΔH for reversible, irreversible and free expansion of gases.
Standard states; Heats of reaction; enthalpy of formation of molecules and ions and enthalpy of combustion and its applications; Laws of thermochemistry, Kirchhoff's equations. Statement of the second law of thermodynamics; Concept of heat reservoirs and heat engines; Carnot cycle; Physical concept of Entropy; Entropy change of systems and surroundings for various processes and transformations; Auxiliary state functions (G and A) and Criteria for spontaneity and equilibrium.

Chemical Equilibrium:
Thermodynamic conditions for equilibrium, degree of advancement; Variation of free energy with degree of advancement; Equilibrium constant and standard Gibbs free energy change; Definitions of K_P, K_C and K_X and relation among them; van't Hoff's reaction isotherm, isobar and isochore from different standard states; Shifting of equilibrium due to change in external parameters e.g. temperature and pressure; variation of equilibrium constant with addition to inert gas; Le Chatelier's principle

Solutions
Ideal solutions and Raoult's law, deviations from Raoult's law – non-ideal solutions; Vapour pressure-composition and temperature-composition curves of ideal and non-ideal solutions; Distillation of solutions; Lever rule; Azeotropes
Nernst distribution law and its applications, solvent extraction

Phase Equilibria
Phases, components and degrees of freedom of a system, criteria of phase equilibrium; Gibbs Phase Rule; Derivation of Clausius – Clapeyron equation and its importance in phase equilibria; Phase diagrams of one-component systems (water and CO_2)

Solids
Forms of solids, crystal systems, unit cells, Bravais lattice types, Symmetry elements; Laws of Crystallography - Law of constancy of interfacial angles, Law of rational indices; Miller indices of different planes and interplanar distance, Bragg's law;

Aliphatic Hydrocarbons
Functional group approach for the following reactions (preparations & reactions) to be studied in context to their structures.
Alkanes: (up to 5 Carbons). *Preparation:* catalytic hydrogenation, Wurtz reaction, Kolbe's synthesis.
Alkenes: (up to 5 Carbons). *Preparation:* elimination reactions: dehydration of alcohols and dehydrohalogenation of alkyl halides; *cis* alkenes (partial catalytic hydrogenation) and *trans* alkenes (Birch reduction). *Reactions:* addition of bromine, addition of HX [Markownikoff's (with mechanism) and anti-Markownikoff's addition], hydration, ozonolysis.
Alkynes: (up to 5 Carbons). *Preparation:* acetylene from CaC_2; by dehalogenation of tetra halides and dehydrohalogenation of vicinal dihalides.

Reactions: formation of metal acetylides, hydration reaction.

Error Analysis and Computer Applications
*Error analysis***:** accuracy and precision of quantitative analysis, determinate, indeterminate, systematic and random errors; methods of least squares and standard deviations.
Computer applications: general introduction to computers, different components of a computer; hardware and software; input and output devices; binary numbers and arithmetic; Introduction to computer languages.

Redox reactions
Ion-electron method of balancing equation of redox reaction. Elementary idea on standard redox potentials with sign conventions, Nernst equation (without derivation). Influence of complex formation, precipitation and change of pH on redox potentials; formal potential. Feasibility of a redox titration, redox potential at the equivalence point, redox indicators

CC2/GE 2 Practical: 45 Lectures

Experiment 1: Study of kinetics of acid-catalyzed hydrolysis of methyl acetate

Experiment 2: Study of kinetics of decomposition of H_2O_2 (Clock Reaction)

Experiment 3: Study of viscosity of unknown liquid (glycerol, sugar) with respect to water.

Experiment 4: Determination of solubility of sparingly soluble salt in water, in electrolyte with common ions and in neutral electrolyte (using common indicator)

Experiment 5:Preparation of buffer solutions and find the pH of an unknown buffer solution by colour matching method

Experiment 6: Determination of surface tension of a liquid using Stalagmometer

CC3/GE 3:
(Credits: Theory-04, Practicals-02)
Theory: 60 Lectures

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Chemical Bonding and Molecular Structure
Ionic Bonding: General characteristics of ionic bonding. Energy considerations in ionic bonding, lattice energy and solvation energy and their importance in the context of stability and solubility of ionic compounds. Statement of Born-Landé equation for calculation of lattice energy, Born-Haber cycle and its applications, polarizing power and polarizability. Fajan's rules, ionic character in covalent compounds, bond moment, dipole moment and percentage ionic character.

Covalent bonding: VB Approach: Shapes of some inorganic molecules and ions on the basis of VSEPR and hybridization with suitable examples of linear, trigonal planar, square planar, tetrahedral, trigonal bipyramidal and octahedral arrangements.
Concept of resonance and resonating structures in various inorganic and organic compounds.

MO Approach: Rules for the LCAO method, bonding and antibonding MOs and their characteristics for *s-s*, *s-p* and *p-p* combinations of atomic orbitals, nonbonding combination of orbitals, MO treatment of homonuclear diatomic molecules of 1st and 2nd periods. (including idea of *s- p* mixing) and heteronuclear diatomic molecules such as CO, NO and NO^+. Comparison of VB and MO approaches.

Comparative study of p-block elements:
Group trends in electronic configuration, modification of pure elements, common oxidation states, inert pair effect, and their important compounds in respect of the following groups of elements:
i) B-Al-Ga-In-Tl
ii) C-Si-Ge-Sn-Pb
iii) N-P-As-Sb-Bi
iv) O-S-Se-Te
v) F-Cl-Br-I

Transition Elements (3*d* series)
General group trends with special reference to electronic configuration, variable valency, colour, magnetic and catalytic properties, ability to form complexes and stability of various oxidation states (Latimer diagrams) for Mn, Fe and Cu.
Lanthanoids and actinoids: Electronic configurations, oxidation states, colour, magnetic properties, lanthanide contraction, separation of lanthanides (ion exchange method only).

Coordination Chemistry
Werner's coordination theory, Valence Bond Theory (VBT): Inner and outer orbital complexes of Cr, Fe, Co, Ni and Cu (coordination numbers 4 and 6). Structural and stereoisomerism in complexes with coordination numbers 4 and 6. Drawbacks of VBT. IUPAC system of nomenclature

ELECTROCHEMISTRY
1) Ionic Equilibria
Strong, moderate and weak electrolytes, degree of ionization, factors affecting degree of ionization, ionization constant and ionic product of water; Ionization of weak acids and bases, pH scale, common ion effect; Salt hydrolysis-calculation of hydrolysis constant, degree of hydrolysis and pH for different salts; Buffer solutions; Solubility and solubility product of sparingly soluble salts – applications of solubility product principle

2) Conductance
Conductance, cell constant, specific conductance and molar conductance; Variation of specific and equivalent conductance with dilution for strong and weak electrolytes; Kohlrausch's law of independent migration of ions; Equivalent and molar conductance at infinite dilution and their determination for strong and weak electrolytes; Ostwald's dilution
law; Application of conductance measurement (determination of solubility product and ionic product of water); Conductometric titrations (acid-base)
Transport Number and principles Moving-boundary method

3) Electromotive force
Faraday's laws of electrolysis, rules of oxidation/reduction of ions based on half-cell potentials, applications of electrolysis in metallurgy and industry; Chemical cells, reversible and irreversible cells with examples; Electromotive force of a cell and its measurement, Nernst equation; Standard electrode (reduction) potential; Electrochemical series;

Concentration cells with and without transference, liquid junction potential; pH determinationusing hydrogen electrode and quinhydrone; Qualitative discussion of potentiometric titrations (acid-base, redox, precipitation)

Aromatic Hydrocarbons
Benzene: Preparation: from phenol, by decarboxylation, from acetylene. *Reactions*: electrophilic substitution reaction (general mechanism); nitration (with mechanism), halogenations (chlorination and bromination), and Friedel-Crafts reaction (alkylation and acylation) (up to 4 carbons on benzene).

Organometallic Compounds
Introduction; *Grignard reagents*: *Preparations* (from alkyl and aryl halide); Reformatsky reaction.

Aryl Halides
Preparation: (chloro- and bromobenzene): from phenol, Sandmeyer reactionand effect of nitro substituent (activated nucleophilic substitution

CC3/GE 3 Practical: 45 Lectures

Qualitative semimicro analysis of mixtures containing two radicals. Emphasis should be given to the understanding of the chemistry of different reactions.

Cation Radicals: Na^{+},K^{+}, Ca^{2+}, Sr^{2+}, Ba^{2+}, Al^{3+}, Cr^{3+}, Mn^{2+}/Mn^{4+}, Fe^{3+}, Co^{2+}/Co^{3+}, Ni^{2+}, Cu^{2+}, Zn^{2+}, Pb^{2+}, Sn^{2+}/Sn^{4+}, NH_4^{+}.
Anion Radicals: F^{-}, Cl^{-}, Br^{-}, BrO_3^{-}, I^{-}, IO_3^{-}, SCN^{-}, S^{2-}, SO_4^{2-}, NO_3^{-}, NO_2^{-}, PO_4^{3-}, AsO_4^{3--}, BO_3^{3-}, CrO_4^{2-} / $Cr_2O_7^{2}$

CC4/GE 4:
(Credits: Theory-04, Practicals-02)
Theory: 60 Lectures

Alcohols, Phenols and Ethers
Alcohols: (up to 5 Carbons).
Preparation: 1°-, 2°- and 3°- alcohols: using Grignard reagent, reduction of aldehydes, ketones, carboxylic acid and esters; *Reactions:* With sodium, oxidation (alkaline $KMnO_4$, acidic dichromate).
Diols: Pinacol- pinacolone rearrangement (with mechanism) (*with symmetrical diols* only).
Phenols: Preparation: cumene hydroperoxide method, from diazonium salts; acidic nature of phenols; *Reactions:* electrophilic substitution: nitration and halogenations; Reimer -Tiemann reaction, Schotten –Baumann reaction, Fries rearrangementand Claisen rearrangement.
Ethers: Preparation: Williamson's ether synthesis; *Reaction*: cleavage of ethers with HI.

Carbonyl Compounds
Aldehydes and Ketones (aliphatic and aromatic): (Formaldehye, acetaldehyde, acetone and benzaldehyde): *Preparation:* from acid chlorides, from nitriles and from Grignard reagents; general properties of aldehydes and ketones; *Reactions:* with HCN, $NaHSO_3$, NH_2-G derivatives and with Tollens' and Fehling's reagents; iodoform test; aldol condensation (with mechanism);

Cannizzaro reaction (with mechanism), Wittig reaction, benzoin condensation; Clemmensen reduction, Wolff- Kishner reduction

Carboxylic Acids and Their Derivatives

Carboxylic acids (aliphatic and aromatic): strength of organic acids: comparative study with emphasis on factors affecting pK values; *Preparation:* acidic and alkaline hydrolysis of esters ($B_{Ac}2$ and $A_{AC}2$ mechanisms only) and from Grignard reagents.

*Carboxylic acid derivatives (*aliphatic*):* (up to 5 carbons). *Preparation:* acid chlorides, anhydrides, esters and amides from acids; *Reactions:* Interconversion among acid derivatives. *Reactions:*Claisen condensation; Perkin reaction.

Amines and Diazonium Salts

Amines (aliphatic and aromatic): strength of organic bases; *Preparation*: from alkyl halides, Hofmann degradation;

Reactions: with HNO_2 (distinction of 1°-, 2°- and 3°- amines), Schotten – Baumann reaction , Diazo coupling reaction (with mechanism).

Diazonium salts: Preparation: from aromatic amines; *Reactions:* conversion to benzene, phenol, benzoic acid and nitrobenzene.

Nitro compounds (aromatic): reduction under different conditions (acidic, neutral and alkaline).

Amino Acids and Carbohydrates

Amino Acids: Preparations (glycine and alanine only)*:* Strecker synthesis, Gabriel's phthalimide synthesis; general properties; zwitterion, isoelectric point.

Carbohydrates: classificationand general properties; glucose and fructose: constitution; osazone formation; oxidation-reduction reactions; ascending (Kiliani –Fischer method) and descending (Ruff's method) in monosaccharides (aldoses only); mutarotation

Crystal Field Theory

Crystal field effect, octahedral symmetry. Crystal field stabilization energy (CFSE), Crystal field effects for weak and strong fields. Tetrahedral symmetry. Factors affecting the magnitude of D. Spectrochemical series. Comparison of CFSE for O_h and T_d complexes, Tetragonal distortion of octahedral geometry.

Jahn-Teller distortion, Square planar coordination

Quantum Chemistry & Spectroscopy

Spectroscopy and its importance in chemistry. Wave-particle duality. Link between spectroscopy and quantum chemistry. Electromagnetic radiation and its interaction with matter. Types of spectroscopy. Difference between atomic and molecular spectra

Postulates of quantum mechanics, quantum mechanical operators.

Free particle. Particle in a 1-D box (complete solution), quantization, normalization of wave functions, concept of zero-point energy.

Rotational Motion: Schrödinger equation of a rigid rotator and brief discussion of its results (solution not required). Quantization of rotational energy levels.

Microwave (pure rotational) spectra of diatomic molecules. Selection rules. Structural information derived from rotational spectroscopy.

Vibrational Motion: Schrödinger equation of a linear harmonic oscillator and brief discussion of its results (solution not required). Quantization of vibrational energy levels. Selection rules, IR spectra of diatomic molecules.

CC4/GE 4 Practical: 45 Lectures

1.Qualitative Analysis of Single Solid Organic Compound(s)

Experiment A: Detection of special elements (N, Cl, and S) in organic compounds.
Experiment B: Solubility and Classification (solvents: H_2O, dil. HCl, dil. NaOH)
Experiment C: Detection of functional groups: Aromatic-NO_2, Aromatic -NH_2, -COOH, carbonyl (no distinction of –CHO and >C=O needed), -OH (phenolic) in solid organic compounds.
Experiments A - C with unknown (at least 6) solid samples containing not more than two of the above type of functional groups should be done.

2.Identification of a pure organic compound

Solid compounds: oxalic acid, tartaric acid, succinic acid, resorcinol, urea, glucose, benzoic acid and salicylic acid.
Liquid Compounds:methyl alcohol, ethyl alcohol, acetone, aniline, dimethylaniline, benzaldehyde, chloroform and nitrobenzene

Reference Books

1. Kotz, J.C., Treichel, P.M. & Townsend, J.R. *General Chemistry* Cengage Learning India Pvt. Ltd., New Delhi (2009).
2. Mahan, B.H. *University Chemistry* 3rd Ed. Narosa (1998). 3. Petrucci, R.H. *General Chemistry* 5th Ed. Macmillan Publishing Co.: New York (1985).
4. Chugh, K.L., Agnish, S.L. *A Text Book of Physical Chemistry* Kalyani Publishers
5. N. G. Mukherjee *Quantum Chemistry, molecular Spectroscopy and Photochemistry*.Archana Publishing Center,(2010*).*
6. Bahl, B.S., Bahl, A., Tuli, G.D., *Essentials of Physical Chemistry* S. Chand & Co. ltd.
7. Palit, S. R., *Elementary Physical Chemistry* Book Syndicate Pvt. Ltd.
8. N. G. Mukherjee, *Elementary Physical Chemistry* Archana Publishing Center,(2014*).*
9. Mandal, A. K. *Degree Physical and General Chemistry* Sarat Book House
10. Pahari, S., *Physical Chemistry* New Central Book Agency
11. Palit, S.R., *Practical Physical Chemistry* Science Book Agency
12. Mukherjee, N.G., *Selected Experiments in Physical Chemistry* J. N. Ghose & Sons
13. Dutta, S.K., *Physical Chemistry Experiments* Bharati Book Stall
14.*Practical Workbook Chemistry (Honours), UGBS, Chemistry*, University of Calcutta, 2015
15. Banerjee, S. P. *A Text Book of Analytical Chemistry*, The New Book Stall.
16. Gangopadhyay, P. K. *Application Oriented Chemistry*, Book Syndicate.
17. Mondal, A. K & Mondal, S. *Degree Applied Chemistry*, Sreedhar Publications
18. Khosla, B. D.; Garg, V. C. & Gulati, A. *Senior Practical Physical Chemistry,* R. Chand & Co.: New Delhi (2011).
19. Ghosal, Mahapatra & Nad, *An Advanced Course in Practical Chemistry*, New Central
20. Sethi, A. *Conceptual Organic Chemistry;* New Age International Publisher.
21. Parmar, V. S. *A Text Book of Organic Chemistry*, S. Chand & Sons.
22. Madan, R. L. *Organic Chemistry*, S. Chand & Sons.
23. Wade, L. G., Singh, M. S., *Organic Chemistry*, *Pearson*.

24. Finar, I. L. *Organic Chemistry* (*Volume 1*), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
25. Morrison, R. T. & Boyd, R. N. *Organic Chemistry*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
26. Bahl, A. & Bahl, B.S. *Advanced Organic Chemistry*, S. Chand, 2010.
27. Cotton, F.A. & Wilkinson, G. *Basic Inorganic Chemistry*, Wiley.
28. Shriver, D.F. & Atkins, P.W. *Inorganic Chemistry*, Oxford University Press.
29. Wulfsberg, G. *Inorganic Chemistry*, Viva Books Pvt. Ltd.
30. Rodgers, G.E. *Inorganic & Solid State Chemistry*, Cengage Learning India Ltd., 2008.

DSE (A)

Any one from the following

DSE A-1: NOVEL INORGANIC SOLIDS

(Credits: Theory-04, Practicals-02)

Theory: 60 Lectures

Synthesis and modification of inorganic solids: (10 Lectures)

Conventional heat and beat methods, Co-precipitation method, Sol-gel methods, Hydrothermal method, Ion-exchange and Intercalation methods.

Inorganic solids of technological importance: (10 Lectures)

Solid electrolytes – Cationic, anionic, mixed Inorganic pigments – coloured solids, white and black pigments.
Molecular material and fullerides, molecular materials & chemistry – one-dimensionalmetals, molecular magnets, inorganic liquid crystals.

Nanomaterials: (10 Lectures)

Overview of nanostructures and nanomaterials: classification.
Preparation of gold and silver metallic nanoparticles, self-assembled nanostructures-control of nanoarchitecture-one dimensional control. Carbon nanotubes and inorganic nanowires.Bio-inorganic nanomaterials, DNA and nanomaterials, natural and antisical nanomaterials, bionano composites.

Introduction to engineering materials for mechanical construction: (10 Lectures)

Composition, mechanical and fabricating characteristics and applications of various types of cast irons, plain carbon and alloy steels, copper, aluminum and their alloys like duralumin, brasses and bronzes cutting tool materials, super alloys thermoplastics, thermosets andcomposite materials.

Composite materials (10 Lectures)

Introduction, limitations of conventional engineering materials, role of matrix in composites,classification, matrix materials, reinforcements, metal-matrix composites, polymer-matrixcomposites, fibre-reinforced composites, environmental effects on composites, applicationsof composites.

Speciality polymers: (10 Lectures)

Conducting polymers - Introduction, conduction mechanism, polyacetylene, polyparaphenylene and polypyrole, applications of conducting polymers, Ion-exchange resins and their applications. Ceramic & Refractory: Introduction, classification, properties, raw

materials, manufacturing and applications.

Reference Books:

• Shriver & Atkins. Inorganic Chemistry, Peter Alkins, Tina Overton, Jonathan Rourke, Mark Weller and Fraser Armstrong, 5th Edition, Oxford University Press (2011-2012)
• Adam, D.M. Inorganic Solids: An introduction to concepts in solid-state structural chemistry.
• Frank J. Ovens, Introduction to Nanotechnology

PRACTICAL – DSEA-1 : NOVEL INORGANIC SOLIDS

(45 Lectures)

1. Determination of cation exchange method
2. Determination of total difference of solids.
3. Synthesis of hydrogel by co-precipitation method.
4. Synthesis of silver and gold metal nanoparticle

Reference Book

• Fahan, *Materials Chemistry*, Springer (2004).

DSE-A-2: INORGANIC MATERIALS OF INDUSTRIAL IMPORTANCE

(Credits: Theory-04, Practicals-02)

Theory: 60 Lectures

Silicate Industries: (16 Lectures)

Glass: Glassy state and its properties, classification (silicate and non-silicate glasses).Manufacture and processing of glass. Composition and properties of the following types of glasses: Soda lime glass, lead glass, armoured glass, safety glass, borosilicate glass, fluorosilicate, coloured glass, photosensitive glass.

Ceramics: Important clays and feldspar, ceramic, their types and manufacture. Hightechnology ceramics and their applications, superconducting and semiconducting oxides, fullerenes carbon nanotubes and carbon fibre.

Cements: Classification of cement, ingredients and their role, Manufacture of cement and thesetting process, quick setting cements.

Fertilizers: (8 Lectures)

Different types of fertilizers. Manufacture of the following fertilizers: Urea, ammonium nitrate, calcium ammonium nitrate, ammonium phosphates; polyphosphate, superphosphate, compound and mixed fertilizers, potassium chloride, potassium sulphate.

Surface Coatings: (10 Lectures)

Objectives of coatings surfaces, preliminary treatment of surface, classification of surface coatings. Paints and pigments-formulation, composition and related properties. Oil paint, Vehicle, modified oils, Pigments, toners and lakes pigments, Fillers, Thinners, Enamels, emulsifying agents. Special paints (Heat retardant, Fire retardant, Eco-friendly paint, Plastic paint), Dyes, Wax polishing, Water and Oil paints, additives, Metallic coatings (electrolytic and electroless), metal spraying and anodizing.

Batteries: (6 Lectures)

Primary and secondary batteries, battery components and their role, Characteristics of Battery. Working of following batteries: Pb acid, Li-Battery, Solid state electrolyte battery. Fuel cells, Solar cell and polymer cell.

Alloys: (10 Lectures)

Classification of alloys, ferrous and non-ferrous alloys, Specific properties of elements in alloys. Manufacture of Steel (removal of silicon decarbonization, demanganization, desulphurization dephosphorisation) and surface treatment (Arand heat treatment, nitriding, carburizing). Composition and properties of different types of steels.

Catalysis: (6 Lectures)

General principles and properties of catalysts, homogenous catalysis (catalytic steps and examples) and heterogenous catalysis (catalytic steps and examples) and their industrial applications, Deactivation or regeneration of catalysts.

Phase transfer catalysts, application of zeolites as catalysts.

Chemical explosives: (4 Lectures)

Origin of explosive properties in organic compounds, preparation and explosive properties of lead azide, PETN, cyclonite (RDX). Introduction to rocket propellants.

Reference Books

1. E. Stocchi: *Industrial Chemistry*, Vol-I, Ellis Horwood Ltd. UK.
2. R. M. Felder, R. W. Rousseau: *Elementary Principles of Chemical Processes*, Wiley Publishers, New Delhi.
3. W. D. Kingery, H. K. Bowen, D. R. Uhlmann: *Introduction to Ceramics*, Wiley Publishers, New Delhi.
4. J. A. Kent: Riegel's *Handbook of Industrial Chemistry*, CBS Publishers, New Delhi.
5. P. C. Jain, M. Jain: *Engineering Chemistry*, Dhanpat Rai & Sons, Delhi.
6. R. Gopalan, D. Venkappayya, S. Nagarajan: *Engineering Chemistry*, Vikas

Publications, New Delhi.
7. Sharma, B.K. & Gaur, H. *Industrial Chemistry,* Goel Publishing House, Meerut (1996).

PRACTICALS-DSE A2 LAB INORGANIC MATERIALS OF INDUSTRIAL IMPORTANCE

(45 Lectures)

1. Determination of free acidity in ammonium sulphate fertilizer.
2. Estimation of Calcium in Calcium ammonium nitrate fertilizer.
3. Estimation of phosphoric acid in superphosphate fertilizer.
4. Electroless metallic coatings on ceramic and plastic material.
5. Determination of composition of dolomite (by complexometric titration).
6. Analysis of (Cu, Ni); (Cu, Zn) in alloy or synthetic samples.
7. Analysis of Cement.
8. Preparation of pigment (zinc oxide).

Reference Books

1. E. Stocchi: *Industrial Chemistry,* Vol-I, Ellis Horwood Ltd. UK.
2. R. M. Felder, R. W. Rousseau: *Elementary Principles of Chemical Processes*, Wiley Publishers, New Delhi.
3. W. D. Kingery, H. K. Bowen, D. R. Uhlmann: *Introduction to Ceramics,* Wiley Publishers, New Delhi.
4. J. A. Kent: Riegel's *Handbook of Industrial Chemistry*, CBS Publishers, New Delhi.
5. P. C. Jain, M. Jain: *Engineering Chemistry*, Dhanpat Rai & Sons, Delhi.
6. R. Gopalan, D. Venkappayya, S. Nagarajan: *Engineering Chemistry,* Vikas
7. Publications, New Delhi.
8. Sharma, B.K. & Gaur, H. *Industrial Chemistry,* Goel Publishing House, Meerut (1996).

DSE(B)

Any one from the following

DSE-B1: GREEN CHEMISTRY AND CHEMISTRY OF NATURAL PRODUCTS

(Credits: Theory-04, Practicals-02)

Theory: 60 Lectures

Introduction to Green Chemistry: (04 Lectures)

What is Green Chemistry? Need for Green Chemistry. Goals of Green Chemistry. Limitations/ Obstacles in the pursuit of the goals of Green Chemistry

Principles of Green Chemistry and Designing a Chemical synthesis: (16 Lectures)

Twelve principles of Green Chemistry with their explanations and examples and special emphasis on the following:

- Designing a Green Synthesis using these principles; Prevention of Waste/ byproducts; maximum incorporation of the materials used in the process into the final products , Atom Economy, calculation of atom economy of the rearrangement, addition, substitution and elimination reactions.
- Prevention/ minimization of hazardous/toxic products reducingtoxicity.

- Green solvents–supercritical fluids, water as a solvent for organic reactions, ionic liquids, PEG, solventless processes.
- Energy requirements for reactions – alternative sources of energy: use of microwaves and ultrasonic energy.
- Use of catalytic reagents (wherever possible) in preference to stoichiometric reagents; catalysis and green chemistry.

Examples of Green Synthesis/ Reactions and some real world cases: (20lectures)

1. Green Synthesis of the following compounds: adipic acid, catechol, disodium iminodiacetate (alternative to Strecker synthesis)
2. Microwave assisted reactions in water: Hofmann Elimination, methyl benzoate to benzoic acid, oxidation of toluene and alcohols; microwave assisted reactions in organic solvents: Diels-Alder reaction and Decarboxylation reaction
3. Ultrasound assisted reactions: sonochemical Simmons-Smith Reaction (Ultrasonic alternative to Iodine)
4. Green counterpart of common organic reactions: Aldol, Friedel-Crafts, Michael, Knoevenagel, Cannizzaro, benzoin condensation and Dieckmann condensation.
5. Rearrangement reactions by green approach: Fries rearrangement, Claisen rearrangement, Beckmann rearrangement, Baeyer-Villiger oxidation.

Future Trends in Green Chemistry: (12 Lectures)

Oxidation reagents and catalysts; Biomimetic, multifunctional reagents; Combinatorial green chemistry; Proliferation of solventless reactions. Green chemistry in sustainable development.

Alkaloids **(5 Lectures)**

Hoffmann's exhaustive methylation, Emde's modification, Structure elucidation Natural occurrence, General structural features, Isolation and their physiological action. Synthesis of Hygrine. Medicinal importance of Nicotine, Hygrine, Quinine, Morphine, Cocaine and Reserpine.

Terpenes **(3 Lectures)**

Occurrence, classification, isoprene rule; Elucidation of stucture and synthesis of Citral.

Reference Books

1. Anastas, P.T. & Warner, J.K.: *Green Chemistry - Theory and Practical*, Oxford University Press (1998).
2. Matlack, A.S. *Introduction to Green Chemistry*, Marcel Dekker (2001).
3. Cann, M.C. & Connely, M.E. *Real-World cases in Green Chemistry*, American Chemical Society, Washington (2000).
4. Ryan, M.A. & Tinnesand, M. *Introduction to Green Chemistry*, American Chemical Society, Washington (2002).
5. Lancaster, M. *Green Chemistry: An Introductory Text* RSC Publishing, 2nd Edition, 2010.
6. Ahluwalia, V. K & Kidwai, M. R. New Trends in Green Chemistry, Anamalaya Publishers, 2005.

PRACTICALS-DSE-B1 LAB GREEN CHEMISTRY

(45 Lectures)

1. Acetylation of primary amine (preparation of acetanilide).
2. [4+2] Cycloaddition reaction (Diels-Alder reaction between furan and maleic anhydride).
3. Preparation of biodiesel from vegetable/waste cooking oil.
4. Photoreduction of benzophenone to benzopinacol in the presence of sunlight.
5. Pinacol-pinacolone rearrangement reaction (preparation of benzopinacolone).
6. Solid state synthesis of benzilic acid from benzil.
7. Benzoin condensation using thiamine hydrochloride as a catalyst instead of potassium cyanide.
8. Green multicomponent synthesis (three component coupling).
9. Base catalysed aldol condensation (synthesis of dibenzal propanone from benzaldehyde and acetone).
10. Bromination of *trans*-stilbene using bromide/bromate mixture.
11. Preparation and characterization of gold nanoparticles using tea leaves.
12. Extraction of D-limonene from orange peel using liquid carbon dioxide.
13. Electrophilic aromatic substitution reaction (nitration of salicylic acid).
14. Green radical coupling reaction.

Reference Books

1. Anastas, P.T & Warner, J.C. *Green Chemistry: Theory and Practice,* Oxford University Press (1998).
2. Kirchoff, M. & Ryan, M.A. *Greener approaches to undergraduate chemistryexperiment*. American Chemical Society, WashingtonDC (2002).
3. Ryan, M.A. *Introduction to Green Chemistry*, Tinnesand; (Ed), American Chemical Society, WashingtonDC (2002).
4. Sharma, R.K.; Sidhwani, I.T. & Chaudhari, M.K. I.K. *Green Chemistry Experiment:A monograph International Publishing House Pvt Ltd. New Delhi*. Bangalore CISBN978-93-81141-55-7 (2013).
5. Cann, M.C. & Connelly, M. E. *Real world cases in Green Chemistry*, American Chemical Society (2008).
6. Cann, M. C. & Thomas, P. *Real world cases in Green Chemistry*, American Chemical Society (2008).
7. Lancaster, M. *Green Chemistry: An Introductory Text* RSC Publishing, 2nd Edition, 2010.
8. Pavia, D.L., Lampman, G.M., Kriz, G.S. & Engel, R.G. *Introduction to OrganicLaboratory Techniques: A Microscale and Macro Scale Approach*, W.B.Saunders,1995.
9. Finar, I. L. *Organic Chemistry* (*Volume 1*), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).

DSE-B2: ANALYTICAL METHODS IN CHEMISTRY

(Credits: Theory-04, Practicals-02)

Theory: 60 Lectures

Optical methods of analysis: (30 Lectures)

Origin of spectra, interaction of radiation with matter, fundamental laws of spectroscopy and selection rules, validity of Beer-Lambert's law.

UV-Visible Spectrometry: Basic principles of instrumentation (choice of source,monochromator and detector) for single and double beam instrument;
Basic principles of quantitative analysis: estimation of metal ions from aqueous solution,geometrical isomers, keto-enol tautomers. Determination of composition of metal complexes using Job's method of continuous variation and mole ratio method.
Infrared Spectrometry: Basic principles of instrumentation (choice of source, monochromator& detector) for single and double beam instrument; sampling techniques.

Structural illustration through interpretation of data, Effect and importance of isotope substitution.

Flame Atomic Absorption and Emission Spectrometry: Basic principles of instrumentation(choice of source, monochromator, detector, choice of flame and Burner

designs. Techniques of atomization and sample introduction; Method of background correction, sources of chemical interferences and their method of removal. Techniques for the quantitative estimation of trace level of metal ions from water samples.

Thermal methods of analysis: (8 Lectures)

Theory of thermogravimetry (TG), basic principle of instrumentation.
Techniques for quantitative estimation of Ca and Mg from their mixture.

Electroanalytical methods: (7 Lectures)

Classification of electroanalytical methods, basic principle of pH metric, potentiometric and conductometric titrations. Techniques used for the determination of equivalence points. Techniques used for the determination of pKa values.

Separation techniques: (15 Lectures)

Solvent extraction: Classification, principle and efficiency of the technique.

Mechanism of extraction: extraction by solvation and chelation.
Technique of extraction: batch, continuous and counter current extractions.

Qualitative and quantitative aspects of solvent extraction: extraction of metal ions from aqueous solution, extraction of organic species from the aqueous and nonaqueous media.

Chromatography: Classification, principle and efficiency of the technique.
Mechanism of separation: adsorption, partition & ion exchange.
Development of chromatograms: frontal, elution and displacement methods.

Qualitative and quantitative aspects of chromatographic methods of analysis: IC, GLC, GPC, TLC and HPLC.

Stereoisomeric separation and analysis: Measurement of optical rotation, calculation of Enantiomeric excess (ee)/ diastereomeric excess (de) ratios and determination of enantiomeric composition using NMR, Chiral solvents and chiral shift reagents. Chiral chromatographic techniques using chiral columns (GC and HPLC).

Role of computers in instrumental methods of analysis.

Reference Books

1. Mendham, J., *A. I. Vogel's Quantitative Chemical Analysis 6th Ed.*, Pearson, 2009.
2. Willard, H.H. *et al.*: *Instrumental Methods of Analysis*, 7th Ed. Wardsworth Publishing Company, Belmont, California, USA, 1988.
3. Christian, G.D. *Analytical Chemistry*, 6th Ed. John Wiley & Sons, New York, 2004.
4. Harris, D.C.: *Exploring Chemical Analysis*, 9th Ed. New York, W.H. Freeman, 2016.
5. Khopkar, S.M. *Basic Concepts of Analytical Chemistry*. New Age International Publisher, 2009.
6. Skoog, D.A. Holler F.J. & Nieman, T.A. *Principles of Instrumental Analysis*, Cengage Learning India Ed.
7. Mikes, O. *Laboratory Hand Book of Chromatographic & Allied Methods*, Elles

Harwood Series on Analytical Chemistry, John Wiley & Sons, 1979.
8. Ditts, R.V. Analytical Chemistry; Methods of separation, van Nostrand, 1974.

PRACTICALS- DSE-B-2: ANALYTICAL METHODS IN CHEMISTRY

(45 Lectures)

I. Separation Techniques by:

Chromatography:

(a) Separation and identification of the monosaccharides present in the given mixture (glucose & fructose) by paper chromatography. Reporting the R_f values.

(b)Separate a mixture of Sudan yellow and Sudan Red by TLC technique and identify them on the basis of their R_f values.

(c) Chromatographic separation of the active ingredients of plants, flowers and juices by TLC

Solvent Extractions:

To separate a mixture of Ni^{2+}& Fe^{2+} by complexation with DMG and extracting the Ni^{2+}-DMG complex in chloroform, and determine its concentration by spectrophotometry.

II. Analysis of soil:

(i) Determination of pH of soil.
(ii) Estimation of calcium, magnesium, phosphate

III. Ion exchange:

Determination of exchange capacity of cation exchange resins and anion exchange resins.

IV. Spectrophotometry

1. Determination of pKa values of indicator using spectrophotometry.
2. Determination of chemical oxygen demand (COD).
3. Determination of Biological oxygen demand (BOD).

Reference Books

1. Mendham, J., *A. I. Vogel's Quantitative Chemical Analysis 6thEd.*, Pearson, 2009.
2. Willard, H.H. *et al.*: *Instrumental Methods of Analysis*, 7th Ed. Wardsworth Publishing Company, Belmont, California, USA, 1988.
3. Christian, G.D. *Analytical Chemistry*, 6th Ed. John Wiley & Sons, New York, 2004.
4. Harris, D.C.*Exploring Chemical Analysis*, 9th Ed. New York, W.H. Freeman, 2016.
5. Khopkar, S.M. *Basic Concepts of Analytical Chemistry*. New Age International Publisher, 2009.
6. Skoog, D.A. Holler F.J. and Nieman, T.A. *Principles of Instrumental Analysis*, Cengage Learning India Edition.
7. Mikes, O. & Chalmes, R.A. *Laboratory Handbook of Chromatographic & AlliedMethods*, Elles Harwood Ltd. London.
8. Ditts, R.V. *Analytical Chemistry: Methods of separation.*Van Nostrand, New York, 1974.

SKILL ENHANCEMENT COURSES (SEC)

SEC(A)

SEC1 : Basic Analytical Chemistry

(Credits 2 , 30 lectures)

Introduction: Introduction to Analytical Chemistry and its interdisciplinary nature. Concept of sampling. Importance of accuracy, precision and sources of error in analytical measurements. Presentation of experimental data and results, from the point of view of significant figures.

Analysis of soil: Composition of soil, Concept of pH and pH measurement, Complexometric titrations, Chelation, Chelating agents, use of indicators

a. Determination of pH of soil samples.

b. Estimation of Calcium and Magnesium ions as Calcium carbonate by complexometric titration.

Analysis of water: Definition of pure water, sources responsible for contaminating water, water sampling methods, water purification methods.

a. Determination of pH, acidity and alkalinity of a water sample.

b. Determination of dissolved oxygen (DO) of a water sample.

Analysis of food products: Nutritional value of foods, idea about food processing and food preservations and adulteration.

a. Identification of adulterants in some common food items like coffee powder, asafoetida, chilli powder, turmeric powder, coriander powder and pulses, etc.

b. Analysis of preservatives and colouring matter.

Chromatography: Definition, general introduction on principles of chromatography, paper chromatography, TLC etc.

a. Paper chromatographic separation of mixture of metal ion (Fe3+ and Al3+).

b. To compare paint samples by TLC method.

Ion-exchange: Column, ion-exchange chromatography etc.

Determination of ion exchange capacity of anion / cation exchange resin (using batch procedure if use of column is not feasible).

Analysis of cosmetics: Major and minor constituents and their function

a. Analysis of deodorants and antiperspirants, Al, Zn, boric acid, chloride, sulphate.

b. Determination of constituents of talcum powder: Magnesium oxide, Calcium oxide, Zinc oxide and Calcium carbonate by complexometric titration.

Suggested Applications (Any one):

a. To study the use of phenolphthalein in trap cases.

b. To analyze arson accelerants.

c. To carry out analysis of gasoline.

Suggested Instrumental demonstrations:

a. Estimation of macro nutrients: Potassium, Calcium, Magnesium in soil samples by flame photometry.

b. Spectrophotometric determination of Iron in Vitamin / Dietary Tablets.

c. Spectrophotometric Identification and Determination of Caffeine and Benzoic Acid in Soft Drink.

Reference Books:

1. Willard, H. H. *Instrumental Methods of Analysis*, CBS Publishers.

2. Skoog & Lerry. *Instrumental Methods of Analysis*, Saunders College Publications, New

York.
3. Skoog, D.A.; West, D.M. & Holler, F.J. *Fundamentals of Analytical Chemistry 6th Ed.*, Saunders College Publishing, Fort Worth (1992).
4. Harris, D. C. *Quantitative Chemical Analysis*, W. H. Freeman.
5. Dean, J. A. *Analytical Chemistry Notebook*, McGraw Hill.
6. Day, R. A. & Underwood, A. L. *Quantitative Analysis*, Prentice Hall of India.
7. Freifelder, D. Physical Biochemistry *2nd Ed.*, W.H. Freeman and Co., N.Y. USA (1982).
8. Cooper, T.G. *The Tools of Biochemistry*, John Wiley and Sons, N.Y. USA. 16 (1977).
9. Vogel, A. I. *Vogel's Qualitative Inorganic Analysis 7th Ed.*, Prentice Hall.
10. Vogel, A. I. Vogel's *Quantitative Chemical Analysis 6th Ed.*, Prentice Hall.
11. Robinson, J.W. *Undergraduate Instrumental Analysis 5th Ed.*, Marcel Dekker, Inc., New York

SEC2 – ANALYTICAL CLINICAL BIOCHEMISTRY

(Credits: 2 Lectures:30)

Carbohydrates: Biological importance of carbohydrates, Metabolism, Cellular currency of energy (ATP), Glycolysis, Alcoholic and Lactic acid fermentations, Krebs cycle.
Isolation and characterization of polysachharides.
Proteins: Classification, biological importance; Primary and secondary and tertiary structures of proteins: α-helix and β- pleated sheets, Isolation, characterization, denaturation of proteins.
Enzymes: Nomenclature, Characteristics (mention of Ribozymes), and Classification; Active site, Mechanism of enzyme action, Stereospecificity of enzymes, Coenzymes and cofactors, Enzyme inhibitors, Introduction to Biocatalysis: Importance in "Green Chemistry" and Chemical Industry.
Lipids: Classification. Biological importance of triglycerides and phosphoglycerides and cholesterol; Lipid membrane, Liposomes and their biological functions and underlying applications.
Lipoproteins: Properties, functions and biochemical functions of steroid hormones. Biochemistry of peptide hormones.
Structure of DNA (Watson-Crick model) and RNA, Genetic Code, Biological roles of DNA and RNA: Replication, Transcription and Translation, Introduction to Gene therapy.
Biochemistry of disease: A diagnostic approach by blood/ urine analysis.
Blood: Composition and functions of blood, blood coagulation. Blood collection and preservation of samples. Anaemia, Regulation, estimation and interpretation of data for blood sugar, urea, creatinine, cholesterol and bilirubin.
Urine: Collection and preservation of samples. Formation of urine. Composition and estimation of constituents of normal and pathological urine.

Reference Books

1. Cooper, T.G. Tool of Biochemistry. Wiley-Blackwell (1977).
2. Wilson, K. & Walker, J. Practical Biochemistry. Cambridge University Press (2009).
3. Varley, H., Gowenlock, A.H & Bell, M.: Practical Clinical Biochemistry, Heinemann, London (1980).
4. Devlin, T.M., Textbook of Biochemistry with Clinical Correlations, John Wiley & Sons, 2010.
5. Berg, J.M., Tymoczko, J.L. & Stryer, L. Biochemistry, W.H. Freeman, 2002.
6. Talwar, G.P. & Srivastava, M. Textbook of Biochemistry and Human Biology, 3rd Ed. PHI Learning.
7. Nelson, D.L. & Cox, M.M. Lehninger Principles of Biochemistry, W.H. Freeman, 2013.

8. O. Mikes, R.A. Chalmers: Laboratory Handbook of Chromatographic Methods, D. Van Nostrand & Co., 1961.

SEC(B)

SEC 3 – PHARMACEUTICALS CHEMISTRY

(Credits: 2 Lectures: 30)

Drugs & Pharmaceuticals

Drug discovery, design and development; Basic Retrosynthetic approach. Synthesis of the representative drugs of the following classes: analgesics agents, antipyretic agents, anti-inflammatory agents (Aspirin, paracetamol, lbuprofen); antibiotics (Chloramphenicol); antibacterial and antifungal agents (Sulphonamides; Sulphanethoxazol, Sulphacetamide, Trimethoprim); antiviral agents (Acyclovir), Central Nervous System agents (Phenobarbital, Diazepam),Cardiovascular (Glyceryl trinitrate), antilaprosy (Dapsone), HIV-AIDS related drugs (AZT- Zidovudine).

Fermentation

Aerobic and anaerobic fermentation. Production of (i) Ethyl alcohol and citric acid, (ii) Antibiotics; Penicillin, Cephalosporin, Chloromycetin and Streptomycin, (iii) Lysine, Glutamic acid, Vitamin B2, Vitamin B12 and Vitamin C.

Reference Books

1. Patrick, G. L. Introduction to Medicinal Chemistry, Oxford University Press, UK, 2013.
2. Singh, H. & Kapoor, V.K. Medicinal and Pharmaceutical Chemistry, Vallabh Prakashan, Pitampura, New Delhi, 2012.
3. Foye, W.O., Lemke, T.L. & William, D.A.: Principles of Medicinal Chemistry, 4th ed., B..I. Waverly Pvt. Ltd. New Delhi.

SEC 4 - PESTICIDE CHEMISTRY

(Credits: 02)

30 Lectures

General introduction to pesticides (natural and synthetic), benefits and adverse effects, changing concepts of pesticides, structure activity relationship, synthesis and technical manufacture and uses of representative pesticides in the following classes: Organochlorines (DDT, Gammexene,); Organophosphates (Malathion, Parathion); Carbamates (Carbofuran and carbaryl); Quinones (Chloranil), Anilides (Alachlor and Butachlor).

Reference Book:

• R. Cremlyn: *Pesticides*, John Wiley.

UNIVERSITY OF CALCUTTA

Notification No. CSR/ 12 /18

It is notified for information of all concerned that the Syndicate in its meeting held on 28.05.2018 (vide Item No.14) approved the Syllabi of different subjects in Undergraduate Honours / General / Major courses of studies (CBCS) under this University, as laid down in the accompanying pamphlet:

List of the subjects

Sl. No.	Subject	Sl. No.	Subject
1	Anthropology (Honours / General)	29	Mathematics (Honours / General)
2	Arabic (Honours / General)	30	Microbiology (Honours / General)
3	Persian (Honours / General)	31	Mol. Biology (General)
4	Bengali (Honours / General /LCC2 /AECC1)	32	Philosophy (Honours / General)
5	Bio-Chemistry (Honours / General)	33	Physical Education (General)
6	Botany (Honours / General)	34	Physics (Honours / General)
7	Chemistry (Honours / General)	35	Physiology (Honours / General)
8	Computer Science (Honours / General)	36	Political Science (Honours / General)
9	Defence Studies (General)	37	Psychology (Honours / General)
10	Economics (Honours / General)	38	Sanskrit (Honours / General)
11	Education (Honours / General)	39	Social Science (General)
12	Electronics (Honours / General)	40	Sociology (Honours / General)
13	English ((Honours / General/ LCC1/ LCC2/AECC1)	41	Statistics (Honours / General)
14	Environmental Science (Honours / General)	42	Urdu (Honours / General /LCC2 /AECC1)
15	Environmental Studies (AECC2)	43	Women Studies (General)
16	Film Studies (General)	44	Zoology (Honours / General)
17	Food Nutrition (Honours / General)	45	Industrial Fish and Fisheries – IFFV (Major)
18	French (General)	46	Sericulture – SRTV (Major)
19	Geography (Honours / General)	47	Computer Applications – CMAV (Major)
20	Geology (Honours / General)	48	Tourism and Travel Management – TTMV (Major)
21	Hindi (Honours / General /LCC2 /AECC1)	49	Advertising Sales Promotion and Sales Management –ASPV (Major)
22	History (Honours / General)	50	Communicative English –CMEV (Major)
23	Islamic History Culture (Honours / General)	51	Clinical Nutrition and Dietetics CNDV (Major)
24	Home Science Extension Education (General)	52	Bachelor of Business Administration (BBA) (Honours)
25	House Hold Art (General)	53	Bachelor of Fashion and Apparel Design – (B.F.A.D.) (Honours)
26	Human Development (Honours / General)	54	Bachelor of Fine Art (B.F.A.) (Honours)
27	Human Rights (General)	55	B. Music (Honours / General) and Music (General)
28	Journalism and Mass Communication (Honours / General)		

The above shall be effective from the academic session 2018-2019.

SENATE HOUSE
KOLKATA-700073
The 4th June, 2018

Paul 4/6/18
(Dr. Santanu Paul)
Deputy Registrar

UNIVERSITY OF CALCUTTA

SYLLABUS

FOR

THREE-YEAR B.Sc. HONOURS COURSE

UNDER CHOICE BASED CREDIT SYSTEM

BOTANY

FOR SESSION 2018-2019

Core courses (CC-Total 14 courses to be studied in semesters. All theoretical papers i.e., BOT-A…TH are of 4 credits each and the respective practical papers i.e., BOT-A….P of 2 credits each)

SEM I:

1. Phycology and Microbiology (BOT-A-CC-1-1-TH, BOT-A-CC-1-1-P)
2. Mycology and Phytopathology (BOT-A-CC-1-2-TH, BOT-A-CC-1-2-P)

SEM II

3. Plant anatomy (BOT-A-CC-2-3-TH, BOT-A-CC-2-3-P)
4. Archegoniate (BOT-A-CC-2-4-TH, BOT-A-CC-2-4-P)

SEM III

5. Palaeobotany and Palynology (BOT-A-CC-3-5-TH, BOT-A-CC-3-5-P)
6. Reproductive biology of Angiosperms (BOT-A-CC-3-6-TH, BOT-A-CC-3-6-P)
7. Plant systematic (BOT-A-CC-3-7-TH, BOT-A-CC-3-7-P)

SEM IV

8. Plant geography, Ecology and Evolution (BOT-A-CC-4-8-TH, BOT-A-CC-4-8-P)
9. Economic Botany (BOT-A-CC-4-9-TH, BOT-A-CC-4-9-P)
10. Genetics (BOT-A-CC-4-10-TH, BOT-A-CC-4-10-P)

SEM V

11. Cell and Molecular biology (BOT-A-CC-5-11-TH, BOT-A-CC-5-11-P)
12. Biochemistry (BOT-A-CC-5-12-TH, BOT-A-CC-5-12-P)

SEM VI

13. Plant Physiology (BOT-A-CC-6-13-TH, BOT-A-CC-6-13-P)
14. Plant Metabolism (BOT-A-CC-6-14-TH, BOT-A-CC-6-14-P)

Skill enhancement courses (SEC- 2, two papers to be selected from the list taking 1 from SEC A in 3rd SEM and 1 from SEC B in 4th SEM. Both the papers of 2 credits each and theoretical only)

SEC A (SEM III)

1. Applied Phycology, Mycology and Microbiology (BOT-A-SEC-A-3-1)
2. Biofertilizers (BOT-A-SEC-A-3-2)

SEC B (SEM IV)

3. Plant Breeding (BOT-A-SEC-B-4-3)
4. Mushroom Culture Technology (BOT-A-SEC-B-4-4)

Discipline specific elective courses (DSE, four courses to be selected from the 2 groups (A & B). A student shall choose any one paper from each of Group- A and Group- B in 5th AND 6th SEM. Each course comprises of theoretical component of 4 credits and practical ones of 2 credits)

DSE-A (Group- A)

SEM V

1. Biostatistics (BOT-A-DSE-A-5-1-TH, BOT-A-DSE-A-5-1-P)
2. Industrial and Environmental Biology (BOT-A-DSE-A-5-2-TH, BOT-A-DSE-A-5-2-P)

SEM VI

3. Medicinal and Ethnobotany (BOT-A-DSE-A-6-3-TH, BOT-A-DSE-A-6-3-P)
4. Stress Biology (BOT-A-DSE-A-6-4-TH, BOT-A-DSE-A-6-4-P)

DSE-B (Group-B)

SEM V

5. Plant Biotechnology (BOT-A-DSE-B-5-5-TH, BOT-A-DSE-B-5-5-P)
6. Horticultural practices and Post Harvest Technology (BOT-A-DSE-B-5-6-TH, BOT-A-DSE-B-5-6-P)

SEM VI

7. Research Methodology (BOT-A-DSE-B6-7-TH, BOT-A-DSE-B-6-7-P)
8. Natural resource management (BOT-A-DSE-B-6-8-TH, BOT-A-DSE-B-6-8-P)

DISSERTATION/PROJECT: A Dissertation / Project may be given in lieu of a DSE. This is considered as a special course and will be of 6 credits. (Vide page 4 of CUS/268(CIR/18, dated 07.05.2018)). However, the details of the topics, modalities of evaluation etc. to be notified latter on.

SEMESTER	COURSE OPTED	COURSE NAME	CREDIT
I	Core Course 1- BOT-A-CC-1-1-TH	Phycology and microbiology	4
	Core Course 1- BOT-A-CC-1-1-P	Phycology and microbiology Practical	2
	Core Course 2- BOT-A-CC-1-2-TH	Mycology and phytopathology	4
	Core Course 2- BOT-A-CC-1-2-P	Mycology and phytopathology Practical	2
II	Core Course 3- BOT-A-CC-2-3-TH	Plant anatomy	4
	Core Course 3- BOT-A-CC-2-3-P	Plant anatomy Practical	2
	Core Course 4- BOT-A-CC-2-4-TH	Archegoniate	4
	Core Course 4- BOT-A-CC-2-4-P	Archegoniate Practical	2
III	Core Course 5- BOT-A-CC-3-5-TH	Palaeobotany and palynology	4
	Core Course 5- BOT-A-CC-3-5-P	Palaeobotany and palynology Practical	2
	Core Course 6- BOT-A-CC-3-6-TH	Reproductive biology of angiosperms	4
	Core Course 6- BOT-A-CC-3-6-P	Reproductive biology of angiosperms Practical	2
	Core Course 7- BOT-A-CC-3-7-TH	Plant systematics	4
	Core Course 7- BOT-A-CC-3-7-P	Plant systematics Practical	2
	SEC A – BOT-A-SEC-A-3-1/ BOT-A-SEC-A-3-2	Only **ONE** paper to be selected	2
IV	Core Course 8- BOT-A-CC-4-8-TH	Plant geography, ecology and evolution	4
	Core Course 8- BOT-A-CC-4-8-P	Plant geography, ecology and evolution Practical	2
	Core Course 9- BOT-A-CC-4-9-TH	Economic botany	4
	Core Course 9- BOT-A-CC-4-9-P	Economic botany Practical	2
	Core Course 10- BOT-A-CC-4-10-TH	Genetics	4
	Core Course 10- BOT-A-CC-4-10-P	Genetics Practical	2
	SEC B – BOT-A-SEC-B-4-3/ BOT-A-SEC-B-4-4	Only **ONE** paper to be selected	2
V	Core Course 11- BOT-A-CC-5-11-TH	Cell and molecular biology	4
	Core Course 11- BOT-A-CC-5-11-P	Cell and molecular biology Practical	2
	Core Course 12- BOT-A-CC-5-12-TH	Biochemistry	4
	Core Course 12- BOT-A-CC-5-12-P	Biochemistry Practical	2
	DSE A: BOT-A-DSE-A-5-1 & 2-TH & P	Only **ONE** paper to be selected from Group A	4 & 2
	DSE B: BOT-A-DSE-B-5-5 & 6-TH & P	Only **ONE** paper to be selected from Group B	4 & 2

VI	Core Course 13- BOT-A-CC-6-13-TH	Plant physiology	4
	Core Course 13- BOT-A-CC-6-13-P	Plant physiology practical	2
	Core Course 14- BOT-A-CC-6-14-TH	Plant metabolism	4
	Core Course 14- BOT-A-CC-6-14-P	Plant metabolism Practical	2
	DSE A: BOT-A-DSE-A-6-3&4-TH & P	Only **ONE** paper to be selected Group A	4 & 2
	DSE B: BOT-A-DSE-B-6-7&8 -TH & P	Only **ONE** paper to be selected Group B	4 & 2

C.U. B.Sc. BOTANY (HONOURS)

SEMESTER I

CORE COURSE 1
PHYCOLOGY AND MICROBIOLOGY (BOT-A-CC-1-1-TH)
THEORETICAL
(Credits 4, Lectures-60)

PHYCOLOGY

1. General account :

1.1. Thallus organization, Structure of algal cell, 1.2. Ultrastructure of Plastids and Flagella, 1.3. Origin and evolution of sex, 1.4. Life cycle patterns, 1.5. Significant contributions of important phycologists (Fritsch, Smith, R. N. Singh, T.V. Desikachary, H.D. Kumar, M.O.P. Iyengar)

…….5 lectures

2. Classification:

2.1. Criteria and basis of Fritsch's classification

2.2. Classification by Lee (2008) upto phylum with examples

2.3. Salient features of Cyanobacteria, Rhodophyta, Chlorophyta , Charophyta, Bacillariophyta, Xanthophyta, Phaeophyta, Heterokantophyta.

…….5 lectures

3. Cyanobacteria:

3.1. Ultrastructure of cell, 3.2. Heterocyst - structure and function, 3.3. Ecology.

…….4 lectures

4. Bacillariophyta:

4.1. Cell structure, 4.2. Cell division, 4.3. Auxospore formation in Centrales and Pennales.

…….6 lectures

5. Life History:

5.1. *Chlamydomonas*, 5.2. *Oedogonium*, 5.3. *Chara*, 5.4. *Ectocarpus*, 5.5. *Polysiphonia*, 5.6. Evolutionary significance of *Prochloron*.

…….10 lectures

MICROBIOLOGY

1. *Virus*:

1.1. Discovery, 1.2.Plant virus- types, 1.3. Transmission and translocation of Plant virus, 1.4. TMV-

Physicochemical characteristics and Multiplication, 1.5. One step growth curve, 1.6. Lytic cycle (T4 phage) and Lysogenic cycle (Lambda phage), Significance of lysogeny, 1.7.Viroids and Prions.

…….10 lectures

2. *Bacteria*:

2.1. Discovery, .2.2. Distinguishing features of Archaea and Bacteria, 2.3. Characteristics of some major groups: Proteobacteria (Enterobacteria), Firmicutes, Mollicutes, Actinobacteria, Spirochaetes, Chlamydiae, 2.4. Bacterial growth curve and generation time, 2.5.Flagella (ultrastructure) & Pilli, 2.6. Cell wall – chemical structure and differences between Gram +ve & Gram – ve bacteria, 2.7. Bacterial genome and plasmid, 2.8. Endospore - formation, structure and function, 2.9.Genetic Recombination (a) Transformation – with special emphasis on Natural and Induced competence and DNA uptake, (b) Conjugation– F- factor, F^+ X F^-, Hfr X F^-, concept of F', chromosome mobilization, (c) Transduction– Generalised and specialized.

…….20 lectures

PRACTICAL- PHYCOLOGY AND MICROBIOLOGY (BOT-A-CC-1-1-P)
(Credits 2)

1. Work out: Algae, Bacterial staining
2. Identification with reasons: (Algae and bacteria)
3. Classroom performance (Lab notebook, submission and permanent slides)
4. Viva- voce

ALGAE

1. Work out of the following algae with reproductive structure (Free hand drawing and drawing under drawing prism with magnification): *Oedogonium*, *Chara*, *Ectocarpus.*

2. Study of (a) Permanent slides : *Gloeotrichia, Volvox, Vaucheria, Coleochaete, Polysiphonia,* Centric and Pennate diatom*;* (b) Macroscopic specimens : *Laminaria*, *Sargassum.*

MICROBIOLOGY

1. Preparation of bacterial media – (a) Nutrient agar and nutrient broth, (b) Preparation of slants and pouring Petri-plates.

2. Sub-culturing of bacterial culture.

3. Gram staining from bacterial culture.

4. Microscopic examination of bacteria from natural habitat (curd) by simple staining.

FIELD WORK

At least one local excursion to be conducted for study and collection of algae (only 5 from natural habitat) and another local excursion should be conducted to give an introductory idea about plant diversity (Collection not required).

CLASSROOM PERFORMANCE

1. Laboratory Note Book of each section must be signed by the respective teacher with date during practical classes.

2. Slides (permanent) prepared during practical classes.

3. Submission (5 algae collected from natural habitat and identified latter)

CORE COURSE 2

MYCOLOGY AND PHYTO-PATHOLOGY (BOT-A-CC-1-2-TH)

THEORETICAL

(Credits 4, Lectures 60)

MYCOLOGY

1. General Account:

1.1. Hyphal forms, 1.2. Fungal spore forms and mode of liberation, 1.3. Sexual reproduction and degeneration of sex, 1.4. Parasexuality and sexual compatibility, 1.5. Life cycle patterns.

…….6 lectures

2. Classification:

2.1. Classification of Fungi (Ainsworth, 1973) upto sub-division with diagnostic characters and examples. 2.2. General characteristics of Myxomycota, Oomycota, Zygomycota, Ascomycota, Basidiomycota, Deuteromycota.

…….6 lectures

3. Life history:

3.1. *Synchytrium*, 3.2. *Rhizopus*, 3.3. *Ascobolus*, 3.4. *Agaricus*.

…….10 lectures

4. *Mycorrhiza*:

4.1. Types with salient features, 4.2. Role in Agriculture & Forestry.

…….4 lectures

5. Lichen:

5.1. Types, 6.2. Reproduction, 6.3. Economic and ecological importance

…….4 lectures

PHYTO-PATHOLOGY

1. Terms and Definitions :

1.1. Disease concept, 1.2. Symptoms, 1.3. Etiology & causal complex, 1.4. Primary and secondary inocula, 1.5. Infection, 1.6. Pathogenecity and pathogenesis, 1.7. Necrotroph and Biotroph, 1.8. Koch's Postulates, 1.9. Endemic, Epidemic, Pandemic and Sporadic disease, 1.10. Disease triangle, 1.11. Disease cycle (monocyclic, polycyclic and polyetic).

…….6 lectures

2. Host – Parasite Interaction:

2.1. Mechanism of infection (Brief idea about Pre-penetration, Penetration and Post-penetration), 2.2. Pathotoxin (Definition,criteria and example), 2.3. Defense mechanism with special reference to Phytoalexin, 2.4. Resistance- Systemic acquired and Induced systemic.

…….6 lectures

3. Plant Disease Management :

3.1. Quarantine, 3.2. Chemical, 3.3. Biological, 3.4. Integrated.

…….8 lectures

4. Symptoms , Causal organism, Disease cycle and Control measures of:

4.1. Late blight of Potato, 4.2. Brown spot of rice, 4.3. Black stem rust of wheat, 4.4. Stem rot of jute.

…….10 lectures

PRACTICAL- MYCOLOGY AND PHYTO-PATHOLOGY (BOT-A-CC-1-2-P)
(Credits 2)

MYCOLOGY

1. Work out of the following fungi with reproductive structures (including microscopic measurement of Reproductive structures): *Rhizopus* (asexual), *Ascobolus* , *Agaricus* .

2. Study from permanent slides: Zygospore of *Rhizopus*, Conidia of *Fusarium*,Conidiophore of

Penicillium.

3. Morphological study of Fungi (fruit body of *Polyporus*, *Cyathus*), Lichens (fruticose and foliose).

PHYTO- PATHOLOGY

1. Preparation of fungal media (PDA).

2. Sterilization process.

3. Isolation of pathogen from diseased leaf.

4. Inoculation of fruit and subculturing.

5. Identification : Pathological specimens of Brown spot of rice, Bacterial blight of rice , Loose smut of wheat, Stem rot of jute, Late blight of potato; Slides of uredial, telial, pycnial & aecial stages of *Puccinia graminis*.

FIELD WORK

At least one local excursion to be conducted for study and collection of macrofungi (only 5).

CLASSROOM PERFORMANCE

1. Laboratory Note Book of each section must be signed by the respective teacher with date during practical classes

2. Slides (permanent) prepared during practical classes.

3. Submission (5 Macro fungi)

SEMESTER- II

CORE COURSE 3

PLANT ANATOMY (BOT-A-CC-2-3-TH)

(Credits 4, Lectures 60)

ANATOMY

1. Cell wall:

1.1. Ultrastructure & Chemical constituents, 1.2. Plasmodesmata- ultrastructure, 1.3. Concept of Apoplast and Symplast, 1.4. Growth and Thickening of cell wall.

…….8 lectures

2. Stomata:

2.1. Types (Metcalfe and Chalk, Stebbins and Khush).

…….4 lectures

3. Stele:

3.1 Leaf-trace and leaf-gap, 3.2. Stelar types & evolution

…….4 lectures

4. Primary structure of stem and root- Monocot and Dicot. Leaf- dorsiventral and isobilateral.

…….8 lectures

5. Secondary growth:

5.1. Normal (intra- & extra-stelar), 5.2. Anomalous (stem of *Bignonia*, *Boerhavia*, *Tecoma*, *Dracaena* and root of *Tinospora*).

…….12 lectures

6. Mechanical tissues and the Principles governing their distribution in plants.

……..8 lectures

7. Developmental Anatomy:

7.1. Organisation of shoot apex (Tunica–Corpus) and Root apex (Korper-Kappe), 7.2. Plastochrone.

……..8 lectures

8. Ecological Anatomy:

Adaptive anatomical features of 8.1. Hydrophytes, 8.2. Xerophytes.

…….4 lectures

9. Scope of plant anatomy: application in systematics, forensics and pharmacognosy.

…….4 lectures

PRACTICAL- PLANT ANATOMY (BOT-A-CC-2-3-P)

(Credits 2)

1.Workout on Plant Anatomy

2. Identification with reasons

3.Classroom performance: (Lab records, slides)

4. Viva

PLANT ANATOMY

1. Microscopic studies on: Types of stomata, sclereids, raphides (*Colocasia*), cystolith (*Ficus* leaf) starch grains, aleurone grains, laticiferous ducts, oil glands.

2. Study of anatomical details through permanent slides/ temporary stained mounts- a) Root- Monocot and dicot, b) Stem- Monocot and dicot, c) Leaf- Monocot and dicot.

3. Study of anomalous secondary structure in stem of *Bignonia*, *Boerhaavia*, *Tecoma*, *Dracaena* and root of *Tinospora*

4. Study of adaptive anatomical features: Hydrophytes (*Nymphaea* – petiole) and Xerophytes (*Nerium* – leaf).

CORE COURSE 4
ARCHAEGONIATE (BOT-A-CC-2-4-TH)
THEORITICAL
(Credits 4, Lectures 60)

BRYOPHYTES

1. General Account :

1.1. General characteristics and adaptations to land habit, 1.2. Classification (Strotler and Crandle Strotler, 2009) up to class with diagnostic characters and examples.

…….4 lectures

2. Life History: Gametophyte structure and Reproduction, Development and Structure of sporophyte, Spore dispersal in:

2.1. *Marchantia*, 2.2. *Anthoceros,* 2.3*. Funaria.*

…….6 lectures

3. Phylogeny:

3.1. Unifying features of archaegoniates; transition to land habit, 3.2. Origin of Alternation of Generations (Homologous and Antithetic theory), 3.3. Evolution of Sporophytes (Progressive and Regressive concept), 3.4. Origin of Bryophytes.

…….4 lectures

4. Importance :

Role of bryophytes in: 4.1. Plant succession, 4.2. Pollution Monitoring, 4.3. Economic importance of bryophytes with special reference to *Sphagnum*.

…….2 lectures

PTERIDOPHYTES

1. General Account:

1.1. Colonisation and rise of early land plants, 1.2. Classification of vascular plants by Gifford & Foster (1989) upto division (Rhyniophyta to Filicophyta) with diagnostic characters and examples.

…….4 lectures

2. Life History:

Sporophyte structure, Reproduction and Structure of gametophyte in 2.1. *Psilotum*, 2.2. *Selaginella*, 2.3. *Equisetum*, 2.4. *Pteris*.

…….8 lectures

3. Telome concept and its significance in the origin of different groups of Pteridophytes.

…….4 lectures

4. Heterospory and Origin of Seed habit.

…….4 lectures

5. Economic importance as food, medicine and Agriculture.

…….2 lectures

GYMNOSPERMS

1. Classification of vascular plants by Gifford & Foster (1989) upto division (Progymnospermophyta to Gnetophyta) with diagnostic characters and examples.

…….4 lectures

2. Progymnosperms :
Diagnostic characters of the group, 2.2.Vegetative and reproductive features of Archeopteris, 2.3. Phylogenetic importance.

…….6 lectures

3. Life History :

Distribution in India; Vegetative and Reproductive structure of sporophyte, Development of gametophyte in : 3.1. *Cycas* , 3.2. *Pinus* and 3.3. *Gnetum*.

…….8 lectures

4. Economic Importance with reference to Wood, Resins, Essential oils, and Drugs.

…….4 lectures

PRACTICAL- ARCHAEGONIATE (BOT-A-CC-2-4-P)
(Credits 2)

1.Workout on Pteridophytes

2. Identification with reasons (Bryophytes, Pteridophytes and Gymnosperms)

3.Classroom performance: (Lab records, slides)

4. Field report

5. Viva

BRYOPHYTES

1. Morphological study of the plant body: Genera as mentioned in theoretical syllabus and *Riccia, Porella*.

2. Study from permanent slides : *Riccia* (V.S. of thallus with sporophyte), *Marchantia* (L.S. through gemma cup, antheridiophore , archegoniophore) , *Anthoceros* (L.S. of sporophyte) , *Funaria* (L.S. of capsule).

PTERIDOPHYTES

1. Morphological study of the sporophytic plant body: Genera as mentioned in the theoretical syllabus and *Lycopodium, Ophioglossum* and *Marsilea*.

2. Workout of the reproductive structures: *Selaginella, Equisetum, Pteris*.

3. Study from permanent slides: *Psilotum* (T.S. of synangium), *Lycopodium* (L.S. of strobilus), *Ophioglossum* (L.S. of spike), *Dryopteris* (gametophyte), *Marsilea* (L.S. of sporocarp).

GYMNOSPERMS

1. Morphological study: *Cycas* (microsporophyll and megasporophyll), *Pinus* (female and male cone), *Gnetum* (female and male cone).

2. Study from permanent slides: *Cycas* (L.S. of ovule), *Pinus* (L.S. of male and female cone), *Ginkgo* (L.S. of female strobilus), *Gnetum* (L.S. of male cone and ovule).

FIELD STUDY

Botanical excursion to familiarize the students with the natural habitats of these groups is desirable. No individual collection should be allowed. Students should submit only photographs in their field report.

SEMESTER- III

CORE COURSE-5

PALAEOBOTANY AND PALYNOLOGY (BOT-A-CC-3-5-TH)

THEORETICAL

(Credits 4, Lectures 60)

PALAEOBOTANY & PALYNOLOGY

1. Geological time scale with dominant plant groups through ages.

…….4 lectures

2. Plant Fossil:

2.1. Types: Body fossil (Micro- and Megafossils), Trace fossil, Chemical fossil, Index fossil, 2.2. Different modes of preservation (Schopf, 1975), 2.3. Conditions favouring fossilization, 2.4. Nomenclature and Reconstruction, 2.5. Principle of fossil dating (a brief idea), 2.6.Importance of fossil study.

…….12 lectures

3. Fossil Pteridophytes:

Structural features, Geological distribution and Evolutionary significance of 3.1. *Rhynia*, 3.2. *Lepidodendron* (Reconstructed), 3.3. *Calamites* (Reconstructed).

…….10 lectures

4. Fossil gymnosperms:

Structural features and Geological distribution of reconstructed genera: 4.1. *Lyginopteris*, 4.2. *Williamsonia*, 4.3.*Cordaites*.

…….10 lectures

5. Indian Gondwana System - Three fold division with major megafossil assemblages.

…….6 lectures

6. Palynology:

6.1. Spore and Pollen, 6.2. Pollen aperture types, 6.3. NPC classification (Erdtman). 6.4. Pollen wall-Sporopollenin, Stratification and Ornamentation (sculpturing).

…….10 lectures

7. Applied Palynology:

Basic concepts of: 7.1. Palaeopalynology, 7.2. Aeropalynology, 7.3. Forensic palynology, 7.4. Melissopalynology.

…….8 lectures

PRACTICAL- PALAEOBOTANY AND PALYNOLOGY (BOT-A-CC-3-5-P)

(Credits 2)

1. Study from permanent preparations
2. Identification with reasons
3. Classroom performance: (Lab records)
4. Viva

PALAEOBOTANY AND PALYNOLOGY

1. Morphological study: *Ptilophyllum* and *Glossopteris* leaf fossils.

2. Study from permanent slides: T.S. of stem of *Rhynia*, *Lepidodendron*, *Calamites*, *Lyginopteris*, *Cordaites*.

3. Study of Pollen types (colpate, porate and colporate) from permanent slides.

Slides may be prepared from specimens: Colpate (*Leonurus sibiricus*/ *Brassica* sp.), Porate (*Hibiscus rosa-sinensis*), Colporate (*Cassia sophera*/ *C. tora*).

CLASSROOM PERFORMANCE

1. Laboratory Note Book of each section must be signed by the respective teacher with date during practical classes.

CORE COURCE- 6

REPRODUCTIVE BIOLOGY OF ANGIOSPERMS (BOT-A-CC-3-6-TH)

THEORETICAL

(Credits 4, Lectures 60)

MORPHOLOGY OF ANGIOSPERMS

1. Inflorescence types with examples.

…….8 lectures

2. Flower, induction of flowering, flower development- genetic and molecular aspects.

…….14 lectures

3. Fruits and seeds - types with examples.

…….8 lectures

EMBRYOLOGY

1. **Pre-fertilisation changes :**

1.1. Microsporogenesis and Microgametogenesis, 1.2. Megasporogenesis and Megagametogenesis (monosporic, bisporic and tetrasporic).

…….6 lectures

2. **Fertilisation:**

2.1. Pollen germination, 2.2. Pollen tube- growth, entry into ovule and discharge, 2.3. Double fertilization.

…….6 lectures

3. **Post-fertilization changes :**

3.1. Embryogenesis in Capsella, 3.2. Development of Endosperm (3 types).

…….10 lectures

4. **Apomixis & Polyembryony:**

4.1. Apomixis- Apospory and Apogamy, 4.2.Polyembryony- different types.

…….8 lectures

PRACTICAL- REPRODUCTIVE BIOLOGY OF ANGIOSPERMS (BOT-A-CC-3-6-P)
(Credits 2)

1. Identification with reasons (Morphology)
2.Classroom performance: (Lab records)
3. Field Records (Field note book/ project work)
4. Viva

REPRODUCTIVE BIOLOGY OF ANGIOSPERMS

1. Inflorescence types- study from fresh/ preserved specimens
2. Flowers- study of different types from fresh/ preserved specimens
3. Fruits- study from different types from fresh/preserved specimens
4. Study of ovules (permanent slides/ specimens/photographs)- types (anatropous, orthotropous, amphitropous and campylotropous)
5. Field study desirable
6. A project supported along with photographs taken during field study to be submitted giving comprehensive idea about different types of inflorescence, flowers and fruits.

CLASSROOM PERFORMANCE

Same as above.

CORE COURSE- 7
PLANT SYSTEMATICS (BOT-A-CC-3-7-TH)
THEORETICAL
(Credits 4, Lectures 60)

TAXONOMY OF ANGIOSPERMS

1. Introduction:

1.1. Components of Systematic: Nomenclature, Identification, Classification; 1.2. Taxonomy and its phases - Pioneer, Consolidation, Biosystematic and Encyclopaedic; alpha- and omega- taxonomy.

…….6 lectures

2. Nomenclature:

Type method, Publication, Rank of taxa, Rules of priority, Retention and rejection of names, Author Citation, Effective and valid publication, Elementary knowledge of ICN- Principles.

…….6 lectures

3. Systems of classification:

Broad outline of Bentham & Hooker (1862-1883), Cronquist (1988), Takhatajan (1991) - system of classification with merits and demerits. Brief reference of angiosperm phylogeny group (APG III) classification.

3.1. Systematics in Practice: Herbaria and Botanical Gardens – their role in teaching and research; important Herbaria and Botanical Gardens of India and world (3 each); 3.2. Dichotomous keys – indented and bracketed.

…….20 lectures

4. Phenetics and Cladistics:

Brief idea on Phenetics, Numerical taxonomy- methods and significance; Cladistics- construction of dendrogram and primary analysis; Monophyletic, polyphyletic and paraphyletic groups; Plesiomorphy and apomorphy.

…….8 lectures

5. Data sources in Taxonomy:

Supportive evidences from: 5.1. Phytochemistry, 5.2. Cytology, 5.3. Palynology and 5.4. Molecular biology data (Protein and Nucleic acid homology).

…….8 lectures

6. Diagnostic features, Systematic position (Bentham & Hooker and Cronquist), Economically important plants (parts used and uses) of the following families:

6.1. Monocotyledons: Alismataceae, Gramineae (Poaceae), Cyperaceae, Palmae (Arecaceae), Liliaceae, Musaceae, Zingiberaceae, Cannaceae, Orchidaceae.

6.2. Dicotyledons: Nymphaeaceae, Magnoliaceae, Leguminosae (subfamilies), Polygonaceae, Euphorbiaceae, Malvaceae, Umbelliferae (Apiaceae), Labiatae (Lamiaceae), Solanaceae, Scrophulariaceae, Acanthaceae, Rubiaceae, Cucurbitaceae, Compositae (Asteraceae).

…….12 lectures

PRACTICAL- PLANT SYSTEMATICS (BOT-A-CC-3-7-P)
(Credits 2)

1.Workout on Angiosperms

2. Spot Identification

3.Classroom performance: (Lab records)

4. Field Records (Field note book, Herbarium specimens)

5. Viva

ANGIOSPERMS

1. Work out, description, preparation of floral formula and floral diagram, identification up to genus with the help of suitable literature of wild plants and systematic position according to Benthum Hooker system of classification from the following families: Malvaceae, Fabaceae (Papilionaceae), Solanaceae, Scrophulariaceae, Acanthaceae, Labiatae (Lamiaceae), Rubiaceae.

2. Spot identification (Binomial, Family) of common wild plants from families included in the theoretical syllabus (list to be provided).

FIELD WORK

At least three excursions including one excursion to Acharya Jagadish Chandra Bose Indian Botanic Garden (Shibpur, Howrah) and Central National Herbarium (CNH).

FIELD RECORDS

1. Field Note Book (authenticated) with field notes on the plants of the area of excursion and

voucher specimen book.

2. Herbarium specimen: Preparation of 25 angiospermic specimens (identified with author citation, voucher number and arranged following Bentham & Hooker's system of classification) to be submitted during examination.

CLASSROOM PERFORMANCE

Same as above.

SEMESTER IV

CORE COURSE-8

PLANT GEOGRAPHY, ECOLOGY AND EVOLUTION (BOT-A-CC-4-8-TH)

THEORETICAL

(Credits 4, Lectures 60)

PLANT GEOGRAPHY

1. Phytogeographical regions:

1.1. Phytogeographical regions of India (Chatterjee 1960); 1.2. Dominant flora of Eastern Himalaya, Western Himalaya and Sunderban.

…….8 lectures

2. Endemism:

2.1 Endemic types and Factors; 2.2. Age & Area hypothesis and Epibiotic theory; 2.3. Endemism in Indian flora.

…….6 lectures

ECOLOGY

1. Preliminary idea on:

1.1. Habitat and Niche, 1.2. Ecotone and edge–effect, 1.3. Microclimate, 1.4. Ecads, ecotype and ecoclines, 1.5. Carrying capacity.

…….4 lectures

2. Community ecology:

2.1. Community- Characteristics and diversity, 2.2. Ecological succession –Primary and secondary, Seral stages (with reference to Hydrosere), autogenic and allogenic succession.

…….6 lectures

3.1. Plant indicators (metallophytes); 3.2. Phytoremediation.

…….4 lectures

4. Conservation of Biodiversity:

4.1. Level of Biodiversity: genetic, species & ecosystem diversity, 4.2. Biodiversity hot spots- criteria,

Indian hotspots, 4.3. *In- situ* and *ex-situ* conservation, 4.4. Seed-banks, 4.5. Cryopreservation

…….16 lectures

EVOLUTION

1.1 Introduction, 1.2. Theories of evolution: Natural selection, Group selection, Neutral theory of molecular evolution, 1.3. Phyletic gradualism, Punctuated equilibrium and Stasis

…….6 lectures

2.1 Brief idea on: Stabilizing directional, disruptive and sexual selection; Speciation: Sympatric and allopatric speciation; Coevolution, Adaptive radiation, Reproductive isolation

…….4 lectures

3.1. Simplified phylogeny of bacteria, algae, fungi, bryophyte, pteridophyte and gymnosperm, 3.2. Phylogenetic tree.

…….6 lectures

PRACTICAL- PLANT GEOGRAPHY, ECOLOGY AND EVOLUTION (BOT-A-CC-4-8-P)

(Credits 2)

1.Workout on ecological parameters

2.Classroom performance: (Lab records)

3. Field Records (Field note book of phytogeographical study and ecological study)

4. Viva

PLANT GEOGRAPHY

1. Field visit- at least one long excursion at different phytogeographical region of India.

2. Study of local flora and submission of a project report highlighting phytogeographical characteristics of the region.

ECOLOGY

1. Study of community structure by quadrat method and determination of (i) Minimal size of the quadrat, (ii) Frequency, density and abundance of components (to be done during excursion/ field visit).

2. Comparative anatomical studies of leaves form polluted and less polluted areas.

3. Measurement of dissolved O_2 by azide modification of Winkler's method.

4. Comparison of free CO_2 from different sources.

CORE COURSE- 9

ECONOMIC BOTANY (BOT-A-CC-4-9-TH)

THEORETICAL

(Credits 4, Lectures 60)

1. Origin of cultivated crops: Concepts of centre of origin, their importance with reference to Vavilov's work. Examples of major plant introductions; crop domestication and loss of genetic diversity; evolution of new crops/ varieties, importance of germplasm diversity.

…….6 lectures

2. Cereals: Rice and wheat (origin, morphology, processing and uses).

…….6 lectures

3. Legumes: Origin, morphology and uses of gram and mung bean. Importance to man and environment.

…….6 lectures

4. Sugar and starches: Morphology and processing of sugarcane, products and byproducts of sugarcane industry. Potato- morphology, propagation and uses.

…….5 lectures

5. Spices: Listing of important spices, their family and part used.

…….6 lectures

6. Beverages: Tea (morphology, processing and uses).

…….5 lectures

7. Oil and fats: General description, classification, extraction, their uses and health implications of mustard, soybean, coconut (Botanical name, family and uses). Essential oils- general account, extraction methods, comparison with fatty oils and their uses.

…….10 lectures

8. Drug-yielding plants: Therapeutic and habit forming drugs with special reference to Cinchona, Digitalis, Papavar, Cannabis and Tobacco (morphology, processing, uses and health hazards).

…….8 lectures

9. Timber: general account with special reference to Sal and Teak.

…….4 lectures

10. Fibers: Cotton and Jute (Morphology, extraction and uses).

…….4 lectures

PRACTICAL- ECONOMIC BOTANY (BOT-A-CC-4-9-P)

(Credits 2)

1. Workout, micro-chemical tests

2. Identification- T.S./L.S. of permanent slides

3.Classroom performance: (Lab records, permanent slides)

4. Field visit desirable to give an idea about cultivation of any crop (viz. rice, jute, mustard, tea, potato)

5. Field record of the visit, properly authenticated by escorting teacher

ECONOMIC BOTANY

1. Cereals: Wheat (habit sketch, L.S./T.S. of grain, starch grains, micro-chemical tests); rice (habit sketch, study of paddy and grain, starch grains, micro-chemical tests)
2. Legume: Soybean, ground nut (habit, fruit, seed structure, micro-chemical tests)
3. Source of sugars and starches: Sugarcane (habit sketch; cane juice- micro-chemical tests); potato (habit sketch, tuber morphology, T.S. of tuber to show localization of starch grains, W.M. of starch grains, micro-chemical tests.
4. Tea- tea leaves, tests for tannin
5. Mustard- plant specimen, seeds, tests for fat in crushed seeds
6. Habit sketch of *Digitalis*, *Papaver* and *Cannabis*.
7. Sal, Teak- section of young stem.
8. Jute- specimen, transverse section of stem, tests for lignin on T.S. of stem and study of fibre following maceration technique.

CORE COURSE 10
GENETICS (BOT-A-CC-4-10-TH)
THEORETICAL
(Credits 4, Lectures 60)

1. Introduction: Mendelian genetics and its extension

…….6 lectures

2. Linkage, Crossing over and Gene Mapping:

2.1.Complete and incomplete linkage (example), linked gene does not assort independently (example), linkage group, 2.2. Crossing over, crossing over produces recombination (example), detection of crossing over (McClintock's experiment), and 2.3.Molecular mechanism of crossing over (Holliday model), 2.4. Gene mapping with three point test cross, detection of middle gene in three point test cross, calculation of recombination frequencies, 2.5. Co-efficient of coincidence and

interference, mapping function, 2.6. Problems on gene mapping, 2.7. Molecular mapping – ISH, FISH (brief idea).

…….16 lectures

3. Epistasis and Polygenic inheritance in plants.

…….4 lectures

4. Aneuploidy and Polyploidy: Types, examples, meiotic behaviour and importance of: 4.1. Aneuploidy, 4.2. Polyploidy, 4.3. Speciation and evolution through polyploidy.

…….8 lectures

5. Chromosomal aberration: Types and meiotic behaviour of: 5.1. Deletion, 5.2. Duplication, 5.3. Translocation, and 5.4. Inversion.

…….6 lectures

6. Mutation :

6.1. Point mutation-Transition, Transversion and Frame shift mutation, 6.2. Molecular mechanisms (tautomerisation, alkylation, deamination, base analogue incorporation, dimerisation), 6.3. DNA repair (brief idea).

…….8 lectures

7. Structural organisation of Gene:

7.1. One Gene–one polypeptide concept, 7.2. Split gene, 7.3. Overlapping gene, 7.4. Repetitive DNA-tandem and interspersed, 7.5. Transposon (Ac-Ds system), 7.6. Homoeotic gene in plants (ABCE Quartet model of flowering).

…….12 lectures

PRACTICAL- GENETICS (BOT-A-CC-4-10-P)

(Credits 2)

1. Genetics

2. Identification

3. Classroom performance (Laboratory Records and slides)

4 Viva- voce

GENETICS

1. Introduction to chromosome preparation: Pre-treatment, Fixation, Staining, Squash and Smear preparation, Preparation of permanent slides.

2. Determination of mitotic index and frequency of different mitotic stages in pre-fixed root tips of *Allium cepa*.

3. Study of mitotic chromosome: Metaphase chromosome preparation, free hand drawing under high power objective, drawing with drawing prism under oil immersion lens, determination of 2n number, and comment on chromosome morphology of the following specimens from root tips:

Allium cepa, *Aloe vera*, *Lens esculenta*.

4. Study of chromosomal aberrations developed due to exposure to any two pollutants/ pesticides etc.

5. Study of meiotic chromosome: Smear preparation of meiotic cells, identification of different stages and free hand drawing of the following specimens from flower buds: *Allium cepa* and *Setcreasea* sp.

6. Identification from permanent slides : Meiosis – (i) normal stages (ii) abnormal stages – laggard, anaphase bridge, ring chromosome (*Rhoeo discolor*); Mitosis – (i) normal stages, (ii) abnormal stages- early separation, late separation, multipolarity, sticky bridge, laggard, fragmentation, (ii) pollen mitosis.

SEMESTER V

CORE COURSE- 11
CELL AND MOLECULAR BIOLOGY (BOT-A-CC-5-11-TH)
THEORETICAL
(Credits 4, Lectures 60)

CELL BIOLOGY

1. Origin and Evolution of Cells:

1.1. Evolution of nucleic acid (from PNA to DNA), Concept of RNA world, Ribozymes, First cell, 1.2. Origin of eukaryotic cell (endosymbiotic theory), 1.3. Small RNA- riboswitch, RNA interference, si RNA, mi RNA- brief idea, 1.4.Organellar DNA (cp- and mt- DNA).

…….6 lectures

2. Nucleus and Chromosome:

2.1. Nuclear envelope, Nuclear lamina and Nuclear pore complex, 2.2. Nucleolus-ultrastructure and ribosome biogenesis, 2.3. Chromatin ultrastructure and DNA packaging in eukaryotic chromosome, 2.4. Centromere: types, structure and function.

…….6 lectures

3. Cell cycle and its regulation:

3.1. Kinetochore and spindle apparatus-structural organization and functions, 3.2.Microtubules-structure, organization and function, 3.3. Mechanism of cell cycle control in Yeast (checkpoints and role of MPF), Apoptosis (Brief idea).

…….6 lectures

MOLECULAR BIOLOGY

1. DNA Replication, Transcription and Translation (Prokaryotes & Eukaryotes):

1.1. Central Dogma, 1.2. Semiconservative DNA replication – mechanism, enzymes involved in DNA replication- DNA polymerase, DNA gyrase, Helicase, Ligase, primase and other accessory proteins, 1.3. Eukaryotic replication with special reference to replication licensing factor, assembly of new nucleosome, replication at the end chromosome telomere, telomerase concept, 1.4. Fidelity of DNA replication- prokaryote: nucleotide selection, proof reading, mismatch repair; eukaryote: through selection of error prone DNA polymerase, 1.5.Transcription, 1.6 RNA processing, 1.7. Aminoacylation of tRNA, 1.8. Translation.

…….20 lectures

2. Gene Regulation:

2.1 Concept of Lac-operon, 2.2. Positive and negative control.

…….4 lectures

3. Genetic Code:

3.1 Properties-evidences & exceptions, 3.2. Decipherence of codon (Binding technique).

…….4 lectures

4. Recombinant DNA Technology:

4.1. Restriction endonuclease, - types and roles, 4.2. Vector (plasmid pBR 322), 4.3. Marker gene, 4.4. Steps of cloning technique, 4.5. PCR and its application, 4.6. Genomic DNA and cDNA library.

…….10 lectures

5. Development and causes of Cancer (in general and brief), tumor suppressor gene and oncogene.

…….4 lectures

PRACTICAL- CELL BIOLOGY (BOT-A-CC-5-11-P)
(Credits 2)

1. Work out

2.Identification

3.Classroom performance (Laboratory Records and slides)

4.Preparation of models/charts

5. Viva-voce

CELL BIOLOGY

1. Study of plant cell structure with the help of epidermal peal mount of Onion/*Rhoeo*/*Crinum*
2. Measurement of cell size by the technique of micrometry.
3. Counting cells per unit volume with the help of haemocytometer (Yeast/pollengrains)
4. Cytochemical staining of DNA- Pyronine-methyl green staining.

5. Estimation of DNA content through DPA staining.
6. Estimation of RNA through orcinol method.
7. Study of nucleolus through hematoxylin/ orcin staining and determination of nucleolar frequency.
8. Preparation of models/ charts: rolling circle, theta replication, semi-discontinuous replication, prokaryotic RNA polymerase and eukaryotic RNA polymerase II, assembly of spliceosome mechinary, splicing mechanism in group I and group II introns, ribozyme and alternative splicing.

CORE COURSE- 12
BIOCHEMISTRY (BOT-A-CC-5-12-TH)
THEORETICAL
(Credits 4, Lectures 60)

1. Biochemical Foundations:

1.1. Covalent and non-covalent bonds; hydrogen bond; Van der Waal's forces; 1.2. Structure and properties of water; 1.3. pH and buffer (inorganic and organic); 1.4. Handerson-Hasselbalch equation; 1.5. Isoelectric point.

…….6 lectures

2. Molecules of life:

2.1. Nucleic Acids – structure of nucleosides and nucleotides ; oligo- and poly nucleotides , B & Z form of DNA, RNA- different forms; nucleotide derivatives (ATP, NADP), 2.2. Proteins – structure and classification of amino acids; primary, secondary, tertiary and quaternary structure of proteins; 2.3. Carbohydrates - structure of mono-, di- and polysaccharide; stereoisomers, enantiomers and epimers; 2.4. Lipids - structure of simple lipid and compound lipid (phospholipids and glycolipids), fatty acids- saturated and unsaturated.

…….24 lectures

3. Energy flow and enzymology:

3.1. Bioenergetics-Thermodynamic principles; free energy; energy rich bonds- phosphoryl group transfer and ATP; redox potentials and Biological redox reactions, 3.2. Enzymes – classification and nomenclature (IUBMB); Co-factors and co-enzymes; isozymes, 3.3. Mechanism of enzyme action; enzyme inhibition; 3.4. Enzyme kinetics (Michaelis- Menten equation) and simple problems.

…….18 lectures

4. Cell membrane:

4.1. Membrane chemistry, 4.2. Membrane transport (uniport, symport, antiport), mechanism of ion

uptake.

…….6 lectures

5. Phosphorylation: ATP Synthesis- Chemiosmotic model, Oxidative and Photophosphorylation- Mechanism and differences.

…….6 lectures

PRACTICAL- BIOCHEMISTRY (BOT-A-CC-5-12-P)
(Credits 2)

1. Workout on Plant Biochemistry (Quantitative & Qualitative)
2. Classroom performance (Laboratory Records and slides)
3. Viva

PLANT BIOCHEMISTRY

Qualitative:

1. Detection of organic acids: citric, tartaric, oxalic and malic from laboratory samples.
2. Detection of carbohydrate and protein from plant samples.
3. Detection of the nature of carbohydrate – glucose, fructose , sucrose and starch from laboratory samples.
4. Detection of Ca, Mg, Fe, S from plant ash sample.

Quantitative:

1. Preparation of solutions and buffers.
2. Estimation of amino-nitrogen by formol titration method (glycine) .
3. Estimation of glucose by Benedicts quantitative reagent.
4. Estimation of titratable acidity from lemon.
5. Estimation of catalase activity in plant samples and effect of substrate, enzyme concentration and pH on enzyme activity.
6. Estimation of urease activity in plant samples.
7. Colorimetric estimation of protein by Folin phenol reagent.

SEMESTER VI

CORE COURSE-13
PLANT PHYSIOLOGY (BOT-A-CC-6-13-TH)
THEORETICAL (Credits 4, Lectures 60)

1. Plant-water relations:

1.1 Concept of water potential, components of water potential in plant system, 1.2. Soil-plant-Atmosphere continuum concept, Cavitation in xylem and embolism, 1.3. Stomatal physiology-mechanism of opening and closing, Role of carbon di-oxide, potassium ion, abscisic acid and blue light in stomatal movement, Antitranspirants.

…….6 lectures

2. Mineral nutrition: essential and beneficial elements, macro- and micronutrients, methods of study and use of nutrient solutions, criteria for essentiality, mineral deficiency symptoms, roles of essential elements, chelating agents.

…….6 lectures

3. Organic Translocation:

3.1. Phloem sap, P-protein, 3.2. Phloem loading and unloading, 3.3. Mass-flow (pressure flow) hypothesis and its critical evaluation.

…….6 lectures

4. Plant Growth Regulators:

4.1. Physiological roles of Auxin, Gibberellin, Cytokinin, Abscisic acid, Ethylene, 4.2. Chemical nature – IAA, GA3, Kinetin, 4.3. Biosynthesis and bioassay of IAA, 4.4. Mode of action of IAA, 4.5. Brassinosteroids and Polyamines as PGRs (brief idea).

…….18 lectures

5. Photomorphogenesis:

5.1. Concept of photomorphogenesis, 5.2. Photoperiodism and plant types, 5.3. Perception of photoperiodic stimulus, 5.4. Critical day length, concept of light monitoring, 5.5. Phytochrome, cryptochrome and phototropins- chemical nature and role in photomorphogenesis, 5.6. Role of GA in flowering, 5.7. Vernalisation – role of low temperature in flowering, 5.8. Concept of biological clock and biorhythm.

…….12 lectures

6. Seed dormancy: 6.1. Types, Causes and Methods of breaking seed dormancy, 6.2. Biochemistry of seed germination.

…….6 lectures

7. Physiology of Senescence and Ageing.

…….6 lectures

PRACTICAL- PLANT PHYSIOLOGY (BOT-A-CC-6-13-P)
(Credits 2)

1. Plant Physiology

2. Classroom performance (Laboratory records)

3. Viva- voce

PLANT PHYSIOLOGY

1. Determination of loss of water per stoma per hour.

2. Relationship between transpiration and evaporation.

3. Measurement of osmotic pressure of storage tissue by weighing method.

4. Measurement of osmotic pressure of *Rhoeo* leaf by plasmolytic method.

5. Effect of temperature on absorption of water by storage tissue and determination of Q_{10}.

6. Rate of imbibition of water by starchy, proteinaceous and fatty seeds and effect of seed coat.

7. To study the phenomenon of seed germination (effect of light).

8. To study the induction of amylase activity in germinating grains.

9. To study the effect of different concentrations of IAA on *Avena* coleopotile elongation (IAA bioassay)

CORE COURSE 14
PLANT METABOLISM (BOT-A-CC-6-14-TH)
THEORETICAL
(Credits 4, Lectures 60)

1. Concept of metabolism: Introduction, Anabolic and catabolic metabolic pathways, regulation of metabolism, role of regulatory enzymes (allosteric, covalent modulation and isozymes)

…….4 lectures

2. Photosynthesis:

2.1.Chemical structure of chlorophyll a and b, absorption and action spectra, biological significance of carotenoid pigments, 2.2. Red drop and Emerson effect, Components of photosystems (light harvesting complex), photochemical reaction centres, Cyclic and noncyclic electron transport, Water splitting mechanism, 2.3. Calvin cycle – Biochemical reactions & stoichiometry, 2.4. HSK Pathway– three variants of the pathway, 2.5. Photosynthetic efficiency of C_3 and C_4 plants and crop

productivity, 2.6. Photorespiration – mechanism and significance, 2.7. Crassulacean Acid Metabolism– mechanism and ecological significance.

…….16 lectures

3. Respiration:

3.1. EMP pathway, regulation and its anabolic role, 3.2. Conversion of Pyruvic acid to Acetyl CoA, 3.3. TCA-cycle and its amphibolic role, 3.4. Oxidative pentose phosphate pathway and its significance, 3.5. Mitochondrial electron transport system, uncouplers, 3.6. Oxidation of cytosolic NADH+H^+ , 3.7. Stoichiometry of glucose oxidation (aerobic).

…….12 lectures

4. Nitrogen Metabolism:

4.1. Assimilation of nitrate by plants, 4.2. Biochemistry of dinitrogen fixation in Rhizobium, 4.3. General principle of amino acid biosynthesis (including GS and GOGAT enzyme system).

…….10 lectures

5. Lipid metabolism:

5.1. synthesis and breakdown of triglycerides, ß-oxidation, glyoxalate cycle, gluconeogenesis and its role in mobilization of the lipids during seed germinbations, α- oxidation.

…….8 lectures

6. Mechanism of signal transduction: receptor-ligand interactions, second messenger concept, calcium-calmodilin, G protein, MAP-kinase cascade.

…….10 lectures

PRACTICAL- PLANT METABOLISM (BOT-A-CC-6-14-P)

(Credits 2)

1. Workout on Plant metabolism

2. Classroom performance (Laboratory Records)

3. Viva

PLANT METABOLISM

1. A basic idea of chromatography: Principle, paper chromatography and column chromatography; demonstration of column chromatography.

2. Separation of plastidial pigments by solvent and paper chromatography.

3. Estimation of total chlorophyll content from different chronologically aged leaves (young, mature and senescence) by Arnon method.

4. Effect of HCO_3 concentration on oxygen evolution during photosynthesis in an aquatic plant and to find out the optimum and toxic concentration (either by volume measurement or bubble counting).

5. Measurement of oxygen uptake by respiring tissue (per g/hr.)

6.. Determination of the RQ of germinating seeds.

7. Test of seed viability by TTC method.

SKILL ENHANCEMENT COURSE- ELECTIVE (SEC)

SEC-A

APPLIED PHYCOLOGY, MYCOLOGY AND MICROBIOLOGY (BOT-A-SEC-A-3-1)

THEORETICAL

(Credits 2, Lectures 30)

APPLIED PHYCOLOGY

1. Algae as food and source of phycocolloid (Agar-agar, Algin, Carrageenan), 2. Diatomite, 3. Algal toxin, 4. Algal Biotechnology – potential of microalgae for SCP, β-carotene, Biodiesel, bioplastics from algae.

…….10 lectures

APPLIED MYCOLOGY

1. Fungi as food, 2. Cheese and Ethanol- Industrial production (brief outline), 3. Fungal sources and uses of Enzyme (Cellulase), Amino acid (Tryptophan), Vitamin (Riboflavin), Antibiotic (Griseofulvin), Pharmaceuticals (Cyclosporin-A). 4. Aflatoxin

…….10 lectures

APPLIED MICROBIOLOGY

1. Industrial Production of Vinegar and Streptomycin (brief outline), 2. Microbial sources and uses of Enzyme (Amylase, Protease), Amino acid (Glutamic acid, Lysine), Polysaccharides (Dextran), 3. Use of microbes as Biofertilizer and Biopesticides, 3.4. Use of microbes in mineral processing.

…….10 lectures

BIOFERTILIZERS (BOT-A-SEC-A-3-2)

THEORETICAL

(Credits 2, Lectures 30)

1. General account about the microbes used as biofertilizers- *Rhizobium*- isolation, identification, mass multiplication, carrier based inoculants, actinorrhizal symbiosis.

…….4 lectures

2. ***Azospirillum*:** isolation and mass multiplication- carrier based inoculants, associative effect of different microorganisms.

…….4 lectures

3. ***Azotobacter*:** classification, characteristics- crop response to *Azetobacter* inoculants, maintenance and mass multiplication.

…….4 lectures

4. Cyanobacteria (Blue green algae), *Azolla* and *Anabaena azollae* association, nitrogen fixation. Factors affecting growth, blue green algae and *Azolla* in rice cultivation.

…….4 lectures

5. *Mycorrhizal* association, types of mycorrhizal association, phosphorus nutrition, growth and yield- colonisation of VAM – isolation and inoculum production of VAM and its influence on growth and yield of crop plants.

…….8 lectures

6. **Organic farming**- green manuring and organic fertilizers, recycling of biodegradable municipal, agricultural and industrial wastes- biocompost making methods, types and methods of vermicomposting- field application.

…….6 lectures

SEC-B

PLANT BREEDING (BOT-A-SEC-B-4-3)

THEORITICAL

(Credits 2, Lectures 30)

1. **Plant breeding:** introduction and objectives, breeding systems- modes of reproduction in crop plants, important achievements and undesirable consequence of plant breeding.

…….4 lectures

2. **Methods of crop improvement:** Introduction- centres of origin and domestication of crop plants, plant genetics resources; acclimatization, selection methods- for self pollination, cross pollinated and vegetatively propagated plants, hybridization- for self, cross and vegetatively propagated plants, procedure, advantages and limitations.

…….6 lectures

3. Maintenance of germplasm, 3.1. Mass selections and Pure line selection, 3.2. Back cross method.

…….6 lectures

4. Heterosis and hybrid seed production, 4.1. Male sterility and its use in plant breeding.

…….2 lectures

5. Inbreeding and inbreeding depression, effect of outcrossing- a very brief idea.

…….4 lectures

6. Molecular Breeding (use of DNA markers in plant breeding).

…….2 lectures

7. Role of mutations, polyploidy, distant hybridization and role of biotechnology in crop improvements.

…….6 lectures

MUSHROOM CULTURE TECHNOLOGY (BOT-A-SEC-B-4-4)

THEORETICAL

(Credits 2, Lecture 30)

1. Introduction, nutritional and medicinal value of edible mushrooms; poisonous mushrooms, types of edible mushrooms available in India- *Volvariella volvacea, Pleurotus citrinopileatus*, *Agaricus bisporus*.

…….5 lectures

2. **Cultivation technology:** infrastructure: substrates (locally available), polythene bags, vessels, inoculation hook, inoculation loop, low cost stoves, sieves, culture racks, mushroom unit (thatched house), water sprayer, tray, small polythene bag. Pure culture: medium, sterilization, preparation of spawn, multiplication. Mushroom bed preparation- paddy straw, sugarcane trash, maize straw, banana leaves,. Factors affecting the mushroom bed preparation- low cost technology, composting technology in mushroom production.

…….12 lectures

3. **Storage and nutrition:** short term storage (Refrigeration- upto 24 hours), long term storage (canning, pickels, papads), drying, storage in salt solutions. Nutrition- proteins- amino acids, mineral elements nutrition- carbohydrates, crude fibre content- vitamins.

…….8 lectures

4. **Food preparation:** type of foods prepared from mushroom. Research centres- National level and regional level. Cost benefit ratio- marketing in India and abroad. Export value.

…….5 lectures

DISCIPLINE SPECIFIC ELECTIVE COURSES

DSE-A

BIOSTATISTICS (BOT-A-DSE-A-5-1-TH)

THEORETICAL

(Credits 4, Lectures 60)

1. **Biostatistics:** Definition, statistical methods, basic principles, variables- measurements, functions, limitations and uses of statistics.

…….12 lectures

2. **Biometry:** Data, Sample, Population, Random sampling, Frequency distribution- definition only.

…….12 lectures

3. **Central tendency–** Arithmetic Mean, Mode and Median; Measurement of dispersion–

Coefficient of variation, Standard Deviation, Standard error of Mean.

…….10 lectures

4. **Test of significance:** chi- square test for goodness of fit.

…….6 lectures

5. **Probability-** multiplicative and additive rules of probability: application and importance.

…….6 lectures

6. **Measurement of gene frequency:** Hardy-Weinberg equilibrium- conditions applied for its implications (simple problems to calculate genotypic and allelic frequencies).

…….14 lectures

PRACTICAL- BIOSTATISTICS (BOT-A-DSE-A-5-1-P)
(Credits 2)

1. Workout
2. Classroom performance (Laboratory Records)
3. Viva

BIOSTATISTICS

1. Univariate analysis of statistical data: Statistical tables, mean, mode, median, standard deviation and standard error (using seedling population / leaflet size).
2. Calculation of correlation coefficient values and finding out the probability.
3. Determination of goodness of fit in Mendellian and modified mono-and dihybrid ratios (3:1, 1:1, 9:3:3:1, 1:1:1:1, 9:7, 13:3, 15:1) by Chi-square analysis and comment on the nature of inheritance.
4. Calculation of 'F' value and finding out the probability value for the F value
5. Basic idea of computer programme for statistical analysis of correlation coefficient,'t' test, standard error, standard deviation.

INDUSTRIAL AND ENVIRONMENTAL MICROBIOLOGY (BOT-A-DSE-A-5-2-TH)
THEORETICAL
(Credits 4, Lectures 60)

1. Scope of microbes in industry and environment.

…….6 lectures

2. Bioreactors/ Fermenters and fermentation process: solid- state and liquid-state (stationary and submerged) fermentations; batch and continuous fermentations. Components of a typical

bioreactors, types of bioreactors- laboratory, pilot scale and production fermenters. Constantly stirred fermenter, tower fermenter, fixed bed and fluidized bed bioreactors and air- lift Fermenter.

…….12 lectures

3. Microbial production of industrial products: microorganisms involved, media, fermentation conditions, down stream processing and uses; filtration, centrifugation, cell disruption, solvent extraction, precipitation and ultrafiltration, liophilisation, spray drying, hands on microbial fermentations for the production and estimation of enzymes amylase or lipase activity, organic acids (citric or glutamic acid), alcohol (ethanol) and antibiotic (Penicillin).

…….12 lectures

4. Microbial enzymes of industrial interest and enzyme immobilization: microorganisms for industrial applications. Methods of immobilization, advantages and applications of immobilization, large scale application of immobilized enzymes (glucose isomerase and penicillin acylase).

…….8 lectures

5. Microbes and quality of environment: distribution of microbes in air, isolation of microorganisms from soil, air and water.

…….8 lectures

6. Microbial flora of water: water pollution, role of microbes in sewage and domestic waste water treatment systems. Determination of BOD, COD of water samples. Microorganisms as indicators of water quality, check coliform and fecal coliform in water samples.

…….8 lectures

7. Microbes in agriculture and remediation of contaminated soils: biological fixation, mycorrhizae, bioremediation of contaminated soils, isolation of root nodulating bacteria, arbuscular mycorrhizal colonization in plant roots.

…….8 lectures

PRACTICAL- INDUSTRIAL AND ENVIRONMENTAL MICROBIOLOGY (BOT-A-DSE-A-5-2-P)
(Credits 2)

1. Workout
2. Classroom performance (Laboratory Records)
3. Viva

INDUSTRIAL AND ENVIRONMENTAL MICROBIOLOGY

1. Principals and functioning of instruments in microbiology laboratory
2. Hands on sterilization techniques and preparation of culture media.
3. Preparation of slant, stab and pouring petriplate.

4. A visit to any educational institute/ industry to see an industrial fermenter, and other down-stream processing operations.

MEDICINAL AND ETHNOBOTANY (BOT-A-DSE-A-6-3-TH)
THEORETICAL
(Credits 4, Lectures 60)

1. Medicinal botany: History, scope and importance of medicinal plant, a brief idea about indigenous medicinal sciences- ayurveda, siddha and unani. Polyherbal formulations.

…….14 lectures

2. Pharmacognosy- General account :

2.1 Pharmacognosy and its importance in modern medicine, 2.2 Crude drugs, 2.3 Classification of drugs- chemical and pharmacological, 2.4 Drug evaluation– organoleptic, microscopic, chemical, physical and biological, 2.5. Major pharmacological groups of plant drugs and their uses.

…….12 lectures

3. Secondary metabolites:

3.1 Definition of secondary metabolites and difference with primary metabolites , 3.2 Interrelationship of basic metabolic pathways with secondary metabolite biosynthesis (outlines only), 3.3 Major types–terpenoids, phenolics, flavonoids, alkaloids and their protective action against pathogenic microbes and herbivores.

…….14 lectures

4. Pharmacologically active constituents:

Source plants (one example) parts used and uses of: 3.1 Steroids (Solasodin, Diosgenin, Digitoxin), 3.2 Tannin (Catechin), 3.3 Resins (Gingerol, Curcuminoids), 3.4 Alkaloids (Quinine, Atropine. Pilocarpine, Strychnine, Reserpine, Vinblastine), 3.5. Phenols (Sennocide and Capsaicin).

…….4 lectures

5. Ethnobotany and folk medicine: Definition, methods of study, application, Indian scenario, national interacts, Palaeo-ethnobotany, folk medicines in ethnobotany, ethnomedicine, ethnoecology, ethnic communities of India, application of natural products to certain diseases- Jaudice, cardiac, infertility, diabetics, blood pressure and skin diseases.

…….16 lectures

PRACTICAL- MEDICINAL AND ETHNOBOTANY (BOT-A-DSE-A-6-3-P)
(Credits 2)

1. Workout and chemical tests

2. Classroom performance (Laboratory Records)

3. Viva

MEDICINAL AND ETHNOBOTANY

1. Chemical tests for (a) Tannin (*Camellia sinensis* / *Terminalia chebula*), (b) Alkaloid (*Catharanthus roseus*) .

2. Powder microscopy – *Zingiber* and *Holarrhena* .

3. Histochemical tests of (a) Curcumin (*Curcuma longa*), (b) Starch in non-lignified vessel (*Zingiber*), (c) Alkaloid

(stem of *Catharanthus* and bark of *Holarrhena*).

STRESS BIOLOGY (BOT-A-DSE-A-6-4-TH)

THEORETICAL

(Credits 4, Lectures 60)

1. Plant stress- definition. Acclimation and adaptation.

…….2 lectures

2. Environmental factors- water stress, salinity stress and temperature stress- plant response. Pathogenesis- related (PR) proteins, systemic acquired resistance; mediation of insect and disease resistance by jasmonates.

…….20 lectures

3. Stress sensing mechanism in plants: calcium modulation, phospholipid signaling.

…….20 lectures

4. Developmental and physiological mechanisms that protect plants against environmental stress: adaptation of plants, changes in root-shoot ratios, aerenchyma development; osmotic adjustment, compatible solute production.

…….12 lectures

5. Reactive oxygen species- production and scavenging mechanism.

…….6 lectures

PRACTICAL- STRESS BIOLOGY (BOT-A-DSE-A-6-4-P)

(Credits 2)

1. Workout

2. Classroom performance (Laboratory Records)

3. Viva

STRESS BIOLOGY

1. Quantitative estimation of peroxidase activity in the seedlings in the absence and presence of salt stress.

2. Superoxide dismutase activity in the absence and presence of stress.

3. Catalase activity in the presence and absence of stress.

4. Comparative study of plants/seedlings subjected to different degree of stress/ pollutants.

5. To study the effect of stress (salt/ water/ heavy metal) on seed germination and seedling growth (any commonly available specimen)

DSE-B

PLANT BIOTECHNOLOGY (BOT-A-DSE-B-5-5-TH)

THEORETICAL

(Credits 4, Lectures 60)

1. Plant tissue culture –Introduction:

1.1. Basic concept and milestones, 1.2. Cellular totipotency, 1.3. Tissue culture media, 1.4. Aseptic manipulation, 1.5. Cyto-differentiation and dedifferentiation.

…….10 lectures

2. Callus culture:

2.1. Callus induction, maintenance and application, 2.2. Suspension culture- introductory idea.

…….6 lectures

3. Plant regeneration:

3.1. Organogenesis (direct and indirect), 3.2. Somatic embryogenesis, 3.3. Significance of organogenesis and somatic embryogenesis, 3.4. Artificial seed.

…….8 lectures

4. Haploid Culture:

4.1. Anther and Pollen culture methods, 4.2. Applications.

…….6 lectures

5. Protoplast Culture:

5.1. Protoplast isolation and culture, 5.2. Protoplast fusion (somatic hybridization), 5.3. Significance.

…….6 lectures

6. Plant Genetic Engineering:

6.1. Brief concept of different gene transfer methods, special emphasis on *Agrobacterium* mediated gene transfer, Role of Reporter gene, 6.2. Achievements in crop biotechnology,

environment and industry (suitable example)- pest resistant plants (BT cotton), herbicide resistance, disease and stress tolerance, transgenic crop with improved quality (flavr tomato, golden rice), role of transgenic in population degradation (super-bug), leaching of minerals, production of industrial enzymes, oil, edible vaccine.

…….24 lectures

PRACTICAL- PLANT BIOTECHNOLOGY (BOT-A-DSE-B-5-5-P)
(Credits 2)

1. Field report on a visit to a tissue culture lab.
2. Classroom performance (Laboratory Records, charts/ models)
3. Viva

PLANT BIOTECHNOLOGY

1. Familiarization of basic equipments in plant tissue culture

2. Study through photographs/ charts/ models of anther culture, somatic embyogenesis, endosperm and embryo culture, micropropagation.

3. Preparation of basal media. Sterilization techniques.

4. Demonstration of any tissue culture technique during visit in a plant tissue culture lab.

DSE B
HORTICULTURAL PRACTICES AND POST- HARVEST TECHNOLOGY (BOT-A-DSE-B-5-6-TH)
THEORETICAL
(Credits 4, Lectures 60)

1. **Horticulture** –scope, importance and branches. Role in rural economy and employment generation; importance in food and nutritional security; urban horticulture and ecoturism.

   …….4 lectures
2. **Ornamental plants:** types, classifications (annuals, perennials, climbers and trees), identification and salient features of some ornamental plants (rose, marigold, gladiolus, carnations, orchids, poppies, gerberas, tuberose, sages, cacti and succulants). Ornamental flowering trees (Indian laburnum, gulmohor, jacaranda, Lagerostoemia, fishtail and Erica palms, simul, coral tree).

   …….4 lectures
3. **Fruit and vegetable crops:** production, origin and distribution; description of plants and their

economic products; management and marketing of vegetables and fruit crops; identification of some fruits and some vegetables varieties (citrus, banana, mango, chillis and cucurbits).

…….4 lectures

4. **Horticultural techniques:** application manures, fertilizers, nutrients and PGRs; weed controls, biofertilizers, biopesticides, irrigation methods. Hydroponics, propagation methods; vegetative (grafting, cutting, layering, budding), sexual (seed production), scope and limitations.

…….8 lectures

5. Landscaping and garden designing: planning and lay out (parks and gardens).

…….6 lectures

6. **Floriculture:** cut flowers, bonsai, commerce (market demand and supply), importance of flower shows and exhibitions.

…….6 lectures

7. **Post harvest technology:** Importance of post harvest technology in horticultural crops, evaluation of quality, traits; harvesting and handling of fruits, vegetables, cut flower; principles, methods of preservation and processing, methods of minimizing losses during storage and transportation; food irradiation- advantages and disadvantages; food safety.

…….10 lectures

8. **Disease control and management:** field and post harvest diseases, identification of deficiency symptoms, remedial measures and nutritional management practices; crop sanitation; IPM strategies (genetic, biological and chemical methods for pest control); quarantine practices; identification of common diseases and pest of ornamental fruits and vegetable crops.

…….8 lectures

9. **Horticultural crops-** conservation and management: documentation and conservation of germplasm. Role of micropropagation and tissue culture techniques; varieties and cultivars of various horticultural crops; IPR issues, national international and professional societies and sources of information on horticulture.

…….10 lectures

PRACTICAL- HORTICULTURAL PRACTICES AND POST- HARVEST TECHNOLOGY (BOT-A-DSE-B-5-6-P)
(Credits 2)

Field trip- field visits to gardens, standing crop sites, nurseries, vegetable gardens, horticultural fields at IARI/AHSI or other suitable locations and if possible to cold storage.

RESEARCH METHODOLOGY (BOT-A-DSE-B-6-7-TH)

THEORETICAL

(Credits 4, Lectures 60)

1. Basic concepts of research: research- definition and types of research (Descriptive vs. analytical, applied vs. fundamental, quantitative vs. qualitative, conceptual vs. emperical), research methods vs. methodology; literature- review and its consolidation; library research; field research; laboratory research.

.....10 lectures

2. General laboratory techniques: common calculations in botany laboratories; understanding the details on the label of reagent bottles; molarity and normality of common amino acids and bases; preparation of solutions. Dilution, percentage, molar, molal and normal solutions. Techniques of handling micropipettes; knowledge about common toxic chemicals and safety measures in their handling.

.....12 lectures

3. Data collection and documentation of observations. Maintaining of laboratory records, tabulation and generation of graphs. Imaging of tissue specimens and application of scale bars. The art of field photography.

.....6 lectures

4. Overview of biological problems: plant science research key areas, model organisms in research.

.....6 lectures

5. Methods to study plant cells/ tissue structure: whole mounts, peal mounts, squash preparations, clearing, maceration and sectioning, tissue preparation- fixation, dehydration etc., paraffin and plastic infiltration, preparation of thin and ultra-thin sections.

.....6 lectures

6. Plant micro-techniques: staining procedures, classification and chemistry of stains, staining equipments. Cytogenetic techniques with squashed plant materials.

.....12 lectures

7. The art of scientific writing and its presentation: numbers, units, abbreviations and nomenclature used in scientific writing. Writing references. Power point presentation. Poster presentation. Scientific writing ethics. Introduction to copy write- academic misconduct/ plagiarism.

.....8 lectures

PRACTICAL- RESEARCH METHODOLOGY (BOT-A-DSE-B-6-7-P)

(Credits 2)

1. Experiments based on calculations
2. Plant microtechnique experiments

3. The art of imaging of samples through photomicrography and field photography
4. Poster/ power point presentation on defined topics
5. Technical writing on topics assigned.

Natural resource management (BOT-A-DSE-B-6-8-TH)

THEORETICAL

(Credits 4, Lectures 60)

Unit 1: Natural resources

Definition and types.

…….. 2 lectures

Unit 2: Sustainable utilization

Concept, approaches (economic, ecological and socio-cultural).

…….. 8 lectures

Unit 3: Land

Utilization (agricultural, pastoral, horticultural, silvicultural); Soil degradation and management.

…….. 8 lectures

Unit 4: Water

Fresh water (rivers, lakes, groundwater, aquifers, watershed); Marine; Estuarine; Wetlands; Threats and management strategies.

…….. 8 lectures

Unit 5: Biological Resources

Biodiversity-definition and types; Significance; Threats; Management strategies; Bioprospecting; IPR; CBD; National Biodiversity Action Plan).

…….. 12 lectures

Unit 6: Forests

Definition, Cover and its significance (with special reference to India); Major and minor Forest products; Depletion; Management.

…….. 6 lectures

Unit 7: Energy

Renewable and non-renewable sources of energy.

…….. 6 lectures

Unit 8: Contemporary practices in resource management

EIA, GIS, Participatory Resource Appraisal, Ecological Footprint with emphasis on carbon footprint, Resource Accounting; Waste management.

…….. 8 lectures

Unit 9: National and international efforts in resource management and conservation

…….. 4 lectures

PRACTICAL- Natural resource management (BOT-A-DSE-B-6-8-P)
(Credits 2)

1. Estimation of solid waste generated by a domestic system (biodegradable and non-biodegradable) and its impact on land degradation.
2. Estimation of foliar dust deposition.
3. Determination of total solid in water (TDS)
4. Determination of chemical properties of soil by rapid spot test (carbonate, iron, nitrate)
5. Estimation of organic carbon percentage present in soil sample.
6. Collection of data on forest cover of specific area.

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8. Pteridophytes

1. Spore, K.R. The Morphology of Pteridophyte, Latest Ed. , Huchinson & Co. Ltd.

2. Rashid, A. An Introduction to Pteridophyta, Latest Ed., Vani Educational Books.

3. Vashista, P.C. Pteridophyta, Latest Ed., S. Chand & Company Pvt. Ltd.

4. Gifford, E. M. & Foster, A. S. Morphology & Evolution of Vascular Plants (3rd ed.), 1998, Freeman and Co.

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2. Vashishta, P.C. Gymnosperm, Latest Ed., S. Chand & Company Pvt.

3. Karkar, R.K. & Karkar, R. The Gymnosperms, Latest Ed.

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10. Ecology & Plant Geography

1. Chapman and Riss. Ecology: Principles and Applications, Latest Ed., Cambridge University Press

2. Shukla, R.S. & Chandel, P.S. Plant Ecology, Latest Ed., S. Chandel and Co.

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12. Anatomy

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5. Eames, A.J. & Mac. Daniels, L.H. An Introduction to Plant Anatomy, Latest Ed., McGraw Hill

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7. Cutter, E.G. Plant Anatomy: Experiment and Interpretations, Part I & II, Edward Arnold

8. Beck, C.B. An Introduction to plant Structure and Development (2nd ed.), Cambridge University Press

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13. Morphology and Taxonomy of Angiosperms

1. Judd, W.S., Campbell, C.S., Kellogg, E.A., Stevens, P.F. and Donoghue, M.J. Plant Systematics, A Phylogenetic Approach (4th ed.), 2016, Sinauer Associaties, Inc.

2. Jones, S.B. and Luchsinger, A.E. Plant Systematics (2nd ed.), 1987, McGraw Hill Book Company

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2. Allaed, R.W. Principles of Plant Breeding, 1960, John Wiley & Sons.

3. Poehlman, J.M. & Barthakur, D. Plant Breeding, Latest Ed., Oxford & IBH.

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5. Barley, N.T.J. Statistical Methods in Biology, Latest Ed., Cambridge University Press

6. Roy, D. Plant Breeding: Analysis & Exploitation of Variation, 2000, Narosa Publishing House.

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8. Kar, D.K. and Halder, S. Plant Breeding & Biometry, 2006, New Central Book Agency.

9. Dutta, Animesh K. Basic Biostatistics & its Application 2006, New Central Book Agency.

18. Plant Biotechnology

1. Chawla, H.S. An Introduction to Plant Biotechnology (2nd ed.), 2002,Oxford & IBH

2. Borer, A., Sentos, F.R. & Bowen, D.B. Understanding Biotechnology, 2003, Pearson Education

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4. Walker, J.M. & Rapley, R. Molecular Biology & Biotechnology, 2000, Royal Society of Chemistry

5. Collin, H.A. and Edwards, S. Plant Cell Culture, 1998, Bios Scientific Publishers

6. Dixon, R.A. & Gonzales, R. A. Plant Cell Culture: A Practical Approach, 1994, Oxford University Press

7. Gamorgs, O.L. & Phillips, G.C. Plant Cell, Tissue and Organ Culture: Fundamental method, Narosa Publishing House

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19. Natural resource management

1. Vasudevan, N. (2006). Essentials of Environmental Science. Narosa Publishing House, New Delhi.

2. Singh, J. S., Singh, S.P. and Gupta, S. (2006). Ecology, Environment and Resource Conservation. Anamaya Publications, New Delhi.

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UNIVERSITY OF CALCUTTA

SYLLABUS

FOR

THREE-YEAR B.Sc. PROGRAMME IN

BOTANY (GENERAL COURSE)

UNDER CHOICE BASED CREDIT SYSTEM

BOTANY

Syllabus for three-year B.Sc. Botany Programme

(With effect from 2018-2019)

CORE COURSES (4)

Each theoretical course of 4 credits and practical of 2 credits.

1. Plant diversity I (Phycology, Mycology, Phytopathology, Bryophytes and Anatomy) – a) Theoretical- BOT-G-CC-1-1-TH b) Practical- BOT-G-CC-1-1-P (… … GE-1-1-TH & P)

2. Plant diversity II (Pteridophytes, Gymnosperms, Palaeobotany, Morphology and Taxonomy) – a) Theoretical- BOT-G-CC-2-2-TH b) Practical- BOT-G-CC-2-2-P (… … GE-2-2-TH & P)

3. Cell biology, Genetics and Microbiology – a) Theoretical- BOT-G-CC-3-3-TH b) Practical- BOT-G-CC-3-3-P (… … GE-3-3-TH & P)

4. Plant physiology and metabolism – a) Theoretical- BOT-G-CC-4-4-TH b) Practical- BOT-G-CC-4-4-P (… … GE-4-4-TH & P)

N.B.: The above said four core courses (CC) may be considered as GE 1, 2, 3 & 4 respectively for the honours students of other allied disciplines opting Botany as one of the general courses.

Skill enhancement courses (SEC, four courses to be selected strictly on 2 subjects out of 3 subjects opted taking 2 courses from each subject. Each general subject shall have 2 groups (A & B) of SEC papers. One paper from Group A from each of the 2 subjects to be chosen in the 3rd and 5th Semester, one paper from Group B of each of the 2 subjects to be chosen in the 4th and 6th Semesters. Each paper of 2 credits and theoretical only)

SEC A

1. Plant breeding and biometry (BOT-G-SEC-A-3/5-1)
2. Biofertilizers (BOT-G-SEC-A-3/5-2)

SEC B

1. Plant biotechnology (BOT-G-SEC-B-4/6-3)
2. Mushroom culture technology (BOT-G-SEC-B-4/6-4)

Discipline specific elective courses (DSE, two courses to be selected from the list taking one each from Group A in 5th semester and one from Group B in 6th Semester. Each course comprises of theoretical component of 4 credits and practical ones of 2 credits)

DSE A

1. Phytochemistry and medicinal botany- a) Theoretical- BOT-G-DSE-A-5-1-TH, b) Practical- BOT-G-DSE-A-5-1-P
2. Natural resource management- a) Theoretical- BOT-G-DSE-A-5-2-TH, b) Practical- BOT-G-DSE-A-5-2-P

DSE B

3. Economic botany- a) Theoretical- BOT-G-DSE-B-6-3-TH, b) Practical- BOT-G-DSE-B-6-3-P
4. Horticultural practices and post harvest technology - a) Theoretical- BOT-G-DSE-B-6-4-TH, b) Practical- BOT-G-DSE-B-6-4-P

SEMESTER	CORE COURSES (CC-1-4)	ABILITY ENHANCEMENT COMPULSORY COURSE (AEC-1&2)	SKILL ENHANCEMENT COURSE (SEC-1-4)	DISCIPLINE SPECIFIC ELECTIVE COURSE (DSE-1&2)
I	PLANT DIVERSITY I (PHYCOLOGY, MYCOLOGY, PHYTOPATHOLOGY, BRYOPHYTES AND ANATOMY) **BOT-G-CC-1-1-TH** PRACTICALS **BOT-G-CC-1-1-P** OTHER DESCIPLINES (2)	AECC-1 ENGLISH COMUUNICATION		
II	PLANT DIVERSITY II (PTERIDOPHYTES, GYMNOSPERMS, PALAEOBOTANY, MORPHOLOGY AND TAXONOMY) **BOT-G-CC-2-2-TH** PRACTICALS **BOT-G-CC-2-2-P** OTHER DESCIPLINES (2)	AECC-2 ENVIRONMENTAL SCIENCE		
III	CELL BIOLOGY, GENETICS AND MICROBIOLOGY **BOT-G-CC-3-3-TH** PRACTICALS **BOT-G-CC-3-3-P** OTHER DESCIPLINES (2)		SEC-A	
IV	PLANT PHYSIOLOGY AND METABOLISM **BOT-G-CC-4-4-TH** PRACTICALS **BOT-G-CC-4-4-P** OTHER DESCIPLINES (2)		SEC-B	
V			SEC-A	DSE-A (any one from GROUP A) THEORY & PRACTICAL OTHER DESCIPLINES (2)
VI			SEC-B	DSE-B (any one from GROUP B) THEORY & PRACTICAL OTHER DESCIPLINES (2)

SEMESTER I

CORE COURSE 1
PLANT DIVERSITY I (PHYCOLOGY, MYCOLOGY, PHYTOPATHOLOGY, BRYOPHYTES AND ANATOMY) (BOT-G-CC-1-1-TH)
THEORETICAL
(Credits 4, Lectures 60)

1. Introduction to different plant groups

…….2 lectures

2. Phycology

2.1. Diagnostic characters and examples of Cyanophyceae, Rhodophyceae, Chlorophyceae, Charophyceae and Phaeophyceae, 2.2 Classification: Criteria and system of Fritsch, 2.3. Life histories of *Chlamydomonas*, *Chara* and *Ectocarpus*, 2.4. Role of algae in the environment, agriculture, biotechnology and industry.

…….14 lectures

3. Mycology

3.1 Diagnostic characters and examples of Oomycotina, Mastigomycotina, Zygomycotina, Ascomycotina, Basidiomycotina, Deuteromycotina (Ainsworth, 1973). 3.2 Life histories of *Rhizopus* and *Ascobolus*, 3.3. Economic importance of fungi, 3.4 Fungal symbioses: *Mycorrhiza*, Lichen and their importance.

…….12 lectures

4. Phytopathology

4.1 Symptoms - necrotic, hypoplastic and hyperplastic, 4.2 Koch's postulates, 4.3 Biotrophs and Necrotrophs, 4.4 Disease triangle, 4.5 Pathotoxins and phytoalexins (brief concept), 4.6 Symptoms, causal organism, disease cycle and control measures of plant diseases (Late blight of potato, Brown spot of Rice, Stem rot of jute).

…….10 lectures

5. Bryophytes

5.1 Unifying features of archaegoniates and transition to land habit, 5.2 Amphibian nature of bryophytes, 5.3 Diagnostic characters and examples of Hepaticopsida, Anthocerotopsida and Bryopsida (Proskauer 1957), 5.4 Life histories of *Marchantia* and *Funaria*, 5.5 Ecological and economic importance.

…….10 lectures

6. Anatomy

6.1 Stomata - Types (Metcalfe & Chalk), 6.2 Anatomy of root, stem and leaf of monocots and dicots, 6.3 Stelar types and evolution, 6.4 Secondary growth – normal in dicot stem and anomaly in stem of *Tecoma* & *Dracaena*.

…….12 lectures

PRACTICAL- PLANT DIVERSITY I (PHYCOLOGY, MYCOLOGY, PHYTOPATHOLOGY, BRYOPHYTES AND ANATOMY) (BOT-G-CC-1-1-P)
(Credits 2)

1. Work out: Microscopic preparation, drawing and labeling of *Chlamydomonas*, *Chara*, *Ectocarpus*, *Rhizopus* and *Ascobolus*

2. Anatomical studies (following double staining method) of: 2a. Stem- *Cucurbita*, sunflower and maize. 2b. Root- *Colocassia*, gram and orchid. 2c. Leaf- Nerium

3. Identification with reasons: 3a. Cryptogamic specimens (macroscopic/microscopic as prescribed in the theoretical syllabus. 3b. Pathological specimens (herbarium sheets) of Late blight of potato, Brown spot of rice and stem rot of jute.

4. Laboratory records: Laboratory note books (regularly signed) and slides (prepared in class) are to be submitted at the time of Practical Examination. Regular attendance in the class must be credited.

5. Atleast one local excursion to be conducted to give an idea of plant diversity, habitat of algae and fungi

SEMESTER II

CORE COURSE 2
PLANT DIVERSITY II (PTERIDOPHYTES, GYMNOSPERMS, PALAEOBOTANY, MORPHOLOGY AND TAXONOMY) (BOT-G-CC-2-2-TH)
THEORETICAL
(Credits 4, Lectures 60)

1. Pteridophytes

1.1 Diagnostic characters and examples of Psilophyta, Lycophyta, Sphenophyta & Filicophyta (Gifford & Foster 1989). 1.2 Life histories of *Selaginella* and *Pteris*, 1.3 Economic importance.

…….12 lectures

2. Gymnosperms

2.1 Progymnosperms (brief idea), 2.2 Diagnostic characters and examples of Cycadophyta, Coniferophyta and Gnetophyta (Gifford & Foster 1989), 2.3 Life histories of Cycas and Pinus, 2.4 Williamsonia (reconstructed), 2.5 Economic importance of Gymnosperms.

…….12 lectures

3. Paleobotany & Palynology

3.1 Fossil, fossilization process and factors of fossilization, 3.2 Importance of fossil study. 3.3 Geological time scale, 3.4 Palynology - Definition, spore & pollen (brief idea), Applications.

…….10 lectures

4. Angiosperm Morphology

4.1 Inflorescence types with examples, 4.2 Flower, 4.3 Fruits and seeds- type and examples.

…….12 lectures

5. Taxonomy of Angiosperms

5.1 Artificial, Natural and Phylogenetic systems of c1assificaiton with one example each, 5.2 Diagnostic features of following families- Malvaceae, Leguminosae (Fabaceae), Cucurbitaceae,

Rubiaceae, Compositae (Asteraceae), Solanaceae, Acanthaceae, Labiatae (Lamiaceae), Orchidaceae, Gramineae (Poaceae).

…….14 lectures

PRACTICAL- PLANT DIVERSITY II (PTERIDOPHYTES, GYMNOSPERMS, PALAEOBOTANY, MORPHOLOGY AND TAXONOMY) (BOT-G-CC-2-2-P)
(Credits 2)

1. Dissection, drawing and labelling, description of angiospermic plants and floral parts, floral formula and floral diagram, identification (family) from the following families: Leguminosae (Fabaceae), Malvaceae, Solanaceae, Labiatea (Lamiaceae), Acanthaceae.

2. Identification with reasons:

Macroscopic specimens of *Selaginella* and *Pteris*, male and female strobilus of *Cycas* and *Pinus*, Anatomical slides (stellar types, transfusion tissue, sieve tube, sunken stomata, lenticels), inflorescence types.

3. Spot identification of the following Angiospermic plants (scientific names and families): *Sida rhombifolia* (Malvaceae), *Abutilon indicum* (Malvaceae), *Cassia sophera* (Fabaceae), *Tephrosia halimtonii* (Fabaceae), *Crotolaria palida* (Fabaceae), *Coccinia grandis* (Cucurbitaceae), *Solanum indicum* (Solanaceae), *Nicotiana plumbagenifolia* (Solanaceae), *Leucas aspera* (Lamiaceae), *Leonurus sibiricus* (Lamiaceae), *Parthenium hysterophorus* (Asteraceae), *Tridax procumbense* (Asteraceae), *Eclipta prostrate* (Asteraceae), *Eragrostis tenella* (Poaceae), *Chrysopogon aciculantus* (Poaceae), *Eleusine indica* (Poaceae), *Vanda taesellata* (Orchidaceae).

4. Laboratory records: Laboratory note books (regularly signed) and slides (prepared in class) are to e submitted at the time of Practical Examination. Regular attendance in the class must be credited.

5. Field excursion: Local Excursions (at least two including one to Acharya Jagadish Chandra Bose Botanic Garden, Shibpur, Howrah)

6. Field Records: Field note book and 15 herbarium sheets of common Angiospermic weeds are to be prepared and submitted at the time of Practical Examination. Regular attendance in the class must be credited.

SEMESTER III

CORE COURSE 3
CELL BIOLOGY, GENETICS AND MICROBIOLOGY (BOT-G-CC-3-3-TH)
THEORETICAL
(Credits 4, Lectures 60)

1. Cell Biology and Genetics

1.1 Ultrastructure of nuclear envelope, nucleolus and their functions, 1.2 Molecular organisation of metaphase chromosome (Nucleosome concept).

…….6 lectures

2. Chromosomal aberrations- 2.1 deletion, duplication, inversion & translocation, 2.2 Aneuploidy & Polyploidy-types, importance and role in evolution.

…….6 lectures

3. Central Dogma, 3.1 Transcription and Translation.

…….10 lectures

4. Genetic Code- properties.

…….4 lectures

5. Linkage group and Genetic map (three-point test cross).

…….6 lectures

6. Mutation – 6.1 Point mutation (tautomerisation; transition, transversion and frame shift), 6.2 Mutagen-physical and chemical.

…….8 lectures

7. Brief concept of Split gene, Transposons.

…….4 lectures

2. Microbes

2.1 Viruses- Discovery, general structure, replication (general account), DNA virus (T-phage); Lytic and lysogenic cycle, RNA virus (TMV); Economic importance; 2.2 Bacteria- discovery, general characteristics and cell structure; reproduction- vegetative, asexual and recombination (conjugation, transformation and transduction); Economic importance.

……. 16 lectures

RACTICAL- CELL BIOLOGY, GENETICS AND MICROBIOLOGY (BOT-G-CC-3-3-P)
(Credits 2)

1. Cell Biology:

Staining (Aceto-orcein) and squash preparation of onion root tip: study of mitotic stages. Determination of mitotic index (from onion root tip).

2. Microbiology:

Workout gram staining (curd/any natural source)

3. Identification with reasons:

Cytological slides of different mitotic and meiotic stages.

Different forms of bacteria (*Coccus*, *Bacillus*, *Spiral*)

4. Laboratory Records: Laboratory note books (regularly signed) and slides (prepared in class) are to be submitted at the time of Practical Examination. Regular attendance in the class must be credited

SEMESTER IV

CORE COURSE 4
PLANT PHYSIOLOGY AND METABOLISM (BOT-G-CC-4-4-TH)
THEORETICAL (Credits 4, Lectures 60)

1. Proteins
1.1 Primary, secondary and tertiary structure, 1.2 Nucleic acid- DNA structure, RNA types, 1.3 Enzyme- Classifications with examples (IUBMB), Mechanism of action.

…….8 lectures

2. Transport in plants
2.1 Ascent of sap and Xylem cavitation , 2.2 Phloem transport and source-sink relation.

…….4 lectures

3. Transpiration
3.1 Mechanism of stomatal movement, significance.

…….4 lectures

4. Photosynthesis
4.1 Pigments, Action spectra and Enhancement effect, 4.2 Electron transport system and Photophosphorylation, 4.3 C3 and C4 photosynthesis, CAM- Reaction and Significance.

…….12 lectures

5. Respiration
5.1 Glycolysis & Krebs cycle— Reactions and Significance, 5.2 ETS and oxidative phosphorylation.

…….8 lectures

6. Nitrogen metabolism
6.1 Biological dinitrogen fixation, 6.2 Amino acid synthesis (reductive amination and transamination).

…….6 lectures

7. Plant Growth regulators
7.1 Physiological roles of Auxin, Gibberellin, Cytokinin, Ethylene, ABA.

…….10 lectures

8. Photoperiodism (Plant types, Role of phytochrome and GA in flowering) and Vernalization.

…….6 lectures

9. Senescence (brief idea).

…….2 lectures

PRACTICAL- PLANT PHYSIOLOGY AND METABOLISM (BOT-G-CC-4-4-P)
(Credits 2)

Plant Physiology:

i) Experiment on Plasmolysis.

ii) Measurement of leaf area (graphical method) and determination of transpiration rate per unit

area by weighing method.

iii) Imbibition of water by dry seeds - proteinaceous and fatty seeds.

iv) Evolution of O2 during photosynthesis (using graduated tube).

v) Evolution of CO2 during aerobic respiration and measurement of volume.

SEC A

PLANT BREEDING AND BIOMETRY (BOT-G-SEC-A-3/5-1)

(Credits 2, Lectures 30)

1. Plant breeding:

1.1 Introduction and objective, 1.2 Techniques of hybridisation.

…….2 lectures

2. Mass and Pure line selection:

2.1 Procedure, 2.2 Advantages and limitations.

…….8 lectures

3. Heterosis and hybrid seed production.

…….4 lectures

4. Role of mutation, polyploidy, distant hybridization and role of biotechnology in crop improvement.

…….8 lectures

5. Biometry:

5.1 Measures of central tendency (Mean, Median and Mode), 5.2 Standard error and standard deviation, 5.3 Test of significance: Chi-square test for goodness of fit.

…….8 lectures

BIOFERTILIZERS (BOT-G-SEC-A-3/5-2)

(Credits 2, Lectures 30)

1. **Biofertilizers:** General account about microbes used as biofertilisers; *Rhizobium*-identification, mass multiplication. Actinorrhizal symbiosis.

   …….4 lectures
2. ***Azospirillum***- identification, mass multiplication, associative effect of different microorganisms. *Azotobacter* and crop response to *Azotobacter* inoculums.

   …….6 lectures
3. Cyanobacteria, *Azolla*, *Anabaena* and *Azolla* association, blue green algae and *Azolla* in rice cultivation.

   …….6 lectures
4. **Mycorrhizal association:** 4.1 Types of Mycorrhizal association- Brief idea, 4.2 Its influence on growth and yield of crop plants.

…….6 lectures

5. **Organic farming:** 5.1 Green manuring and organic fertilizers, 5.2 Biocompost and vermicompost- making methods and field applications. 5.3 Recycling of biodegradable municipal, industrial and agricultural wastes.

…….8 lectures

SEC B

PLANT BIOTECHNOLOGY (BOT-G-SEC-B-4/6-3)

(Credits 2, Lectures 30)

1. Plant tissue culture- 1.1 Introduction and basic concepts, 1.2 Cellular potency, 1.3 Callus culture and plant regeneration.

…….4 lectures

2. Micropropagation- 2.1 Somatic embryogenesis and artificial seed.

…….4 lectures

3. Protoplast culture and its application.

…….6 lectures

4. Recombinant DNA technology- 4.1 Recombinant DNA, 4.2 Restriction enzymes, 4.3 Plasmids as vectors.

…….8 lectures

5. Gene cloning (basic steps).

…….4 lectures

6. Achievements in crop biotechnology- 6.1 Pest resistant plant (Bt cotton), 6.2 Transgenic crops with improved quality (flavr tomato and golden rice).

…….4 lectures

MUSHROOM CULTURE TECHNOLOGY (BOT-G-SEC-D-4/6-4)

(Credits 2, Lectures 30)

1. **Mushroom**- nutritional and medicinal value of mushrooms. Poisonous mushrooms.

…….4 lectures

2. Cultivation techniques/ technology of edible mushrooms in India: *Volvarealla volvacea, Pleuretus citrinopyrineatus, Agaricus bisporus*.

…….12 lectures

3. **Storage**- short term and long term, storage, drying.

…….6 lectures

4. **Food preparation**- types of foods prepared from mushroom. Cost and benefit ratio.

…….6 lectures

5. **Research centres**- national and regional.

…….2 lectures

DSE A (Group A)
PHYTOCHEMISTRY AND MEDICINAL BOTANY (BOT-G-DSE-A-5-1-TH)
THEORETICAL
(Credit 4, Lectures 60)

1. **Medicinal botany-** History, scope and importance of medicinal plants, a broef idea about indigenous medicinal sciences- Ayurbeda, Siddha and Unani. Polyherbal formulations.

…….14 lectures

2. **Phramacognosy**- 2.1 Scope and its importance, 2.2 Primary metabolites, 2.3 Secondary metabolites- alkaloids, terpenoids, phenolics and their functions.

…….10 lectures

3. **Organoleptic** evaluation of crude drugs.

…….10 lectures

4. **Pharmcologically active constituents:** Source plants (one example), parts used and uses of: 4.1 Steroids (Diosgenin, Digitoxin), 4.2 Tannin (Catechin), 4.3 Resins (Gingerol, Curcumnoids), 4.4 Alkaloids (Strychnine, Reserpine, Vinblastine), 4.5 Phenols (Capsaicin).

…….6 lectures

5. **Ethnobotany and folk medicine:** 5.1 Brief idea, 5.2 Applications of ethnobotany, 5.3 Application of natural product to certain diseases- Jaundice, Cardiac and Diabetics.

…….20 lectures

PRACTICAL- PHYTOCHEMISTRY AND MEDICINAL BOTANY (BOT-G-DSE-A-5-1-P)
(Credit 2)

1. Preparations of solution and buffers
2. Acquaintance with laboratory instruments- Autoclave, Incubator, Clinical centrifuge, Analytical balance, pH meter, Colorimeter, Water bath, Distillation plant, Laminar air flow.
3. Qualitative test for proteins and carbohydrates, reducing and non reducing sugar (glucose, fructose and sucrose)
4. Tests (chemical) for tannin and alkaloid
5. Identification of medicinal plants (list to be provided)
6. Field study (local) and listing of medicinal plants. Records to be substantiated with photographs and description.

NATURAL RESOURCE MANAGEMENTS (BOT-G-DSE-A-5-2-TH)
THEORETICAL
(Credits 4, Lectures 60)

1. Natural resources- definition and types.

…….2 lectures

2. Sustainable utilization- concept, approaches (economic, ecological and socio-cultural).

…….10 lectures

3. Land utilization. Soil degradation and management.

…….8 lectures

4. Water, fresh water marine, estuarine. Wetlands- threats and management.

…….10 lectures

5. Biological resources, biodiversity- definition and types. Significance, threats and management strategies.

…….10 lectures

6. Forests- definition, cover and its significance (with special reference to India). Major and minor forest products.

…….8 lectures

7. Energy- renewable and non-renewable source of energy.

…….8 lectures

8. EIA and waste management.

…….4 lectures

PRACTICAL- NATURAL RESOURCE MANAGEMENTS (BOT-G-DSE-A-5-2-P)
(Credits 2)

1. Estimation of solid waste generated by a domestic system (biodegradable and non-biodegradable) and its impact on land degradation.
2. Measurement of dominant woody species by DBH (diameter at breast height)
3. Study of community structure by Quadrat method and determination of minimal size of quadrat, frequency density and abundance of components to be done during field visit.
4. Measurement of dissolved O_2 by azide modification of Winkler's method.
5. Determination of chemical properties of soil by rapid spot test (carbonate, iron, nitrate)

DSE B

ECONOMIC BOTANY (BOT-G-DSE-B-6-3-TH)

THEORETICAL (Credits 4, Lectures 60)

1. Origin of cultivated plants: 1.1 Concepts of centres of origin and their importance with reference to Vavilov's work.

…….12 lectures

2. Rice- origin, morphology and uses.

…….12 lectures

3. Legumes: General account with special reference to *Vigna.*

…….8 lectures

4. Beverages: Tea- morphology, processing and uses.

…….12 lectures

5. Study of the following economically important plants (Scientific names, families, parts used and importance): 5.1 Cereals- Rice, wheat, 5.2 Pulses- Mong, gram, 5.3 Spices- Ginger, cumin, 5.4 Beverages- Tea, coffee, 5.5 Medicinal plants- Cinchona, neem, Ipecac, Vasaka, 5.6 Oil yielding plants- Mustard, groundnut, coconut, 5.7 Vegetables- Potato, raddish, bottle groud, cabbage, 5.8 Fibre yielding plants- Cotton, jute, 5.9 Timber yielding plants- Teak, Sal 5.10 Fruits- Mango, apple, 5.11 Sugar yielding plant- Sugarcane.

…….16 lectures

PRACTICAL- ECONOMIC BOTANY (BOT-G-DSE-B-6-3-P)

(Credits 2)

1. Study of economically important plants (rice/jute/ tea) through herbarium specimens and field study.
2. Study of cultivation practices in field and submission of report.
3. Study of local economically important plants and submission of report with photographs.

HORTICULTURAL PRACTICES AND POST HARVEST TECHNOLOGY (BOT-G-DSE-B-6-4-TH)

THEORETICAL

(Credits 4, Lectures 60)

1. Horticulture- role in rural economy and employment generation. Urban horticulture- its scope and importance.

…….6 lectures

2. Ornamental plants- identification and salient features of some ornamental plants (rose, marigold, gladiolus, gerberas, tube rose, carnations, cacti and succulents). Ornamental flowering trees (Gulmohor, Lagerstromia, Shimul, Coral tree and jacaranda).

…….12 lectures

3. Identification of some fruits and vegetable plants- Citrus, Banana, Papaya, Mango, Jackfruit, Chillies and cucurbits. Fruit processing- scope and benefits.

…….10 lectures

4. Horticultural techniques- propagation methods, application of manure, fertilizers, nutrients and PGR. Weed control. Biofertilizers and biopesticides.

…….12 lectures

5. Post harvest technology- importance of post harvest technology in horticultural practices. Harvesting and handling of fruits, vegetables and cut flower. Methods of preservation and processing.

…….10 lectures

6. Disease control and management- field and post harvest diseases of common crops. Crop sanitation, quarantine practices. Identification of common diseases and pest of fruits and vegetable crops.

…….10 lectures

PRACTICAL- HORTICULTURAL PRACTICES AND POST HARVEST TECHNOLOGY (BOT-G-DSE-B-6-4-P)

(Credits 2)

1. Field trips to gardens, standing crop sites, nurseries, vegetable gardens, horticultural fields and cold storages.

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Suggested Readings

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4. Fungi, Lichen & Plant Pathology

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2. Swaminathan, M. (1990) Food and Nutrition. Bappco, The Bangalore Printing and Publishing Co. Ltd., No. 88, Mysore Road, Bangalore - 560018.

3. Tewari, Pankaj Kapoor, S.C., (1988). Mushroom cultivation, Mittal Publications, Delhi.

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UNIVERSITY OF CALCUTTA

Notification No. CSR/ 12 /18

It is notified for information of all concerned that the Syndicate in its meeting held on 28.05.2018 (vide Item No.14) approved the Syllabi of different subjects in Undergraduate Honours / General / Major courses of studies (CBCS) under this University, as laid down in the accompanying pamphlet:

List of the subjects

Sl. No.	Subject	Sl. No.	Subject
1	Anthropology (Honours / General)	29	Mathematics (Honours / General)
2	Arabic (Honours / General)	30	Microbiology (Honours / General)
3	Persian (Honours / General)	31	Mol. Biology (General)
4	Bengali (Honours / General /LCC2 /AECC1)	32	Philosophy (Honours / General)
5	Bio-Chemistry (Honours / General)	33	Physical Education (General)
6	Botany (Honours / General)	34	Physics (Honours / General)
7	Chemistry (Honours / General)	35	Physiology (Honours / General)
8	Computer Science (Honours / General)	36	Political Science (Honours / General)
9	Defence Studies (General)	37	Psychology (Honours / General)
10	Economics (Honours / General)	38	Sanskrit (Honours / General)
11	Education (Honours / General)	39	Social Science (General)
12	Electronics (Honours / General)	40	Sociology (Honours / General)
13	English ((Honours / General/ LCC1/ LCC2/AECC1)	41	Statistics (Honours / General)
14	Environmental Science (Honours / General)	42	Urdu (Honours / General /LCC2 /AECC1)
15	Environmental Studies (AECC2)	43	Women Studies (General)
16	Film Studies (General)	44	Zoology (Honours / General)
17	Food Nutrition (Honours / General)	45	Industrial Fish and Fisheries – IFFV (Major)
18	French (General)	46	Sericulture – SRTV (Major)
19	Geography (Honours / General)	47	Computer Applications – CMAV (Major)
20	Geology (Honours / General)	48	Tourism and Travel Management – TTMV (Major)
21	Hindi (Honours / General /LCC2 /AECC1)	49	Advertising Sales Promotion and Sales Management –ASPV (Major)
22	History (Honours / General)	50	Communicative English –CMEV (Major)
23	Islamic History Culture (Honours / General)	51	Clinical Nutrition and Dietetics CNDV (Major)
24	Home Science Extension Education (General)	52	Bachelor of Business Administration (BBA) (Honours)
25	House Hold Art (General)	53	Bachelor of Fashion and Apparel Design – (B.F.A.D.) (Honours)
26	Human Development (Honours / General)	54	Bachelor of Fine Art (B.F.A.) (Honours)
27	Human Rights (General)	55	B. Music (Honours / General) and Music (General)
28	Journalism and Mass Communication (Honours / General)		

The above shall be effective from the academic session 2018-2019.

SENATE HOUSE
KOLKATA-700073
The 4th June, 2018

(Dr. Santanu Paul)
Deputy Registrar

UNIVERSITY OF CALCUTTA
PHYSIOLOGY (HONS.) SYLLABUS FOR CBCS

CORE COURSES(CC)

Semester 1
CC--1. Cellular Basis of Physiology ,Genetics & Enzymes
CC--2. Biophysical Principles and Chemistry of Biomolecules

Semester 2
CC--3. Cell Signalling & Nerve-muscle Physiology
CC--4. Nervous System

Semester 3
CC--5. Blood and Body Fluids
CC--6. Cardiovascular System
CC--7. Respiratory System

Semester 4
CC--8. Digestion and Metabolism
CC--9. Molecular Biology
CC--10. Nutrition and Dietetics Public Health

Semester 5
CC--11. Special Senses
CC--12. Endocrinology

Semester 6
CC--13. Reproductive Physiology & Developmental Biology
CC--14. Excretory Physiology

GENERIC ELECTIVE (GE)

GE- 1 is equivalent to CC-1 of one general subject in Semester 1

GE- 2 is equivalent to CC-2 of one general subject in Semester 2

GE- 3 is equivalent to CC-3 of one general subject in Semester 3

GE- 4 is equivalent to CC-4 of one general subject in Semester 4

Discipline Specific Electives (DSE)

DSE -- A (ONE course in Semester 5 & ONE course in Semester 6)
1. Biostatistics
2. Microbiology & Immunology

3. Ergonomics
4. Community and Public Health

DSE - B (ONE course in Semester 5 & ONE course in Semester 6)
1. Chronobiology and Stress Physiology
2. Advanced Molecular Biology and Nanotechnology
3. Toxicology and Pharmacology
4. Work, Exercise and Sports Physiology

Ability Enhancement Compulsory Courses(AECC)

AECC- 1: Communicative English or any other Modern Indian Language in Semester 1

AECC-2: Environmental Studies in Semester 2

Skill Enhancement Course (SEC)

SEC -- A (ONE course in Semester 3)
1. Hematological Techniques
2. Clinical Biochemistry

SEC -- B (ONE course in Semester 4)
1.. Detection of Food Additives /Adulterants and Xenoboiotics
2. Bio-Medical Technology and Bioinformatics

UNIVERSITY OF CALCUTTA
PHYSIOLOGY (HONS.) SYLLABUS FOR CBCS

Credit Distribution Across Courses

COURSE TYPE	TOTAL PAPERS	CREDITS THEORY+ PRACTICAL
Core Courses	14	14X4=56 14X2=28
Discipline Specific Electives	4	4X4=16 4X2=8
Generic Electives (Contents of the Syllabus to be found in the 'General Course Syllabus' for the respective subjects)	4	4X4=16 4X2=8
Ability Enhancement Language Courses	2	2X2=4
Skill Enhancement Courses	2	2X2=4
TOTALS	**26**	**140**

Core Courses

1. Cellular Basis of Physiology ,Genetics & Enzymes
2. Biophysical Principles and Chemistry of Biomolecules
3. Cell Signalling & Nerve-muscle Physiology
4. Nervous System
5. Blood and Body Fluids
6. Cardiovascular System
7. Respiratory System
8. Digestion and Metabolism
9. Molecular Biology
10. Nutrition and Dietetics
11. Special Senses
12. Endocrinology
13. Reproductive Physiology& Developmental Biology
14. Excretory Physiology

Outline of Courses and Credits in each Semester

Semester I

CC1TH.

Cellular Basis of Physiology

Cell Structure and function--Electron microscopic structure and functions of Nucleus, endoplasmic reticulum, ribosomes, Golgi bodies, mitochondria, lysosomes, peroxisomes ,cytoskeletal elements, centrosomes and plasma membrane .

.

Cellular transport—Passive and active transport. Ion channels, ionophores.

☐**Intercellular communication**--- Basic idea of tight junctions, gap junctions, adherens junctions, desmosomes and cell adhesion molecules.Extracellular matrix components.

Genetics

Chromosome Structure-- Morphology. Chromosomal DNA packaging-nucleosomes and higher level of organisation of chromatin. Euchromatin and heterochromatin..Human genome and its characteristics. Mitochondrial DNA. Epistasis, Penetrance, Expressivity, Pleiotropism. Karyotyping.

☐**Cell cycle** – Events and regulatory role of cyclin. Cell division- Mitosis & Meiosis-phases and significance. Crossing-over, Linkage.

☐Enzymes

Classification-EC nomenclature, Concept of apoenzyme,
holoenzyme, coenzyme, cofactors and prosthetic group. Mechanism of enzymes. Concept of initial rate, maximum velocity and steady-statekinetics. Michaelis constant, Michaelis-Menten equation, Graphical representation of hyperbolic kinetics-- Lineweaver-Burk plot. Significance of Km and Vmax. Factors influencing enzyme-catalyzed reactions : substrate concentration, enzyme concentration, pH, temperature. Competitive, noncompetitive and uncompetitive inhibitions. Regulation of enzyme activities--covalent modifications, allosteric modifications: K- and M- series. Feed-back inhibition. Rate-limiting enzymes. Isozymes, Ribozymes and Abzymes. (4)

CC1P.

1. Study of various stages of meiosis from grasshopper testis
2. Cell viability study by Trypan blue staining
3. Osmotic fragility test of goat blood R.B.C
4. Staining of adipose tissue using Sudan III or IV. **(2)**

CC2TH.

Biophysical Principles

☐**Diffusion :**Its characteristics, factors influencing and physiological

applications.

☐**Osmosis:** Osmotic pressure – laws, determination – freezing point depression method and physiological applications.

☐**Surface tension & viscosity:**-- Physiological applications.

☐**pH& Buffer**- Henderson Hasselbach- equation (quantitative problems). Determination of pH.

☐**Colloids :**Classification, properties – optical, electrical, electrokinetic. Physiological importance of colloids.

☐**Gibbs-Donnan membrane equilibrium**.

☐**Thermodynamics :**Type of surroundings and systems. First Law– Internal energy, enthalpy. Second Law – Entropy, Free energy change, Endergonic and Exergonic reactions, Reversible and Irreversible processes, Equilibrium constant. Physiological steady-state, Living body as a thermodynamic system.

. Instruments

Principles of construction, uses and advantages and disadvantages : Compound microscope, Phase contrast microscope, Fluorescence microscope, Polarizing microscope, Confocal microscopy, Transmission and Scanning electron microscope. Photoelectric colorimeter, Spectrophotometer and pH meter.

☐**Carbohydrates :**Definition and classification. *Monosaccharides*– Classification, structure, stereoisomerism, optical isomerism, optical activity, epimerism. Cyclic structures- Pyranose and furanose forms, anomerism, mutarotation and its mechanism. Chemical reactions of monosaccharides (Glucose & Fructose) ---- Reactions with concentrated mineral acids, alkali, phenylhydrazine and their biochemical importance. Derivatives of monosaccharides -----Amino sugars, deoxy sugars, sugar alcohols, sugar acids, sugar esters, their biochemical and physiological importance.
Disaccharides – Maltose, Lactose and Sucrose : Structure, Occurrence and Physiological importance.
Polysaccharides – Starch, Glycogen, Dextrin,Cellulose, Glycosaminoglycans, Glycoproteins, Sialic acids.

☐**Lipids :**Definition and classification. Fatty acids - Classification, systemic nomenclature and structure. Mono-, Di- and Triglycerides. Properties of Fat and Fatty acids Hydrolysis, Saponification number, Iodine number, Acetyl number, Acid number, Reichert-Meissl number. Cis-trans isomerism. Eicosanoids, Phospholipids, Glycolipids, Sphingolipids, Cholesterol & its ester ---- their structure and physiological importance. Lipoproteins - Structure and classification.

☐**Amino acids :**Classification, Structure, Nomenclature and Optical properties. Protonicequilibria of amino acids – Zwitterions, Isoelectric point, titration curve of amino acids. Reactions with ninhydrin and formaldehyde.

☐**Peptides and Proteins :**Structure and properties of peptide bonds -- Phi and Psi angles. Reactions with Sanger's and Edman's reagent. Biuret reaction. Different levels of protein structure -- Primary, Secondary (α-helix and β-pleated sheet), Tertiary and Quarternary. Forces stabilizing the structures. Denaturation and Renaturation.

☐**Purine and Pyrimidine :**Structure, nomenclature and tautomerism.

☐**Nucleic acids :**Nucleosides and Nucleotides -- structure. Polynucleotides. DNA double helix --- Primary, Secondary and Tertiary structure. A-DNA, B-DNA and Z-DNA. RNA - Structure and types. Denaturation and annealing of DNA. Hyperchromicity, melting temperature and half Cot value. **(4)**

CC2P.

1. Qualitative tests for the identification of physiologically important substances: Hydrochloric acid, Lactic Acid, Uric Acid, Albumin, Gelatin, Peptone, Starch, Dextrin, Glucose, Fructose, Lactose, Sucrose, Urea, Acetone, Glycerol and Bile salts

2. Preparation Of Buffer and pH measurement. . **(2)**

Semester II

CC3TH.

Cell Signalling :

Cell surface receptor proteins – ion channel coupled, G-protein coupled and enzyme-coupled. Intracellular messengers – cAMP, cGMP, IP3, DAG, Protein kinases, Ca^{2+},CO,NO. Signal transduction pathways: Phosphatidylinositides, MAP kinase, JAK-STAT, SMAD.

☐Nerve :

Structure, classification and functions of neurons and neuroglias. Cytoskeletal elements and axoplasmic flow. Myelinogenesis. The resting membrane potential. The action potential. Electrotonic potentials. Current of injury. Propagation of nerve impulse in different types of nerve fibers. Compound action potentials. Properties of nerve fibers : excitability, conductivity, all or none law, accommodation, adaptation, summation, refractory period, indefatigability. Chronaxie, rheobase and utilization time. Synapses : types, structure, synaptic transmission of the impulse, synaptic potentials, neurotransmitters, cotransmitters, neuromodulators. The neuromuscular junction : structure, transmission, end-plate potential, MEPP, post-tetanic potentiation. Motor unit. Motor point. Injury to peripheral nerves – degeneration and regeneration in nerve fiber, changes in the nerve cell body, transneuronal degeneration, changes in receptors and motor end-plates, denervation hypersensitivity. Thermal changes of nerve during activity. Nerve growth factors.

☐Muscle:

Microscopic and electron microscopic structure of skeletal, smooth and cardiac muscles. The sarcotubular system. Red and white striated muscle fibers. Single-unit and multi-unit smooth muscle. Muscle groups : antagonists and agonists. Properties of skeletal muscle: excitability, contractility, all or none law, summation of stimuli, summation of contractions, effects of repeated stimuli, genesis of tetanus, onset of fatigue, refractory period, tonicity, conductivity, extensibility and elasticity. Optimal load, optimal length of fibers. Muscle proteins. Mechanism of skeletal and smooth muscle contraction and relaxation : Excitation-contraction coupling. Dihydropyridine receptors & Ryanodine receptors. Mechanical components of muscle. Isometric and isotonic contractions – muscle length,

tension and velocity relationships. Chemical, thermal and electrical changes in skeletal muscle during contraction and relaxation. Electromyography. (4)

CC3P.

1. Staining of isolated nerve fiber by silver nitrate method.
2. Staining of skeletal & cardiac muscle by methylene blue.
3. Staining of collagen in tissue sections. **(2)**

CC4TH.

The Nervous System

☐Structural organization of different parts of brain and spinal cord. Reflex action – definition, reflex arc, classification and properties.

☐**Autonomic nervous system :**organization, outflow, ganglia, centers and functions. Chemical transmission in autonomic nervous systems.

☐**CSF:** Formation, circulation and functions. Blood-CSF and Blood-Brain barrier.

☐**Ascending and descending tracts :**origin, courses, termination and functions.

☐**Functions of the spinal cord** with special reference to functional changes following hemisection and complete section of spinal cord. Pain production, perception and regulation. Referred pain.

☐**Muscle spindle and golgi tendon organ:** their structure, innervations and functions, postural reflexes. Decorticate, decerebrate rigidity and spinal animal.

☐**Brain:** Structure, nerve connections and functions of brainstem, cerebellum, reticular formation, hypothalamus, thalamus, basal nuclei and cerebral cortex- Speech and aphasia.
Structure and functions of vestibular apparatus.

☐**Limbic system:** Structure, connections and functions.
Physiology of sleep, learning, memory, and emotion.
Cerebral circulation & stroke.
Principles,uses, advantages and disadvantages of CT scan, MRI and PETscan
.

Molecular neurobiology : General concept of ionotropic and metabotropic receptors. Structure, sub-types and functions of nicotinic and muscarinic acetylcholine receptors, adrenoceptors, glutamate receptors (NMDA and AMPA receptors), GABA, opiate, serotonin, dopamine and histamine receptors. (4)

CC4P.

1. Basic concepts of brain imaging. Identification of different structures of

human brain using CT scan and MRI images.
2.Study and use of Kymograph, induction coil, key, Gastrocnemius-sciatic nerve preparation and kymographic recording of isotonic muscle twitch, effects of two successive stimuli and load (afterload) on muscle twitch. (2)

Semester III

CC5TH.

Physiology of Blood and Body Fluids

Bone marrow: Formed elements of blood–origin, formation, functions and fate.
Plasma proteins Origin and functions.
Erythropoiesis Role of erythropoietin and leucopoiesis.
Haemoglobin : Structure, reactions, biosynthesis and catabolism. Foetal haemoglobin. Abnormal haemoglobins- Sickle-cell anemia and Thalassemia.
Blood volume : Regulation and determination by dye and radioisotope methods.
Hemostasis : Factors, mechanism, anticoagulants, procoagulants. Disorders of hemostasis- Hemophilia, Thrombosis and Embolism.
Blood group :ABO and Rh systems (Chemical nature of relevant biomolecules). Erythroblastosis foetalis. Blood transfusion and its hazards.
Lymph and tissue fluids : Formation, circulation, functions and fate.
Lymphatic organs : Histological structures and functions of lymph gland and spleen. Splenomegaly causes and effects.
Circulatory disorder : Oedema**. (4)**

CC5P.

1.Haematological experiments : Preparation and staining of blood film with Leishman's stain. Identification of blood cells. Total count of W.B.C and R.B.C .Differential count of W.B.C. Haemoglobin estimation by Sahli's hemoglobinometer. Preparation of haemin crystals.
Preparation and staining of bone marrow. Measurement of diameter of megakaryocytes. Reticulocyte staining. **(2)**

CC6TH

. Cardiovascular System

Anatomy of the heart. Properties of cardiac muscle. Origin and propagation of cardiac impulse. Heart Block.
Cardiac cycle : Pressure and volume changes. Heart sounds. Murmurs.
Cardiac output : Measurement by application of Fick's principle & factors affecting.
Starling's law of heart.
Electrocardiography: The normal electrocardiogram, electrocardiographic leads, vectorial analysis, the vectorcardiogram and the mean electrical axis of heart. The His bundle electrogram.
Principles of Echocardiography.
Cardiac Arrhythmias &. Myocardial Infarctions.
The pulse: Arterial and venous.

Hemodynamics of blood flow.
Cardiac and vasomotor centers, baroreceptors and chemoreceptors, innervation of the heart and blood vessels, cardiac and vasomotor reflexes. Cardiovascular homeostasis – neural and chemical control of cardiac functions and blood vessels.
Atherosclerosis.Coronary Circulation.
Blood pressure: Its measurement and factors affecting. Cardiovascular adjustment after haemorrhage. **(4)**

CC6P.
1.Cardiovascular Physiology Experiments : Determination of Blood pressure by Auscultatory Method. Determination of mean pressure, pulse pressure and pulse rate. Preparation of Amphibian Ringer Solution. Interpretation of Kymographic recording of the movements of perfused heart of toad and the effects of acetylcholine and adrenaline on the contraction of heart.ECG. (2)

CC7TH.
Respiratory System
Anatomy and histology of the lung and airways.
Mechanics of breathing : Role of respiratory muscles, glottis. Compliance of lungs and chest wall, pressure-volume relationships, alveolar surface tension and surfactant, work of breathing.
Spirometry: Lung volumes and capacities. Dead space.
Pulmonary Circulation : Ventilation- perfusion ratio.
Transport of gases in body : Partial pressure and composition of normal atmospheric gases in inspired, expired, alveolar airs and blood. Oxygen dissociation curve of hemoglobin and myoglobin – factors affecting. Carbon dioxide dissociation curve. Regulation of respiration -- neural and chemical, respiratory centers, chemoreceptors, baroreceptors, pulmonary receptors.
Disorders of Breathing : Hypoxia : Types& effects. Asphyxia, Voluntary hyperpnoea, Apnoea, Cyanosis, Periodic breathing, Asthma, Emphysema.
Non-respiratory functions of lung. **(4)**

CC7P.
1.**Respiratory Human Experiments:** Pneumographic recording of effects of hyperventilation, breath-holding and talking. Lung function tests using Spirometry(Digital) and analysis of the results . (2)

Semester IV

CC8TH.
Digestion
Anatomy and histology of alimentary canal.
Digestive glands – histological structures of salivary glands, pancreas, liver.
Deglutition. Movements of alimentary canal and their regulations.
Composition, functions and regulation of the secretion of salivary, gastric,

pancreatic and intestinal juices and bile. Enterohepatic circulation.
Digestion and absorption of carbohydrates, lipids, proteins and nucleic acids.
Defecation. GALT. Basic concepts of Peptic Ulcer, Jaundice and Gallstones.

Metabolism

Redox potential. Mitochondrial Electron Transport Chain. Oxidative phosphorylation- inhibitors and uncouplers.

Carbohydrate : Glycolysis, R-L cycle. TCA cycle, Gluconeogenesis - Cori cycle, Anaplerotic reactions and Amphibolic nature of TCA cycle. Pentose phosphate pathway. Glycogenesis and Glycogenolysis.

Lipid: β-oxidation and biosynthesis of saturated and monounsaturated fatty acids. Biosynthesis of lecithin. Biosythesis of Cholesterol. Ketone body metabolism.
Hormonal regulation of the above mentioned biochemical pathways not required.

Amino acids: Amino acids - Amino acid pool. Deamination, transamination, amination and decarboxylation. Synthesis of Urea and Nitric oxide. Glucogenic andketogenic amino acids. Metabolism of glycine, methionine, tryptophan and phenylalanine.

Purines and Pyrimidines– Biosynthesis :*de novo* and salvage pathways. Catabolism.
*Regulation of the above mentioned biochemical pathways/cycle not required.***(4)**

CC8P.

☐1.**Dale's Experiment :**Kymographic recording of normal movements of rat's intestine using Dale's apparatus and effects of acetylcholine and adrenaline on normal intestinal movements of rats..

2.**Biochemical estimations:**
Quantitative estimation of amino nitrogen by Sorensen's formol titration method (percentage as well as total quantity to be done). **(2)**

CC9TH.
Molecular Biology

☐DNA replication—Meselson and Stahl Experiment, DNA Polymerases, Ligases and other regulatory proteins. Transcription – RNA Polymerase and other regulatory mechanism in prokaryotes.Genetic code – properties and wobble hypothesis. Translation – codon-anticodon interaction and mechanism in prokaryotes. Regulation of gene expression : operon concept – the lac operon. Gene mutation – agents and types. DNA repairing processes. Concept of oncogenes and properties of cancer cells. Recombinant DNA technology in brief and its applications – gene therapy, transgenic animal.

Methodologies : Chromatography: Principles and uses of : TLC, Gel filtration, Affinity chromatography,ion-exchange chromatography. Electrophoresis: Principles and method, uses of Agarose gel electrophoresis, SDS – PAGE. Ultracentrifugation: moving boundary

and density gradient ultracentrifugation. Radioactivity – Classification and properties. Their use – radiolabelling of biomolecules and its detection by autoradiography. Principles of RIA, ELISA. Western, Northern and Southern blotting techniques. Polymerase chain reaction-basic concept. (4)

CC9P.

Biochemical estimations:

1.Colorimetric methods—

i) Estimation of serum protein by Lowry method and serum albumin by Bromocresol green dye method and calculation of A/G ratio. ii) Estimation of blood glucose by Folin–Wu method .(iii) Estimation of serum urea by DAM method.

2.Thin layer chromatography. **(2)**

CC10TH.

Nutrition and dietetics

☐**Vitamins:** Thiamin, Riboflavin, Niacin, Pyridoxine, Pantothenic Acid, Biotin, Cyanocobalamin, Folic Acid, Ascorbic Acid, Inositol. Vitamins A, D, E and K. Dietary sources, daily requirements, biochemical functions, deficiency symptoms, hypervitaminosis, antivitamins.

☐**Minerals:** Sources, biological functions of sodium, potassium, calcium, phosphorus, iron, zinc, iodine and fluoride.

☐**SDA, RQ and BMR :**Factors affecting. Determination of BMR.

☐Fuel Values of Food. Body calorie requirements – adult consumption unit.

Dietary requirements of carbohydrate, protein, lipid and other nutrients.

Balanced diet and principles of formulation of balanced diets for adult man, adult woman,lactating woman and pregnant women.. Nitrogen balance.Protein sparers.Supplementary value of proteins.Biological value of proteins.Net protein utilization.Protein efficiency ratio.Dietary fibers. **(4)**

CC10P.

☐**Nutrition and Dietetics :**

1.Composition and nutritional value of common foodstuff.

2.Diet survey report of a family as per ICMR specification.

3.Qualitative analysis of milk, potato, flour, rice, pulses. **(2)**

Semester V

CC11HT:

Special Senses

Characteristics of special senses, Sensory Coding -- Weber-Fechner law, Steven's power law.

Vision: Structure of eyeball. Histological details of retina, peripheral retina, fovea and blind spot. Retinal detachment. Visual pathway and centers. Effects of lesion in visual pathway. Mechanism of accommodation. Errors of refraction and their corrections. Formation and Circulation of Aqueous

Humour. Cataract and Glaucoma. Photopic and scotopic vision. Chemical and electrical changes in retina on exposure to light. Visual processing in the retina. Positive and negative after- images. Contrast phenomenon. Light and dark adaptation. Colour vision—Trichromatic, Single and Double Opponent mechanism. Colour blindness. Visual field-- perimetry. Visual acuity – measurement, mechanism and factors affecting. Critical fusion frequency-Ferry-Porter law.

Hearing : Structure and functional significance of auditory apparatus. Organ of Corti. Auditory pathways and centers. Mechanism of hearing – Excitation of Hair Cells, Conversion of Sound Waves into Action Potentials in the Auditory Nerve. Mechanism of discrimination of sound frequencies and intensities. Localization of sound source. Deafness.

Olfaction and Gustation: Structure and functions of the receptor organs, nerve pathways, Centers. Signal Transduction of olfactory and gustatory stimuli. Olfactory and Gustatory Coding. Abnormalities of olfactory and taste sensation. **(4)**

CC11P.

1. Determination of Visual Acuity by Snellen's Chart
2. Determination of Colour Blindness by Ishihara Chart.
3. Determination of Deafness by Tuning Fork Tests.
4. Study and identification of stained sections of different mammalian tissues and organs: Cardiac muscle, Skeletal muscle, Smooth muscle, Trachea ,Lung, Hyaline cartilage, Artery, Vein, Cerebellum, Cerebral cortex, Spinal cord,
5. Silver nitrate preparation of corneal cell space. **(2)**

CC12TH.

Endocrinology

Hypothalamus as a neuroendocrine organ. Anterior and posterior pituitary -- histological structure of the gland. Chemical nature, molecular mechanism of action, functions and regulation of secretion of their hormones. Hypo- and hyperactive states of the gland.

Pineal gland – Histological structure. Chemical nature, biosynthesis, molecular mechanism of action, functions and regulation of secretion of melatonin.

Thyroid and Parathyroid -- Histological structure of the glands. Chemical nature, molecular mechanism of action, functions and regulation of secretion of the hormones. Hypo- and hyperactive states of the glands.

Adrenal cortex and medulla -- Histological structure of the gland. Chemical nature, molecular mechanism of action, functions and regulation of secretion of the hormones. Biosynthesis of catecholamines. Hypo- and hyperactive states of the gland.

Heart as an endocrine organ.

Pancreatic islets -- Histological structure. Chemical nature, molecular mechanism of action, functions and regulation of secretion of the hormones. Hormonal control of blood sugar. Hyperinsulinism and diabetes mellitus.

Gastro-intestinal hormones -- Chemical nature, molecular mechanism olfaction, functions and regulation of secretion of the hormones. **(4)**

CC12P.

1. Study of Effects of Oxytocin and Adrenaline on uterine contractions of albino rat.
2. Study and identification of stained sections of different mammalian tissues and organs: Parotid gland, Submaxillary gland, Sublingual gland ,Tongue, Oesophagus, Stomach, Duodenum, Jejunum, Ileum, Large intestine and Liver. **(2)**

Semester VI

CC13TH.

Reproductive Physiology

Primary and accessory sex organs and secondary sex characters. Histology of testis. Endocrine functions of testis. Spermatogenesis. Hypothalamic control of testicular functions. Histology of ovary. Ovarian hormones and their functions. Oogenesis and ovulation. Formation and functions of corpus luteum. Hypothalamic control of ovarian functions. Physiology of puberty. Menstrual cycle and its regulation. Abnormalities in menstrual cycle. Onset of menopause and postmenopausal changes. Structure and functions of placenta. Maintenance of pregnancy and the bodily changes during pregnancy. Parturition. Pregnancy tests. Development of mammary glands, lactation and their hormonal control.

Developmental Biology

Stem cell : Characteristics and applications.Totipotency,Differentiation.
Ultra structure : Sperm and Ovum. **Fertilization,Blastulation,Implantation, Gastrulation**(Concept of induction, determination and differentiation).
Organogenesis : Development of Heart, urinary system and genital system.
Fetal Circulation. **(4)**

CC13P.

1. Study and identification of stained sections of different mammalian tissues and organs: Kidney, Ureter, Skin, Uterus, Testis, Ovary, Thyroid gland, Pancreas, Spleen, Lymph gland.
2. Pregnancy Test by immunological method using kit.
3. Silver nitrate preparation of urinary bladder for study of cell spaces. **(2)**

CC14TH.

Excretory System, Environmental Pollutants and Human Health

Kidney : Anatomy of kidney. Histology of nephron. Renal circulation – peculiarities and autoregulation. Formation of urine – glomerular function and tubular functions. Counter-current multiplier and exchanger. Renal regulation of osmolarity and volume of blood fluids. Diabetes insipidus. Formation of hypertonic urine. Renal regulation of acid-base balance, acidification of urine. Renal function tests – creatinine, inulin, urea, and PAH clearance tests. Physiology of urinary bladder and micturition. Constituents of urine. Abnormal constituents of urine, and pathophysiological significance. Renal dialysis. Non-excretory functions of kidney.

Skin and Body Temperature Regulation : Structure and functions of skin. Cutaneous circulation. Sweat glands –structure and composition of sweat. Mechanism of sweat formation, secretion and its regulation. Insensible perspiration. Regulation of body temperature in homeotherms – its physical and physiological processes, roles of neural and hormonal processes. Pyrexia, hyperthermia and hypothermia.

Environmental Pollutants and Human Health : Sources and effects of Chlorinated hydrocarbons, Organophosphorus, Organocarbamates, Lead, Arsenic, Fluorine, Aluminium, Ionizing and non-ionizing radiations. **(4)**

CC14P.

1.Identification of normal and abnormal constituents of urine.

2**.** Staining and identification of histological sections of liver, adrenal gland, thyroid gland, ovary, testes, and kidney. **(2)**

Suggested Readings

1. Text book of Medical Physiology, by A.C. Guyton. W.B. Saunders Co.
2. Best & Taylor's Physiological Basis of Medical Practice, O.P.Tandon & Y.Tripathi, Lippincott Williams & Wilkins
3. Ganong's Review of Medical Physiology. Barrett *et.al*, McGraw Hill Lange
4. Harper's Illustrated Biochemistry, V.W. Rodwell and others, Lange
5. Lehninger's Principles of Biochemistry. By D.L. Nelson and M. M. Cox, Worth Publishers Inc.
6. Textbook of Medical Physiology, D.Venkatesh & H.H.Sudhakar, Wolters Kluwer
7. Text Book of Biochemistry, by E.S. West. W.R. Todd. H.S. Mason. J.T. Van Bruggen. The Macmillan Company.
8. Biochemistry, D.Das, Academic Publishers.
9. Biophysics and Biophysical Chemistry, D.Das. Academic Publishers.
10. Samson Wright's Applied Physiology, C.A. Keele. E Neil & N. Toels. Oxford University Press.
11. Physiology, R.M. Berne & M.N. Levy, C.V. Mosby Co.
12. Basic Histology, L.C. Junqueira & J Carneiro, McGraw- Hill .
13. diFiore's Atlas of Histology, V.P. Eroschenko, Wolters-Kluwer
14. The Cell – A Molecular Approach, G.M. Cooper & R.E.Hausman, ASM Press SINAUER.
15. Cell Biology, G.Karp, John Wiley & Sons, Inc.
16. Core Text Book of Neuro-Anatomy, by M.B. Carpenter; the Williams and Wilkins Company.
17. The Human Nervous System, by Charles Nobach, Mc Graw Hill Book Co.
18. The Human Nervous System. By M.L. Barr & J.A. Kierman, Harper & Row.
19. Essential Food and Nutrition, by M. Swaminathan. The Bangalore Printing & Publishing Co.
20. Cell & Molecular Biology, EDP De Robertis & EMF De Robertis; Lea & Febiger
21. Molecular Biology of the Gene, by J.D. Watson, H.H. Nancy & others; BenjaminCummings.
22. Molecular Biology of the Cell, B. Alberts and others, Garland.
23. Textbook of Medical Physiology, Indu Khurana, Elsevier
24. Textbook of Medical Biochemistry, R.Chawla *et.al* , Wolters-Kluwer
25. Biochemistry, J.M.Berg, J.L. Tymoczko & L. Stryer, W.H. Freeman
26. William's Text Book of Endocrinology Larsen *et. al* An Imprint of Elsevier.
27. Endocrinology, Mac E. Hadley, Pearson Education.
28. Vander's Human Physiology, E.P. Widmaier *et al*., McGraw-Hill, Higher Education.
29. Concise Medical Physiology by S.K. Chaudhuri, New Central Book Agency.
30. Medical Physiology by A.B. Mahapatra, Current Books International.
31. Endocrinology. Vols.I , II and III by L.O. DeGroot. W.B. Saunders Co.
32. Langman's Medical Embryology by J.W. Sadler, Lippincott Williams and Wilkins.
33. Essentials of Human Embryology by A.K. Datta. Current Books International.
34. Human Embryology by I. Singh & G.P.Pal, McMillan.
35. Human Physiology An Integrated Approach by D.U. Silverthorn,Pearson.

Discipline Specific Electives (DSE)

Group A

1. Biostatistics
2. Microbiology & Immunology
3. Ergonomics
4. Community and Public Health

Group B

1. Work, Exercise and Sports Physiology
2. Advanced Molecular Biology & Nanotechnology
3. Chronobiology and Stress Physiology
4. Toxicology and Pharmacology

Semester V	Semester VI
Group – A 1 & 2 (Anyone)	Group – A 3 & 4 (Anyone)
Group – B 1 & 2 (Anyone)	Group – B 3 & 4 (Anyone)

Group A

1. Biostatistics (DSE A1TH)

Scope of statistics – utility and misuse. Principles of statistical analysis of biological data.
Basic concepts – variable. Population and Sampling -- parameter, statistic.
Presentation of data-frequency distribution, frequency polygon, histogram, bar diagram and pie diagram.
Different classes of statistics- mean median, mode, mean deviation, variance, standard deviation, standard error of the mean. Standard score.
Degrees of freedom. Probability. Normal distribution. Student's tdistribution.
Testing of hypothesis - Null hypothesis, errors of inference, levels of significance, t-test and z score for significance of difference.
Distribution-free test - Chi-square test.
Linear correlation and linear regression.
One way ANOVA **(4)**

DSE A1P

Computation of mean, median, mode, standard deviation and standard error of the mean with physiological data like body temperature, pulse rate, respiratory rate, height and weight of human subjects. Graphical representation of data in frequency polygon and histogram. Student's t test for significance of difference between means. Determination of correlation coefficient (r) and computation of linear regression equation.

Statistical analysis and graphical representation of biological data with computer using One way Anova . **(2)**

Suggested Readings

1. Statistics in Biology and Psychology by D.Das and A.Das Academic Publishers.
2. An Introduction to Biostatistics, N. Gurumani, M.J.P. Publishers, Chennai.
3. Biostatistical Analysis by J.H Zar, Pearson.
4. Statistical Methods in Biology, Norman T.J.Bailey, Cambridge University Press.

2. Microbiology & Immunology (DSE A2TH)

Classification of microorganisms. Techniques employed for the identification of microorganisms -- microscopic and biochemical methods.

Control of microbial growth : Physical and Chemical methods used in sterilization, disinfection and pasteurization.

Bacteriology : Bacterial classification based on staining techniques (Gram stain and Acid-fast stain) and morphological aspect. Bacterial structure :cell-wall, LPS layer, pili, flagella, chromosome, plasmid, spores and cysts.

Culture of bacteria : Nutritional requirement – complex and synthetic media, preparation of media ; physical factors required for growth (temperature, pH and gaseous requirement) ; bacterial growth curve : different phases and their significance ; quantitative estimation of bacterial growth ; continuous growth culture and its utility.

Food microbiology : Beneficial and harmful microorganisms in food, causative organisms of food-borne infections- mode of transmission and methods of prevention.

Bacterial metabolism: Fermentation, Glyoxalate cycle and Entner-Doudoroff pathway.

Bacterial genetics : Transformation, conjugation and transduction.

Treatment of bacterial infection : Chemotherapeutic agents. antibiotics- definition, bactericidal and bacteriostatic and their mechanism of action.

Virology : Viral structure – virion, prion and bacteriophages ; classification of viruses based on nucleic acid composition and host system, replication of bacteriophages – lytic and lysogenic cycle.

Overview of innate and acquired immunity : Elements of acquired immunity: Characteristics of immune response, cells and organs involved in immune response.

Immunogens and antigens : Requirements of immunogenicity, epitopes recognized by B- & T- cells, haptens, adjuvants, cross-reactivity. Antibody structure, classification and functions.

Kinetics of antibody responses : Primary & secondary. Antigen - antibody interactions - Primary interaction : association constant, affinity & avidity. Secondary interaction : precipitation & agglutination. B-cell receptor.

MHC molecules :structure of class I and II molecules, brief idea of peptide binding by MHC molecules, cellular distribution.

Antigen processing and presentation: T-cell receptor. T-cell maturation and differentiation - thymic selection in brief. B-cell activation &differentiation : thymus dependent and independent antibodies, T-B co-operation, the carrier effect.

Cytokines : Produced by TH1 & TH2 cells, regulating specific immune response only.

Complement : Activation components – classical, alternative and lectin. Biological consequence of complement activation. Cell-mediated effector responses : CTLS, NK cells, K cells.
Brief idea of autoimmunity, cancer immunotherapy and AIDS. Hypersensitivity reactions and their types
Vaccination : Passive and active immunization, types and uses of vaccine.
Toxins and toxoids.
Hybridoma technology (4)

DSE A2P
1. Gram staining of bacteria and identification of Gram positive and Gram negative bacteria.
2. Determination of human blood group using immunological method.
3. Quantitation of antigen or antibody by precipitin test.
4. Isolation and staining of splenocytes.
5. Lactophenol cotton blue staining of yeast cells. (2)

Suggested readings:

1. Microbiology, Pelczar Tata McGrawhill.
2. General Microbiology By Stanier *et.al*, Prentice Hall.
3. Microbiology An Introduction, G.J Tortora, Pearson.
4. Prescott's Microbiology, J. Willey *et.al*., McGraw-Hill
5. Kuby Immunology by T.J Kindt et.al, W.H Freeman.
6. Cellular and Molecular Immunology, A.K. Abbas *et.al,* Elsevier.

3. Ergonomics (DSE A3TH)

Introduction to Ergonomics

A brief history of ergonomics
Multidisciplinary approach to Ergonomics
Definition and scope of Ergonomics
Role of ergonomics in health safety and productivity

Human machine interaction

Introduction to man machine interaction and interfaces
Fundamentals of human computer interaction
Fundamental idea of display and control

Anthropometric considerations in Ergonomics

Definition of anthropometry
Common terminologies used in anthropometry
Different body dimensions measured in anthropometry
Basic Concepts of reach, clearance, posture, range of motion.
Concept of percentile and its calculation and use of percentile values in anthropometry

The work place

Workplace components. Work place stressors and work place risk factors

Environmental Ergonomics

Ergonomic consideration of thermal environment
Ergonomic consideration of visual environment
Ergonomic consideration of environmental noise

Workplace and workplace design

Anthropometric principles in workplace design

Design principles for sitting and standing work

Ergonomic principles of load handling

Fundamentals of manual material handling

Different categories of movement in manual load handling

Ergonomic principles of safe load handling

Musculoskeletal Disorders

Basic idea about the role of skeletal system in movement, categories of joints, role of muscles, soft tissues and bones in movement

Risk factors for musculoskeletal disorders

Different types of musculoskeletal disorders

Evaluation of musculoskeletal disorders by questionnaire technique

Basic concept of OWAS method of work posture analysis.

Ergonomic intervention

Ergonomic principles of reducing work place stressors and improving work efficiency

DSE A3P

1. Determination of heat stress by WBGT indices
2. Assessment of llumination
3. Basic anthropometric measurements
4. Determination of range of motion by goniometer and strength by hand grip dynamometer
5. Assessment of prevalence of musculoskeletal disorder by questionnaire method

Suggested Readings

1. Fitting the task to the man: A textbook of Occupational Ergonomics. KHE Kroemer and E Grandjean. Taylor and Francis.
2. Engineering Physiology: Bases of Human factors / Ergonomics, KHE Kroemer and HB Kroemer. Van Reinhold.
3. Bodyspace: Anthropometry, Ergonomics and Design. S.Phesant, Taylor and Francis
4. Human Factors in Engineering. EJ McCormick and H Saunders. 5th Edition. McGraw-Hill .
5. Ergonomics Man in His working Environment. Murrell K. 3rd Ed. Springer.
6. Introduction to Ergonomics,R.S. Bridger, Routledge : Taylor & Francis group

4. **Community and Public Health (DSE A 4TH)**

Basic idea about community,public health issues.

Malnutrition in a community, over nutrition and possible remedial measures.

Diet management of obese, diabetic, hypertensive individuals and athletes.

Iron and iodine deficiency.

Population problem – principles and methods of family planning,. Problem of infertility and Assisted Reproductive Technologies. PCM -- Marasmus, Kwashiorkor, Marasmic Kwashiorkor, endemic goiter, nutritional anemias, rickets, osteomalacia, xeropthalmia, beriberi and their social implications. Principles and social importance of

immunization against diseases. Etiology, epidemiology and prevention -- Communicable diseases : Cholera, Malaria, Swine flu, Japanese Encephalitis, Rabies, Dengue, Hepatitis and AIDS; Non-communicable diseases – Hypertension and Obesity.

DSE A4P

1. Calculation of Body Surface Area (using nomogram), Body Mass Index and Ponderal Index from anthropometric measurements.

2. A report (hand-written) on the basis of field survey from ONE of the followings:
a) Physiological parameters of human (at least three parameters).
b) Anthropometric measurements on human (at least three parameters).
c) Epidemiological studies on human.

Suggested Readings

1. Park's Textbook of Preventive and Social Medicine, K.Park, M/s. Banarasidas Bhanot, 2015.
2. Communicable Disease Control Handbook, Jeremy Hawker *et.al*, Blackwell Publishing

Group B

1. Work,Exercise and Sports Physiology (DSE B1TH)

Introduction to work physiology

Definitions in work and exercise Physiology,

Fundamental concepts of work; work characteristics, work cycle and work pauses

Different categories of work

Different approaches to describe work and work load.

Physiological basis of work

Physiology of muscle action

Physical work load; Static and dynamic work

Physiological responses to static and dynamic work

Relationship between oxygen consumption and heart rate

Effect of heat stress on physiological responses to work load

Work load assessment

Physiological assessment of work load, work load classification, cardiovascular and respiratory indices for evaluating work load. acceptable work load.

Work Organization

Fundamental concept of work organization

Principles of reducing stress from physical work load

Exercise and Physical fitness

Exercise, physical activity and physical fitness. Benefits of exercise Components of fitness and their evaluation

Physical Working Capacity

Concept of maximal physical working capacity VO2 max,and its estimation by different methods. Factors affecting VO2max. Step test, bicycle ergometry and treadmill exercise for assessment of Physical working capacity.

Bioenergetics

Work power and energy, sources of energy. Aerobic and anaerobic capacity, EPOC, lactate threshold and lactate tolerance and their limitations. Determination of energy cost by direct and indirect methods

Athletic performance based on aerobic capacity and O_2 debt

Training Principles

Training principles, different training methods. Training principles for different sports activities. Over training and detraining and their physiological effects. Ergogenic aids.

Body composition

Determination of Physical growth status. Methodologies for body composition analysis. (2)

DSE B1P

1.Determination of BMI, BSA, PI, waist hip ratio, body fat percentage and body type
2.Determination of V_{O2}max by Queen's College Test and physical fitness by modified Harvard step test
3.Determination of agility, flexibility and anaerobic power by shuttle run, sit and reach and vertical jump test
4.Recording of heart rate and blood pressure during static and dynamic work, determination of workload from heart rate and cardiac indices and classification of work load. (2)

Suggested Readings

1. Exercise Physiology: Theory and Application to Fitness and Performance. S.K. Powers and E.T. Howley. 10th edition. McGraw Hill publishers.
2. Exercise Physiology: Nutrition, Energy, and Human Performance. W.D. McArdle, F.I. Katch and V.L. Katch. 7th edition. Lippincott,Williams & Wilkins publishers.
3. Physiology of Sport and Exercise. J. H. Wilmore, D. L. Costill, W. Larry Kenney. Human Kinetics
4. Textbook of Work Physiology: Physiological Bases of Exercise. Per- Olof Åstrand, Kaare Rodahl, Hans A. Dahl, Sigmund B. Strømme . Human Kinetics
5. Fox's Physiological Basis for Exercise and Sport by M. L.Foss. S. J. Keteyian, E. L. Fox , William C Brown Pub
6. The Physiology of Work, K. Rodahl, Taylor & Francis,
7. Essentials of Exercise Physiology, V.L. Katch, W.D. McArdle, F.I. Katch, Wolters Kluwer

2. Advanced Molecular Biology (DSE B2TH)

Repetitive DNA, interrupted genes, gene families, transposons.
Control of gene expression – attenuation and antitermination, Operon - trp, arabinose, DNA methylation, (DCM, DAM). Post-transcriptional modifications, cap, poly A tail splicing, RNA editing. Role of chromatin in gene expression and gene silencing.
Cell-cell communication and quorum sensing in bacteria.
Molecular basis of apoptosis in brief.
Protein sequencing methods, detection of post translation modification of proteins. DNA sequencing methods. Molecular markers in genome analysis. Methods for analysis of gene expression at RNA and protein level, large scale expression, such as Micro array based techniques . RFLP, RAPD and AFLP techniques.Gene Knockout.Point mutations and deletions. Methods for detection of molecules in living cells, in situ localization by techniques such as FISH and GISH.Genomic medicine. Genetic counselling. Outline of ChIP technique. .
. Fundamentals of nanoscience :The nanoscale dimension and paradigm.Definition of a Nano system,Example- bone minerals and silk. Engineered Nanostructures—Carbon nanotubes, Gold & Silver nanoparticles. Bionanomaterials – Self-assembly in bionanostructures, e.g., virus self-assembly. Nanomotors- Ribosomes and mammalian myosin. Applications of Nanomaterials in Biology-- Biochemical sensor, Labelling and cellular imaging, Cancer treatment and Regenerative Medicine. (4)

DSE B2P

1. SDS-PAGE of proteins.
2. Isolation of DNA from animal cells.
3. Estimation of RNA by Orcinol method . (2)

Suggested Readings

1. Harper's Illustrated Biochemistry 30th edition. Lange.
2. Biotechnology: Lessons from Nature. D.S. Goodsell, Wiley India , 2012.
3. Nanobiotechnology: Concepts, Applications and Perspectives, Niemeyer and Mirkin, Wiley India , 2013.
4. Molecular Cell Biology,Berk,Kaiser,Lodish *et.al,* WH Freeman.

3.Chronobiology and Stress Physiology (DSE B3TH)

Different types of physiological rhythms – ultradian, circadian, infradian.
Different zeitgebers and their relation with circadian clock.
Hormonal biorhythms and their significance: adrenocortical, pineal and prolactin.
Neural basis of biological clock and role of suprachiasmatic nuclei.
Sleep-wakefulness cycle.
Body temperature rhythm.
Time keeping genes.
Jet-lag and shift work.
Stress : Physical and Emotional Stressors. General Adaptation Syndrome.
Role of Hypothalamic-Pituitary-Adrenal Axis and Sympathoadrenal Medullary Axes in coping stress.
Effects of chronic stress: Immunological, Cardiovascular Disease, Emotional.

Heat disorders and its preventive measures. Effects of hypobaric and hyperbaric environment. Caisson disease. Preventive measures for hypobaric and hyperbaric effects.

Oxidative stress-Formation of Reactive Oxygen Species and the role of Catalase, Superoxide Dismutase, Glutathione. Peroxidase and Glutathione Reductase in combating oxidative stress – role of vitamins. (4)

DSE3P

1.Project work on assessment of individual differences in human circadian rhythms (chronotype in human population) by questionnaire method among school children and college students.

2.Assessment of environmental heat load.

3.Assessment of noise level using noise level meter.

4.Determination of diurnal and /or circalunar rhythm of body temperature of college going students. **(2)**

Suggested Readings

1. Chronobiology – The Biological Timekeeping, J.C. Dunlap, Sinauer Associates
2. The Rhythm of Life, M. Kelly, The New York Times Bestseller
3. Biological Rhythms, Vinod Kumar, Narosa Publishers
4 Behavioural Endocrinology, R.J. Nelson,Sinauer Associates
5. Physiology of Stress, Hans Selye, Jones and Bartlett Publishers

4.Toxicology and Pharmacology (DSE B4TH)

Toxins and Toxicology Factors Affecting toxicity.

LD_{50}, LOD_{50}, ED_{50}, NOEL, LOEL

Concepts of Biomagnification and Bioconcentration

The importance of pharmacology in the study of physiological processes. Definition of drug, agonist and antagonist. Drug delivery Drug reactivity. Pharmacokinetics : Drug-receptor interaction, Desensitization of receptors, Absorption, Distribution, Permeation, Elimination,Clearance,Halflife. Pharmacodynamics:dose-responsecurves.Beneficial versus toxic effects of drugs. Drug biotransformation. Bioavailability. Drug accumulation. Therapeutic index. Anaesthetics : types and mechanism of action of general anaesthetics. Sedatives - hypnotics: benzodiazepine, zolpidem. Diuretics - Carbonic anhydrase inhibitor, loop diuretic, potassium sparing and osmotic diuretics. Neuromuscular blockers :Tubocurarine and succinyl choline. Organ system effects and mechanism of action of adrenoceptor agonists and antagonists:

Adrenergic stimulants : Amphetamine and ephedrine. α- adrenergic stimulants – Methaxomine and clonidine. β- adrenergic stimulants – Metaproterenol and salbutamol.

Adrenergic antagonists :Labetelol. α- adrenergic blockers – Phenoxybenzamine andphentolamine. β- adrenergic blockers – Propranolol and atenolol.

Antianginaldrugs :Nitroglycerine and calcium-channel blocker – Nifedipine and verapamil. (4)

DSE B4P

Kymographic recording of the effects of atropine and propranonol on the perfused heart of toad. (2)

Suggested Readings

1.Goodman and Gilman"s The Pharmacological basis of Therapeutics, McGraw-Hill.
2.Basic and Clinical Pharmacology by E.G Katzung .Appleton sand Lange.
3.Textbook of Pharmacology by Seth and Seth Elsevier.

Skill Enhancement Course (SEC)

SEC-A (One course in Semester 3)

1. Hematological Techniques
2. Clinical Biochemistry

SEC-B (One course in Semester 4)

1**.**Detection of Food Additives /Adulterants and Xenobiotics
2. Bioinformatics

SEC-A

1. **Haematological techniques**

Blood groups - ABO and Rh. Immunological basis of identification of ABO and Rh blood groups. Biochemical basis of ABO system and Bombay phenotype .Blood transfusion - precaution and hazards. Concept of Blood Bank. Erythropoietin and thrombopoietin. Abnormal haemoglobins. thalassaemia and sickle-cell anaemia. Glycemic index , Glycated haemoglobin, C peptide C-reactive protein, Ghrehlin and Leptin in health and diseases. Definition, determination and significance of TC, DC, ESR, Arneth count, PCV, MCV,MHC, MCHC, bleeding time,clotting time and prothrombin time. Anaemia - types (definition and causes).Leucocytosis, leucopenia and leukaemia.Purpura. (2)

Suggested Readings:

1. Wintrobe"s- Clinical Haematology By J. P. Greer et.al., Wolters Kluwers
2. William's Haematology By E. Deutler et. Al., McGrawhill

3. Clinical Biochemistry

Pathophysiological significance of the following blood constituents: glucose, serum protein, albumin, urea, creatinine, uric acid, bilirubin and ketone bodies. Lipid and thyroid profile in health and disease. Pathophysiological significance of the following serum enzymes and proteins: Lactate dehydrogenase, Creatine kinase, Amylase, Acid and Alkaline phosphatases, β-glucurodinase, Alanine and Aspartate Transaminases, Lipase, γ-glutamyl transpeptidase, Regan Isoenzyme, Cardiac Troponins. (2)

Suggested Readings:

1.Harpers Illustrated Biochemistry By V.W.Rodwell et.al., McGrawhill.

2.Text Book of Medical Biochemistry By M.N.Chatterjea and Rana Shinde, Jaypee.

3. Biochemistry, D. Das, Academic Publishers.

SEC-B

1.Detection of Food Additives /Adulterants and Xenobiotics

Definition ,examples and health hazards of food additives/adulterants. Tests for identifying Food Adulterants in food samples and their pathophysiological effects: Metanil yellow, Rhodamin B, Saccharin, Monosodium glutamate, Aluminium foil, Chicory, Bisphenol A and Bisphenol S, Margarine, Lead, Arsenic, Mercury, Polychlorinated Biphenyls, Dioxin and Urea.
Concept of Xenobiotics- Types, sources and fate. Types of reactions in detoxification and their mechanisms- oxidation, reduction, hydrolysis and conjugation. (2)

Suggested Readings:

1.Harper's Illustrated Biochemistry By V.W.Rodwell et.al., McGrawhill

2.Text Book of Medical Biochemistry By M.N.Chatterjea and Rana Shinde., Jaypee

2.Bioinformatics

Introduction to Bioinformatics, Bioinformatic databases- PubMed, PDB, Gen Bank, NCBI. Bioinformatic tools- FASTA, BLAST. Applications of bioinformatics- Analysis and interpretation of sequence data, homology searches, sequence alignments and pattern searching, analysis and interpretation of genome data- gene prediction, full gene comparison. Introduction to computational biology- prediction of 3-D protein structure, identification of unknown protein, drug design and application in medical sciences.(2)

Suggested Readings:

1. Bioinformatics -Principles and Applications By Z. Ghosh and B. Mallick., Springer.
2. Bioinformatics-Databases, Tools and Algorithms By O. Bosu and S. K. Thukral., Oxford Higher Education.

3. Introduction to Bioinformatics By Attwood et. Al., Pearson.
4. Harpers Illustrated Biochemistry By V.W.Rodwell et.al., McGrawhill.

University of Calcutta

PHYSIOLOGY (GENERAL) SYLLABUS FOR CBCS

CORE COURSES(CC) / GENERIC ELECTIVE (GEN)

Semester 1

CC-1 / GEN 1
Cellular Basis of Physiology and Genetics
Biophysical Principles, Enzymes and Chemistry of Bio-molecules
Digestion, Absorption & Metabolism

Semester 2

CC-2 / GEN2
Blood and Body Fluids
Cardiovascular System
Respiratory System

Semester 3

CC-3 / GEN 3
Nerve-muscle Physiology
Nervous System
Special Senses

Semester 4

CC-4 / GEN 4
Endocrinology
Reproductive Function
Excretory Physiology

Discipline Specific Electives (DSE)

DSE -- A (ONE course in Semester 5)

1. Biostatistics
2. Haematology

DSE - B (ONE course in Semester 6)

1. Work, Exercise and Sports Physiology
2. Human Nutrition and Dietetics

Ability Enhancement Compulsory Courses(AECC)

AECC- 1: Communicative English or any other Modern Indian Language in Semester 1

AECC-2: Environmental Studies in Semester 2

Skill Enhancement Course (SEC)

SEC -- A (ONE course in Semester 3)

1 Microbiology & Immunology
2. Clinical Biochemistry

SEC -- B (ONE course in Semester 4)

1. Detection of Food Additives /Adulterants and Xenoboiotics
2. Communty health and formulation of diet charts.

Outline of Courses and Credits in Each Semester

Semester I

Core Courses (CC).Theoretical (TH)

CC1TH / GEN 1 TH

Cellular Basis of Physiology

Structure and functions of plasma membrane, nucleus and different cell organelles – Endoplasmic reticulum, Golgi bodies,Mitochondria, Lysosome and Peroxisome.

Biophysical Principles, Enzymes and Chemistry of Bio-molecules

Physiological importance of the following physical processes: Diffusion , Osmosis and Surface tension. pH and Buffers – Significance in human body and maintenance of pH in the blood. Colloids - Classification and physiological importance.

Enzymes: Classification, factors affecting enzyme action. Concept of coenzymes and isozymes.

Carbohydrates **:** Definition and classification.
Monosaccharides – Classification, structure, physiological importance.
Disaccharides – Maltose, Lactose and Sucrose: Structure, occurrence and physiological importance.
Polysaccharides – Starch, Glycogen, Dextrin, Cellulose.
Lipids : Definition and classification. Fatty acids – Classification.
— Definition and importance of, Saponification number and,
Iodine number.. Phospholipids, Cholesterol &
its ester – physiological importance.
Amino acids, Peptides and Proteins**:** Classification and structure.
Structure of peptide bonds.

Nucleic acids:Structure of DNA and RNA.

Digestion & Metabolism

Structure in relation to functions of alimentary canal and digestive glands. Composition, functions and regulation of secretion of digestive juices including bile. Digestion and absorption of carbohydrate, protein and lipid. Movements of the stomach and small intestine.

Glycolysis, TCA cycle, Importance of Glycogenesis, Glycogenolysis and. Gluconeogenesis. Beta oxidation of saturated fatty acid. Importance of Ketone bodies . Deamination & Transamination. Formation of urea . (4)

CC1P / GEN 1P:

Examination and staining of fresh tissues : Squamous, Ciliated and Columnar Epithelium by Methylene Blue stain.
Qualitative tests for identification of : Glucose, Fructose, Lactose, Sucrose, Starch, Dextrin, Lactic acid, Hydrochloric acid , Albumin, Acetone, Glycerol and Bile Salts.
Quantitative estimation of amino nitrogen by Sorensen's formol titration method (percentage to be done) (2)

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Semester II

CC2TH / GEN 2TH-

Blood and Body Fluids

Blood: composition and functions. Plasma proteins: origin and functions. Blood cells-- their morphology and functions. Erythropoiesis. Hemoglobin : different types of compounds and derivatives. Coagulation of blood: mechanism, procoagulants, anticoagulants.. Lymph and tissue fluids: composition, formation, and functions.

Cardiovascular System

Anatomy and histology of the heart. Properties of cardiac muscle. Origin and propagation of cardiac impulse. Cardiac cycle : Events. Heart sounds. Heart rate. Cardiac output: Determination by following Fick principle, factors affecting. Pulse - arterial and venous. Blood pressure and factors controlling. Baro- and chemoreceptors. Vasomotor reflexes. Peculiarities of regional circulations: coronary and cerebral.

Respiratory System

Anatomy and histology of the respiratory passage and organs.Role of respiratory muscles in breathing. Lung volumes and capacities. Exchange of respiratory gases between lung and blood and between blood and tissues. Transport of oxygen and carbon dioxide in blood. Regulation of respiration - neural and chemical. Hypoxia. (4)

CC2P GEN 2P:

Preparation and staining of human blood film with Leishman's stain and identification of different types of blood cells.
Preparation of hemin crystals.
Demonstration- kymographic recording of the unperfused heart of toad and effects of warm and cold saline.

Measurement of systolic and diastolic pressure by sphygmomanometer and determination of pulse and mean pressure.
Measurement of peak expiratory flow rate.
Pneumographic recording of normal respiratory movements and effects of hyperventilation and breath-holding. (2)

Semester III

CC3TH / GEN 3TH

Nerve-muscle Physiology

Structure of neurons. Origin and propagation of nerve impulse. Velocity of impulse in different types of nerve fiber. Properties of nerve fibers: all or none law, rheobase and chronaxie, refractory period. indefatiguability. Synapses: structure, mechanism of synaptic transmission. Motor unit. Myoneural junction: structure, mechanism of impulse transmission. Degeneration and regeneration in nerve fibers.

Different types of muscle and their structure. Red and white muscle. Muscular contraction: structural, mechanical and chemical changes in skeletal muscle during contraction and relaxation. Isotonic and isometric contractions. Properties of muscle: all or none law, beneficial effect, summation, refractory period, tetanus, fatigue.

Nervous System

A brief outline of organization and basic functions (sensory, motor and association) of the nervous system, central and peripheral nervous system.
Ascending tracts carrying touch, kinaesthetic,temperature and pain sensations.
Descending tracts: pyramidal tract and brief outline of the extra-pyramidal tracts.
Reflex action - definition, reflex arc, classification, properties. Functions of the spinal cord. Outline of functions of brain stem.
A brief idea of the structure, connections and functions of cerebellum. Different nuclei and functions of thalamus and hypothalamus. Cerebral cortex: histological structure and localization of functions. CSF : composition, formation, circulation and functions.
A brief description of the organization of the autonomic (sympathetic and parasympathetic) nervous system. Functions of sympathetic and parasympathetic nervous system. A brief idea of speech, aphasia, conditioning, learning and memory.

Special Senses

Olfaction and Gustation: Structure of sensory organ, neural pathway of olfactory and gustatory sensation. Mechanism of olfactory and gustatory sensation. Olfactory and gustatory adaptation. After-taste.

Audition: Structure of ear, auditory pathway, mechanism of hearing.

Vision: Structure of the eye. Histology of retina. Visual pathway. Light reflex. Chemical changes in retina on exposure to light. Accommodation - mechanism. Errors of refraction. Light and dark adaptation. Elementary idea of colour vision and colour blindness. (4)

CC3P / GEN 3P:

Silver Nitrate preparation of nodes of Ranvier.
Silver nitrate preparation of corneal cell space.
Examination and staining of skeletal and cardiac muscles by Methylene Blue stain.
Demonstration : Use of kymograph, induction coil and mercury key. Recording of simple muscle curve with sciatic-gastrocnemius muscle preparation of toad.
Determination of visual acuity by Snellen's chart / Landolt's C chart.
Determination of colour blindness by Ishihara chart.
Exploration of conductive and perceptive deafness by tuning fork method. (2)

Semester IV

CC4TH / GEN 4TH

Endocrinology

Hormones - classification. Elementary idea of mechanism of hormone action.

Hypothalamus: Basic concept of neurohormone.
Hypothalamo-hypophyseal tract and portal system.
Pituitary: Histological structure, hormones, functions. Hypo and hyper active states of pituitary gland.
Thyroid: Histological structure. Functions of thyroid hormones (T_4T_3).
Thyrocalcitonin. Hypo and hyper-active states of thyroid.
Parathyroid: Histological structure, functions of parathyroid hormone. Tetany.
Adrenal Cortex: Histological structure and functions of different hormones.
Hypo and hyper-active states of adrenal cortex.

Adrenal Medulla: Histological structure and functions of medullary hormones. The relation of adrenal medulla with the sympathetic nervous system.
Pancreas: Histology of islets of Langerhans. Origin and functions of pancreatic hormones. Diabetes mellitus.

Brief idea of the origin and functions of renin-angiotensin, prostaglandins. erythropoietin and melatonin. Elementary idea of gastrointestinal hormone.

Reproductive Physiology

Primary and accessory sex organs and secondary sex characters.
Testis: histology, spermatogenesis, testicular hormones and their functions.
Ovary: histology, oogenesis, ovarian hormones and their functions.
Menstrual cycle and its hormonal control.
Maintenance of pregnancy – role of hormones. Development of mammary gland and lactation - role of hormones.

Excretory Physiology

Structure and function relationship of kidney. Mechanism of formation of urine. Normal and abnormal constituents of urine. Physiology of micturition. Renal regulation of acid-base balance. Non-excretory functions of kidney.

Structure and functions of skin. Insensible and sensible perspiration Regulation of body temperature –– physical and physiological processes involved in it. Physiology of sweat secretion and its regulation. (4)

CC4P / GEN 4P:

Study and Identification of Stained Sections of Different Mammalian Tissues and Organs: Esophagus, Stomach, Small Intestine, Large Intestine, Liver, Lung,Trachea, Spinal cord, Cerebral cortex, Cerebellum, Thyroid Gland, Adrenal Gland, Pancreas, Spleen,Testes, Ovary, Kidney, Artery and Vein.
Identification of :
Normal constituents of urine : Chloride, Sulphate, Phosphate, Creatinine and Urea;
Abnormal constituents of urine: Glucose, Protein, Acetone, Bile pigment and Bile Salt. (2)

Suggested Readings

1. *Human Physiology Vol. 1* & 2, C. C. Chatterjee, Medical Allied Agency.
2. *Sharirbigyan (Bengali) Vol. I* & 2, J. Debnath, Sridhar Prakashani.
3. *Principles of Physiology,* D.Pramanik, Academic Publishers, Kolkata.
4. *Concise Medical Physiology,S.* K. Chaudhuri, New Central Book Agency.
5. *Biochemistry,* D. Das, Academic Publishers.
6. *Paripak, Bipak* 0 *Pusti,* D. Das, Paschim Banga Rajya Pustak Parshad.
7. *Snatok Sharirbidya*, A. Bandopadhyay, Calcutta Book House.
8. diFiore's Atlas of Histology, V.P. Eroschenko, Wolters-Kluwer
9. *Essentials of Exercise Physiology,* L.G. Shaver, Surjeet Publications.
10. *Text Book of Medical Physiology,* A.C.Guyton, W.B. Saunders Co.
11. Textbook of Medical Physiology, D.Venkatesh & H.H.Sudhakar, Wolters Kluwer
12. Textbook of Medical Physiology, Indu Khurana, Elsevier

15. *Medical Physiology,* A.B. Singha Mahapatra, Current Books International.
16. *Essentials of Medical Physiology:* K. Sembulingam and P. Sembulingam, Jaypee Brothers Medical Publishers Pvt. Ltd.
19. *Nutritive Value of Indian Foods* by C. Gopalan and other, NIN, Hyderabad.
20. *Practical Physiology*, by M.K. Manna, Sritara Prakashani, Kolkata

Discipline Specific Electives

DSE: GROUP-A

Biological Statistics (DSE A1TH)

Basic concepts– Variable, population, parameter, sample, statistic. Classification of data – qualitative and quantitative, continuous and discontinuous. Presentation of data–frequency distribution, bar diagram, pie diagram, frequency polygon and histogram.
Mean, median, mode, standard deviation and standard error of ungrouped data. Concept of probability, Null and Alternate Hypotheses, Characteristics and uses of Normal and t-distributions. (4)

DSE A1P

Computation of mean, median, mode, standard deviation and standard error of the mean using physiological data like body temperature, pulse rate, respiratory rate, height and weight of human subjects. Graphical representation of data in bar diagram, pie diagram frequency polygon and histogram. (2)

Suggested Readings

1. Statistics in Biology and Psychology by D.Das and A.Das Academic Publishers.
2. Essentials of Biostatistics, I.Saha and B.Paul, Academic Publishers.

Haematology (DSE A2TH):

Blood groups - ABO and Rh. Immunological basis of identification of ABO and Rh blood groups. Biochemical basis of ABO system and Bombay phenotype.Blood transfusion - precaution and hazards. Concept of blood bank.
Erythropoietin and thrombopoietin .Foetal haemoglobin.Abnormal haemoglobins - thalassaemia and sickle-cell anaemia. Definition, determination and significance of TC, DC, ESR, Arneth count, PCV, MCV, MHC, MCHC, bleeding time, clotting time and prothrombin time. Anaemia - types (definition and causes). Leucocytosis, Leucopenia and Leukaemia. Purpura. Disorders of coagulation. (4)

DSE A2P:

DC of WBC, Estimation of haemoglobin , Blood group determination, Bleeding time and Clotting time. (2)

Suggested Readings

1. Medical Physiology A.B.S. Mahapatra, Current Books International.
2. Text Book of Medical Biochemistry By M.N.Chatterjea and Rana Shinde., Jaypee

DSE: GROUP - B

Work & Exercise Physiology and Ergonomics (DSE B1TH)

Concept of physical work and physiological work. Classification of work loads. Energetics of muscular work. Measurement of energy cost. Cardiovascular and respiratory responses to graded exercise.Maximal oxygen consumption and post-exercise oxygen consumption – definition, factors affecting, measurement and significance. Muscle fatigue and recovery. Physical fitness and its assessment by modified Harvard Step Test.

Ergonomics. Importance of ergonomics in occupational health and well being. Definition of anthropometry. Different body dimensions measured in anthropometry and their significance. (4)

DSE B1P

Measurement of resting and working heart rate using thirty beats and ten beats methods respectively.

Measurement of blood pressure before and after exercise.

Determination of Physical Fitness Index by modified Harvard Step Test.

Measurement of some common anthropometric parameters- stature, weight, eye height (standing), shoulder height, sitting height, knee height (sitting), arm reach from wall, mid-arm circumference, waist circumference, hip circumference, neck circumference,head circumference, chest circumference.

Calculation of BSA and BMI from anthropometric data. (2)

Suggested Readings

1. Essentials of Exercise Physiology, V.L. Katch, W.D. McArdle, F.I. Katch, Wolters Kluwer
2. Exercise Physiology and Ergonomics An Introduction, A.Goswami, Academic Publishers.

Human nutrition and dietetics (DSE B2TH):

Basic constituents of food and their nutritional significance. Vitamins-Classification, functions, deficiency symptoms and daily requirements. Hypervitaminosis. Mineral metabolism – Ca, P, Fe. BMR: definition, factors affecting. Respiratory quotient: definition, factors affecting and significance. Biological value of proteins. Essential and non-essential amino acids. Nitrogen balance. SDA : definition and importance.
Body calorie requirements – adult consumption unit. Dietary requirements of carbohydrate, protein, lipid and other nutrients. Dietary fibres. Principles of diet survey. Composition and nutritional value of common food stuffs. (4)

DSE B2P:

Diet survey report (hand-written) of a family (as per ICMR specification): Each student has to submit a report on his/her own family. (2)

Suggested Readings

1. Essential Food and Nutrition, by M. Swaminathan. The Bangalore Printing & Publishing Co.
2. Biochemistry, U. Satyanarayan, NCBA

Ability Enhancement Compulsory Courses (AECC)

English / MIL Communication (AECC 1TH):
Environmental Science (AECC 2TH)

Skill Enhancement Course (SEC)

SEC A

Microbiology & Immunology (SECA1)

Viruses - DNA virus and RNA virus. Viroids and Prions. Bacteriophages. Bacteria-structure and morphological classification. Gram positive and Gram negative and acid-fast bacteria. Pathogenic and non-pathogenic bacteria - definition with a few examples. Physical and chemical methods used in disinfection,sterilization and pasteurization. Nutritional requirement – complex and synthetic media, preparation of media ; physical factors required for growth (temperature, pH and gaseous requirement). Bacterial growth curve. Elementary idea of bacteriostatic and bacteriocidal agents.

Beneficial and harmful microorganisms in food.
Elementary knowledge of innate and acquired immunity. Humoral and cell mediated immunity. Toxins and toxoids.Vaccination – Passive and active immunisation, types and uses of vaccine.
Immunological basis of allergy and inflammation. (2)

Suggested readings:

1. Microbiology, Pelczar Tata McGrawhill.
2. Prescott's Microbiology, J. Willey *et.al*., McGraw-Hill

Clinical Biochemistry (SEC A2)

Pathophysiological significance of the following blood constituents: glucose, serum protein, albumin, urea, creatinine, uric acid, bilirubin and ketone bodies. Lipid profile in health and diseases. Pathophysiological significance of the following serum enzymes and isozymes: Lactate dehydrogenase, Creatine kinase, Amylase, Acid and Alkaline phosphatases, β-glucurodinase SGPT and SGOT. (2)

SEC B

Detection of Food Additives / Adulterants & Xenobiotics (SEC B1):

Definition of food adulterants/ additive. Tests for identifying food adulterants-- Metanil yellow, Rhodamin B, Saccharin, Monosodium glutamate, Aluminium foil , Dioxin, Chicory and Bisphenol.
Concept of Xenobiotics- Types, sources and fate. Types of reactions in detoxification and their mechanisms- oxidation,reduction, hydrolysis and conjugation. (2)

Suggested Readings:

1. Harpers Illustrated Biochemistry By V.W.Rodwell et.al., McGrawhill
2. Text Book of Medical Biochemistry By M.N.Chatterjea and Rana Shinde., Jaypee

Community and Public Health (SEC B2)

Basic idea about community, public health issues.
Malnutrition in a community, over nutrition and possible remedial measures.
Diet management of obese, diabetic.

Basic idea of PCM and their prevention.

PCM -- Marasmus, kwashiorkor. Endemic goiter, rickets, osteomalacia, xeropthalmia, beriberi and their social implications. Etiology, epidemiology and prevention of:

Communicable diseases : Malaria, Dengue, Hepatitis and AIDS; Non-communicable diseases – Hypertension and Obesity.

Population problem – principles and methods of family planning, and Assisted Reproductive Technologies.

Principles of formulation of diet chart of growing children, pregnant & lactating women and diabetic patients. (2)

Suggested Reading

1. Park's Textbook of Preventive and Social Medicine, K.Park, M/s. Banarasidas Bhanot, 2015.

UNIVERSITY OF CALCUTTA

Notification No. CSR/ 12 /18

It is notified for information of all concerned that the Syndicate in its meeting held on 28.05.2018 (vide Item No.14) approved the Syllabi of different subjects in Undergraduate Honours / General / Major courses of studies (CBCS) under this University, as laid down in the accompanying pamphlet:

List of the subjects

Sl. No.	Subject	Sl. No.	Subject
1	Anthropology (Honours / General)	29	Mathematics (Honours / General)
2	Arabic (Honours / General)	30	Microbiology (Honours / General)
3	Persian (Honours / General)	31	Mol. Biology (General)
4	Bengali (Honours / General /LCC2 /AECC1)	32	Philosophy (Honours / General)
5	Bio-Chemistry (Honours / General)	33	Physical Education (General)
6	Botany (Honours / General)	34	Physics (Honours / General)
7	Chemistry (Honours / General)	35	Physiology (Honours / General)
8	Computer Science (Honours / General)	36	Political Science (Honours / General)
9	Defence Studies (General)	37	Psychology (Honours / General)
10	Economics (Honours / General)	38	Sanskrit (Honours / General)
11	Education (Honours / General)	39	Social Science (General)
12	Electronics (Honours / General)	40	Sociology (Honours / General)
13	English ((Honours / General/ LCC1/ LCC2/AECC1)	41	Statistics (Honours / General)
14	Environmental Science (Honours / General)	42	Urdu (Honours / General /LCC2 /AECC1)
15	Environmental Studies (AECC2)	43	Women Studies (General)
16	Film Studies (General)	44	Zoology (Honours / General)
17	Food Nutrition (Honours / General)	45	Industrial Fish and Fisheries – IFFV (Major)
18	French (General)	46	Sericulture – SRTV (Major)
19	Geography (Honours / General)	47	Computer Applications – CMAV (Major)
20	Geology (Honours / General)	48	Tourism and Travel Management – TTMV (Major)
21	Hindi (Honours / General /LCC2 /AECC1)	49	Advertising Sales Promotion and Sales Management –ASPV (Major)
22	History (Honours / General)	50	Communicative English –CMEV (Major)
23	Islamic History Culture (Honours / General)	51	Clinical Nutrition and Dietetics CNDV (Major)
24	Home Science Extension Education (General)	52	Bachelor of Business Administration (BBA) (Honours)
25	House Hold Art (General)	53	Bachelor of Fashion and Apparel Design – (B.F.A.D.) (Honours)
26	Human Development (Honours / General)	54	Bachelor of Fine Art (B.F.A.) (Honours)
27	Human Rights (General)	55	B. Music (Honours / General) and Music (General)
28	Journalism and Mass Communication (Honours / General)		

The above shall be effective from the academic session 2018-2019.

SENATE HOUSE
KOLKATA-700073
The 4th June, 2018

Paul 4/6/18
(Dr. Santanu Paul)
Deputy Registrar

U.G. Syllabus

for

Physics (Honours & General)

University of Calcutta

2018

Contents

1 Scheme of CBCS Curriculum

1.1 Basic Courses Types under CBCS

In CBCS there are some basic types of courses. The ones that are relevant to the B.Sc. curricula have been described below.

1. **Core Course (CC)**: A *discipline specific compulsory* basic course.
2. **Discipline Specific Elective Course (DSE)**: A *discipline specific elective* course which is more advanced or specialized.
3. **Generic Elective Course (GEC)**: An *inter-disciplinary elective* course to be opted from a discipline other than ones main discipline(s) of choice (e.g., a course in a discipline other than in which honours has been taken).
4. **Skill Enhancement Course (SEC)**: A *discipline specific elective* skill enhancement course.
5. **Ability Enhancement Compulsory Course (AECC)**: These are *compulsory* courses. There are two of them. AECC-1 is Communicative English / Modern Indian Language (e.g.:Bengali, Urdu, Hindi.) & AECC-2 is Environmental Science.

1.2 Credit Structure

In CBCS, all courses have credits assigned to them.

For any course, one of the following three modes teaching will be used:

1. Theory + Practical
2. Theory + Tutorial
3. Theory only

The credit structure is described below:

	Theory + Practical		**Theory + Tutorial**		**Theory**	**Total Credits**
	Theory	**Practical**	**Theory**	**Tutorial**	**Theory**	
CC	4	2	5	1		6
DSE	4	2	5	1		6
GE	4	2	5	1		6
SEC					2	2
AECC					2	2

Class Assignments The class assignment for different course segments (theory, practical, tutorial) are as follows:

- **Theory: 1 credit = 1 hour / week**
- **Practical: 1 credit = 2 hours / week**
- **Tutorial: 1 credit = 1 hour / week**

Duration of the Semesters The semesters will comprise **15 to 18 weeks of direct teaching.**

Grading The evaluation and final grading will also depend crucially on the credits of the papers.

A Grade Point Average system will be used. The weight factor (or importance) with which a particular paper will contribute to the final CGPA (Cumulative Grade Point Average) will depend on the credit of the course.

Please refer to the University Regulations for details.

1.3 Selection of DSE

Honours

- A student must choose four DSE papers from his/her honours subject - two papers in the 5th semester and two papers in the 6th semester.
- There are two groups of DSE papers, DSE-A and DSE-B. Each of these groups are further divided into two subgroups DSE-A1, DSE-A2, and DSE-B1, DSE-B2 respectively.
- In the 5th semester a student will be expected to choose one paper from DSE-A1 and one paper from DSE-B1.
- Similarly, in the 6th semester a student will be expected to choose one paper from DSE-A2 and one paper from DSE-B2.

General

- A student must choose six DSE papers.
- For each subject of the student's chosen combination (e.g.: Physics- Chemistry-Mathematics), a student must choose two DSE papers - one in the 5th semester and one in the 6th semester.
- For each subject there will be two groups of DSE papers, DSE-A and DSE-B.
- The DSE paper in the 5th semesters must be chosen from DSE-A and the DSE paper in the 6th semester must be chosen from DSE-B.

1.4 Selection of SEC

Honours

- A student must choose two SEC papers from the honours discipline - one in the 3rd semester and one in the 4th semester.
- For each subject there will be two groups of SEC papers, SEC-A and SEC-B.
- The SEC paper in the 3rd semester must be chosen from Group A and the SEC paper in the 4th semester must be chosen from Group B.

General

- A student must choose four SEC papers - one each in the 3rd, 4th, 5th and 6th semesters.
- The four SEC papers must be chosen from two of the subjects in his/her chosen combination (e.g.: Physics, Chemistry, Mathematics).
- Two of the papers must be chosen from one subject and two from the other.
- For each subject there will be two groups of SEC papers, SEC-A and SEC-B.
- The SEC papers in the 3rd and 5th semesters must be chosen from Group-A of two subjects.
- The SEC papers in the 4th and 6th semesters must be chosen from Group-B of the same subjects as above.

1.5 B.Sc. Honours - Semesterwise Courses

The number of different types of courses to be taken in the different semesters have been specified in the table below.

	Sem-1	Sem-2	Sem-3	Sem-4	Sem-5	Sem-6	Total	Credits
CC	2	2	3	3	2	2	14	$14 \times 6 = 84$
DSE					2	2	4	$4 \times 6 = 24$
GE	1	1	1	1			4	$4 \times 6 = 24$
SEC			1	1			2	$2 \times 2 = 4$
AECC	1	1					2	$2 \times 2 = 4$
Total	4	4	5	5	4	4	26	140

Note:

1. **The CC for general course of a subject other than the honours subject is to be treated as GE course.**
2. **The four GE courses must be chosen from two interdisciplinary subjects other than Physics, taking at least one from the Science / Home Science Division (Please see University Regulation). However, any discipline may be chosen in any semester.**

Special Note:
Across all courses (for both, Honours and General) 10 marks will be reserved for Internal Assessment and 10 marks will be reserved for Attendance.

1.6 B.Sc. Honours - Course Details

Core Courses (Honours)

Sem	Course Type	Course Name	Teaching Mode	Credit	Marks
1	CC	Mathematical Physics - I	Theory	4	50
			Practical	2	30
	CC	Mechanics	Theory	4	50
			Practical	2	30
2	CC	Electricity and Magnetism	Theory	4	50
			Practical	2	30
	CC	Waves and Optics	Theory	4	50
			Practical	2	30
3	CC	Mathematical Physics - II	Theory	4	50
			Practical	2	30
	CC	Thermal Physics	Theory	4	50
			Practical	2	30
	CC	Digital Systems and Applications	Theory	4	50
			Practical	2	30
4	CC	Mathematical Physics - III	Theory	4	50
			Practical	2	30
	CC	Elements of Modern Physics	Theory	4	50
			Practical	2	30
	CC	Analog Systems and Applications	Theory	4	50
			Practical	2	30
5	CC	Quantum Mechanics and Applications	Theory	4	50
			Practical	2	30
	CC	Solid State Physics	Theory	4	50
			Practical	2	30
6	CC	Electro-magnetic Theory	Theory	4	50
			Practical	2	30
	CC	Statistical Mechanics	Theory	4	50
			Practical	2	30

Choices for DSE (Honours)

Sem	Course Type - Group	Course Name	Teaching Mode	Credit	Marks
5	DSE-A1 (Any one)	Advanced Mathematical Methods - I	Theory	5	65
			Tutorial	1	15
		Communication Electronics	Theory	4	50
			Practical	2	30
	DSE-B1 (Any one)	Advanced Mathematical Methods - II	Theory	5	65
			Tutorial	1	15
		Nuclear and Particle Physics	Theory	5	65
			Tutorial	1	15
6	DSE-A2 (Any one)	Astronomy and Astrophysics	Theory	5	65
			Tutorial	1	15
		Advanced Dynamics	Theory	4	50
			Practical	2	30
	DSE-B2 (Any one)	General Relativity	Theory	5	65
			Tutorial	1	15
		Nano Materials and Applications	Theory	5	65
			Tutorial	1	15

Choices for SEC (Honours)

Sem	Course Type - Group	Course Name	Teaching Mode	Credit	Marks
3	SEC-A (Any one)	Basics of Programming and Scientific Word Processing	Theory	2	80
		Electrical Circuits and Network Skills	Theory	2	80
4	SEC-B (Any one)	Computer Algebra System and Figure Drawing Skill	Theory	2	80
		Renewable Energy and Energy Harvesting	Theory	2	80

1.7 B.Sc. General - Semesterwise Courses

The number of different types of courses to be taken in the different semesters have been specified in the table below.

	Sem-1	Sem-2	Sem-3	Sem-4	Sem-5	Sem-6	Total	Credits
CC	3	3	3	3			12	$12 \times 6 = 72$
DSE					3	3	6	$6 \times 6 = 36$
GE								
SEC			1	1	1	1	4	$2 \times 4 = 8$
AECC	1	1					2	$2 \times 2 = 4$
Total	4	4	4	4	4	4	24	120

Note:

1. **The CC must be chosen from three different disciplines.**
2. **The four SEC must be chosen from two different disciplines.**

1.8 B.Sc. General - Course Details

Core Courses (General)

Sem	Course Type	Course Name	Teaching Mode	Credits	Marks
1	CC	Mechanics	Theory	4	50
			Practical	2	30
2	CC	Electricity and Magnetism	Theory	4	50
			Practical	2	30
3	CC	Thermal Physics	Theory	4	50
			Practical	2	30
4	CC	Waves and Optics	Theory	4	50
			Practical	2	30

Choices for DSE (General)

Sem	Course Type - Group	Course Name	Teaching Mode	Credit	Marks
5	DSE-A (Any one)	Electronics and Instrumentation	Theory	4	50
			Practical	2	30
		Modern Physics	Theory	5	65
			Tutorial	1	15
6	DSE-B (Any one)	Solid State Physics	Theory	4	50
			Practical	2	30
		Nuclear and Particle Physics	Theory	5	65
			Tutorial	1	15

Choices for SEC (General)

Sem	Course Type - Group	Course Name	Teaching Mode	Credit	Marks
3/5	SEC-A (Any one)	Basics of Programming and Scientific Word Processing	Theory	2	80
		Electrical Circuits and Network Skills	Theory	2	80
4/6	SEC-B (Any one)	Computer Algebra System and Figure Drawing Skill	Theory	2	80
		Renewable Energy and Energy Harvesting	Theory	2	80

Part I

Physics Syllabus : Honours Course

2 Syllabi for Core Courses (Honours)

2.1 Semester - 1: Mathematical Physics - I

Mathematical Physics - I (Theory)

Paper: PHS-A-CC-1-1-TH **Credits: 4**

1. Calculus

   (a) Recapitulation: Limits, continuity, average and instantaneous quantities, differentiation. Plotting functions. Intuitive ideas of continuous, differentiable, etc. functions and plotting of curves. Approximation: Taylor and binomial series (statements only).

   (b) First Order and Second Order Differential equations: First Order Differential Equations and Integrating Factor. Homogeneous Equations with constant coefficients. Wronskian and general solution. Statement of existence and Uniqueness Theorem for Initial Value Problems. Particular Integral.

   (c) Calculus of functions of more than one variable: Partial derivatives, exact and inexact differentials. Integrating factor, with simple illustration. Constrained Maximization using Lagrange Multipliers.

2. Vector Algebra and Vector Calculus

   (a) Recapitulation of Vector Algebra. Idea of linear independence, completeness, basis and representation of vectors. Properties of vectors under rotations. Scalar product and its invariance under coordinate rotations. Vector product, Scalar triple product and their interpretation in terms of area and volume respectively.

   (b) Vector Differentiation: Scalar and Vector fields. Directional derivatives and normal derivative. Gradient of a scalar field and its geometrical interpretation. Divergence and curl of a vector field. Del and Laplacian operators. Vector identities.

   (c) Vector Integration: Ordinary Integrals of Vectors. Multiple integrals, Jacobian. Notion of infinitesimal line, surface and volume elements. Line, surface and volume integrals of Vector fields. Flux of a vector field. Gauss' divergence theorem, Green's and Stokes Theorems and their applications (no rigorous proofs).

3. Orthogonal Curvilinear Coordinates

   (a) Orthogonal Curvilinear Coordinates. Derivation of Gradient, Divergence, Curl and Laplacian in Cartesian, Spherical and Cylindrical Coordinate Systems.

4. Matrices

   (a) Addition and Multiplication of Matrices. Null Matrices. Diagonal, Scalar and Unit Matrices. Transpose of a Matrix. Symmetric and Skew-Symmetric Matrices. Conjugate of a Matrix. Hermitian and Skew- Hermitian Matrices. Singular and Non-Singular matrices. Orthogonal and Unitary Matrices. Trace of a Matrix. Inner Product.

   (b) Eigen-values and Eigenvectors. Cayley- Hamiliton Theorem. Diagonalization of Matrices. Solutions of Coupled Linear Ordinary Differential Equations. Functions of a Matrix.

Reference Books

- Mathematical Methods for Physicists, G.B. Arfken, H.J. Weber, F.E. Harris, 2013, 7th Edn., Elsevier.
- An introduction to ordinary differential equations, E.A. Coddington, 2009, PHI learning
- Differential Equations, George F. Simmons, 2007, McGraw Hill.
- Mathematical Tools for Physics, James Nearing, 2010, Dover Publications.
- Mathematical methods for Scientists and Engineers, D.A. McQuarrie, 2003, Viva Book.
- Advanced Engineering Mathematics, D.G. Zill and W.S. Wright, 5 Ed., 2012, Jones and Bartlett Learning.
- Mathematical Physics, Goswami, 1st edition, Cengage Learning
- Engineering Mathematics, S.Pal and S.C. Bhunia, 2015, Oxford University Press
- Advanced Engineering Mathematics, Erwin Kreyszig, 2008, Wiley India.
- Essential Mathematical Methods, K.F.Riley & M.P.Hobson, 2011, Cambridge Univ. Press
- Mathematical methods in the Physical Sciences, M. L. Boas, 2005, Wiley.

Mathematical Physics - I (Practical)

Paper: PHS-A-CC-1-1-P **Credits: 2**

List of Practicals

1. Introduction and Overview
   (a) Computer architecture and organization, memory and Input/output devices.
2. Basics of scientific computing
   (a) Binary and decimal arithmetic, Floating point numbers, algorithms, Sequence, Selection and Repetition, single and double precision arithmetic, underflow &overflow- emphasize the importance of making equations in terms of dimensionless variables, Iterative methods.
3. Errors and error Analysis.
   (a) Truncation and round off errors, Absolute and relative errors, Floating point computations.
4. Introduction to plotting graphs with Gnuplot / QtiPlot (or some other GUI based free software like Grace, Origin etc.)
   (a) Basic 2D graph plotting - plotting functions and data files, fitting data using gnuplot's fit function, polar and parametric plots, modifying the appearance of graphs, exporting plots.
5. Introduction to programming in python:
   (a) Introduction to programming, constants, variables and data types, dynamical typing, operators and expressions, modules, I/O statements, file handling, iterables, compound statements, indentation in python, the if-elif-else block, for and while loops, nested compound statements.
6. Programs
   (a) Elementary calculations with different type of data e.g., area and volume of regular shapes using formulae. Creation and handling one dimensional array. Sum and average of a list of numbers stored in array, finding the largest and lowest number from a list, swapping two data in a list, sorting of numbers in an array using bubble sort, insertion sort method. Calculation of term value in a series and finding the other terms with a seed (value of particular term) and calculation of different quantities with series. Convergence and accuracy of series. Introduction of three dimensional array. Simple calculations of matrices e.g., addition, subtraction, multiplication.

(b) Curve fitting, Least square fit, Goodness of fit, standard deviation

i. Ohms law to calculate R,

ii. Hooke's law to calculate spring constant

Note:

A list of suggestive numerical problems will be circulated from time to time.

Reference Books

- Introduction to Numerical Analysis, S.S. Sastry, 5th Edn. , 2012, PHI Learning Pvt. Ltd.
- Learning with Python-how to think like a computer scientist, J. Elkner, C. Meyer, and A. Downey, 2015, Dreamtech Press.
- Introduction to computation and programming using Python, J. Guttag, 2013, Prentice Hall India.
- Effective Computation in Physics- Field guide to research with Python, A. Scopatz and K.D. Huff, 2015, O'Rielly A first course in Numerical Methods, U.M. Ascher & C. Greif, 2012, PHI Learning.
- Elementary Numerical Analysis, K.E. Atkinson, 3 rd Edn., 2007, Wiley India Edition.
- Numerical Methods for Scientists & Engineers, R.W. Hamming, 1973, Courier Dover Pub.
- An Introduction to computational Physics, T.Pang, 2nd Edn., 2006,Cambridge Univ. Press Computational Physics, Darren Walker, 1st Edn., 2015, Scientific International Pvt. Ltd.

2.2 Semester - 1: Mechanics

Mechanics (Theory)

Paper: PHS-A-CC-1-2-TH **Credits: 4**

1. Fundamentals of Dynamics

(a) Review of Newtons Laws: Mechanistic view of the Universe. Concepts of Inertial frames, force and mass. Solution of the equations of motion (E.O.M.) in simple force fields in one, two and three dimensions using cartesian, cylindrical polar and spherical polar coordinate systems.

(b) Dynamics of systems of particles: Difficulty of solving the E.O.M. for systems of particles. Newton's third Law. External and Internal forces. Momentum and Angular Momentum of a system. Torque acting on a system. Conservation of Linear and Angular Momentum. Centre of mass and its properties. Two-body problem.

(c) Variable- mass system: motion of rocket.

2. Work and Energy

(a) Work - Kinetic Energy Theorem. Conservative Forces: Force as the gradient of a scalar field - concept of Potential Energy. Other equivalent definitions of a Conservative Force. Conservation of Energy.

(b) Qualitative study of one dimensional motion from potential energy curves. Stable and Unstable equilibrium.

(c) Energy of a system of particles.

3. Gravitation and Central Force Motion

(a) Central Force. Reduction of the two body central force problem to a one-body problem. Setting up the E.O.M. in plane polar coordinates.

(b) Differential equation for the path. Motion under an Inverse-square force. Newton's Law of Gravitation. Inertial and gravitational mass. Kepler's Laws. Satellite in circular orbit and applications. Geosynchronous orbits. Weightlessness. Basic idea of global positioning system (GPS).

(c) Gravitational potential energy. Potential and field due to spherical shell and solid sphere.

4. Non-Inertial Systems

(a) Galilean transformations and Galilean invariance.

(b) Non-inertial frames and idea of fictitious forces. E.O.M with respect to a uniformly accelerating frame. E.O.M with respect to a uniformly rotating frame - Centrifugal and Coriolis forces. Laws of Physics in a laboratory on the surface of the earth.

5. Rotational Dynamics

(a) The Rigid Body: Constraints defining the rigid body. Degrees of freedom for a rigid body;

(b) Relation between Angular momentum and Angular Velocity - Moment of Inertia Tensor. Calculation of moment of inertia for rectangular, cylindrical and spherical bodies.

(c) E.O.M for rotation about a fixed axis.

(d) Principal Axes transformation. Transformation to a body fixed frame. E.O.M for the rigid body with one point fixed (Euler's equations of motion). General motion of a rigid body - translation plus rotation. Kinetic energy of rotation.

6. Elasticity

   (a) Relation between Elastic constants. Twisting torque on a Cylinder or Wire. Bending of a beam . Internal bending moment. Elastic potential energy.

7. Fluid Motion

   (a) Kinematics of Moving Fluids: Idea of compressible and incompressible fluids, Equation of continuity; streamline and turbulent flow, Reynold's number. Euler's Equation. The special case of fluid statics $\vec{F} = \nabla p$: Simple applications (e.g: Pascal's law and Archimedes principle).

   (b) Poiseuille's equation for Flow of a viscous Liquid through a Capillary Tube.

Reference Books

- An introduction to mechanics, D. Kleppner, R.J. Kolenkow, 1973, McGraw-Hill.
- Mechanics, Berkeley Physics, vol.1, C.Kittel, W.Knight, et.al. 2007, Tata McGraw-Hill.
- Physics, Resnick, Halliday and Walker 8/e. 2008, Wiley. Analytical Mechanics, G.R. Fowles and G.L. Cassiday. 2005, Cengage Learning.
- Feynman Lectures, Vol. I, R.P.Feynman, R.B.Leighton, M.Sands, 2008, Pearson Education
- University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole.

Additional Books for Reference

- Mechanics, D.S. Mathur, S. Chand and Company Limited, 2000 University Physics.
- F.W Sears, M.W Zemansky, H.D Young 13/e, 1986, Addison Wesley

Mechanics (Practical)

Paper: PHS-A-CC-1-2-P **Credits: 2**

List of Practicals

1. To determine the Moment of Inertia of a metallic cylinder / rectangular bar about an axis passing through the C.G. and to determine the Modulus of Rigidity of the suspension wire.

2. To determine the Moment of Inertia of a Flywheel.

3. To determine Coefficient of Viscosity of water by Capillary Flow Method (Poiseuille's method).

4. Determination of Young's modulus of the material of a beam by the method of flexure.

5. To determine the elastic constants of a material by Searle's method.

6. To determine the value of g using Bar Pendulum.

7. To determine the height of a building using sextant.

General Topics

1. Measurements of length (or diameter) using vernier caliper, screw gauge and traveling microscope.

2. To study the random error in observations.

Reference Books

- Advanced Practical Physics for students, B. L. Flint and H.T. Worsnop, 1971, Asia Publishing House.

- Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers.

- A Text Book of Practical Physics, I.Prakash & Ramakrishna, 11th Edn, 2011, Kitab Mahal.

- Engineering Practical Physics, S.Panigrahi & B.Mallick, 2015, Cengage Learning India Pvt. Ltd.

- Practical Physics, G.L. Squires, 2015, 4th Edition, Cambridge University Press.

2.3 Semester - 2: Electricity and Magnetism

Electricity and Magnetism (Theory)

Paper: PHS-A-CC-2-3-TH **Credits: 4**

1. Electrostatic Field

   (a) Coulombs law and Principle of superposition leading to the definition of Electrostatic Field. Field lines.

   (b) Divergence of the Electrostatic field. Flux, Gauss's theorem of electrostatics. Applications of Gauss theorem to find Electric field due to charge configurations with spherical, cylindrical and planar symmetry.

   (c) Curl of the Electrostatic Field and its conservative nature. Electric potential. Potential for a uniformly charged spherical shell and solid sphere. Calculation of electric field from potential.

   (d) Laplace's and Poisson equations. Uniqueness Theorems. Method of Images and its application to: (1) Plane Infinite Sheet and (2) Sphere.

   (e) Conductors: Electric field and charge density inside and on the surface of a conductor. Conductors in an electrostatic field. Force per unit area on the surface. Capacitance of a conductor. Capacitance an isolated spherical conductor. Parallel plate condenser.

   (f) Electrostatic energy of system of charges. Electrostatic energy of a charged sphere.

   (g) Energy per unit volume in electrostatic field.

2. Dielectric properties of matter

   (a) Electric potential and field due to an electric dipole. Electric dipole moment. Force and torque on a dipole.

   (b) Electric Fields inside matter: Electric Polarization. Bound charges. Displacement vector. Relations between E, P and D. Gauss's theorem in dielectrics. Linear Dielectric medium. Electric Susceptibility and Permittivity. Capacitor (parallel plate, spherical, cylindrical) filled with dielectric.

3. The Magnetostatic Field

   (a) Biot-Savart's law. Force on a moving point charge due to a magnetic field: Lorentz force law. Application of Biot-Savart's law to determine the magnetic field of a straight conductor, circular coil. Force between two straight current carrying wires.

   (b) Divergence of the magnetic field - its solenoidal nature. Magnetic vector potential.

(c) Curl of the magnetic field. Ampere's circuital law. Its application to (1) Infinite straight wire, (2) Infinite planar surface current, and (3) Solenoid.

4. Magnetic properties of matter.

   (a) Potential and field due to a magnetic dipole. Magnetic dipole moment. Force and torque on a magnetic dipole in a uniform magnetic field.

   (b) Magnetization. Bound currents. The magnetic intensity - H. Relation between B, H and M. Linear media. Magnetic Susceptibility and Permeability. Brief introduction of dia-, para- and ferro-magnetic materials. B-H curve and hysteresis.

5. Electro-magnetic induction

   (a) Ohms law and definition of E.M.F. Faraday's laws of electromagnetic induction, Lenz's law. Self-Inductance and Mutual Inductance. Reciprocity Theorem. Introduction to Maxwell's Equations. Charge conservation. Displacement current and resurrection of Equation of Continuity.

   (b) Energy stored in magnetic field.

6. Electrical circuits

   (a) AC Circuits: Kirchhoff's laws for AC circuits. Complex Reactance and Impedance. Series LCR Circuit: (1) Resonance, (2) Power Dissipation and (3) Quality Factor, and (4) Band Width. Parallel LCR Circuit

7. Network theorems

   (a) Ideal Constant-voltage and Constant-current Sources. Network Theorems: Thevenin theorem, Norton theorem, Superposition theorem, Reciprocity theorem, Maximum Power Transfer theorem. Applications to dc circuits.

Reference Books

- Introduction to Electrodynamics, D.J. Griffiths, 3rd Edn., 1998, Benjamin Cummings.
- Electricity, Magnetism & Electromagnetic Theory, S. Mahajan and Choudhury, 2012, Tata McGraw Hill.
- Electricity and Magnetism, Edward M. Purcell, 1986 McGraw-Hill Education.
- Feynman Lectures Vol.2, R.P.Feynman, R.B.Leighton, M. Sands, 2008, Pearson Education.

- Elements of Electromagnetics, M.N.O. Sadiku, 2010, Oxford University Press.
- Ellectricity and Magnetism, D.Chattopadhyay and P.C.Rakshit, New Central Book Agency, 2011.
- Electricity and Magnetism, J.H.Fewkes & J.Yarwood. Vol. I, 1991, Oxford Univ. Press.

Electricity and Magnetism (Practical)

Paper: PHS-A-CC-2-3-P **Credits: 2**

List of Practicals

1. To determine an unknown Low Resistance using Potentiometer.
2. To determine an unknown Low Resistance using Carey Foster's Bridge.
3. To verify the Thevenin and Norton theorems.
4. To verify the Superposition, and Maximum power transfer theorems.
5. To study response curve of a Series LCR circuit and determine its (a) Resonant frequency, (b) Impedance at resonance, (c) Quality factor Q, and (d) Band width.
6. To study the characteristics of a series RC Circuit.
7. Determination of horizontal component of the earths magnetic field.

General Topics

1. Using a Multimeter for measuring (a) Resistances, (b) AC and DC Voltages, (c) DC Current, (d) Capacitances, and (e) Checking electrical fuses should be taught in the Practical classes as a general prerequisite.

Note:

- For the sake of brevity, details of ballistic galvanometer have been omitted from the theory course. Some part of the theory may be needed for the experiments. This should be covered as part of Practical.

Reference Books

- Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House.
- A Text Book of Practical Physics, I.Prakash & Ramakrishna, 11th Ed., 2011, Kitab Mahal.

- Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers.
- Engineering Practical Physics, S.Panigrahi and B.Mallick, 2015, Cengage Learning.
- A Laboratory Manual of Physics for undergraduate classes, D.P.Khandelwal, 1985, Vani Pub.

2.4 Semester - 2: Waves and Optics

Waves and Optics (Theory)

Paper: PHS-A-CC-2-4-TH **Credits: 4**

1. Oscillations
   (a) SHM: Simple Harmonic Oscillations. Differential equation of SHM and its solution. Kinetic energy, potential energy, total energy and their time-average values. Damped oscillation. Forced oscillations: Transient and steady states; Resonance, sharpness of resonance; power dissipation and Quality Factor.
2. Superposition of Harmonic Oscillations
   (a) Superposition of Collinear Harmonic oscillations: Linearity and Superposition Principle. Superposition of two collinear oscillations having (1) equal frequencies and (2) different frequencies (Beats). Superposition of N collinear Harmonic Oscillations with (1) equal phase differences and (2) equal frequency differences.
   (b) Superposition of two perpendicular Harmonic Oscillations: Graphical and Analytical Methods. Lissajous Figures with equal an unequal frequency and their uses.
3. Wave motion
   (a) Plane and Spherical Waves. Longitudinal and Transverse Waves. Plane Progressive (Traveling) Waves. Wave Equation. Particle and Wave Velocities. Differential Equation. Pressure of a Longitudinal Wave. Energy Transport. Intensity of Wave.
   (b) Water Waves: Ripple and Gravity Waves
4. Velocity of Waves
   (a) Velocity of Transverse Vibrations of Stretched Strings.
   (b) Velocity of Longitudinal Waves in a Fluid in a Pipe. Newton's Formula for Velocity of Sound. Laplace's Correction.

5. Superposition of Harmonic Waves

   (a) Standing (Stationary) Waves in a String: Fixed and Free Ends. Analytical Treatment. Changes with respect to Position and Time. Energy of Vibrating String. Transfer of Energy. Normal Modes of Stretched Strings. Plucked and Struck Strings. Melde's Experiment.

   (b) Longitudinal Standing Waves and Normal Modes. Open and Closed Pipes.

   (c) Superposition of N Harmonic Waves. Phase and Group Velocities.

6. Wave optics

   (a) Electromagnetic nature of light. Definition and properties of wave front. Huygens Principle. Temporal and Spatial Coherence.

7. Interference

   (a) Division of amplitude and wavefront. Young's double slit experiment. Lloyd's Mirror and Fresnel's Biprism. Phase change on reflection: Stokes' treatment. Interference in Thin Films: parallel and wedge-shaped films. Fringes of equal inclination (Haidinger Fringes); Fringes of equal thickness (Fizeau Fringes). Newton's Rings: Measurement of wavelength and refractive index.

8. Interferometers

   (a) Michelson Interferometer-(1) Idea of form of fringes (No theory required), (2) Determination of Wavelength, (3) Wavelength Difference, (4) Refractive Index, and (5) Visibility of Fringes.

   (b) Fabry-Perot interferometer.

9. Diffraction and Holography

   (a) Fraunhofer diffraction: Single slit. Circular aperture, Resolving Power of a telescope. Double slit. Multiple slits. Diffraction grating. Resolving power of grating.

   (b) Fresnel Diffraction: Fresnel's Assumptions. Fresnel's Half-Period Zones for Plane Wave. Explanation of Rectilinear Propagation of Light. Theory of a Zone Plate: Multiple Foci of a Zone Plate. Fresnel's Integral, Fresnel diffraction pattern of a straight edge, a slit and a wire.

   (c) Holography: Principle of Holography. Recording and Reconstruction Method. Theory of Holography as Interference between two Plane Waves. Point source holograms.

Reference Books

- Waves: Berkeley Physics Course, vol. 3, Francis Crawford, 2007, Tata McGraw-Hill.
- Fundamentals of Optics, F.A. Jenkins and H.E. White, 1981, McGraw-Hill.
- Principles of Optics, Max Born and Emil Wolf, 7th Edn., 1999, Pergamon Press.
- Optics, Ajoy Ghatak, 2008, Tata McGraw Hill.
- Optics, 4th Edn., Eugene Hecht, Pearson Education Limited, 2014.
- The Physics of Vibrations and Waves, H. J. Pain, 2013, John Wiley and Sons.
- The Physics of Waves and Oscillations, N.K. Bajaj, 1998, Tata McGraw Hill.
- Fundamental of Optics, A. Kumar, H.R. Gulati and D.R. Khanna, 2011, R. Chand Publications.
- A textbook of Optics; N Subramanyam, B. Lal and M.N.Avadhanulu; S.Chand. Publishing.

Waves and Optics (Practical)

PHS-A-CC-2-4-P **Credits: 2**

List of Practicals

1. To determine the frequency of an electric tuning fork by Melde's experiment and verify $\lambda^2 - T$ law.
2. To determine refractive index of the Material of a prism using sodium source.
3. To determine the dispersive power and Cauchy constants of the material of a prism using mercury source.
4. To determine wavelength of sodium light using Fresnel Biprism.
5. To determine wavelength of sodium light using Newton's Rings?
6. To determine the thickness of a thin paper by measuring the width of the interference fringes produced by a wedge-shaped Film.
7. Measurement of the spacing between the adjacent slits in a grating by measuring sin θ vs λ graph of a certain order of grating spectra.

General Topics

1. In the practical classes, students should be thoroughly familiarized with Schuster's focusing for their general proficiency with spectrometers.

Reference Books

- Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House.
- A Text Book of Practical Physics, I. Prakash & Ramakrishna, 11th Ed., 2011, Kitab Mahal.
- Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers.
- A Laboratory Manual of Physics for undergraduate classes, D.P.Khandelwal, 1985, Vani Pub.

2.5 Semester - 3: Mathematical Physics - II

Mathematical Physics - II (Theory)

Paper: PHS-A-CC-3-5-TH **Credits: 4**

1. Fourier Series

   (a) Periodic functions. Orthogonality of sine and cosine functions, Dirichlet Conditions (Statement only). Expansion of periodic functions in a series of sine and cosine functions and determination of Fourier coefficients. Complex representation of Fourier series. Expansion of functions with arbitrary period. Expansion of non-periodic functions over an interval. Even and odd functions and their Fourier expansions. Application. Summing of Infinite Series. Term-by-Term differentiation and integration of Fourier Series. Parseval Identity.

2. Frobenius Method and Special Functions

   (a) Singular Points of Second Order Linear Differential Equations and their importance. Frobenius method and its applications to differential equations. Legendre, Bessel, Hermite and Laguerre Differential Equations. Properties of Legendre Polynomials: Rodrigues Formula, Generating Function, Orthogonality. Simple recurrence relations. Expansion of function in a series of Legendre Polynomials. Bessel Functions of the First Kind: Generating Function, simple recurrence relations. Zeros of Bessel Functions (Jo(x) and J1(x))and Orthogonality.

3. Some Special Integrals

   (a) Beta and Gamma Functions and Relation between them. Expression of Integrals in terms of Gamma Functions. Error Function (Probability Integral).

4. Variational calculus in physics

   (a) Functionals. Basic ideas of functionals. Extremization of action as a basic principle in mechanics. Lagrangian fomulation. Euler's equations of motion for simple systems: harmonics oscillators, simple pendulum, spherical pendulum, coupled oscillators. Cyclic coordinates. Symmetries and conservation laws. Legendre transformations and the Hamiltonian formulation of mechanics. Canonical equations of motion. Applications to simple systems.

5. Partial Differential Equations

   (a) Solutions to partial differential equations, using separation of variables: Laplace's Equation in problems of rectangular, cylindrical and spherical symmetry. Wave equation and its solution for vibrational modes of a stretched string, rectangular and circular membranes. Diffusion Equation.

Reference Books

- Mathematical Methods for Physicists: Arfken, Weber, 2005, Harris, Elsevier.
- Fourier Analysis by M.R. Spiegel, 2004, Tata McGraw-Hill.
- Mathematics for Physicists, Susan M. Lea, 2004, Thomson Brooks/Cole.
- Differential Equations, George F. Simmons, 2006, Tata McGraw-Hill.
- Partial Differential Equations for Scientists & Engineers, S.J. Farlow, 1993, Dover Pub.
- Engineering Mathematics, S.Pal and S.C. Bhunia, 2015, Oxford University Press.
- Mathematical methods for Scientists & Engineers, D.A. McQuarrie, 2003, Viva Books.
- Mathematical Physics, P. K. Chattopadhyay, 2014, New Academic Science.

Mathematical Physics - II (Practical)

Paper: PHS-A-CC-3-5-P **Credits: 2**

List of Practicals

1. Introduction to Numerical computation using numpy and scipy.

   (a) Introduction to the python numpy module. Arrays in numpy, array operations, array item selection, slicing, shaping arrays. Basic linear algebra using the linalg submodule. Introduction to online graph plotting using matplotlib. Introduction to the scipy module. Uses in optimization and solution of differential equations.

2. Solution of Linear system of equations by Gauss elimination method and Gauss Seidel method.

3. Diagonalization of matrices, Inverse of a matrix, Eigen vectors, eigen values problems

   (a) Solution of mesh equations of electric circuits (3 meshes)

   (b) Solution of coupled spring mass systems (3 masses)

4. Generation of Special functions using User defined functions

   (a) Generating and plotting Legendre Polynomials Generating and plotting Bessel function (Make use of generating function and recursion formula).

5. Root finding: Bisection and Newton-Raphson method.

6. Interpolation by Lagranges method.

7. Numerical differentiation - forward and backward difference formulae.

8. Numerical integration - trapezoidal and simpsons rule.

9. Solution of ODE: First order Differential equation - Euler's method.

10. Basic 3D graph plotting - plotting functions and data files, parametric plots, Surface and contour plots.

Note:

A list of suggestive numerical problems may be circulated from time to time.

Reference Books

- Mathematical Methods for Physics and Engineers, K.F Riley, M.P. Hobson and S. J. Bence, 3rd ed., 2006, Cambridge University Press.
- Complex Variables, A.S. Fokas & M.J. Ablowitz, 8th Ed., 2011, Cambridge Univ. Press.
- Numpy beginners guide, Idris Alba, 2015, Packt Publishing.
- Computational Physics, D.Walker, 1st Edn., 2015, Scientific International Pvt. Ltd.
- Simulation of ODE/PDE Models with MATLAB, OCTAVE and SCILAB: Scientific and Engineering Applications: A.V. Wouwer, P. Saucez, C.V. Fernandez. 2014 Springer.

2.6 Semester - 3: Thermal Physics

Thermal Physics (Theory)

Paper: PHS-A-CC-3-6-TH **Credits: 4**

1. Introduction to Thermodynamics

   (a) Zeroth and First Law of Thermodynamics: Extensive and intensive Thermodynamic Variables, Thermodynamic Equilibrium, Zeroth Law of Thermodynamics & Concept of Temperature. Concept of Work & Heat, State Functions, Internal Energy and First Law of Thermodynamics. Its differential form, First Law & various processes. Applications of First Law: General Relation between CP and CV, Work Done during Isothermal and Adiabatic Processes, Compressibility and Expansion Co-efficient.

   (b) Second Law of Thermodynamics: Reversible and Irreversible process with examples. Conversion of Work into Heat and Heat into Work. Heat Engines. Carnot's Cycle, Carnot engine & efficiency. Refrigerator & coefficient of performance, 2nd Law of Thermodynamics: Kelvin-Planck and Clausius Statements and their Equivalence.

   (c) Carnot's Theorem. Applications of Second Law of Thermodynamics: Thermodynamic Scale of Temperature and its Equivalence to Perfect Gas Scale.

   (d) Entropy: Concept of Entropy, Clausius Theorem. Clausius Inequality, Second Law of Thermodynamics in terms of Entropy. Entropy of a perfect gas. Principle of Increase of Entropy. Entropy Changes in Reversible and Irreversible processes with examples. Entropy of the Universe. Entropy Changes in Reversible and Irreversible Processes. Principle of Increase of Entropy. Temperature-Entropy diagrams for Cycle. Third Law of Thermodynamics. Unattainability of Absolute Zero.

2. Thermodynamic Potentials

   (a) Thermodynamic Potentials: Internal Energy, Enthalpy, Helmholtz Free Energy, Gibb's Free Energy. Their Definitions, Properties and Applications. Surface Films and Variation of Surface Tension with Temperature. Magnetic Work, Cooling due to adiabatic demagnetization, First and second order Phase Transitions with examples, Clausius Clapeyron Equation and Ehrenfest equations

   (b) Maxwell's Thermodynamic Relations

   (c) Derivations and applications of Maxwell's Relations, Maxwell's Relations:(1) Clausius Clapeyron equation, (2) Values of Cp-Cv, (3) TdS Equations, (4) Joule-Kelvin coefficient for Ideal and Van der Waal Gases, (5) Energy equations, (6) Change of Temperature during Adiabatic Process.

3. Kinetic Theory of Gases

   (a) Distribution of Velocities: Maxwell-Boltzmann Law of Distribution of Velocities in an Ideal Gas and its Experimental Verification. Doppler Broadening of Spectral Lines and Stern's Experiment. Mean, RMS and Most Probable Speeds. Degrees of Freedom. Law of Equipartition of Energy (No proof required). Specific heats of Gases.

   (b) Molecular Collisions: Mean Free Path. Collision Probability. Estimates of Mean Free Path. Transport Phenomenon in Ideal Gases: (1) Viscosity, (2) Thermal Conductivity and (3) Diffusion. Brownian Motion and its Significance.

   (c) Real Gases: Behavior of Real Gases: Deviations from the Ideal Gas Equation. The Virial Equation. Andrew's Experiments on CO2 Gas. Critical Constants. Continuity of Liquid and Gaseous State. Vapour and Gas. Boyle Temperature. Van der Waal's Equation of State for Real Gases. Values of Critical Constants. Law of Corresponding States. Comparison with Experimental Curves. P-V Diagrams. Joule's Experiment. Free Adiabatic Expansion of a Perfect Gas. Joule-Thomson Porous Plug Experiment. Joule- Thomson Effect for Real and Van der Waal Gases. Temperature of Inversion. Joule-Thomson Cooling.

4. Conduction of Heat

   (a) Thermal conductivity, diffusivity. Fourier's equation for heat conduction – its solution for rectilinear flow of heat.

Reference Books

- Heat and Thermodynamics, M.W. Zemansky, Richard Dittman, 1981, McGraw-Hill.

- Thermal Physics, S. Garg, R. Bansal and Ghosh, 2nd Edition, 1993, Tata McGraw-Hill.
- Modern Thermodynamics with Statistical Mechanics, Carl S. Helrich, 2009, Springer.
- Thermodynamics, Kinetic Theory & Statistical Thermodynamics, Sears & Salinger. 1988, Narosa.
- Concepts in Thermal Physics, S.J. Blundell and K.M. Blundell, 2nd Ed., 2012, Oxford University Press
- Thermodynamics and an introduction to thermostatistics, H. B. Callen, 1985, Wiley.
- Thermal Physics, A. Kumar and S.P. Taneja, 2014, R. Chand Publications.

Thermal Physics (Practical)

Paper: PHS-A-CC-3-6-P **Credits: 2**

List of Practicals

1. Verification of Stefan's law using a torch bulb.
2. Determination of the coefficient of thermal expansion of a metallic rod using an optical lever.
3. Calibration of a thermocouple by direct measurement of the thermo-emf using operational amplifier and the constants. [One end in ice and another end at water bath which to be heated.]
4. Calibration of a thermocouple by direct measurement of the thermo-emf using potentiometer and the constants. [one end in ice and another end at water bath which to be heated.
5. Calibration of thermocouple [one end at room temperature other end in the oil bath] and determination of boiling point of water.
6. To determine the Coefficient of Thermal Conductivity of a bad conductor by Lee and Charlton's disc method.
7. To determine the Temperature Coefficient of Resistance by Platinum Resistance Thermometer (PRT).

Reference Books

- Advanced Practical Physics for students, B. L. Flint and H.T. Worsnop, 1971, Asia Publishing House.
- A Text Book of Practical Physics, I.Prakash & Ramakrishna, 11th Ed., 2011, Kitab Mahal.
- Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers.
- A Laboratory Manual of Physics for undergraduate classes, D. P. Khandelwal, 1985, Vani Pub.

2.7 Semester - 3: Digital Systems and Applications

Digital Systems and Applications (Theory)

Paper: PHS-A-CC-3-7-TH **Credits: 4**

1. Integrated Circuits
   (a) Active & Passive components. Discrete components. Wafer. Chip. Advantages and drawbacks of ICs. Scale of integration: SSI, MSI, LSI and VLSI (basic idea and definitions only). Classification of ICs. Examples of Linear and Digital lCs.
2. Digital Circuits
   (a) Difference between Analog and Digital Circuits. Binary Numbers. Decimal to Binary and Binary to Decimal Conversion. BCD, Octal and Hexadecimal numbers. AND, OR and NOT Gates (realization using Diodes and Transistor). NAND and NOR Gates as Universal Gates. XOR and XNOR Gates and application as Parity Checkers.
3. Boolean algebra
   (a) De Morgan's Theorems. Boolean Laws. Simplification of Logic Circuit using Boolean Algebra. Fundamental Products. Idea of Minterms and Maxterms. Conversion of a Truth table into Equivalent Logic Circuit by (1) Sum of Products Method and (2) Karnaugh Map.
4. Data processing circuits
   (a) Basic idea of Multiplexers, De-multiplexers, Decoders, Encoders.
5. Circuits
   (a) Arithmetic Circuits: Binary Addition. Binary Subtraction using 2's Complement. Half and Full Adders. Half & Full Subtractors, 4-bit binary Adder/Subtractor.

6. Sequential Circuits: SR, D, and JK Flip-Flops. Clocked (Level and Edge Triggered) Flip-Flops. Preset and Clear operations. Race-around conditions in JK Flip-Flop. M/S JK Flip-Flop.

7. Timers

   (a) IC 555: block diagram and applications: Astable multivibrator and Monostable multivibrator.

8. Shift registers

   (a) Serial-in-Serial-out, Serial-in-Parallel-out, Parallel-in-Serial-out and Parallel-in-Parallel-out Shift Registers (only up to 4 bits).

9. Counters (4 bits)

   (a) Ring Counter. Asynchronous counters, Decade Counter. Synchronous Counter.

10. Computer Organization

    (a) Input/Output Devices. Data storage (idea of RAM and ROM). Computer memory. Memory organization & addressing. Memory Interfacing. Memory Map.

Reference Books

- Digital Principles and Applications, A.P. Malvino, D. P. Leach and Saha, 7th Ed., 2011, Tata McGraw
- Fundamentals of Digital Circuits, Anand Kumar, 2nd Edn, 2009, PHI Learning Pvt. Ltd.
- Digital Circuits and systems, Venugopal, 2011, Tata McGraw Hill.
- Digital Electronics G K Kharate ,2010, Oxford University Press
- Digital Systems: Principles & Applications, R.J.Tocci, N.S.Widmer, 2001, PHI Learning
- Logic circuit design, Shimon P. Vingron, 2012, Springer.
- Digital Electronics, Subrata Ghoshal, 2012, Cengage Learning.
- Digital Electronics, S.K. Mandal, 2010, 1st edition, McGraw Hill
- Microprocessor Architecture Programming & applications with 8085, 2002, R.S. Goankar, Prentice Hall.

Digital Systems and Applications (Practical)

Paper: PHS-A-CC-3-7-P **Credits: 2**

List of Practicals

1. To design OR & AND logic with diode and resistor. Basic logic gates with Transistors. To verify the logics by any type of universal gate NAND/NOR.
2. Formation of different combinational problems by construction of Truth Table and implementation using basic logic gates.
3. Construction of half adder and full adder
4. Construction of half subtractor, full subtractor, adder-subtractor using full adder IC
5. Construction of FF circuits using NAND gates.
6. Construction of 4 bit shift registers (serial & parallel) using D type FF IC.
7. Construction of astable multivibrator using 555 Timer.

Reference Books

- Modern Digital Electronics, R.P. Jain, 4th Edition, 2010, Tata McGraw Hill.
- Basic Electronics: A text lab manual, P.B. Zbar, A.P. Malvino, M.A. Miller, 1994, Mc-Graw Hill.

2.8 Semester - 4: Mathematical Physics - III

Mathematical Physics - III (Theory)

Paper: PHS-A-CC-4-8-TH **Credits: 4**

1. Complex Analysis

   (a) Brief Revision of Complex Numbers. and their Graphical Representation. Euler's formula, Roots of Complex Numbers. Functions of Complex Variables. Analyticity and Cauchy-Riemann Conditions. Examples of analytic functions. Singular functions: poles and branch points, order of singularity, branch cuts. Integration of a function of a complex variable. Cauchy's Inequality. Cauchy's Integral formula. Simply and multiply connected region. Laurent and Taylor's expansion. Residues and Residue Theorem. Application in solving Definite Integrals.

2. Integrals Transforms

   (a) Fourier Transforms: Fourier Integral theorem. Fourier Transform. Examples. Fourier transform of trigonometric, Gaussian, finite wave train & other functions. Representation of Dirac delta function as a Fourier Integral. Fourier transform of derivatives, Inverse Fourier transform, Convolution theorem. Properties of Fourier transforms (translation, change of scale, complex conjugation, etc.). Three dimensional Fourier transforms with examples. Application of Fourier Transforms to differential equations: One dimensional Wave and Diffusion/Heat Flow Equations.

3. Introduction to probability

   (a) Independent random variables: Sample space and Probability distribution functions. Binomial, Gaussian, and Poisson distribution with examples. Mean and variance.

4. Special theory of Relativity

   (a) Michelson-Morley Experiment and its outcome. Postulates of Special Theory of Relativity. Lorentz Transformations. Simultaneity and order of events. Lorentz contraction. Time dilation. Relativistic transformation of velocity. Relativistic Dynamics. Variation of mass with velocity. Massless Particles. Mass-energy Equivalence. Transformation of Energy and Momentum.

   (b) Relativity in Four Vector Notation: Four-vectors, Lorentz Transformation and Invariant interval, Space-time diagrams. Proper time and Proper velocity. Relativistic energy and momentum - Four momentum. Conservation of four momentum and applications to collisions. Minkowski Force.

Reference Books

- Mathematical Methods for Physics and Engineers, K.F Riley, M.P. Hobson and S. J. Bence, 3rd ed., 2006, Cambridge University Press.
- Mathematics for Physicists, P. Dennery and A.Krzywicki, 1967, Dover Publications.
- Complex Variables, A.S.Fokas & M.J.Ablowitz, 8th Ed., 2011, Cambridge Univ. Press.
- Complex Variables, A.K. Kapoor, 2014, Cambridge Univ. Press.
- Complex Variables and Applications, J.W. Brown & R.V. Churchill, 7th Ed. 2003, Tata McGraw-Hill.
- First course in complex analysis with applications, D.G. Zill and P.D. Shanahan, 1940, Jones & Bartlett.

- Relativity - The Special and General Theory, A. Einstein, Methuen & Co. Ltd., 1920.
- Introduction to Special Relativity, R. Resnick, 2010, John Wiley and Sons.
- Introduction to Electrodynamics, D.J. Griffiths, 3rd Ed., 1998, Benjamin Cummings, 1991.

Mathematical Physics - III (Practical)

Paper: PHS-A-CC-4-8-P **Credits: 2**

List of Practicals

1. Solution of ODE/PDE:
   (a) Initial value problem: Modified-Euler and Runge-Kutta second order and fourth order methods.
   (b) Boundary value problems: Finite difference method with fixed step size.

   Application to simple physical problems.
2. Dirac-delta function:

   Evaluate $\frac{1}{\sqrt{2\pi\sigma^2}} \int e^{-\frac{(x-2)^2}{2\sigma^2}} (x+3)\, dx$ for $x = 1, 0.1, 0.01$ and show that it tends to 5.
3. Fourier series
   (a) Program to sum $\sum_{n=0}^{\infty} (0.2)^n$
   (b) Evaluate the fourier coefficients of a given periodic function (square wave).
4. Frobenius method and special functions.
   (a) $\int_{-1}^{+1} P_n(\mu) P_m(\mu)\, d\mu = \delta_{nm}$
   (b) Plot $P_n(x)$, $j_\nu(x)$
   (c) show recursion relation.
5. Evaluation of trigonometric functions e.g. $\sin\theta$. Given Bessel's function at N points find its value at an intermediate point.
6. Complex analysis:
   (a) Integrate $\int_0^{\infty} \frac{\sin x}{x} dx$ numerically and check with computer integration

(b) Root finding:

i. Compute the nth roots of unity for n = 2, 3, and 4.

ii. Find the two square roots of $-5 + 12i$.

7. Integral transform: FT of e^{-x^2}

8. Introduction to OCTAVE.

Note:

A list of suggestive numerical problems may be circulated from time to time.

Reference Books

- Mathematical Methods for Physics and Engineers, K.F Riley, M.P. Hobson and S. J. Bence, 3rd ed., 2006, Cambridge University Press.
- Mathematics for Physicists, P. Dennery and A. Krzywicki, 1967, Dover Publications.
- Simulation of ODE/PDE Models with MATLAB, OCTAVE and SCILAB: Scientific and Engineering Applications: A. Vande Wouwer, P. Saucez, C. V. Fernanndez. 2014 Springer ISBN: 978-3319067896.
- A Guide to MATLAB, B.R. Hunt, R.L. Lipsman, J.M. Rosenberg, 2014, 3rd Edn., Cambridge University Press.
- https://web.stanford.edu/ boyd/ee102/laplace_ckts.pdf.
- https://ocw.nthu.edu.tw/ocw/upload/12/244/12handout.pdf.

2.9 Semester - 4: Elements of Modern Physics

Elements of Modern Physics (Theory)

Paper: PHS-A-CC-4-9-TH **Credits: 4**

1. Unit 1

(a) Blackbody Radiation, Planck's quantum, Planck's constant. Photoelectric effect and Compton scattering - light as a collection of photons. Davisson-Germer experiment. De- Broglie wavelength and matter waves. Wave-particle duality. Wave description of particles by wave packets. Group and Phase velocities and relation between them. Probability interpretation: Normalized wave functions as probability amplitudes.

(b) Two-Slit experiment with photons and electrons. Linear superposition principle as a consequence.

(c) Position measurement- gamma ray microscope thought experiment. Heisenberg uncertainty principle (Statement with illustrations). Impossibility of a particle following a trajectory.

2. Unit 2

   (a) Postulates of Quantum Mechanics: States as normalized vectors (normalized wave functions). Dynamical variables as linear Hermitian operators. Predictions of quantum mechanics from solving the eigenvalue equation for the observables. Illustration using two and three level systems. Expectation values of observables.

   (b) Time evolution: Schrodinger equation for non-relativistic particles. Stationary states. Solution of Schrodinger's equation using expansion in stationary states. Time evolution of expectation values.

   (c) Application to one dimensional systems. Particle moving in one dimension: Position, Momentum and Energy operators. Probability and probability current densities in one dimension. Boundary conditions on wave functions. Ehrenfest theorem. Particle in a one dimensional infinitely rigid box: energy eigenvalues and eigenfunctions, normalization. Quantum dot. Quantum mechanical scattering and tunneling in one dimension across a step potential & rectangular potential barrier.

   (d) Simultaneous measurements: Compatible and incompatible observables and their relation to commutativity. Heisenberg's uncertainty relation for a pair of incompatible observables. Complete and incomplete measurements - degeneracy. Ilustration of the ideas using the Angular momentum operators.

3. Unit 3

   (a) Size and structure of atomic nucleus and its relation with atomic weight; Impossibility of an electron being in the nucleus as a consequence of the uncertainty principle.

   (b) Nature of nuclear force, NZ graph.

   (c) Nuclear Models: Liquid Drop model. semi-empirical mass formula and binding energy. Nuclear Shell Model. Magic numbers.

4. Unit 4

   (a) Radioactivity: stability of the nucleus; Law of radioactive decay; Mean life and half-life; Alpha decay; Beta decay- energy released, spectrum and Pauli's prediction of neutrino; Gamma ray emission, energy-momentum conservation: electron-positron pair creation by gamma photons in the vicinity of a nucleus.

(b) Fission and fusion: mass deficit, relativity and generation of energy. Fission - nature of fragments and emission of neutrons. Nuclear reactor: slow neutrons interacting with Uranium 235; Fusion and thermonuclear reactions driving stellar energy (brief qualitative discussions)

(c) Lasers: Einstein's A and B coefficients. Metastable states. Spontaneous and Stimulated emissions. Optical Pumping and Population Inversion. Three-Level and Four-Level Lasers. Ruby Laser and He-Ne Laser. Basic lasing.

Reference Books

- Concepts of Modern Physics, Arthur Beiser, 2002, McGraw-Hill.
- Primer of Quantum Mechanics; M. Chester; John Wiley & Sons, 1987.
- Introduction to Quantum Mechanics, David J. Griffith, 2005, Pearson Education.
- Physics for scientists and Engineers with Modern Physics, Jewett and Serway, 2010, Cengage Learning.
- Modern Physics, G.Kaur and G.R. Pickrell, 2014, McGraw Hill.
- Quantum Mechanics: Theory & Applications, A.K.Ghatak & S.Lokanathan, 2004, Macmillan

Additional Books for Reference

- Modern Physics, J.R. Taylor, C.D. Zafiratos, M.A. Dubson, 2004, PHI Learning.
- Theory and Problems of Modern Physics, Schaum's outline, R. Gautreau and W. Savin, 2nd Edn, Tata McGraw-Hill Publishing Co. Ltd.
- Quantum Physics, Berkeley Physics, Vol.4. E.H.Wichman, 1971, Tata McGraw-Hill Co.
- Basic ideas and concepts in Nuclear Physics, K.Heyde, 3rd Edn., Institute of Physics Pub.
- Nuclear Physics; S.N.Ghosal; S. Chand Publishing.
- Laser Physics and Spectroscopy, P.N.Ghosh, Levant Books, India, 2016.
- Six Ideas that Shaped Physics: Particle Behave like Waves, T.A.Moore, 2003, McGraw Hill.

Elements of Modern Physics (Practical)

Paper: PHSA-CC-4-9-P **Credits: 2**

List of Practicals

1. Measurement of Plank constant using LED
2. Determination of ionization potential of Mercury
3. Determination of e/m by using bar magnet.
4. To study the photoelectric effect: variation of photocurrent versus intensity and wavelength of light.
5. To determine the wavelength of H-alpha emission line of Hydrogen atom.
6. To show the tunneling effect in tunnel diode using I-V characteristics.
7. To determine (1) wavelength and (2) angular spread of He-Ne laser/ solid state laser using plane diffraction grating.

Reference Books

- Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House.
- Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers.
- A Text Book of Practical Physics, I.Prakash & Ramakrishna, 11th Edn, 2011,Kitab Mahal.

2.10 Semester - 4: Analog Systems and Applications

Analog Systems and Applications (Theory)

Paper: PHS-A-CC-4-10-TH **Credits: 4**

1. Semiconductor Diodes

   (a) P and N type semiconductors. Energy Level Diagram. Conductivity and Mobility, Concept of Drift velocity. PN Junction Fabrication (Simple Idea). Barrier Formation in PN Junction Diode. Static and Dynamic Resistance. Current Flow Mechanism in Forward and Reverse Biased Diode. Drift Velocity. Derivation for Barrier Potential, Barrier Width and Current for Step Junction. Current Flow Mechanism in Forward and Reverse Biased Diode.

2. Two-terminal Devices and their Applications.

   (a) Rectifier Diode: Half-wave Rectifiers. Centre-tapped and Bridge Full-wave Rectifiers, Calculation of Ripple Factor and Rectification Efficiency, C-filter.

   (b) Zener Diode and Voltage Regulation. Principle and structure of (1) LEDs, (2) Photodiode and (3) Solar Cell.

3. Bipolar Junction transistors n-p-n and p-n-p Transistors. Characteristics of CB, CE and CC Configurations. Current gains α and β Relations between α and β. Load Line analysis of Transistors. DC Load line and Q-point. Physical Mechanism of Current Flow. Active, Cutoff and Saturation Regions.

4. Field Effect transistors Basic principle of operations only.

5. Amplifiers

   (a) Amplifiers: Transistor Biasing and Stabilization Circuits. Fixed Bias and Voltage Divider Bias. Transistor as 2-port Network. h-parameter Equivalent Circuit. Analysis of a single-stage CE amplifier using Hybrid Model. Input and Output Impedance. Current, Voltage and Power Gains. Classification of Class A, B & C Amplifiers. Frequency response of a CE amplifier.

   (b) Coupled Amplifier: Two stage RC-coupled amplifier.

   (c) Feedback in Amplifiers: Effects of Positive and Negative Feedback on Input Impedance, Output Impedance, Gain, Stability, Distortion and Noise.

   (d) Sinusoidal Oscillators: Barkhausen's Criterion for self-sustained oscillations. RC Phase shift oscillator, determination of Frequency. Hartley & Colpitts oscillators.

   (e) Operational Amplifiers (Black Box approach): Characteristics of an Ideal and Practical Op-Amp. (IC 741) Open-loop and Closed-loop Gain. Frequency Response. CMRR. Slew Rate and concept of Virtual ground.

   (f) Applications of Op-Amps: Linear - (1) Inverting and non-inverting amplifiers, (2) Adder, (3) Subtractor, (4) Differentiator, (5) Integrator, (6) Log amplifier, (7) Zero crossing detector (8) Wein bridge oscillator. Non-linear – (1) inverting and non-inverting comparators, (2) Schmidt triggers.

   (g) Conversion: Resistive network (Weighted and R-2R Ladder). Accuracy and Resolution. A/D Conversion (successive approximation)

Reference Books

- Integrated Electronics, J. Millman and C.C. Halkias, 1991, Tata Mc-Graw Hill.
- Electronics: Fundamentals and Applications, J.D. Ryder, 2004, Prentice Hall. Solid State Electronic Devices, B.G.Streetman & S.K.Banerjee, 6th Edn.,2009, PHI.
- Learning Electronic Devices & circuits, S.Salivahanan & N.S.Kumar, 3rd Ed., 2012, Tata Mc-Graw Hill.
- OP-Amps and Linear Integrated Circuit, R. A. Gayakwad, 4th edition, 2000, Prentice Hall.
- Microelectronic circuits, A.S. Sedra, K.C. Smith, A.N. Chandorkar, 2014, 6th Edn., Oxford University Press.
- Electronic circuits: Handbook of design & applications, U.Tietze, C.Schenk,2008, Springer.
- Semiconductor Devices: Physics and Technology, S.M. Sze, 2nd Ed., 2002, Wiley India.
- Microelectronic Circuits, M.H. Rashid, 2nd Edition, Cengage Learning Electronic Devices, 7/e Thomas L. Floyd, 2008, Pearson India.

Analog Systems and Applications (Practical)

Paper: PHS-A-CC-4-10-P **Credits: 2**

List of Practicals

1. To study the reverse characteristics of Zener diode and study the load and line regulation.
2. To study the static characteristics of BJT in CE Configuration.
3. To design a CE transistor amplifier of a given gain (mid-gain) using voltage divider bias
4. To study the frequency response of the BJT amplifier in CE mode.
5. To study the static characteristics of FET.
6. To study OPAMP - inverting amplifer, non inverting amplifier, adder, substractar, comparator, integrator, differentiator.
7. To design a Wien bridge oscillator for given frequency using an op-amp.

Reference Books

- Basic Electronics: A text lab manual, P.B. Zbar, A.P. Malvino, M.A. Miller, 1994, Mc-Graw Hill.
- OP-Amps and Linear Integrated Circuit, R. A. Gayakwad, 4th edition, 2000, Prentice Hall.
- Electronic Principle, Albert Malvino, 2008, Tata Mc-Graw Hill. Electronic Devices & circuit Theory, R.L. Boylestad & L.D.
- Nashelsky, 2009, Pearson.

2.11 Semester - 5: Quantum Mechanics and Applications

Quantum Mechanics and Applications (Theory)

Paper: PHS-A-CC-5-11-TH **Credits: 4**

1. Schrodinger Equation
   (a) Description of a particle using wave packets. Spread of the Gaussian wave-packet for a free particle in one dimension. Fourier transforms and momentum space wavefunction. Position-Momentum uncertainty.
2. General discussion of bound states in an arbitrary potential
   (a) Continuity of wave function, boundary condition and emergence of discrete energy levels. Application to one-dimensional problem - square well potential.
3. Quantum mechanics of simple harmonic oscillator.
   (a) Setting up the eigenvalue equation for the Hamiltonian. Energy levels and energy eigenfunctions in terms of Hermite polynomials (Solution to Hermite differential equation may be assumed). Ground state, zero point energy & uncertainty principle.
4. Quantum theory of hydrogen-like atoms
   (a) Reduction of a two body problem to a one body problem. The time independent Schrodinger equation for a particle moving under a central force - the Schrodinger equation in spherical polar coordinates. Separation of variables. Angular equation and orbital angular momentum. Spherical Harmonics (Solution to Legendre differential equation may be assumed). Radial equation for attractive coulomb interaction - Hydrogen atom. Solution for the radial wavefunctions (Solution to Laguerre differential equation may be assumed). Shapes of the probability densities for ground & first excited states.Orbital angular momentum quantum numbers l and m; s, p, d,shells.

5. Generalized Angular Momenta and Spin.

   (a) Generalized angular momentum. Electron's magnetic Moment and Spin Angular Momentum. Gyromagnetic Ratio and Bohr Magneton and the g - factor. Energy associated with a magnetic dipole placed in magnetic field. Larmor's Theorem. Stern-Gerlach Experiment.

   (b) Addition of angular momenta - statement only. Restriction of eigenvalues from $|j_1 - j_2|$ to $|j_1 + j_2|$.

6. Spectra of Hydrogen atom and its fine structure

   (a) Formula for first order nondegenerate perturbative correction to the eigenvalue - statement only.

   (b) Spin-orbit interaction and relativistic correction to the kinetic energy and Darwin term.

   (c) Fine structure of the hydrogen atom spectrum

7. Atoms in Electric & Magnetic Fields

   (a) Zeeman Effect: Normal and Anomalous Zeeman Effect (Formula for first order perturbative correction to the eigenvalue to be assumed).

   (b) Paschen Back effect & Stark effects (Qualitative Discussion only).

8. Many electron atoms

   (a) Identical particles. Symmetric & Antisymmetric Wave Functions. Pauli's Exclusion Principle. Hund's Rule. Periodic table.

   (b) Fine structure splitting. L-S and J-J coupling scheme. Spectral Notations for Atomic States and Term symbols. Spectra of Alkali Atoms (Na etc.).

Reference Books

- A Text book of Quantum Mechanics, P.M.Mathews and K.Venkatesan, 2nd Ed., 2010, McGraw Hill
- Quantum Mechanics, Robert Eisberg and Robert Resnick, 2nd Edn., 2002, Wiley.
- Introduction to Quantum Mechanics, D.J. Griffith, 2nd Ed. 2005, Pearson Education
- Quantum Mechanics, Leonard I. Schiff, 3rd Edn. 2010, Tata McGraw Hill.
- Quantum Mechanics, G. Aruldhas, 2nd Edn. 2002, PHI Learning of India.
- Quantum Mechanics, Bruce Cameron Reed, 2008, Jones and Bartlett Learning.

- Quantum Mechanics: Foundations & Applications, Arno Bohm, 3rd Edn., 1993, Springer
- Quantum Mechanics for Scientists & Engineers, D.A.B. Miller, 2008, Cambridge University Press

Additional Books for Reference

- Quantum Mechanics, Eugen Merzbacher, 2004, John Wiley and Sons, Inc.
- Quantum Mechanics, Walter Greiner, 4th Edn., 2001, Springer

Quantum Mechanics and Applications (Practical)

Paper: PHS-A-CC-5-11-P **Credits: 2**

List of Practical

1. Solve the s-wave Schrodinger equation for the ground state and the first excited state of the hydrogen atom

$$\frac{d^2y}{dr^2} = A(r)\,u(r)\,, \qquad A(r) = \frac{2m}{\hbar^2}\left(V(r) - E\right), \qquad V(r) = \frac{-e^2}{r}$$

Here, m is the reduced mass of the electron. Obtain the energy eigenvalues and plot the corresponding wavefunctions. Remember that the ground state energy of the hydrogen atom is -13.6 eV. Take e = 3.795 $\left(eV\text{Å}\right)^{\frac{1}{2}}$, $\hbar c = 1973\ \left(eV\text{Å}\right)$ and $m = 0.511 \times 10^6\ \left(\frac{eV}{c^2}\right)$. [nm may be used instead of Å- make necessary conversions].

2. Solve the s-wave radial Schrodinger equation for an atom:

$$\frac{d^2y}{dr^2} = A(r)\,u(r)\,, \qquad A(r) = \frac{2m}{\hbar^2}\left(V(r) - E\right)$$

where m is the reduced mass of the system (which can be chosen to be the mass of an electron), for the screened coulomb potential:

$$V(r) = \frac{-e^2}{r}e^{-\frac{r}{a}}$$

Find the energy (in eV) of the ground state of the atom to an accuracy of three significant digits. Also, plot the corresponding wavefunction. Take e = 3.795 $\left(eV\text{Å}\right)^{\frac{1}{2}}$, $m = 0.511 \times 10^6\ \left(\frac{eV}{c^2}\right)$, and a = 3 Å, 5 Å, 7 Å. In these units $\hbar c = 1973\ \left(eV\text{Å}\right)$. The ground state energy is expected to be above -12 eV in all three cases. [nm may be used instead of Å - make necessary conversions]

3. Solve the s-wave radial Schrodinger equation for a particle of mass m.

$$\frac{d^2y}{dr^2} = A(r)\,u(r)\,, \qquad A(r) = \frac{2m}{\hbar^2}\left(V(r) - E\right)$$

for the anharmonic oscillator potential:

$$V(r) = \frac{1}{2}k^2 + \frac{1}{3}br^3$$

for the ground state energy (in MeV) of particle to an accuracy of three significant digits. Also, plot the corresponding wave function. Choose $m = 940\,\frac{MeV}{c^2}$, $k = 100\,Mev\,fm^{-2}$ $b = 0, 10, 30\ Mev\,fm^{-3}$. In these units, $\hbar c = 197.3\,MeV\,, fm$. The ground state energy is expected to lie between 90 and 110 MeV for all three cases.

4. Solve the s-wave radial Schrodinger equation for the vibrations of hydrogen molecule:

$$\frac{d^2y}{dr^2} = A(r)\,u(r)\,, \qquad A(r) = \frac{2\mu}{\hbar^2}\left(V(r) - E\right)$$

where μ is the reduced mass of the two-atom system for the Morse potential:

$$V(r) = D\left(e^{-2\alpha r'} - e^{-\alpha r'}\right), \qquad r' = \frac{r - r_0}{r}$$

Find the lowest vibrational energy (in MeV) of the molecule to an accuracy of three significant digits. Also plot the corresponding wave function. Take $m = 940 \times 10^6\,\frac{eV}{c^2}$, $D = 0.755501\,eV$, $\alpha = 1.44$, $r_0 = 0.131349$ Å

[nm may be used instead of the unit Å- make necessary conversions]

Reference Books

- An introduction to computational Physics, T.Pang, 2nd Edn.,2006, Cambridge Univ.Press
- Simulation of ODE/PDE Models with MATLAB, OCTAVE and SCILAB: Scientific & Engineering Applications: A. Vande Wouwer, P. Saucez, C. V. Fernandez. 2014, Springer.

2.12 Semester - 5: Solid State Physics

Solid State Physics (Theory)

Paper: PHS-A-CC-5-12-TH **Credits: 4**

1. Crystal Structure

   (a) Solids: Amorphous and Crystalline Materials. Lattice Translation Vectors. Lattice with a Basis Central and Non-Central Elements. Unit Cell. Miller Indices. Reciprocal Lattice. Types of Lattices. Brillouin Zones. Diffraction of X-rays by Crystals. Bragg's Law. Atomic and Geometrical Factor.

2. Elementary Lattice Dynamics

   (a) Lattice Vibrations and Phonons: Linear Monoatomic and Diatomic Chains. Acoustical and Optical Phonons. Qualitative Description of the Phonon Spectrum in Solids. Dulong and Petit's Law, Einstein and Debye theories of specific heat of solids. T^3 law

3. Magnetic Properties of Matter

   (a) Dia-, Para-, Ferri- and Ferromagnetic Materials. Classical Langevin Theory of Dia- and Paramagnetic Domains. Quantum Mechanical Treatment of Paramagnetism. Curie's law, Weiss's Theory of Ferromagnetism and Ferromagnetic Domains. Discussion of B-H Curve. Hysteresis and Energy Loss.

4. Dielectric Properties of Materials

   (a) Polarization. Local Electric Field at an Atom. Depolarization Field. Electric Susceptibility. Polarizability. Clausius Mosotti Equation. Classical Theory of Electric Polarizability. Normal and Anomalous Dispersion. Cauchy and Sellmeir relations. Langevin-Debye equation. Complex Dielectric Constant. Optical Phenomena. Application: Plasma Oscillations, Plasma Frequency, Plasmons, TO modes.

5. Ferroelectric Properties of Materials

   (a) Structural phase transition, Classification of crystals, Piezoelectric effect, Pyroelectric effect, Ferroelectric effect, Electrostrictive effect, Curie-Weiss Law, Ferroelectric domains, PE hysteresis loop.

6. Elementary band theory

   (a) Kronig Penny model. Band Gap. Conductor, Semiconductor (P and N type) and insulator. Conductivity of Semiconductor, mobility, Hall Effect. Measurement of conductivity (4 probe method) & Hall coefficient.

7. Superconductivity

   (a) Experimental Results. Critical Temperature. Critical magnetic field. Meissner effect. Type I and type II Superconductors, London's Equation and Penetration Depth. Isotope effect. Idea of BCS theory (No derivation)

Reference Books

- Introduction to Solid State Physics, Charles Kittel, 8th Edition, 2004, Wiley India Pvt. Ltd.
- Elements of Solid State Physics, J.P. Srivastava, 4th Edition, 2015, Prentice-Hall of India
- Introduction to Solids, Leonid V. Azaroff, 2004, Tata Mc-Graw Hill
- Solid State Physics, N.W. Ashcroft and N.D. Mermin, 1976, Cengage Learning
- Solid-state Physics, H. Ibach and H. Luth, 2009, Springer
- Solid State Physics, Rita John, 2014, McGraw Hill
- Elementary Solid State Physics, 1/e M. Ali Omar, 1999, Pearson India
- Solid State Physics and Electronics, A.B.Gupta and N.Islam, Books and Allied (P) Ltd.
- Quantum Mechanics, Statistical Machanics and Solid State Physics, 2010, S.Chand & Company.
- Solid State Physics, M.A. Wahab, 2011, Narosa Publications.

Solid State Physics (Practical)

Paper: PHS-A-CC-5-12-P **Credits: 2**

List of Practicals

1. To study PE hysteresis of ferroelectric crystal.
2. To study BH hysteresis of ferromagnetic material.
3. Measurement of susceptibility of paramagnetic solution by Quink"s tube method.
4. Measurement of magnetic susceptibility of solids.
5. Determination of variation of dielectric constant with frequency.
6. Measurement of hall voltage by four probe method.
7. To study temperature coefficient of a semiconductor (NTC thermistor).

Reference Books

- Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House.
- Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers.
- A Text Book of Practical Physics, I.Prakash & Ramakrishna, 11th Ed., 2011, Kitab Mahal.
- Elements of Solid State Physics, J.P. Srivastava, 2nd Ed., 2006, Prentice-Hall of India.

2.13 Semester - 6: Electromagnetic Theory

Electromagnetic Theory (Theory)

Paper: PHS-A-CC-6-13-TH **Credits: 4**

1. Maxwell Equations
   (a) Review of Maxwell's equations. Vector and Scalar Potentials. Gauge Transformations: Lorentz and Coulomb Gauge. Boundary Conditions at Interface between Different Media. Wave Equations. Plane Waves in Dielectric Media. Poynting Theorem and Poynting Vector. Electromagnetic (EM) Energy Density. Physical Concept of Electromagnetic Field Energy Density, Momentum Density and Angular Momentum Density.
2. EM Wave Propagation in Unbounded Media
   (a) Plane EM waves through vacuum and isotropic dielectric medium, transverse nature of plane EM waves, refractive index and dielectric constant, wave impedance. Propagation through conducting media, relaxation time, skin depth. Wave propagation through dilute plasma, electrical conductivity of ionized gases, plasma frequency, refractive index, skin depth, application to propagation through ionosphere.
3. EM Wave in Bounded Media
   (a) Boundary conditions at a plane interface between two media. Reflection & Refraction of plane waves at plane interface between two dielectric media-Laws of Reflection & Refraction. Fresnel's formulae for perpendicular & parallel polarization cases, Brewster's law. Reflection & Transmission coefficients. Total internal reflection, evanescent waves. Metallic reflection (normal Incidence).

4. Electromagnetic origin of Wave Optics

   (a) Kirchhoff's Integral Theorem, Fresnel-Kirchhoff's Integral formula. (Qualitative discussion only)

   (b) Description of Linear, Circular and Elliptical Polarization. Origin of Double-Refraction: Propagation of E.M. Waves in Anisotropic Media. Symmetric Nature of Dielectric Tensor. Fresnel's Formula.

5. Polarization in uniaxial crystals

   (a) Uniaxial and Biaxial Crystals. Light Propagation in Uniaxial Crystal. Double Refraction. Polarization by Double Refraction. Nicol Prism. Ordinary & extraordinary refractive indices. Phase Retardation Plates: Quarter-Wave and Half-Wave Plates. Production & analysis of polarized light. Babinet Compensator and its Uses.

6. Rotatory polarization.

   (a) Optical Rotation. Biot's Laws for Rotatory Polarization. Fresnel's Theory of optical rotation. Calculation of angle of rotation. Experimental verification of Fresnel's theory. Specific rotation. Laurent's half-shade and biquartz polarimeters.

Reference Books

- Introduction to Electrodynamics, D.J. Griffiths, 3rd Ed., 1998, Benjamin Cummings.
- Optics, E. Hecht, 2016, Pearson.
- Elements of Electromagnetics, M.N.O. Sadiku, 2001, Oxford University Press.
- Introduction to Electromagnetic Theory, T.L. Chow, 2006, Jones & Bartlett Learning
- Fundamentals of Electromagnetics, M.A.W. Miah, 1982, Tata McGraw Hill
- Electromagnetic field Theory, R.S. Kshetrimayun, 2012, Cengage Learning
- Engineering Electromagnetic, Willian H. Hayt, 8th Edition, 2012, McGraw Hill.
- Electromagnetic Field Theory for Engineers & Physicists, G. Lehner, 2010, Springer

Additional Books for Reference

- Electromagnetic Fields & Waves, P.Lorrain & D.Corson, 1970, W.H.Freeman & Co.
- Electromagnetics, J.A. Edminster, Schaum Series, 2006, Tata McGraw Hill.
- Electromagnetic field theory fundamentals, B. Guru and H. Hiziroglu, 2004,Cambridge University Press

Electromagnetic Theory (Practical)

Paper: PHS-A-CC-6-13-P **Credits: 2**

List of Practicals

1. To determine Brewster's angle for air-glass interface using a prism.
2. To study Fresnels law by the reflection on the surface of a prism.
3. To verify the Malus law using a pair of polaroids.
4. To study the specific rotation of opticlly active solution using polarimeter.
5. Determination of wavelength and velocity of ultrasonic waves ion a liquid (kerosene, Xylene etc).
6. To analyze elliptically polarized light by using babinate compensator.
7. To determine dispersive power and resolving power of a plane diffraction grating.

Reference Books

- Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House.
- Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
- A Text Book of Practical Physics, I.Prakash & Ramakrishna, 11th Ed., 2011, Kitab Mahal
- Electromagnetic Field Theory for Engineers & Physicists, G. Lehner, 2010, Springer

2.14 Semester - 6: Statistical Mechanics

Statistical Mechanics (Theory)

Paper: PHS-A-CC-6-14-TH **Credits: 4**

1. Classical Statistical Mechanics

   (a) Macrostate & Microstate, Elementary Concept of Ensemble and Ergodic Hypothesis. Phase Space.

   (b) Microcanonical ensemble, Postulate of Equal a-priori probabilities. Boltzmann hypothesis: Entropy and Thermodynamic Probability.

   (c) Canonical ensemble, Partition Function, Thermodynamic Functions of an Ideal Gas, Classical Entropy Expression, Gibbs Paradox.

   (d) Sackur Tetrode equation, Law of Equipartition of Energy (with proof) - Applications to Specific Heat and its Limitations. Thermodynamic Functions of a Two-Energy Level System. Negative Temperature.

   (e) Grand canonical ensemble and chemical potential.

2. Classical Theory of Radiation

   (a) Properties of Thermal Radiation. Blackbody Radiation. Pure temperature dependence. Kirchhoff's law. Stefan-Boltzmann law: Thermodynamic proof. Radiation Pressure. Wien's Displacement law. Wien's Distribution Law. Rayleigh-Jean's Law. Ultraviolet Catastrophe.

3. Quantum Theory of Radiation

   (a) Spectral Distribution of Black Body Radiation. Planck's Quantum Postulates. Planck's Law of Blackbody Radiation: Experimental Verification. Deduction of (1) Wien's Distribution Law, (2) Rayleigh-Jeans Law, (3) Stefan-Boltzmann Law, (4) Wien's Displacement law from Planck's law.

4. Bose-Einstein Statistics:

   (a) B-E distribution law. Thermodynamic functions of a strongly Degenerate Bose Gas, Bose Einstein condensation, properties of liquid He (qualitative description), Radiation as a photon gas and Thermodynamic functions of photon gas. Bose derivation of Planck's law.

5. Fermi-Dirac Statistics:

   (a) Fermi-Dirac Distribution Law. Thermodynamic functions of a Completely and strongly Degenerate Fermi Gas, Fermi Energy, Electron gas in a Metal, Specific Heat of Metals.

Reference Books

- Statistical Mechanics, R.K. Pathria, Butterworth Heinemann: 2nd Ed.,1996, Oxford University Press.
- Statistical Physics, Berkeley Physics Course, F. Reif, 2008, Tata McGraw-Hill.
- Statistical and Thermal Physics, S. Lokanathan and R.S. Gambhir. 1991, Prentice Hall.
- Thermodynamics, Kinetic Theory and Statistical Thermodynamics, Francis W. Sears and Gerhard L. Salinger, 1986, Narosa.
- Modern Thermodynamics with Statistical Mechanics, Carl S. Helrich, 2009, Springer.
- An Introduction to Statistical Mechanics & Thermodynamics, R.H. Swendsen, 2012, Oxford Univ. Press.
- Statistical Mechanics - an elementary outline, A. Lahiri, 2008, Universities Press.

Statistical Mechanics (Practical)

Paper: PHS-A-CC-6-14-P **Credits: 2**

List of Practicals

1. Computational analysis of the behavior of a collection of particles in a box that satisfy Newtonian mechanics and interact via the Lennard-Jones potential, varying the total number of particles N and the initial conditions:
   (a) Study of local number density in the equilibrium state (i) average; (ii) fluctuations
   (b) Study of transient behavior of the system (approach to equilibrium)
   (c) Relationship of large N and the arrow of time
   (d) Computation of the velocity distribution of particles for the system and comparison with the Maxwell velocity distribution
   (e) Computation and study of mean molecular speed and its dependence on particle mass
   (f) Computation of fraction of molecules in an ideal gas having speed near the most probable speed
2. Computation of the partition function $Z(\beta)$ for examples of systems with a finite number of single particle levels (e.g., 2 level, 3 level, etc.) and a finite number of non-interacting particles N under Maxwell-Boltzmann, Fermi-Dirac and Bose- Einstein statistics:

(a) Study of how $Z(\beta)$, average energy $\langle E \rangle$, energy fluctuation ΔE, specific heat at constant volume C_v, depend upon the temperature, total number of particles N and the spectrum of single particle states.

(b) Ratios of occupation numbers of various states for the systems considered above

(c) Computation of physical quantities at large and small temperature T and comparison of various statistics at large and small temperature T.

3. Plot Planck's law for Black Body radiation and compare it with Raleigh-Jeans Law at high temperature and low temperature.

4. Plot Specific Heat of Solids (a) Dulong-Petit law, (b) Einstein distribution function, (c) Debye distribution function for high temperature and low temperature and compare them for these two cases.

5. Plot the following functions with energy at different temperatures

(a) Maxwell-Boltzmann distribution

(b) Fermi-Dirac distribution

(c) Bose-Einstein distribution

Reference Books

- Elementary Numerical Analysis, K.E.Atkinson, 3 rd Edn . 20 07 , Wiley India Edition

- Statistical Mechanics, R.K. Pathria, Butterworth Heinemann: 2nd Ed., 1996, Oxford University Press.

- Introduction to Modern Statistical Mechanics, D. Chandler, Oxford University Press, 1987

- Thermodynamics, Kinetic Theory and Statistical Thermodynamics, Francis W. Sears and Gerhard L. Salinger, 1986, Narosa.

- Modern Thermodynamics with Statistical Mechanics, Carl S. Helrich, 2009, Springer

- Statistical and Thermal Physics with computer applications, Harvey Gould and Jan Tobochnik, Princeton University Press, 2010.

- Simulation of ODE/PDE Models with MATLAB, OCTAVE and SCILAB: Scientific and Engineering Applications: A. Vande Wouwer, P. Saucez, C. V. Fernandez. 2014 Springer ISBN: 978-3319067896

3 Syllabi for Discipline Specific Elective Courses (Honours)

3.1 DSE-A1: Advanced Mathematical Methods - I

Advanced Mathematical Methods - I - (Theory)

Paper: PHS-A-DSE-A1-TH **Credits: 5 (+1 for Tutorial)**

1. Preliminaries

   (a) Set, Logical Connectivities, Proof and Function: Notion of set and basic set algebra (Venn diagram should not be used to do set algebra). Definition of OR, AND, NOT and IF-THEN. Example of direct proof, proof by contrapositivity and contradiction. Vacuous proof (as for example null set is a subset of every set).

   (b) Definition of function (distinction should be made between function f and the value of the function $f(x)$ of function f at x). For real or complex valued function definition of zeros of a function and Zero function. Equality of functions. Example of function. Constant function (Mention the fact that function is neither a dependence nor an expression), Dirichlet function (Mention the fact that it does not have any graph) and other examples of standard real and complex valued functions.

   (c) Mathematical Induction (Mention that it requires proof) and its applications.

2. Real Numbers and Complex Numbers

   (a) Axiomatic description of real number, Few applications of axioms to show its power (as for example prove $a.0 = 0$, $a(-b) = -(ab)$ $1 > 0$,etc.). Distinction between real or finite number and infinity and also between undefined quantity (as for example $a/0$) and infinity. Complex numbers (Mention the fact that they are two dimensional vectors as Real numbers are one dimensional vectors and unlike real numbers complex numbers do not admit ordering and finally beyond complex number there is only one infinity not two).

   (b) Sequence, Series and Power Series: Definition of sequence and series (Mention the fact that sums in the series are not real sum but limit of finite sums; they actually mimic some of the properties of actual sum). Limit superior and Limit inferior of a sequence. Convergence of a sequence (Stress should be given on $\epsilon - N$ definition of convergence and show proof of few elementary sequences directly from $\epsilon - N$ definition), Power series, Example of power series, Infinite G.P. series, Uniform convergence of power series, example and Weierstrass M-test (Also mention the fact for uniform convergence of a power series we can differentiate or integrate a power series term by

term), Zero power series and equality of two power series. Radius of convergence of a power series mentioning its relation with the Limit Superior of its coefficients.

3. Basics of Calculus

   (a) Differential Calculus in one variable: Definition of limit (Stress should be given on epsilon-delta definition and show proof of some standard limits using epsilon-delta definition, also mention the fact that limiting value of a function when x approaches a does not depend at all on $f(a)$). Definition of Continuity (Mention the fact that if function is continuous at a and $f(a) > 0$, then there exists an open interval around a where function is entirely positive). Definition of derivative (Emphasis given on the first principle and mention the fact that for any arbitrary curve derivative actually defines tangent i.e. we define derivative via tangent). Rolle's Theorem and Mean value Theorem of Differential Calculus (with proof) and its application.

   (b) Integral Calculus in one variable: Definition of Anti derivative and Riemann (or definite) integral. Fundamental Theorem of Integral Calculus (With proof, mention the fact that although they are different, but we use one of them to calculate another). Riemann integral defines area enclosed by arbitrary curve. Mention sufficient conditions for integrability (as for example continuity or piece-wise continuity or even when set of points of discontinuity is countable, the function is integrable). Mean Value Theorem of Integral Calculus (with proof) and its applications.

4. Linear Algebra.

   (a) Abstract Systems. Binary Operations and Relations. Introduction to Groups and Fields. Vector Spaces over Real and Complex Fields. Subspaces. Homomorphism and Isomorphism of Vector Spaces. Linear Independence and Dependence of Vectors. Completeness of a set of vectors. Basis of a vector space. Replacement theorem - uniqueness of cardinality of different bases - Dimensions of a Vector Space. Change of basis. Isomorphism of every n - dimensional vector space with $\mathbb{C}^n$ - basis dependence of this isomorphism.

   (b) Inner products Space. Norm (defined in terms of inner product). Orthogonality. Orthogonal and Orthonormal sets. Orthonormal basis. Change of orthonormal basis. Gram-Schmidt orthogonalization - proof that an orthonormal basis will always exist. Schwarz inequality. Linear functionals on a vector space. Addition and Multiplication by scalars on linear functionals. Dual Space. Bra and Ket vectors and the Bra-Ket notation. Dual Basis. Construction of bra from ket and vice-versa.

   (c) Linear Transformations and Linear Operators. Consequences of linearity: Specification of the action of an operator on a basis defines the

action on the whole space - Representation of Linear Operators by Matrices. Transformation of representations under change of basis. Algebra of Linear Operators. Singular and Non-singular operators. The Adjoint or Hermitian conjugate of an operator. Hermitian, Orthogonal and Unitary operators. Projection operators.

(d) Eigenvalues and Eigenvectors of an operator. Degeneracy and Eigen spaces. Algebraic and Geometric multiplicity of eigenvalues. Diagonalization and Diagonalizability. Normal operators. Eigen properties of Hermitian and Unitary operators. Commuting operators and its relation to simultaneous diagonalizability. Complete sets of commuting operators.

(e) Tensor Products of Inner product spaces. Tensor products of vectors and operators. Extensions of operators to product spaces.

Reference Books

- *Calculus Volume I and II, Tom Apostol, John Wiley and Sons Inc.*
- *Bartle and Sherbert, Introduction to Real Analysis, Third edition, Wiley-India |item Complex Analysis, V.L Ahlfors, McGraw-Hill Inc.*
- *Finite Dimensional Vector Spaces, P. R.Halmos, Springer.*
- *Introduction To Matrices And Linear Transformations, D.T. Finkbeiner, Courier Corporation.*
- Linear Algebra, S. Lipschutz and M.L.Lipson, Schaums Outline Series, 2009 McGraw Hill.

3.2 DSE-A1: Communication Electronics

Communication Electronics - (Theory)

Paper: PHS-A-DSE-A1-TH **Credits: 4**

1. Electronic communication

   (a) Introduction to communication – means and modes. Need for modulation. Block diagram of an electronic communication system. Brief idea of frequency allocation for radio communication system in India (TRAI). Electromagnetic communication spectrum, band designations and usage. Channels and base-band signals. Concept of Noise, signal-to-noise (S/N) ratio.

2. Analog Modulation

   (a) Amplitude Modulation, modulation index and frequency spectrum. Generation of AM (Emitter Modulation), Amplitude Demodulation

(diode detector), Concept of Single side band generation and detection. Frequency Modulation (FM) and Phase Modulation (PM), modulation index and frequency spectrum, equivalence between FM and PM, Generation of FM using VCO, FM detector (slope detector), Qualitative idea of Super heterodyne receiver.

3. Analog Pulse Modulation

   (a) Channel capacity, Sampling theorem, Basic Principles- PAM, PWM, PPM, modulation and detection technique for PAM only, Multiplexing.

4. Digital Pulse Modulation

   (a) Need for digital transmission, Pulse Code Modulation, Digital Carrier Modulation Techniques, Sampling, Quantization and Encoding. Concept of Amplitude Shift Keying (ASK), Frequency Shift Keying (FSK).

5. Introduction to Communication and Navigation systems:

   (a) Satellite Communication– Introduction, need, Geosynchronous satellite orbits geostationary satellite advantages of geostationary satellites. Satellite visibility, transponders (C - Band), path loss, ground station, simplified block diagram of earth station. Uplink and downlink.

   (b) Mobile Telephony System – Basic concept of mobile communication, frequency bands used in mobile communication, concept of cell sectoring and cell splitting, SIM number, IMEI number, need for data encryption, architecture (block diagram) of mobile communication network, idea of GSM, CDMA, TDMA and FDMA technologies, simplified block diagram of mobile phone handset, 2G, 3G and 4G concepts (qualitative only). GPS navigation system (qualitative idea only).

Reference Books

- Electronic Communications, D. Roddy and J. Coolen, Pearson Education India.
- Advanced Electronics Communication Systems- Tomasi, 6th edition, Prentice Hall.
- Electronic Communication systems, G. Kennedy, 3rd Edn, 1999, Tata McGraw Hill.
- Principles of Electronic communication systems – Frenzel, 3rd edition, McGraw Hill

- Communication Systems, S. Haykin, 2006, Wiley India
- Electronic Communication system, Blake, Cengage, 5th edition.
- Wireless communications, Andrea Goldsmith, 2015, Cambridge University Press

Communication Electronics - (Practical)

Paper: PHS-A-DSE-A1-P **Credits: 2**

List of Practicals

1. To design an Amplitude Modulator using Transistor
2. To study envelope detector for demodulation of AM signal
3. To study FM - Generator and Detector circuit
4. To study AM Transmitter and Receiver
5. To study FM Transmitter and Receiver
6. To study Time Division Multiplexing (TDM)
7. To study Pulse Amplitude Modulation (PAM)

Reference Books

- Electronic Communication systems, G. Kennedy, 1999, Tata McGraw Hill.
- Electronic Communication system, Blake, Cengage, 5th edition.

3.3 DSE-A2: Astronomy and Astrophysics

Astronomy and Astrophysics - (Theory)

Paper: PHS-A-DSE-A2-TH **Credits: 5 (+1 for Tutorial)**

1. Astronomical Scales Astronomical Distance.

   (a) Mass and Time, Scales, Brightness, Radiant Flux and Luminosity, Measurement of Astronomical Quantities Astronomical Distances, Stellar Radii, Masses of Stars, Stellar Temperature. Basic concepts of positional astronomy: Celestial Sphere, Geometry of a Sphere, Spherical Triangle, Astronomical Coordinate Systems, Geographical Coordinate Systems, Horizon System, Equatorial System, Diurnal Motion of the Stars, Conversion of Coordinates. Measurement of Time, Sidereal Time, Apparent Solar Time, Mean Solar Time, Equation of Time, Calendar. Basic Parameters of Stars: Determination

of Distance by Parallax Method; Brightness, Radiant Flux and Luminosity, Apparent and Absolute magnitude scale, Distance Modulus; Determination of Temperature and Radius of a star; Determination of Masses from Binary orbits; Stellar Spectral Classification, Hertzsprung-Russell Diagram.

2. Astronomical techniques

   (a) Basic Optical Definitions for Astronomy (Magnification Light Gathering Power, Resolving Power and Diffraction Limit, Atmospheric Windows), Optical Telescopes (Types of Reflecting Telescopes, Telescope Mountings, Space Telescopes, Detectors and Their Use with Telescopes (Types of Detectors, detection Limits with Telescopes).

3. Physical principles

   (a) Gravitation in Astrophysics (Virial Theorem, Newton versus Einstein), Systems in Thermodynamic Equilibrium.

4. The sun and solar family

   (a) The sun (Solar Parameters, Solar Photosphere, Solar Atmosphere, Chromosphere. Corona, Solar Activity, Basics of Solar Magnetohydrodynamics. Helioseismology). The solar family (Solar System: Facts and Figures, Origin of the Solar System: The Nebular Model, Tidal Forces and Planetary Rings, Extra-Solar Planets. Stellar spectra and classification Structure (Atomic Spectra Revisited, Stellar Spectra, Spectral Types and Their Temperature Dependence, Black Body Approximation, H R Diagram, Luminosity Classification). Main sequence, red giants and white dwarfs, Chandrashekhar mass limit, possibility of Neutron star.

5. The milky way

   (a) Basic Structure and Properties of the Milky Way, Nature of Rotation of the Milky Way (Differential Rotation of the Galaxy and Oort Constant, Rotation Curve of the Galaxy and the Dark Matter, Nature of the Spiral Arms), Stars and Star Clusters of the Milky Way, Properties of and around the Galactic Nucleus.

6. Galaxies

   (a) Galaxy Morphology, Hubble's Classification of Galaxies, Elliptical Galaxies (The Intrinsic Shapes of Elliptical, de Vaucouleurs Law, Stars and Gas). Spiral and Lenticular Galaxies (Bulges, Disks, Galactic Halo) The Milky Way Galaxy, Gas and Dust in the Galaxy, Spiral Arms.

7. Large scale structure & expanding universe

   (a) Cosmic Distance Ladder (An Example from Terrestrial Physics, Distance Measurement using Cepheid Variables), Hubble's Law (Distance-Velocity Relation), Clusters of Galaxies (Virial theorem and Dark Matter).

Reference Books

- Modern Astrophysics, B.W. Carroll & D.A. Ostlie, Addison-Wesley Publishing Co.
- Introductory Astronomy and Astrophysics, M. Zeilik and S.A. Gregory, 4 th Edition, Saunders College Publishing.
- The physical universe: An introduction to astronomy, F.Shu, Mill Valley: University Science Books.
- Fundamentals of Astronomy (Fourth Edition), H. Karttunen et al. Springer
- K.S. Krishnasamy, 'Astro Physics a modern perspective,' Reprint, New Age International (p) Ltd, New Delhi,2002.
- Baidyanath Basu, 'An introduction to Astro physics', Second printing, Prentice - Hall of India Private limited, New Delhi, 2001.
- Textbook of Astronomy and Astrophysics with elements of cosmology, V.B. Bhatia, Narosa Publication

3.4 DSE-A2: Advanced Dynamics

Advanced Dynamics - (Theory)

Paper: PHS-A-DSE-A2-TH **Credits: 4**

1. Small Amplitude Oscillations

   (a) Minima of potential energy and points of stable equilibrium, expansion of the potential energy around a minimum, small amplitude oscillations about the minimum, normal modes of oscillations example of N identical masses connected in a linear fashion to (N -1) - identical springs.

2. Dynamical Systems

   (a) Definition of a continuous first order dynamical system. The idea of phase space, flows and trajectories. Simple mechanical systems as dynamical systems: the free particle, particle under uniform gravity, simple and damped harmonic oscillator, pendulum. Sketching flows and trajectories in phase space; sketching variables as functions of time, relating the equations and pictures to the underlying

physical intuition. Other examples of dynamical systems – In Biology: Population models e.g. exponential growth and decay, logistic growth, species competition, predator-prey dynamics, simple genetic circuits In Chemistry: Rate equations for chemical reactions e.g. auto catalysis, bistability In Economics: Examples from game theory. Illustrative examples from other disciplines. Fixed points, attractors, stability of fixed points, basin of attraction, notion of qualitative analysis of dynamical systems, with applications to the above examples. Computing and visualizing trajectories on the computer using software packages. Discrete dynamical systems. The logistic map as an example.

3. Introduction to Chaos and Fractals

   (a) Examples of 2-dimensional billiard, Projection of the trajectory on momentum space. Sinai Billiard and its variants. Computational visualization of trajectories in the Sinai Billiard. Randomization and ergodicity in the divergence of nearby phase space trajectories, and dependence of time scale of divergence on the size of obstacle. Electron motion in mesoscopic conductors as a chaotic billiard problem. Other examples of chaotic systems; visualization of their trajectories on the computer. Self-similarity and fractal geometry: Fractals in nature – trees, coastlines, earthquakes, etc. Need for fractal dimension to describe self-similar structure. Deterministic fractal vs. self-similar fractal structure. Fractals in dynamics – Serpinski gasket and DLA. Chaos in nonlinear finite-difference equations- Logistic map: Dynamics from time series. Parameter dependence- steady, periodic and chaos states. Cobweb iteration. Fixed points. Defining chaos- aperiodic, bounded, deterministic and sensitive dependence on initial conditions. Period- Doubling route to chaos. Nonlinear time series analysis and chaos characterization: Detecting chaos from return map. Power spectrum, autocorrelation, Lyapunov exponent, correlation dimension.

Reference Books

- Classical Mechanics: A Course of Lectures. A.K. Raychaudhuri, 1983, Oxford University Press.
- Mechanics, L. D. Landau and E. M. Lifshitz, 1976, Pergamon.
- Classical Mechanics, P.S. Joag, N.C. Rana, 1st Edn., McGraw Hall.
- Nonlinear Dynamics and Chaos, S.H. Strogatz, Levant Books, Kolkata, 2007
- Understanding Nonlinear Dynamics, Daniel Kaplan and Leon Glass, Springer.Classical Mechanics, H.Goldstein, C.P. Poole, J.L. Safko, 3rd Edn. 2002, Pearson Education.

Advanced Dynamics - (Practical)

Paper: PHS-A-DSE-A2-P **Credits: 2**

List of Practicals

1. To draw the phase portrait of damped harmonic oscillator using numerical techniques.
2. To draw the phase portrait of a pendulum with different values of energy using numerical techniques.
3. To study logistic growth population model for different parameter values drawing cobweb diagrams (few steps).
4. To study the phenomenon of chaos in logistic growth model using simple computer programs and to estimate the corresponding Lyapunov exponent.
5. Computational visualization of trajectories in the Sinai Billiard.
6. Visualization of fractal nature of the chaotic attractors in logistic map by numerically generating the orbit diagram fractal.
7. Computational visualization of formations of a self-similar fractal structure such as middle third cantor set.

Suggested Demonstrations in Class

1. Motion of a pendulum with large amplitude and the dependence of its time period on the amplitude.
2. Motion of a double pendulum with small amplitudes and large amplitudes and appearance of its irregular (chaotic) behaviour.
3. Computational visualization of fractal formations of Fractals in nature -- trees, coastlines, earthquakes.

Reference Books

- Nonlinear Dynamics and Chaos, Steven H. Strogatz, Levant Books, Kolkata, 2007.
- Chaos An Introduction to Dynamical Systems, K. T. Alligood, T. D. Sauer and J. A. Yorke, Springer.
- Understanding Nonlinear Dynamics, Daniel Kaplan and Leon Glass, Springer.
- Simulation of ODE/PDE Models with MATLAB, OCTAVE and SCILAB: Scientific and Engineering Applications: A. Vande Wouwer, P. Saucez, C. V. Fernández. 2014 Springer ISBN: 978-3319067896

- Scilab by example : M. Affouf, 2012, ISBN: 978-1479203444
- Scilab Image Processing : L.M.Surhone . 2010, Betascript Pub., ISBN: 978-6133459274

3.5 DSE-B1: Advanced Mathematical Methods - II

Advanced Mathematical Methods - II - (Theory)

Paper: PHS-A-DSE-B1-TH **Credits: 5 (+1 for Tutorial)**

1. Tensors
   (a) *Cartesian Tensors.* Transformation of Co-ordinates. Einstein's Summation Convention. Relation between Direction Cosines. Tensors. Algebra of Tensors. Sum, Difference and Product of Two Tensors. Contraction. Quotient Law of Tensors. Symmetric and Anti- symmetric Tensors. Invariant Tensors: Kronecker and Alternating Tensors. Association of Antisymmetric Tensor of Order Two and Vectors. Vector Algebra and Calculus using Cartesian Tensors: Scalar and Vector Products, Scalar and Vector Triple Products. Differentiation. Gradient, Divergence and Curl of Tensor Fields. Vector Identities. Isotropic Tensors. Tensorial Character of Physical Quantities. Moment of Inertia Tensor. Stress and Strain Tensors: Symmetric Nature. Elasticity Tensor. Generalized Hooke's Law. Electric Susceptibility tensor.
   (b) *General Tensors.* Transformation of Co-ordinates. Minkowski Space. Contravariant & Covariant Vectors. Contravariant, Covariant and Mixed Tensors. Kronecker Delta and Permutation Tensors. Algebra of Tensors. Sum, Difference & Product of Two Tensors. Contraction. Quotient Law of Tensors. Symmetric and Anti- symmetric Tensors. Metric Tensor.
2. Group Theory
   (a) Groups: Elementary properties of groups, uniqueness of Identity, Inverse, Rearrangement theorem. Conjugate relations, Classes, Subgroup, Invariant Subgroups, Cosets, Coset multiplication, Factor Groups. Centre of a group. Cyclic group, Permutation groups and Transformation Groups. Homomorphism and Isomorphism of groups, Kernel.
   (b) Matrix Representations of Groups Reducible and Irreducible representations. Schur's lemma. Orthogonality theorems. Character tables and their uses.
   (c) Lie Groups: Definition using metric associated with faithful finite dimensional matrix representation. Connected component and Connected Lie group. Compact Lie group.

(d) Lie Algebra: Definition, Lie Product and Structure constants. Lie Subalgebra, Invariant Lie Subalgebra. Homomorphism and Isomorphism of Lie Algebras. Representations of Lie Algebras.

(e) Connection of Lie Groups with Lie Algebra. The matrix exponential and its properties. Fundamental theorem of Lie Algebra. Analytic curves and Tangent vectors in Lie Groups. One parameter Subgroups and the exponential map connection. Special cases of connected and compact Lie groups. Constructing representations of Lie Algebras using corresponding analytic representations of Lie Groups.

(f) SO(3), SU(2) and SU(3) groups as examples.

Reference Books

- Mathematical Methods for Physicists: Weber and Arfken, 2005, Academic Press.
- Mathematical Methods for Physicists: A Concise Introduction: Tai L. Chow, 2000, Cambridge Univ. Press.
- Elements of Group Theory for Physicists by A. W. Joshi, 1997, John Wiley.
- Group Theory and its Applications to Physical Problems by Morton Hamermesh, 1989, Dover.
- Group Theory in Physics, Volume I & II, J.F.Cornwell, Academic Press, 1984.
- Introduction to Mathematical Physics: Methods & Concepts: Chun Wa Wong, 2012, Oxford University Press.

3.6 DSE-B1: Nuclear and Particle Physics

Nuclear and Particle Physics - (Theory)

Paper: PHS-A-DSE-B1-TH **Credits: 5 (+1 for Tutorial)**

1. Recapitulation of general properties of nuclei, nuclear models and radioactivity.

2. Nuclear Reactions

   (a) Types of Reactions, Conservation Laws, kinematics of reactions, Q-value, reaction rate, reaction cross section, Concept of compound and direct Reaction, resonance reaction, Coulomb scattering (Rutherford scattering).

3. Interaction of Nuclear Radiation with matter

   (a) Energy loss due to ionization (Bethe- Block formula), energy loss of electrons, Cerenkov radiation. Gamma ray interaction through matter, photoelectric effect, Compton scattering, pair production, neutron's interaction with matter.

4. Detector for Nuclear Radiations

   (a) Gas detectors: estimation of electric field, mobility of particle, for ionization chamber and GM Counter. Basic principle of Scintillation Detectors and construction of photo-multiplier tube (PMT). Semiconductor Detectors (Si and Ge) for charge particle and photon detection (concept of charge carrier and mobility), neutron detector.

5. Particle Accelerators

   (a) Accelerator facility available in India: Van-de Graaff generator (Tandem accelerator), Linear accelerator, Cyclotron, Synchrotrons.

6. Particle Physics

   (a) Fundamental particles and their families. Fundamental particle-interactions and their basic features. Symmetries and Conservation Laws: energy and momentum, angular momentum, parity, baryon number, Lepton number, Isospin, Strangeness and charm, concept of quark model, color quantum number and gluons. Quark structure of hadrons.

Reference Books

- Introductory nuclear Physics by Kenneth S. Krane (Wiley India Pvt. Ltd., 2008).
- Concepts of nuclear physics by Bernard L. Cohen. (Tata Mcgraw Hill, 1998).
- Introduction to the physics of nuclei & particles, R.A. Dunlap. (Thomson Asia, 2004).
- Introduction to High Energy Physics, D.H. Perkins, Cambridge Univ. Press.
- Introduction to Elementary Particles, D. Griffith, John Wiley & Sons.
- Quarks and Leptons, F. Halzen and A.D. Martin, Wiley India, New Delhi.
- Basic ideas and concepts in Nuclear Physics - An Introductory Approach by K. Heyde (IOP- Institute of Physics Publishing, 2004).
- Radiation detection and measurement, G.F. Knoll (John Wiley & Sons, 2000).

- Physics and Engineering of Radiation Detection, Syed Naeem Ahmed (Academic Press, Elsevier, 2007).
- Theoretical Nuclear Physics, J.M. Blatt & V.F.Weisskopf (Dover Pub.Inc., 1991).

3.7 DSE-B2: General Relativity

General Relativity - (Theory)

Paper: PHS-B-DSE-B2-TH **Credits: 5 (+1 for Tutorial)**

1. Review of Special Relativity in Tensor Notation.
2. Non-Euclidean Geometry
   (a) Manifold - Working definition only.
   (b) Affine Space
      i. Parallel transport, Affine Connection and Affine Space. Affine flatness. Covariant derivative of a vector, tensor. Riemann Tensor. Vanishing Riemann Tensor as a characterization of affine flatness (statement only) - Riemann Tensor as an intrinsic characterization of curvature in Affine space. Affine geodesics.
   (c) Riemann space
      i. Metric and Riemann Space. Metric flatness.
      ii. Riemann space with Affine Connection: Demonstration that requirement of preservation of lengths and angles under parallel transport in a Riemann space leads to a unique Connection called the Metric Connection or Christoffel symbols. Vanishing covariant derivative of the metric as a necessary and sufficient condition for the the affine connection to be the metric connection.
      iii. Metric Geodesics. Demonstrating that for the metric connection, metric geodesics are affine geodesics.
      iv. Vanishing Riemann Tensor (now defined in terms of metric connection) as a characterization of metric flatness (statement only) - Riemann Tensor as an intrinsic characterization of curvature also in Riemann space.
3. General Relativity
   (a) Equation of motion (E.O.M.) of a test particle in force free motion in an inertial reference frame. The geodesic equation as E.O.M. of a test particle in force free motion in a non-inertial reference frame. Time-like and light-like geodesics. Observation that fictitious forces are encoded in the metric connection. Local indistinguishability of the fictitious forces from a gravitational field. Principle of equivalence. Principle of General Covariance.

(b) Encoding gravity in the Metric Connection - necessity of a curved space-time.

(c) Reduction of the Geodesic equation of motion to Newton's E.O.M for static, weak fields (quasi-minkowski metric) in the non-relativistic limit by identification of a metric component with the gravitational potential. Gravitational Red Shift.

(d) Einstein's Field Equations:

i. Requirements on the Field equations: i) it is a tensor equation ii) it admits minkowski metric as a particular solution iii) it is quasi-linear (linear in the 2nd derivative in metric) iii) it has the correct classical limit (i.e., it reduces to Poisson's equation).

ii. The Ricci tensor and the field equations in free space: Weakening the condition for gravity free space - vanishing Curvature tensor to vanishing Ricci tensor.

iii. Field equation in the presence of matter: Energy-momentum tensor as the source term. Problem with non-vanishing divergence of the Ricci Tensor. Ricci scalar, Einstein tensor and resolution of the divergence problem. Einstein's field equations and the Cosmological constant.

4. Consequences of Einstein's Equation

(a) Schwarzschild solution and the Schwarzschild metric (to be assumed). Recovery of Newtonian Gravity in the static, weak-field and non relativistic limit. Bending of stellar light near massive celestial objects. Schwarchild black hole and event horizon.

Reference Books

- The Classical Theory of Fields, L.D.Landau and E.M.Lifshitz, Butterworth-Heinemann.
- Introduction to General Relativity, R. Adler, M. Bazin and M. Schiffer, McGraw-Hill Kogakusha Ltd.
- A first Course in General Relativity, B. Schutz, Cambridge University Press.
- Introducing Einstein's Relativity, Ray D'Inverno, Clarendon Press - Oxford.

3.8 DSE-B2: Nano Materials and Applications

Nano Materials and Applications - (Theory)

Paper: PHS-A-DSE-B2-TH **Credits: 5 (+1 for Tutorial)**

1. Nanoscale Systems

   (a) Length scales in physics, Nanostructures: 1D, 2D and 3D nanostructures (nanodots, thin films, nanowires, nanorods), Band structure and density of states of materials at nanoscale, Size Effects in nano systems, Quantum confinement: Applications of Schrodinger equation- Infinite potential well, potential step, potential box, quantum confinement of carriers in 3D, 2D, 1D nanostructures and its consequences.

2. Synthesis of Nanostructure Materials

   (a) Top down and Bottom up approach, Photolithography. Ball milling. Gas phase condensation. Vacuum deposition. Physical vapor deposition (PVD): Thermal evaporation, E-beam evaporation, Pulsed Laser deposition. Chemical vapor deposition (CVD). Sol-Gel. Electro deposition. Spray pyrolysis. Hydrothermal synthesis. Preparation through colloidal methods. MBE growth of quantum dots.

3. Characterization

   (a) X-Ray Diffraction. Optical Microscopy. Scanning Electron Microscopy. Transmission Electron Microscopy. Atomic Force Microscopy. Scanning Tunneling Microscopy.

4. Optical Properties

   (a) Coulomb interaction in nanostructures. Concept of dielectric constant for nanostructures and charging of nanostructure. Quasi-particles and excitons. Excitons in direct and indirect band gap semiconductor nanocrystals. Quantitative treatment of quasi-particles and excitons, charging effects. Radiative processes: General formalization-absorption, emission and luminescence. Optical properties of heterostructures and nanostructures.

5. Electron Transport

   (a) Carrier transport in nanostrucutures. Coulomb blockade effect, thermionic emission, tunneling and hoping conductivity. Defects and impurities: Deep level and surface defects.

6. Applications

   (a) Applications of nanoparticles, quantum dots, nanowires and thin films for photonic devices (LED, solar cells). Single electron transfer devices (no derivation). CNT based transistors. Nanomaterial Devices: Quantum dots heterostructure lasers, optical switching and optical data storage. Magnetic quantum well; magnetic dots -magnetic data storage. Micro Electromechanical Systems (MEMS), Nano Electromechanical Systems (NEMS).

Reference Books

- C.P. Poole, Jr. Frank J. Owens, Introduction to Nanotechnology (Wiley India Pvt. Ltd.).
- S.K. Kulkarni, Nanotechnology: Principles & Practices (Capital Publishing Company).
- K.K. Chattopadhyay and A. N. Banerjee, Introduction to Nanoscience and Technology (PHI Learning Private Limited).
- Richard Booker, Earl Boysen, Nanotechnology (John Wiley and Sons).
- M. Hosokawa, K. Nogi, M. Naita, T. Yokoyama, Nanoparticle Technology Handbook (Elsevier, 2007).
- Introduction to Nanoelectronics, V.V. Mitin, V.A. Kochelap and M.A. Stroscio, 2011, Cambridge University Press.
- Bharat Bhushan, Springer Handbook of Nanotechnology (Springer-Verlag, Berlin, 2004).

4 Syllabi for Skill Enhancement Courses (Honours)

4.1 SEC-A: Basics of Programming and Scientific Word Processing

Basics of Programming and Scientific Word Processing - (Theory)

Paper: PHS-A-SEC-A-TH **Credits: 2**

1. Elements of Programming
   (a) An overview computers: History of computers, overview of architecture of computer, compiler, assembler, machine language, high level language, object oriented language, programming language.
   (b) Algorithms and Flowcharts:
      i. Algorithm - definition, properties and development.
      ii. Flowchart - Concept of flowchart, symbols, guidelines, types.
2. Basic programming in C/FORTRAN
   (a) Constants, Variables and Data types.
   (b) Operation and Expressions - Arithmetic operators, relational operators, logical operators.
   (c) Managing input/output.
   (d) Decision Making and Branching.
   (e) Decision making and Looping.
   (f) Arrays : One-dimension, two-dimension and multidimensional arrays, declaration of arrays, initialization of one and multi-dimensional arrays.
   (g) User-defined Functions.
3. Visualization
   (a) Introduction to graphical analysis and its limitations. Introduction to Gnuplot. importance of visualization of computational and computational data, basic Gnuplot commands: simple plots, plotting data from a file, saving and exporting, multiple data sets per file, physics with Gnuplot (equations, building functions, user defined variables and functions), Understanding data with Gnuplot.
4. Scientific word processing:
   (a) Introduction to LaTeX TeX/LaTeX word processor, preparing a basic LaTeX file, Document classes, Preparing an input file for LaTeX, Compiling LaTeX File, LaTeX tags for creating different environments, Defining LaTeX commands and environments, Changing the type style, Symbols from other languages.

(b) Equation representation: Formulae and equations, Figures and other floating bodies, Lining in columns- Tabbing and tabular environment, Generating table of contents Bibliography and citation, Making an index and glossary, List making environments,

(c) Fonts, Picture environment and colors, errors.

Reference Books

- Introduction to Numerical Analysis, S.S. Sastry, 5th Edn., 2012, PHI Learning Pvt. Ltd.
- Computer Programming in Fortran 77". V. Rajaraman (Publisher: PHI).
- Schaum's Outline of Theory and Problems of Programming with Fortran, S Lipschutz and A Poe, 1986Mc-Graw Hill Book Co.
- Computational Physics: An Introduction, R.C. Verma, et al. New Age International Publishers, New Delhi(1999)
- E. Balagurnsamy, Programming in ANSI C, Tata McGraw Hill, 2004.
- C. Xavier, C-Language and Numerical Methods, New Age International.
- V. Rajaraman, Computer Oriented Numerical Methods, Prentice Hall of India, 1980.
- Gnuplot in action: understanding data with graphs, Philip K Janert, (Manning 2010).
- LaTeX–A Document Preparation System", Leslie Lamport (Second Edition, Addison- Wesley, 1994).

4.2 SEC-A: Electrical Circuits and Network Skills

Electrical Circuits and Network Skills - (Theory)

Paper: PHS-A-SEC-A-TH **Credits: 2**

1. Basic Electricity Principles

   (a) Voltage, Current, Resistance, and Power. Ohm's law. Series, parallel, and series-parallel combinations. AC Electricity and DC Electricity. Familiarization with multimeter, voltmeter and ammeter.

2. Understanding Electrical Circuits

   (a) Main electric circuit elements and their combination. Rules to analyze DC sourced electrical circuits. Current and voltage drop across the DC circuit elements. Single-phase and three-phase alternating current sources. Rules to analyze AC sourced electrical circuits. Real, imaginary and complex power components of AC source. Power factor. Saving energy and money.

3. Electrical Drawing and Symbols

   (a) Drawing symbols. Blueprints. Reading Schematics. Ladder diagrams. Electrical Schematics. Power circuits. Control circuits. Reading of circuit schematics. Tracking the connections of elements and identify current flow and voltage drop.

4. Generators and Transformers

   (a) DC Power sources. AC/DC generators. Inductance, capacitance, and impedance. Operation of transformers.

5. Electric Motors

   (a) Single-phase, three-phase & DC motors. Basic design. Interfacing DC or AC sources to control heaters & motors. Speed & power of ac motor.

6. Solid-State Devices

   (a) Resistors, inductors and capacitors. Diode and rectifiers. Components in Series or in shunt. Response of inductors and capacitors with DC or AC sources.

7. Electrical Protection

   (a) Relays. Fuses and disconnect switches. Circuit breakers. Overload devices. Ground-fault protection.Page 97 Grounding and isolating. Phase reversal. Surge protection. Interfacing DC or AC sources to control elements (relay protection device)

8. Electrical Wiring

   (a) Different types of conductors and cables. Basics of wiring - Star and delta connection. Voltage drop and losses across cables and conductors. Instruments to measure current, voltage, power in DC and AC circuits. Insulation. Solid and stranded cable. Conduit. Cable trays. Splices: wirenuts, crimps, terminal blocks, split bolts, and solder. Preparation of extension board.

Reference Books

- A text book in Electrical Technology - B L Theraja - S Chand & Co.
- A text book of Electrical Technology - A K Theraja.
- Performance and design of AC machines - M G Say ELBS Edn.

4.3 SEC-B: Computer Algebra System & Figure Drawing Skill

Computer Algebra System & Figure Drawing Skill - (Theory)

Paper: PHS-A-SEC-B-TH **Credits: 2**

1. Elementary symbolic computation using some computer algebra system (CAS) like Yacas or Maxima.
   (a) Arithmetic and other operations on numbers,
   (b) Calculus and elementary functions, Simplification of expressions, Solvers, Differential Equations.
   (c) Linear Algebra
   (d) Operations on polynomials
   (e) List operations
   (f) Predicates
   (g) Input/output and plotting
   (h) Probability and Statistics
   (i) Numerical methods using CAS
   (j) Physics specific applications
2. Figure generation using drawing tools like xfig/ latexdraw/ inkscape etc.
   (a) Drawing lines with/without arrows with different line styles.
   (b) Drawing curves with different line styles including brazier curves.
   (c) Drawing different types of shapes including circle, ellipse, polygons etc.
   (d) Changing figure properties like position, colour, orientation, size, shape, line properties, filling properties etc.
   (e) Grouping and ungrouping of figures.
   (f) Exporting the figure into different file formats.

Reference

- https://yacas.readthedocs.io/en/latest/reference_manual/
- The Maxima Book; Paulo Ney de Souza Richard J. Fateman Joel Moses Cliff Yapp; http://maxima.sourceforge.net/docs/maximabook/maximabook-19-Sept-2004.pdf.
- Get Started With Maxima: https://www.whoishostingthis.com/resources/maxima/
- Xfig user manual: http: //mcj.sourceforge.net/

- LaTeXDraw Manual: https://github.com/arnobl/latexdraw/wiki/Manual
- The Book of Inkscape: The Definitive Guide to the Free Graphics Editor (1st ed.), No Starch Press, p. 476, ISBN 1-59327-181-6
- https://www.youtube.com/watch?v=zUIOEXssTS

4.4 SEC-B: Renewable Energy and Energy Harvesting

Renewable Energy and Energy Harvesting - (Theory)

Paper: PHS-A-SEC-B-TH **Credits: 2**

1. Fossil fuels and Alternate Sources of energy
   (a) Fossil fuels and nuclear energy, their limitation, need of renewable energy, non-conventional energy sources. An overview of developments in Offshore Wind Energy, Tidal Energy, Wave energy systems, Ocean Thermal Energy Conversion, solar energy, biomass, biochemical conversion, biogas generation, geothermal energy tidal energy, Hydroelectricity.
2. Solar energy
   (a) Solar energy, its importance, storage of solar energy, solar pond, non-convective solar pond, applications of solar pond and solar energy, solar water heater, flat plate collector, solar distillation, solar cooker, solar green houses, solar cell, absorption air conditioning. Need and characteristics of photovoltaic (PV) systems, PV models and equivalent circuits, and sun tracking systems.
3. Wind Energy harvesting
   (a) Fundamentals of Wind energy, Wind Turbines and different electrical machines in wind turbines, Power electronic interfaces, and grid interconnection topologies.
4. Ocean Energy
   (a) Ocean Energy Potential against Wind and Solar, Wave Characteristics and Statistics, Wave Energy Devices. Tide characteristics and Statistics, Tide Energy Technologies, Ocean Thermal Energy, Osmotic Power, Ocean Bio-mass.
5. Geothermal Energy
   (a) Geothermal Resources, Geothermal Technologies.
6. Hydro Energy
   (a) Hydropower resources, hydropower technologies, environmental impact of hydro power sources.

7. Piezoelectric Energy harvesting

   (a) Introduction, Physics and characteristics of piezoelectric effect, materials and mathematical description of piezoelectricity, Piezoelectric parameters and modeling piezoelectric generators, Piezoelectric energy harvesting applications, Human power

8. Electromagnetic Energy Harvesting

   (a) Linear generators, physics mathematical models, recent applications

   (b) Carbon captured technologies, cell, batteries, power consumption.

   (c) Environmental issues and Renewable sources of energy, sustainability.

Reference Books

- Non-conventional energy sources - G.D Rai - Khanna Publishers, New Delhi.Solar energy - M P Agarwal - S Chand and Co. Ltd.
- Solar energy - Suhas P Sukhative Tata McGraw - Hill Publishing Company Ltd.
- Godfrey Boyle, "Renewable Energy, Power for a sustainable future", 2004, Oxford University Press, in association with The Open University.
- Dr. P Jayakumar, Solar Energy: Resource Assesment Handbook, 2009.
- J.Balfour, M.Shaw and S. Jarosek, Photovoltaics, Lawrence J Goodrich (USA).
- http://en.wikipedia.org/wiki/Renewable_energy.

Part II

Physics Syllabus : General Course

5 Syllabi for Core Courses (General)

These courses will also serve as Generic Elective (GE) courses for students who have honours in a subject other than Physics.

5.1 Semester - 1: Mechanics

Mechanics (Theory)

Paper: PHS-G-CC-1-1-TH **Credits: 4**

1. Mathematical Methods
   (a) Vector Algebra: Vectors as directed line segments. Addition of vectors and multiplication by a scalar. Scalar and vector products. Basis and representation of vectors.
   (b) Vector Analysis: Derivatives of a vector with respect to a parameter. Gradient, divergence and Curl. Vector integration, line, surface and volume integrals of vector fields. Gauss'-divergence theorem and Stoke's theorem of vectors (Statement only).
2. Laws of Motion
   (a) Laws of Motion: Frames of reference. Newton's Laws of motion. Dynamics of a system of particles. Conservation of momentum. Centre of Mass.
3. Work and Energy
   (a) Work-energy theorem. Conservative forces. Concept of Potential Energy. Conservation of energy.
4. Gravitation
   (a) Motion of a particle in a central force field. Conservation of angular momentum leading to restriction of the motion to a plane and constancy of areal velocity. Newton's Law of Gravitation. Kepler's Laws (statement only). Satellite in circular orbit and applications. Geosynchronous orbits. Basic idea of global positioning system (GPS). Weightlessness.
5. Oscillations
   (a) Simple harmonic motion. Differential equation of SHM and its solutions. Kinetic and Potential Energy, Total Energy and their time averages. Damped oscillations. Forced oscillations with harmonic forces. Compound pendulum.

6. Rotational Motion

   (a) Rotation of a rigid body about a fixed axis. Angular velocity and angular momentum. Moment of Inertia. Torque. Conservation of angular momentum.

7. Elasticity

   (a) Hooke's law - Stress-strain diagram. Elastic moduli-relation between elastic constants - Poisson's Ratio-Expression for Poisson's ratio in terms of elastic constants.

   (b) Twisting couple on a cylinder - Determination of Rigidity modulus by static torsion. Torsional pendulum.

   (c) Bending of beams.

   (d) Work done in stretching and work done in twisting a wire.

8. Surface Tension

   (a) Synclastic and anticlastic surface - Excess of pressure - Application to spherical drops and bubbles - variation of surface tension with temperature.

9. Viscosity

   (a) Rate flow of liquid in a capillary tube - Poiseuille's formula.

Reference Books

- University Physics. FW Sears, MW Zemansky and HD Young13/e, 1986. Addison- Wesley
- Mechanics Berkeley Physics course,v.1: Charles Kittel, et. Al. 2007, Tata McGraw- Hill.
- Physics - Resnick, Halliday & Walker 9/e, 2010, Wiley.
- Engineering Mechanics, Basudeb Bhattacharya, 2 nd edn., 2015, Oxford University Press.
- Physics for Degree Students (For B.Sc. 1st Year); C.L. Arora & P.S. Hemme; S.Chand Publishing.
- University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole.

Mechanics (Practical)

PHS-G-CC-1-1-P **Credits: 2**

List of Practicals

1. Determination of Moment of inertia of cylinder/bar about axis by measuring the time period, of the cradle and with body of known moment of Inertia.

2. Determination of Y modulus of a metal bar of rectangular cross section by the method of flexure.

3. Determination of rigidity modulus of wire by measuring the time period of torsional oscillation of a metal cylinder attached to it.

4. Determination of Moment of Inertia of a flywheel.

5. Determination gravitational acceleration, g using bar pendulum.

6. To determine the height of a building using sextant.

General Topic

1. Measurements of length (or diameter) using vernier caliper, screw gauge and travelling microscope.

2. To study the random error in observations.

Reference Books

- Advanced Practical Physics for students, B. L. Flint and H.T. Worsnop, 1971, Asia Publishing House

- Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers

- A Text Book of Practical Physics, I.Prakash & Ramakrishna, 11th Edn, 2011, Kitab Mahal

- Engineering Practical Physics, S.Panigrahi & B.Mallick, 2015, Cengage Learning India Pvt. Ltd.

- Practical Physics, G.L. Squires, 2015, 4th Edition, Cambridge University Press.

5.2 Semester - 2: Electricity and Magnetism

Electricity and Magnetism (Theory)

Paper: PHS-G-CC-2-2-TH **Credits: 4**

1. Electrostatics

   (a) Coulombs law. Principle of superposition. Electrostatic Field.

   (b) Divergence of the Electrostatic field. Flux, Gauss's theorem of electrostatics. Applications of Gauss theorem to find Electric field due to point charge, infinite line of charge, uniformly charged spherical shell and solid sphere, plane charged sheet, charged conductor.

   (c) Curl of the Electrostatic Field. Electric potential as line integral of electric field. Potential for a uniformly charged spherical shell and solid sphere. Calculation of electric field from potential. Electric potential and field due to an electric dipole. Electric dipole moment. Force and Torque on a dipole.

   (d) Conductors: Electric field and charge density inside and on the surface of a conductor. Force per unit area on the surface. Capacitance of a conductor. Capacitance an isolated spherical conductor. Parallel plate, spherical and cylindrical condenser. Energy per unit volume in electrostatic field.

   (e) Electric Fields inside matter: Electric Polarisation. Bound charges. Displacement vector. Gauss's theorem in dielectrics. Linear Dielectric medium. Electric Succeptibility and Permittivity. Parallel plate capacitor completely filled with dielectric.

2. Magnetism

   (a) Biot-Savart's law and the Lorentz force law. Application of Biot-Savart's law to determine the magnetic field of a straight conductor, circular coil, solenoid carrying current. Force between two straight current carrying wires.

   (b) Divergence of the magnetic field. Magnetic vector potential.

   (c) Curl of the magnetic field. Ampere's circuital law. Determination of the magnetic field of a straight current carrying wire. Potential and field due to a magnetic dipole. Magnetic dipole moment. Force and torque on a magnetic dipole.

   (d) Magnetic fields inside matter: Magnetization. Bound currents. The magnetic intensity - H. Linear media. Magnetic susceptibility and Permeability. Brief introduction of dia-, para- and ferro-magnetic materials.

3. Electromagnetic Induction

4. Ohms law and definition of E.M.F. Faraday's laws of electromagnetic induction, Lenz's law, self and mutual inductance, L of single coil, M of two coils. Energy stored in magnetic field.

5. Linear Network

   (a) Impedance of L, C, R and their combinations. Thevenin & Norton's Theorem. Maximum power transfer theorem and superposition theorem. Anderson's bridge.

6. Maxwell's Equations and Electromagnetic Wave Propagation

   (a) Equation of continuity of current, Displacement current, Maxwell's equations, Poynting vector, energy density in electromagnetic field, electromagnetic wave propagation through vacuum and isotropic dielectric medium, transverse nature of EM waves, Polarization of E.M. waves.

Reference Books

- Itroduction to Electrodynamics, David J Griffiths 3rd Edn, 1998, Benjamin Cummings.
- Electricity and Magnetism, Edward M. Purcell, 1986, McGraw-Hill Education.
- Electricity and Magnetism, J.H. Fewkes & J. Yarwood. Vol. I, 1991, Oxford Univ. Press.
- Electricity and Magnetism, D C Tayal, 1988, Himalaya Publishing House.
- University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole.
- Electricity and Magnetism; R.Murugeshan; S. Chand Publishing.

Electricity and Magnetism (Practical)

Paper: PHS-G-CC-2-2-P **Credits: 2**

List of Practicals

1. Determination of unknown resistance by Carey Foster method.
2. Measurement of a current flowing through a register using potentiometer.
3. Determination of the horizontal components of earths magnetic field.
4. Conversion of an ammeter to a voltmeter.

5. Conversion of a voltmeter to an Ammeter.

6. Verification of Thevenin & Norton theorem and superposition theorem.

General topics

1. Use a Multimeter for measuring (a) Resistances, (b) AC and DC Voltages, (c) DC Current, (d) Capacitances (e) Checking electrical fuses (f) circuit continuity check and (g) moving coil galvanometer (in dead beat and ballistic mode), etc.

Reference Books

- Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House
- A Text Book of Practical Physics, I.Prakash & Ramakrishna, 11th Ed., 2011, Kitab Mahal
- Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
- Engineering Practical Physics, S.Panigrahi and B.Mallick, 2015, Cengage Learning.
- A Laboratory Manual of Physics for undergraduate classes, D.P.Khandelwal, 1985, Vani Pub.

5.3 Semester - 3: Thermal Physics and Statistical Mechanics

Thermal Physics and Statistical Mechanics (Theory)

Paper: PHS-G-CC-3-3-TH **Credits: 4**

1. Laws of Thermodynamics

   (a) Thermodynamic Description of system: Zeroth Law of thermodynamics and temperature. First law and internal energy, conversion of heat into work, Various Thermodynamical Processes, Applications of First Law: General Relation between C_P and C_v, Work Done during Isothermal and Adiabatic Processes. Compressibility and Expansion Coefficients, Reversible and irreversible processes. Second law and Entropy, Carnot's cycle & Carnot's theorem, Entropy changes in reversible & irreversible processes, Entropy-temperature diagrams, Third law of thermodynamics, unattainability of absolute zero.

2. Thermodynamical Potentials

   (a) Enthalpy, Gibbs, Helmholtz and Internal Energy functions, Maxwell's relations and applications - Joule-Thompson Effect, Clausius- Clapeyron Equation, Expression for $(C_P - C_V)$, C_P/C_V, TdS equations.

3. Kinetic Theory of Gases

   (a) Derivation of Maxwell's law of distribution of velocities and its experimental verification, Mean free path (Zeroth Order), Transport Phenomena: Viscosity, Conduction and Diffusion (for vertical case), Law of equipartition of energy (no derivation) and its applications to specific heat of gases; mono-atomic and diatomic gases.

4. Theory of Radiation

   (a) Blackbody radiation, Spectral distribution, Concept of Energy Density, Derivation of Planck's law, Deduction of Wien's distribution law, Rayleigh- Jeans Law, Stefan Boltzmann Law and Wien's displacement law from Planck's law.

5. Statistical Mechanics

   (a) Phase space, Macrostate and Microstate. Ensemble - Ergodic hypothesis. PEAP, Entropy and Thermodynamic probability - Boltzmann hypothesis. Maxwell-Boltzmann law - distribution of velocity - Quantum statistics (qualitative discussion only) - Fermi-Dirac distribution law (statement only) - electron gas as an example of Fermi gas - Bose-Einstein distribution law (statement only) - photon gas as an example of Bose gas- comparison of three statistics.

Reference Books

- Thermal Physics, S. Garg, R. Bansal and C. Ghosh, 1993, Tata McGraw-Hill.
- A Treatise on Heat, Meghnad Saha, and B.N. Srivastava, 1969, Indian Press.
- Thermodynamics, Enrico Fermi, 1956, Courier Dover Publications.
- Heat and Thermodynamics, M.W.Zemasky and R. Dittman, 1981, McGraw Hill.
- Thermodynamics, Kinetic theory & Statistical thermodynamics, F.W.Sears and G.L. Salinger. 1988, Narosa.
- Heat, Thermodynamics and Statistical Physics; B. Lal, N. Subramanyam and P.S.Hemme; S.Chand Publishing.
- Thermal Physics, A. Kumar and S.P. Taneja, 2014, R. chand Publications.
- University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole.

Thermal Physics and Statistical Mechanics (Practical)

Paper: PHS-G-CC-3-3-P **Credits: 2**

List of Practicals

1. Determination of the coefficient of thermal expansion of a metalic rod using an optical lever.
2. Verification of Stefan's law of radiation by the measurement of voltage and current of a torch bulb glowing it beyond draper point.
3. Calibration of a thermocouple by direct measurement of the thermo emf using operational amplifier.
4. To determine the Coefficient of Thermal Conductivity of a bad conductor by Lee and Charlton's disc method.
5. To determine the Temperature Coefficient of Resistance by Platinum Resistance Thermometer (PRT) using constant current source.
6. Determination of the pressure coefficient of air using Jolly's apparatus.

Reference Books

- Advanced Practical Physics for students, B. L. Flint and H.T. Worsnop, 1971, Asia Publishing House.
- A Text Book of Practical Physics, I.Prakash & Ramakrishna, 11th Ed., 2011, Kitab Mahal.
- Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers.
- A Laboratory Manual of Physics for undergraduate classes, D. P. Khandelwal, 1985, Vani Pub.

5.4 Semester - 4: Waves and Optics

Waves and Optics (Theory)

Paper: PHS-G-CC-4-4-TH **Credits: 4**

1. Superposition of Two Collinear Harmonic oscillations
   (a) Linearity & Superposition Principle. (1) Oscillations having equal frequencies and (2) Oscillations having different frequencies (Beats).
2. Superposition of Two Perpendicular Harmonic Oscillation
   (a) Graphical and Analytical Methods. Lissajous Figures with equal an unequal frequency and their uses.

3. Wave Motion - General

   (a) Transverse waves on a string. Travelling and standing waves on a string. Normal Modes of a string. Group velocity, Phase velocity. Plane waves. Spherical waves, Wave intensity.

4. Sound

   (a) Review of SHM, damped & forced vibrations - resonance. Fourier's Theorem - Application to saw tooth wave and square wave. Intensity and loudness of sound - Decibels - Intensity levels. Musical notes - musical scale. Acoustics of buildings: Reverberation and time of reverberation - Absorption coefficient - Sabine's formula - measurement of reverberation time - Acoustic aspects of halls and auditoria.

5. Wave Optics - General

   (a) Electromagnetic nature of light. Definition and Properties of wave front. Huygens Principle.

6. Interference

   (a) Interference: Division of amplitude and division of wavefront. Young's Double Slit experiment. Lloyd's Mirror and Fresnel's Biprism. Phase change on reflection: Stoke's treatment. Interference in Thin Films: parallel and wedge-shaped films. Fringes of equal inclination (Haidinger Fringes); Fringes of equal thickness (Fizeau Fringes). Newton's Rings: measurement of wavelength and refractive index.

7. Michelson's Interferometer

   (a) Idea of form of fringes (no theory needed), Determination of wavelength, Wavelength difference, Refractive index, and Visibility of fringes.

8. Diffraction

   (a) Fraunhofer diffraction- Single slit; Double Slit. Multiple slits and Diffraction grating.

   (b) Fresnel Diffraction: Half-period zones. Zone plate. Fresnel Diffraction pattern of a straight edge, a slit and a wire using half-period zone analysis.

9. Polarization

10. Transverse nature of light waves. Plane polarized light - production and analysis. Circular and elliptical polarization. Optical activity.

Reference Books

- Fundamentals of Optics, F.A Jenkins and H.E White, 1976, McGraw-Hill.
- Principles of Optics, B.K. Mathur, 1995, Gopal Printing.
- University Physics. F.W. Sears, M.W. Zemansky and H.D. Young. 13/e, 1986. Addison-Wesley.
- Fundamentals of Optics, H.R. Gulati and D.R. Khanna, 1991, R. Chand Publications.
- Mechanics; D.S.Mathur and P.S.Hemme; S.Chand Publishing.

Waves and Optics (Practical)

Paper: PHS-G-CC-4-4-P **Credits: 2**

List of Practicals

1. Determination of the refractive index of material of a lens and that of a liquid using a convex lens and a plane mirror.
2. Determination of the focal length of a concave lens by auxiliary lens method.
3. Determination of the frequency of a tuning fork with the help of sonometer using $n - l$ curve.
4. Determination of radius of curvature / wavelength of a monochromatic / quasi monochromatic light using Newtons ring.
5. Measurement of the spacing between the adjacent slits in a grating by measuring $\sin\theta$ vs λ graph of a certain order of grating spectra.
6. Measurement of specific rotation of active solution (e.g., sugar solution) using polarimeter.

Reference Books

- Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House
- A Text Book of Practical Physics, I. Prakash & Ramakrishna, 11th Ed., 2011, Kitab Mahal
- Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
- A Laboratory Manual of Physics for undergraduate classes, D.P.Khandelwal, 1985, Vani Pub.

6 Syllabi for Discipline Specific Elective Courses (General)

6.1 DSE-A: Electronics and Instrumentation

Electronics and Instrumentation - (Theory)

Paper: PHS-G-DSE-A-TH **Credits: 4**

1. Semiconductor Devices and Amplifiers

   (a) Semiconductor Diodes: P and N type semiconductors. Barrier Formation in PN Junction Diode. Qualitative Idea of Current Flow Mechanism in Forward and Reverse Biased Diode. PN junction and its characteristics. Static and Dynamic Resistance. Principle and structure of (1) LEDs, (2) Photodiode, (3) Solar Cell.

   (b) Bipolar Junction transistors: n-p-n and p-n-p Transistors. Characteristics of CB, CE and CC Configurations. Active, Cutoff & Saturation regions Current gains α and β. Relations between α and β. Load Line analysis of Transistors. DC Load line & Q- point. Voltage Divider Bias Circuit for CE Amplifier. H-parameter, Equivalent Circuit. Analysis of single-stage CE amplifier using hybrid Model. Input & output Impedance. Current, Voltage and Power gains. Class A, B & C Amplifiers.

2. Operational Amplifiers

   (a) Characteristics of an Ideal and Practical Op-Amp (IC 741), Open-loop and closed- loop Gain. CMRR, concept of Virtual ground. Applications of Op-Amps: (1) Inverting and non-inverting Amplifiers, (2) Adder, (3) Subtractor, (4) Differentiator, (5) Integrator, (6) Zero crossing detector.

   (b) Sinusoidal Oscillators: Barkhausen's Criterion for Self-sustained Oscillations. Determination of Frequency of RC Oscillator.

3. Digital Circuits

   (a) Difference between Analog and Digital Circuits.

   (b) Binary Numbers. Decimal to Binary and Binary to Decimal Conversion.

   (c) AND, OR and NOT Gates (Realization using Diodes and Transistor). NAND and NOR Gates as Universal Gates. XOR and XNOR Gates. De Morgan's Theorems. Boolean Laws. Simplification of Logic Circuit using Boolean Algebra.

   (d) Fundamental Products. Minterms and Maxterms. Conversion of a Truth Table into an Equivalent Logic Circuit by (1) Sum of Products Method and (2) Karnaugh Map.

(e) Binary Addition. Binary Subtraction (using 2's Complement Method).

(f) Half Adders and Full Adders and Subtractors, 4-bit binary Adder-Subtractor.

4. Instrumentations

(a) Introduction to CRO: Block Diagram of CRO. Applications of CRO: (1) Study of Waveform, (2) Measurement of Voltage, Current, Frequency, and Phase Difference. Power Supply: Half-wave Rectifiers. Centre-tapped and Bridge. Full-wave Rectifiers Calculation of Ripple Factor and Rectification Efficiency. Basic idea about capacitor filter.

(b) Zener Diode and Voltage Regulation.

(c) Timer IC: IC 555 Pin diagram and its application as Astable and Monostable Multivibrator.

Reference Books

- Integrated Electronics, J. Millman and C.C. Halkias, 1991, Tata Mc-Graw Hill.
- Electronic devices & circuits, S. Salivahanan & N.S. Kumar, 2012, Tata Mc-Graw Hill.
- Microelectronic Circuits, M.H. Rashid, 2nd Edn., 2011, Cengage Learning.
- Modern Electronic Instrumentation and Measurement Tech., Helfrick and Cooper, 1990, PHI Learning
- Digital Principles and Applications, A.P. Malvino, D.P. Leach and Saha, 7th Ed., 2011, Tata McGraw Hill.
- Microelectronic circuits, A.S. Sedra, K.C. Smith, A.N. Chandorkar, 2014, 6th Edn., Oxford University Press.
- Fundamentals of Digital Circuits, A. Anand Kumar, 2nd Edition, 2009, PHI Learning Pvt. Ltd.
- OP-AMP & Linear Digital Circuits, R.A. Gayakwad, 2000, PHI Learning Pvt. Ltd.

Electronics and Instrumentation - (Practical)

Paper: PHS-G-DSE-A-P **Credits: 2**

List of Practicals

1. To measure (a) Voltage, and (b) Frequency of a periodic waveform using CRO
2. To verify and design AND, OR, NOT and XOR gates using NAND gates.
3. Half adder, Full adder and 4-bit Binary Adder.
4. To design an astable multivibrator of given specifications using 555 Timer.
5. To study the characteristics of a Transistor in CE configuration.
6. To design a CE amplifier of given gain (mid-gain) using voltage divider bias.
7. To design an inverting and a non-inverting amplifier of given gain using Op-amp 741 and to study their frequency response.

Reference Books

- Basic Electronics: A text lab manual, P.B. Zbar, A.P. Malvino, M.A. Miller, 1994, Mc-Graw Hill.
- Electronics: Fundamentals and Applications, J.D. Ryder, 2004, Prentice Hall.
- OP-Amps & Linear Integrated Circuit, R.A. Gayakwad, 4th Edn, 2000, Prentice Hall.
- Electronic Principle, Albert Malvino, 2008, Tata Mc-Graw Hill.

6.2 DSE-A: Modern Physics

Modern Physics - (Theory)

PHS-G-DSE-A-TH **Credits: 5 (+1 for Tutorial)**

1. Special Theory of Relativity
   (a) Michelson-Morley experiment. Lorentz transformation. Time dilation and length contraction. Velocity addition rule.
   (b) Relativistic dynamics. Elastic collision between two particles. Idea of relativistic momentum and relativistic mass. Mass-energy equivalence.

2. Elements of Quantum Mechanics

   (a) Blackbody Radiation, Planck's quantum, Planck's constant. Photoelectric effect and Compton scattering - light as a collection of photons. Davisson-Germer experiment. De Broglie wavelength and matter waves. Wave-particle duality. Wave description of particles by wave packets. Group and Phase velocities and relation between them. Probability interpretation: Normalized wave functions as probability amplitudes. Heisenberg uncertainty principle (Statement with illustrations). Impossibility of a particle following a trajectory.

   (b) Limitations of Ruherford's model of atomic structure. Bohr's model, its successes and limitations.

   (c) Quantum states as normalized functions and observables as linear hermitian operators. Significance of the eigenvalue equations. Application to a particle in one dimension: Position, Momentum and Energy operators.

   (d) Time evolution of the quantum state: Schrodinger's equation. Stationary states. Properties of wave function. Probability and probability current densities in one dimension.

   (e) Bound states: Particle in a one dimensional rigid box. Energy eigenvalues and eigenvectors.

   (f) Scatterring: Scatterring by a step potential and rectangular barrier. Tunnelling.

3. Atomic Physics

   (a) Quantum theory of hydrogen-like atoms

      i. Schrodinger equation in spherical polar coordinates. Separation of variables. Angular equation and orbital angular momentum. (Solution to the differential equations should be assumed). Radial equation for attractive coulomb interaction - Hydrogen atom. Solution for the radial wavefunctions (Solution to the differential equation should be assumed). Shapes of the probability densities for ground & first excited states. Orbital angular momentum quantum numbers l and m; s, p, d,shells.

   (b) Generalized Angular Momenta and Spin.

      i. Generalized angular momentum. Electron's magnetic moment and Spin Angular Momentum. Gyromagnetic Ratio and Bohr Magneton and the g - factor. Energy associated with a magnetic dipole placed in magnetic field. Stern-Gerlach Experiment.

      ii. Addition of angular momenta - statement only. Restriction of eigenvalues from $|j_1 - j_2|$ to $|j_1 + j_2|$.

      iii. Zeeman effect.

(c) Many electron atoms

i. Identical particles. Symmetric & Antisymmetric Wave Functions. Pauli's Exclusion Principle. Hund's Rule. Periodic table.

Reference Books

- Introduction to Special Relativity, R. Resnick, 2005, John Wiley and Sons.
- Special Relativity (MIT Introductory Physics). A.P. French, 2018, CRC Press.
- Concepts of Modern Physics, Arthur Beiser, 2002, McGraw-Hill.
- Introduction to Modern Physics, Rich Meyer, Kennard, Cooper, 2002, Tata McGraw Hill.
- Introduction to Quantum Mechanics, David J. Griffith, 2005, Pearson Education.
- Physics for scientists and Engineers with Modern Physics, Jewett and Serway, 2010, Cengage Learning.
- Modern Physics, G.Kaur and G.R. Pickrell, 2014, McGraw Hill.
- Quantum Mechanics: Theory & Applications, A.K.Ghatak & S.Lokanathan, 2004, Macmillan Additional Books for Reference Modern Physics, J.R. Taylor, C.D. Zafiratos, M.A. Dubson, 2004, PHI Learning.
- Theory and Problems of Modern Physics, Schaum's outline, R. Gautreau and W. Savin, 2nd Edn, Tata McGraw-Hill Publishing Co. Ltd.
- Quantum Physics, Berkeley Physics, Vol.4. E.H.Wichman, 1971, Tata McGraw-Hill Co.
- Basic ideas and concepts in Nuclear Physics, K.Heyde, 3rd Edn., Institute of Physics Pub.
- Modern Physics; R.Murugeshan & K.Sivaprasath; S. Chand Publishing.
- Six Ideas that Shaped Physics: Particle Behave like Waves, T.A.Moore, 2003, McGraw Hill..

6.3 DSE-B: Solid State Physics

Solid State Physics - (Theory)

Paper: PHS-G-DSE-B-TH **Credits: 4**

1. Preliminary Topics

(a) Review of Schrodinger equation in one dimension, stationary states. Maxwell-Boltzman distribution law.

2. Crystal Structure

   (a) Solids: Amorphous and Crystalline Materials. Lattice Translation Vectors. Lattice with a Basis. Unit Cell. Miller Indices. Reciprocal Lattice. Types of Lattices. Brillouin Zones. Diffraction of X-rays by Crystals. Bragg's Law. Atomic and Geometrical Factor.

3. Elementary Lattice Dynamics

   (a) Lattice Vibrations and Phonons: Linear Monoatomic and Diatomic Chains. Acoustical and Optical Phonons. Qualitative Description of the Phonon Spectrum in Solids. Dulong and Petit's Law, Einstein and Debye theories of specific heat of solids - T^3 law (qualitative discussions only).

4. Magnetic Properties of Matter (qualitative discussions only)

   (a) Dia-, Para-, Ferri- and Ferromagnetic Materials. Classical Langevin Theory of Dia- and Paramagnetic Domains. Quantum Mechanical Treatment of Paramagnetism. Curie's law, Weiss's Theory of Ferromagnetism and Ferromagnetic Domains. Discussion of B-H Curve. Hysteresis and Energy Loss .

5. Dielectric Properties of Materials (qualitative discussions only)

   (a) Polarization. Local Electric Field at an Atom. Depolarization Field. Electric Susceptibility. Polarizability. Clausius Mosotti Equation. Classical Theory of Electric Polarizability. Normal and Anomalous Dispersion. Cauchy and Sellmeir relations.

6. Elementary band theory (qualitative discussions only)

   (a) Kronig Penny model (results should be assumed - no analysis required). Band Gap. Conductor, Semiconductor (P and N type) and insulator. Conductivity of Semiconductor, mobility.

Reference Books

- The Oxford Solid State Basics. S. H. Simon, 2013, Oxford.
- Elementary Solid State Physics, 1/e M. Ali Omar, 1999, Pearson India.
- Introduction to Solid State Physics, Charles Kittel, 8th Ed., 2004, Wiley India Pvt. Ltd.
- Elements of Solid State Physics, J.P. Srivastava, 2nd Ed., 2006, Prentice-Hall of India ► Introduction to Solids, Leonid V. Azaroff, 2004, Tata Mc-Graw Hill.
- Solid State Physics, N.W. Ashcroft and N.D. Mermin, 1976, Cengage Learning.

- Solid State Physics, Rita John, 2014, McGraw Hill.
- Solid-state Physics, H. Ibach and H. Luth, 2009, Springer.
- Solid State Physics; R.K.Puri and V.K.Babbar; S. Chand Publishing.
- Solid State Physics, M.A. Wahab, 2011, Narosa Publications.

Solid State Physics - (Practical)

Paper: PHS-G-DSE-B-P **Credits: 2**

List of Practicals

1. To study PE hysteresis of ferroelectric crystal.
2. To study BH hysteresis of ferromagnetic material.
3. Measurement of susceptibility of paramagnetic solution by Quink"s tube method.
4. Measurement of magnetic susceptibility of solids.
5. Determination of variation of dielectric constant with frequency.
6. Measurement of hall voltage by four probe method.

Reference Books

- Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House.
- Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers.
- A Text Book of Practical Physics, I.Prakash & Ramakrishna, 11th Edn., 2011, Kitab Mahal.
- Elements of Solid State Physics, J.P. Srivastava, 2nd Ed., 2006, Prentice-Hall of India

6.4 DSE-B: Nuclear & Particle Physics

Nuclear & Particle Physics - (Theory)

Paper: PHS-G-DSE-B-TH **Credits: 5 (+1 for Tutorial)**

1. General Properties of Nuclei
   (a) Constituents of nucleus and their Intrinsic properties, quantitative facts about mass, radii, charge density (matter density), binding energy, average binding energy and its variation with mass number, main features of binding energy versus mass number curve, N/A plot, angular momentum, parity, magnetic moment, electric moments, nuclear excites states.
2. Nuclear Models
   (a) Liquid drop model approach, semi empirical mass formula and significance of its various terms, condition of nuclear stability, two nucleon separation energies.
   (b) Evidence for nuclear shell structure - nuclear magic numbers. Basic assumptions of shell model, concept of mean field, residual interaction, concept of nuclear force.
3. Radioactivity
   (a) α - decay: basics of α - decay processes. Theory of α - emission, Gamow factor, Geiger Nuttall law, α - decay spectroscopy.
   (b) β - decay: energy and kinematics of β decay, positron emission, electron capture, neutrino hypothesis.
   (c) γ - decay: Gamma ray emission & kinematics, internal conversion.
4. Nuclear Reactions
   (a) Types of Reactions, Conservation Laws, kinematics of reactions, Q-value, reaction rate, reaction cross section, Concept of compound and direct Reaction, resonance reaction, Coulomb scattering (Rutherford scattering).
5. Interaction of Nuclear Radiation with matter
   (a) Energy loss due to ionization (Bethe- Block formula), energy loss of electrons, Cerenkov radiation. Gamma ray interaction through matter, photoelectric effect, Compton scattering, pair production, neutron's interaction with matter.

6. Detector for Nuclear Radiations

   (a) Gas detectors: estimation of electric field, mobility of particle, for ionization chamber and GM Counter. Basic principle of Scintillation Detectors and construction of photo-multiplier tube (PMT). Semiconductor Detectors (Si and Ge) for charge particle and photon detection (concept of charge carrier and mobility), neutron detector.

7. Particle Accelerators

   (a) Accelerator facility available in India: Van-de Graaff generator (Tandem accelerator), Linear accelerator, Cyclotron, Synchrotrons.

8. Particle Physics

   (a) Fundamental particles and their families. Fundamental particle-interactions and their basic features. Symmetries and Conservation Laws: energy and momentum, angular momentum, parity, baryon number, Lepton number, Isospin, Strangeness and charm. Quark model, color quantum number and gluons. Quark structure of hadrons.

Reference Books

- Introductory nuclear Physics by Kenneth S. Krane (Wiley India Pvt. Ltd., 2008).
- Concepts of nuclear physics by Bernard L. Cohen. (Tata Mcgraw Hill, 1998).
- Introduction to the physics of nuclei & particles, R.A. Dunlap. (Thomson Asia, 2004).
- Introduction to High Energy Physics, D.H. Perkins, Cambridge Univ. Press.
- Introduction to Elementary Particles, D. Griffith, John Wiley & Sons.
- Quarks and Leptons, F. Halzen and A.D. Martin, Wiley India, New Delhi.
- Basic ideas and concepts in Nuclear Physics - An Introductory Approach by K. Heyde (IOP- Institute of Physics Publishing, 2004).
- Radiation detection and measurement, G.F. Knoll (John Wiley & Sons, 2000).
- Physics and Engineering of Radiation Detection, Syed Naeem Ahmed (Academic Press, Elsevier, 2007).
- Theoretical Nuclear Physics, J.M. Blatt & V.F.Weisskopf (Dover Pub.Inc., 1991)

7 Syllabi for Skill Enhancement Courses (General)

7.1 SEC-A: Basics of Programming and Scientific Word Processing

Basics of Programming and Scientific Word Processing - (Theory)

Paper: PHS-G-SEC-A-TH **Credits: 2**

1. Elements of Programming
   (a) An overview computers: History of computers, overview of architecture of computer, compiler, assembler, machine language, high level language, object oriented language, programming language.
   (b) Algorithms and Flowcharts:
      i. Algorithm - definition, properties and development.
      ii. Flowchart - Concept of flowchart, symbols, guidelines, types.
2. Basic programming in C/FORTRAN
   (a) Constants, Variables and Data types.
   (b) Operation and Expressions - Arithmetic operators, relational operators, logical operators.
   (c) Managing input/output.
   (d) Decision Making and Branching.
   (e) Decision making and Looping.
   (f) Arrays : One-dimension, two-dimension and multidimensional arrays, declaration of arrays, initialization of one and multi-dimensional arrays.
   (g) User-defined Functions.
3. Visualization
   (a) Introduction to graphical analysis and its limitations. Introduction to Gnuplot. importance of visualization of computational and computational data, basic Gnuplot commands: simple plots, plotting data from a file, saving and exporting, multiple data sets per file, physics with Gnuplot (equations, building functions, user defined variables and functions), Understanding data with Gnuplot.
4. Scientific word processing:
   (a) Introduction to LaTeX TeX/LaTeX word processor, preparing a basic LaTeX file, Document classes, Preparing an input file for LaTeX, Compiling LaTeX File, LaTeX tags for creating different environments, Defining LaTeX commands and environments, Changing the type style, Symbols from other languages.

(b) Equation representation: Formulae and equations, Figures and other floating bodies, Lining in columns- Tabbing and tabular environment, Generating table of contents Bibliography and citation, Making an index and glossary, List making environments,

(c) Fonts, Picture environment and colors, errors.

Reference Books

- Introduction to Numerical Analysis, S.S. Sastry, 5th Edn., 2012, PHI Learning Pvt. Ltd.
- Computer Programming in Fortran 77". V. Rajaraman (Publisher: PHI).
- Schaum's Outline of Theory and Problems of Programming with Fortran, S Lipsdutz and A Poe, 1986Mc-Graw Hill Book Co.
- Computational Physics: An Introduction, R.C. Verma, et al. New Age International Publishers, New Delhi(1999)
- E. Balagurnsamy, Programming in ANSI C, Tata McGraw Hill, 2004.
- C. Xavier, C-Language and Numerical Methods, New Age International.
- V. Rajaraman, Computer Oriented Numerical Methods, Prentice Hall of India, 1980.
- Gnuplot in action: understanding data with graphs, Philip K Janert, (Manning 2010).
- LaTeX–A Document Preparation System", Leslie Lamport (Second Edition, Addison- Wesley, 1994).

7.2 SEC-A: Electrical Circuits and Network Skills

Electrical Circuits and Network Skills - (Theory)

Paper: PHS-G-SEC-A-TH **Credits: 2**

1. Basic Electricity Principles

   (a) Voltage, Current, Resistance, and Power. Ohm's law. Series, parallel, and series-parallel combinations. AC Electricity and DC Electricity. Familiarization with multimeter, voltmeter and ammeter.

2. Understanding Electrical Circuits

   (a) Main electric circuit elements and their combination. Rules to analyze DC sourced electrical circuits. Current and voltage drop across the DC circuit elements. Single-phase and three-phase alternating current sources. Rules to analyze AC sourced electrical circuits. Real, imaginary and complex power components of AC source. Power factor. Saving energy and money.

3. Electrical Drawing and Symbols

   (a) Drawing symbols. Blueprints. Reading Schematics. Ladder diagrams. Electrical Schematics. Power circuits. Control circuits. Reading of circuit schematics. Tracking the connections of elements and identify current flow and voltage drop.

4. Generators and Transformers

   (a) DC Power sources. AC/DC generators. Inductance, capacitance, and impedance. Operation of transformers.

5. Electric Motors

   (a) Single-phase, three-phase & DC motors. Basic design. Interfacing DC or AC sources to control heaters & motors. Speed & power of ac motor.

6. Solid-State Devices

   (a) Resistors, inductors and capacitors. Diode and rectifiers. Components in Series or in shunt. Response of inductors and capacitors with DC or AC sources.

7. Electrical Protection

   (a) Relays. Fuses and disconnect switches. Circuit breakers. Overload devices. Ground-fault protection.Page 97 Grounding and isolating. Phase reversal. Surge protection. Interfacing DC or AC sources to control elements (relay protection device)

8. Electrical Wiring

   (a) Different types of conductors and cables. Basics of wiring - Star and delta connection. Voltage drop and losses across cables and conductors. Instruments to measure current, voltage, power in DC and AC circuits. Insulation. Solid and stranded cable. Conduit. Cable trays. Splices: wirenuts, crimps, terminal blocks, split bolts, and solder. Preparation of extension board.

Reference Books

- A text book in Electrical Technology - B L Theraja - S Chand & Co.
- A text book of Electrical Technology - A K Theraja.
- Performance and design of AC machines - M G Say ELBS Edn.

7.3 SEC-B: Computer Algebra System & Figure Drawing Skill

Computer Algebra System & Figure Drawing Skill - (Theory)

Paper: PHS-G-SEC-B-TH **Credits: 2**

1. Elementary symbolic computation using some computer algebra system (CAS) like Yacas or Maxima.
   (a) Arithmetic and other operations on numbers.
   (b) Calculus and elementary functions, Simplification of expressions, Solvers, Differential Equations.
   (c) Linear Algebra
   (d) Operations on polynomials
   (e) List operations
   (f) Predicates
   (g) Input/output and plotting
   (h) Probability and Statistics
   (i) Numerical methods using CAS
   (j) Physics specific applications
2. Figure generation using drawing tools like xfig/ latexdraw/ inkscape etc.
   (a) Drawing lines with/without arrows with different line styles.
   (b) Drawing curves with different line styles including brazier curves.
   (c) Drawing different types of shapes including circle, ellipse, polygons etc.
   (d) Changing figure properties like position, colour, orientation, size, shape, line properties, filling properties etc.
   (e) Grouping and ungrouping of figures.
   (f) Exporting the figure into different file formats.

Reference

- https://yacas.readthedocs.io/en/latest/reference_manual/
- The Maxima Book; Paulo Ney de Souza Richard J. Fateman Joel Moses Cliff Yapp; http://maxima.sourceforge.net/docs/maximabook/maximabook-19-Sept-2004.pdf.
- Get Started With Maxima: https://www.whoishostingthis.com/resources/maxima/
- Xfig user manual: http: //mcj.sourceforge.net/

- LaTeXDraw Manual: https://github.com/arnobl/latexdraw/wiki/Manual
- The Book of Inkscape: The Definitive Guide to the Free Graphics Editor (1st ed.), No Starch Press, p. 476, ISBN 1-59327-181-6
- https://www.youtube.com/watch?v=zUIOEXssTSE

7.4 SEC-B: Renewable Energy and Energy Harvesting

Renewable Energy and Energy Harvesting - (Theory)

Paper: PHS-G-SEC-B-TH **Credits: 2**

1. Fossil fuels and Alternate Sources of energy
   (a) Fossil fuels and nuclear energy, their limitation, need of renewable energy, non-conventional energy sources. An overview of developments in Offshore Wind Energy, Tidal Energy, Wave energy systems, Ocean Thermal Energy Conversion, solar energy, biomass, biochemical conversion, biogas generation, geothermal energy tidal energy, Hydroelectricity.
2. Solar energy
   (a) Solar energy, its importance, storage of solar energy, solar pond, non-convective solar pond, applications of solar pond and solar energy, solar water heater, flat plate collector, solar distillation, solar cooker, solar green houses, solar cell, absorption air conditioning. Need and characteristics of photovoltaic (PV) systems, PV models and equivalent circuits, and sun tracking systems.
3. Wind Energy harvesting
   (a) Fundamentals of Wind energy, Wind Turbines and different electrical machines in wind turbines, Power electronic interfaces, and grid interconnection topologies.
4. Ocean Energy
   (a) Ocean Energy Potential against Wind and Solar, Wave Characteristics and Statistics, Wave Energy Devices. Tide characteristics and Statistics, Tide Energy Technologies, Ocean Thermal Energy, Osmotic Power, Ocean Bio-mass.
5. Geothermal Energy
   (a) Geothermal Resources, Geothermal Technologies.
6. Hydro Energy
   (a) Hydropower resources, hydropower technologies, environmental impact of hydro power sources.

7. Piezoelectric Energy harvesting

   (a) Introduction, Physics and characteristics of piezoelectric effect, materials and mathematical description of piezoelectricity, Piezoelectric parameters and modeling piezoelectric generators, Piezoelectric energy harvesting applications, Human power

8. Electromagnetic Energy Harvesting

   (a) Linear generators, physics mathematical models, recent applications

   (b) Carbon captured technologies, cell, batteries, power consumption.

   (c) Environmental issues and Renewable sources of energy, sustainability.

Reference Books

- Non-conventional energy sources - G.D Rai - Khanna Publishers, New Delhi.Solar energy - M P Agarwal - S Chand and Co. Ltd.
- Solar energy - Suhas P Sukhative Tata McGraw - Hill Publishing Company Ltd.
- Godfrey Boyle, "Renewable Energy, Power for a sustainable future", 2004, Oxford University Press, in association with The Open University.
- Dr. P Jayakumar, Solar Energy: Resource Assesment Handbook, 2009.
- J.Balfour, M.Shaw and S. Jarosek, Photovoltaics, Lawrence J Goodrich (USA).
- http://en.wikipedia.org/wiki/Renewable_energy.

8 Note on Syllabi for Generic Elective Courses

The Core Courses (CC) for the B.Sc. General Curriculum with Physics, provided in section 5 above, are to be treated as Generic Elective Course for students studying an honours course in a subject other than Physics.

UNIVERSITY OF CALCUTTA

Notification No. CSR/ 12 /18

It is notified for information of all concerned that the Syndicate in its meeting held on 28.05.2018 (vide Item No.14) approved the Syllabi of different subjects in Undergraduate Honours / General / Major courses of studies (CBCS) under this University, as laid down in the accompanying pamphlet:

List of the subjects

Sl. No.	Subject	Sl. No.	Subject
1	Anthropology (Honours / General)	29	Mathematics (Honours / General)
2	Arabic (Honours / General)	30	Microbiology (Honours / General)
3	Persian (Honours / General)	31	Mol. Biology (General)
4	Bengali (Honours / General /LCC2 /AECC1)	32	Philosophy (Honours / General)
5	Bio-Chemistry (Honours / General)	33	Physical Education (General)
6	Botany (Honours / General)	34	Physics (Honours / General)
7	Chemistry (Honours / General)	35	Physiology (Honours / General)
8	Computer Science (Honours / General)	36	Political Science (Honours / General)
9	Defence Studies (General)	37	Psychology (Honours / General)
10	Economics (Honours / General)	38	Sanskrit (Honours / General)
11	Education (Honours / General)	39	Social Science (General)
12	Electronics (Honours / General)	40	Sociology (Honours / General)
13	English ((Honours / General/ LCC1/ LCC2/AECC1)	41	Statistics (Honours / General)
14	Environmental Science (Honours / General)	42	Urdu (Honours / General /LCC2 /AECC1)
15	Environmental Studies (AECC2)	43	Women Studies (General)
16	Film Studies (General)	44	Zoology (Honours / General)
17	Food Nutrition (Honours / General)	45	Industrial Fish and Fisheries – IFFV (Major)
18	French (General)	46	Sericulture – SRTV (Major)
19	Geography (Honours / General)	47	Computer Applications – CMAV (Major)
20	Geology (Honours / General)	48	Tourism and Travel Management – TTMV (Major)
21	Hindi (Honours / General /LCC2 /AECC1)	49	Advertising Sales Promotion and Sales Management –ASPV (Major)
22	History (Honours / General)	50	Communicative English –CMEV (Major)
23	Islamic History Culture (Honours / General)	51	Clinical Nutrition and Dietetics CNDV (Major)
24	Home Science Extension Education (General)	52	Bachelor of Business Administration (BBA) (Honours)
25	House Hold Art (General)	53	Bachelor of Fashion and Apparel Design – (B.F.A.D.) (Honours)
26	Human Development (Honours / General)	54	Bachelor of Fine Art (B.F.A.) (Honours)
27	Human Rights (General)	55	B. Music (Honours / General) and Music (General)
28	Journalism and Mass Communication (Honours / General)		

The above shall be effective from the academic session 2018-2019.

SENATE HOUSE
KOLKATA-700073
The 4th June, 2018

Paul 4/6/18
(Dr. Santanu Paul)
Deputy Registrar

UNIVERSITY OF CALCUTTA

B.A./B.Sc. ECONOMICS
(HONOURS AND GENERAL)
SYLLABUS UNDER CHOICE BASED CREDIT SYSTEM

To be effective from the academic session 2018-19

BA/BSc ECONOMICS (HONOURS) SYLLABUS,
UNIVERSITY OF CALCUTTA, UNDER
CHOICE BASED CREDIT SYSTEM
To be effective from the academic session 2018-19

Table 1: Marks and Paper distributions with credit

		Credits	
Course Type	**Total Papers**	**Credit**	**Marks**
Core Courses (CC)	14	14*6=84	14*100=1400
Discipline Specific Electives (DSE)	4	4*6 =24	4*100 = 400
Generic Electives (GE) [Covering Two Disciplines with two courses each. Any discipline in any semester]	4	4*6=24	4*100= 400
Ability Enhancement Compulsory Courses-AECC [Consisting of two Ability Enhancement Compulsory Courses – AECC-1 and AECC-2]	2 [AECC-1 is Communicating English/ Modern Indian Languages(MIL) and AECC-2 is Environmental Studies (ENVS)]	2*2=4	100*2= 200
Skill Enhancement Courses (SEC)	2	2*2=4	100*2=200
Totals	26	140	2600

- **Continuous Internal Assessment and Students" Attendance: For each paper 10% will be reserved for continuous internal assessment (CIA) and 10% will be reserved for attendance of the students.** ***CIA may take the form of written examination/s, take-home assignments, viva-voce; presentation etc depending on the course instructor. As per definition CIA will be assessed fully internally by the course instructor.***

Types of tutorials: Tutorial classes are introduced per course (except for AEC and SEC) to give the students an idea of detailed understanding of the course and also to build their confidence on the subject in terms of (i) solving problems, (ii) presenting a paper in terms of board work or power point,(iii) preparation of term paper etc. A tutorial class also helps a teacher to clarify any topic in detail to the students. A tutorial contact hour has been meant to promote teacher-student academic interaction. The norm of examination for this part of the course will be decided later. ***Unlike all other Science subjects Economics should not be treated as a laboratory–based subject.*** After all it is a subject under Social Science and so there is limited scope for introducing practical part for each course. **Only under Discipline Specific Elective-A,**

5th Semester/6th Semester, for the Courses "Applied Econometrics" and "Issues in Indian Economy" (under DSE A) there will be a *practical part* of 30 marks (2 credits) instead of tutorial part of 15 marks (1 credit). Practical classes in case of ―Applied Econometrics‖ will be conducted on the basis of laboratory-based specified softwares (STATA or R). Practical classes for the course ―Issues in Indian economy‖

Method followed for coding the Courses

Economics Honours Core Course 1, 1st semester (Theory): ECO-A-CC-1-1-TH

Economics Honours Core Course 1, 1st semester (Tutorial): ECO-A-CC-1-1TU

Table 2 :Course structure semester-wise: Economics (Honours)

Table 2A :Semester –I (July to December)

Type of Course	Name of the Course	Credit	Marks
Economics Core Course –I (ECO-A-CC-1-1-TH-TU)	Introductory Microeconomics[Theory plus Tutorial]	5+1=6	100
Economics Core Course –II (ECO-A-CC-1-2-TH-TU)	Mathematical Methods for Economics-I [Theory plus Tutorial]	5+1=6	100

Table 2B :Semester –II (January to June)

Type of Course	Name of the Course	Credit	Marks
Economics Core Course –III (ECO-A-CC-2-3-TH-TU)	Introductory Macroeconomics [Theory plus Tutorial]	5+1=6	100
Economics Core Course –IV (ECO-A-CC-2-4.TH-TU)	Mathematical Methods for Economics-II [Theory plus Tutorial]	5+1=6	100

Table 2C :**Semester –III (July to December)**

Type of Course	Name of the Course	Credit	Marks
Economics Core Course –V (ECO-A-CC-3-5-TH-TU)	Intermediate Microeconomics-I [Theory plus Tutorial]	5+1=6	100
Economics Core Course –VI (ECO-A-CC-3-6-TH-TU)	Intermediate Macroeconomics-I [Theory plus Tutorial]	5+1=6	100
Economics Core Course –VII (ECO-A-CC-3-7-TH-TU)	Statistics for Economics [Theory plus Tutorial]	5+1=6	100
Skill Enhancement Course-I (A Group) (ECO-A-SEC-3-1A-TH)	Data Analysis [Theory]/ Rural Development [Theory] [A-Group of SEC consists of two courses. Students will have to select *any one* of the two]	2	100

Table 2D : Semester-IV (January to June)

Type of Course	Name of the Course	Credit	Marks
Economics Core Course –VIII (ECO-A-CC-4-8-TH-TU)	Intermediate Microeconomics-II[Theory plus Tutorial]	5+1=6	100
Economics Core Course –IX (ECO-A-CC-4-9-TH-TU)	Intermediate Macroeconomics-II [Theory plus Tutorial]	5+1=6	100
Economics Core Course –X (ECO-A-CC-4-10-TH-TU)	Introductory Econometrics[Theory plus Tutorial]	5+1=6	100
Skill Enhancement Course-II (B Group) (ECO-A-SEC-4-2B-TH)	Research Methodology [Theory]/ Managerial Economics [Theory] [B-Group of SEC consists of two courses. Students will have to select *any one* of the two]	2	100

Table 2E: Semester –V (July to December)

Type of Course	Name of the Course	Credit	Marks
Economics Core Course –XI (ECO-A-CC-5-11-TH-TU)	International Economics [Theory plus Tutorial]	5+1=6	100
Economics Core Course –XII (ECO-A-CC-5-12-TH-TU)	Indian Economy [Theory plus Tutorial based Term Paper]	5+1=6	100
Two Discipline Specific Elective (DSE) Courses: DSE-A and DSE- B In Semester V these two courses are denoted as DSE-A(1) and DSE-B(1) One out of two courses from : DSE-A(1) One out of two courses from: DSE-B(1) (ECO-A-DSE-5-A(1)-TH-TU/P) and (ECO-A-DSE-5-B(1)-TH-TU)	DSE-A(1) consists of two courses out of which students will have to select *any one* and DSE-B(1) consists of two courses out of which students have to select *any one.* <u>The two courses under DSE-A(1) are</u> Applied Econometrics (AE) : 4(Th) +2 (P)= 6 Economic History of India (1857-1947) (EHI) : 5(Th) +1(Tu) = 6 [Students will have to select any one] <u>The two courses under DSE-B(1) are</u> Comparative Economic Development (1850-1950) (CED): 5(Th) +1(Tu) = 6 Financial Economics (FE) : 5 (Th) + 1 (Tu) =6 [Students will have to select any one]	(5+1)= 6 (5+1)= 6 [Or one (4+2)= 6 and one (5+1)= 6]	100+ 100

Table 2F: Semester –VI (January to June)

Type of Course	Name of the Course	Credit	Marks
Economics Core Course –XIII (ECO-A-CC-6-13-TH-TU)	Public Economics [Theory plus Tutorial]	5+1=6	100
Economics Core Course –XIV (ECO-A-CC-6-14-TH-TU)	Development Economics [Theory plus Tutorial]	5+1=6	100
Two Discipline Specific Elective (DSE) Courses: DSE-A and DSE- B In Semester VI these two courses are denoted as DSE-A(2) and DSE-B(2) One out of two courses from : DSE-A(2) One out of two courses from: DSE-B(2) (ECO-A-DSE-6-A(2)-TH-TU/P) and (ECO-A-DSE-6-B(2)-TH-TU)	DSE-A(2) consists of two courses out of which students will have to select *any one* and DSE-B(2) consists of two courses out of which students have to select *any one.* The two courses under DSE-A(2) are Money and Financial Markets (MFM) : 5(Th) + 1(Tu) =6 Issues in Indian Economy (IIE) : 4(Th) +2 (P)= 6 [Students will have to select any one] The two courses under DSE-B(2) are Environmental Economics (EE) : 5 (Th) +1 (Tu) =6 Issues in Development Economics (IDE) : 5 (Th) +1 (Tu) =6 [Students will have to select any one]	(5+1)= 6 (5+1)=6 [Or one (4+2)=6 and one (5+1)= 6]	100 + 100
Total		**24**	**400**

- **In framing this syllabus the centralized structure of Calcutta University is followed.**
- **Special Note**

(i) *The four Generic Elective papers (courses) for Economics (Honours) students* ***will be from any two subjects other than Economics with the condition that Mathematics is to be one of the Generic Elective Subjects for Economics(Honours) students.*** *Thus students having Economics Honours will select two other disciplines of 200 marks each under Generic Elective and one of the two disciplines should be Mathematics .* ***Students will have to select two courses on Mathematics in any two of the four semesters 1,2, 3 and 4 (where we find Generic Elective Courses). Thus two courses on Mathematics is compulsory for Economics (Honours).*** *The other Discipline can be any other subject. For example, an Economics (Honours) student may opt for Mathematics as Generic Elective in 1st and 3rd semesters and Political Science (or Statistics) in 2nd and 4th Semesters.*

(ii) *Similarly Economics as Generic Elective will be offered to students having Honours in any subject other than Economics.* ***The Generic Elective papers in Economics for Honours students (for students having Honours in any subject other than Economics) will be treated as Core Papers in Economics for General students (for BA/BSc General students having Economics as a Core paper under the General stream). [This has been explained clearly in the context of the syllabus for BA/BSc Economics (General)].Students having Honours in any subject other than Economics will select any two Disciplines or Subjects for the four Generic Elective papers offered.***

Economics Core Course-I: ECO-A-CC-1-1-TH-TU

Introductory Microeconomics

Total Marks: 100 [Theory(Th) 65 + Tutorial(Tu) 15 + Internal Assessment 10+Attendance: 10]

Total Credits: [5(Th)+1(Tu)]=6 ,

No. of Lecture hours (Theory): 75, No. of Tutorial contact hours:15

[For Semester-I]

ECO-A-CC-1-1-TH

Unit 1: Exploring the subject matter of Economics **10 lecture hours**

1.1 Scope and Method of Economics: Wants, Scarcity, Competing Ends and Choice - Defining Economics, Thinking like an economist: Basic Economics Questions, Microeconomics and Macroeconomics, Normative Economics and Positive Economics

1.2Principles of Microeconomics – principles of individual decision making and principles of economic interactions – Introduce trade off, opportunity cost, efficiency, marginal changes and cost-benefit, trade, market economy, property rights, market failure, externality and market power.

1.3 Interdependence and the Gains from Trade- production possibilities frontier and increasing costs, absolute and comparative advantage, comparative advantage and gains from trade.

1.4 Reading and working with graphs

Unit 2: Demand and Supply: How Markets Work **10 lecture hours**

2.1Elementary theory of Demand: Determinants of household demand and market demand, movement along and shift of the demand curve

2.2 Elementary theory of Supply: factors influencing supply, the supply curve, movement along and shift of the supply curve

2.3 The Elementary theory of market price: Determination of equilibrium price in a competitive market.

2.4 Market Adjustment without Government (with illustrations):the effect of shifts in demand and supply, the excess demand function, existence, uniqueness and stability of equilibrium

Unit 3: Market and Adjustments **10 lecture hours**

3.1 The Evolution of Market Economies, Price System and the Invisible Hand

3.2 The Decision-takers - households, firms and central authorities

3.3 The Concepts of Markets- individual market, separation of individual markets, interlinking of individual markets. Difference among markets- competitiveness, goods and factor markets, free and controlled markets. Market and non-market sectors, public and private sectors, economies- free market, command and mixed.

3.4 Different goods: Public goods, Private goods, Common resources and Natural Monopolies.

Unit 4: Market Sensitivity and Elasticity **12 lecture hours**

4.1 Importance of Elasticity in Choice-Decisions

4.2 Method of Calculation- Arc Elasticity, Point Elasticity-definition

4.3 Demand and supply Elasticities-types of elasticity and factors affecting elasticity, Demand Elasticity and Revenue, Long run and Short run elasticities of Demand and Supply

4.4 Income and Cross Price Elasticity

4.5 Applications: Case studies – OPEC and Oil Price, Illegal Drugs

Unit 5: Government Intervention **8 lecture hours**

5.1 The Economic Role of Government with respect to Market: (i) Price Ceiling, Price Floor and Market Adjustment (with short case studies of agricultural administered price, minimum wage and rent control); (ii) Black Market; (iii) Tax and market adjustment ; (iv) Elasticity and Tax incidence

5.2 Comparison of markets with and without government

Unit 6: Utilitarian Approach **25 lecture hours**

(Focus on intuitive explanation and diagrams. Learning to analyze without using calculus a must)

6.1 The History of Utility Theory – From Cardinal to Ordinal Approach.

6.2 Utility in Cardinal Approach- Utility and choice, Total Utility and Marginal Utility, Utility and choice-maximization, marginal utility, theory of demand

6.3 Ordinal utility: Assumptions on preference ordering, indifference curve, marginal rate of substitution and convexity of IC, budget constraint, consumers' equilibrium-interior and corner, Derivation of Demand Curves from ICs, composite good convention. Application: Cash subsidy versus subsidy in kind

6.4 Price consumption curve, Income consumption curveand Engel curve. Price effect - Income and Substitution effect (Hicks and Slutsky),inferior goods and Giffen goods, Marshallian and compensated demand curves

ECO-A-CC-1-1-TU

Tutorial Contact Hours: 15

Texts

1. G.Mankiw. 2007, Economics: Principles and Applications, India edition by South Western, Cengage Learning

2. R.G. Lipsey. An Introduction to Positive Economics, ELBS (6th edition)

3. Lipsey, R. and Chrystal, A. 2007 Economics, OUP

4. Pindyck, Rubinfeld and Mehta, Microeconomics, Pearson

5. G.S.Maddala and E. Miller, 1989, Microeconomics, Prentice Hall, McGraw Hill International Editions

References

1. Karl e Case and Ray C Fair, Principles of Economics, Pearson Education, 8th Edition, 2007
2. P Samuelson and W.Nordhaus, Economics, McGraw hill International Edition (14th edition or later edition)
3. J.E.Stiglitz and C.E.Walsh, Principles of Economics, WW Norton and Company, NY, (3rd edition or later edition)
4. Hal. R Varian , Intermediate Microeconomics, A modern Approach, WW Norton and Company, 8th edition, 2010 (T)
5. Gravelle, H. and Rees,R. , Microeconomics, Prentice Hall
6. Ryan, W.J.L. and Pearce : Price Theory and Applications , Macmillan Education, UK
7. Ferguson, C.E. and Gould, J.P. : Microeconomic Theory, Aitbs Publishers and Distributors, New Delhi.
8. Satya Chakrabarty, Microeconomics, Allied Publishers

Economics Core Course II: ECO-A-CC-1-2-TH-TU

Mathematical Methods in Economics-I

Total Marks: 100 [Theory(Th) 65 + Tutorial(Tu) 15 + Internal Assessment 10+Attendance: 10]

Total Credits: [5(Th)+1(Tu)]=6 ,

No. of Lecture hours: 75, No. of Tutorial contact hours: 15

[For Semester-I]

ECO-A-CC-1-2-TH

1. Preliminaries **10 lectures hours**

- Sets and set operations; functions and their properties; number systems.
- Convex sets; geometric properties of functions: convex functions, their characterizations, properties and applications; further geometric properties of functions: quasi-convex functions, quasi-concave functions, their characterizations, properties and applications.
- Limit and continuity-Different Limit Theorems with proof-concept of first principle.
- Uses of the concept of continuity.

2. Functions of one real variable **10 lecture hours**

- Continuous functions of different types and their graphs- quadratic, polynomial, power, exponential, and logarithmic.
- Concept of derivatives. Limits and derivatives. L' Hospital's rule .Graphical meaning of derivatives. Derivatives of first and second order and their properties; convex, concave and linear function.
- Application in economics- concept of marginal. Concept of elasticity. Concept of average function

3. Single variable optimization **10 lecture hours**

- Local and global optima; Geometric characterizations; characterizations using calculus. Significance of first and second order conditions.
- Interpretation of necessary and sufficient conditions with examples.
- Applications in Economics- profit maximization and cost minimization.

4. Integration of functions **10 lecture hours**

- Integration of different types of functions;
- Methods of Substitution and integration by parts.
- Applications in economics- obtaining total from the marginal.

5. **Matrix Algebra** **20 lecture hours**

- Matrix: its elementary operations; different types of matrix.
- Rank of a matrix.
- Determinants and inverse of a square matrix.
- Solution of system of linear equations-Cramer‘s rule; Eigen values and Eigen vectors.
- System of nonlinear equations- Jacobian determinant and existence of solution.
- The concept of comparative statics
- Applications of Matrix Algebra in input-output analysis-the Leontief Static Open Model (LSOM) - the Hawkins-Simon conditions.

6. Game Theory **15 lecture hours**

- Concept of a game, strategies and payoffs
- Zero-sum games- maxmin and minmax solutions
- Dominant Strategy Equilibrium
- Nash equilibrium
- Nash equilibrium in the context of some common games – Prisoners‘ Dilemma, Battle of Sexes, Matching Pennies

ECO-A-CC-1-2-TU

Tutorial contact hours :15

Texts :

- Alpha C. Chiang and Kavin Wainwright : Fundamental Methods of Mathematical Economics, Mc Graw Hill, 2005.

References

1. K. Sydsaeter and P. Hammond, Mathematics for Economic Analysis, Pearson Educational Asia: Delhi, 2002.

2. Gibbons R. Game Theory for Applied Economists.
3. Mukherji and S. Guha: Mathematical Methods and Economic Theory, Oxford University Press, 2011.
4. Hands, D. W.: Introductory Mathematical Economics, Second Edition, 2004.
5. Silberberg ,E. and Suen, W.: The Structure of Economics : A Mathematical Analysis, Third edition, Mc-Graw Hill, 2001.
6. Apostol T.M. : Calculus, Volume 1, One-variable calculus, with an introduction to linear algebra, (1967) Wiley, ISBN 0-536-00005-0, ISBN 978-0-471-00005-1.
7. K. G. Binmore, Mathematical analysis, Cambridge University Press, 1991.
8. Archibald, G.C. and Lipsey, R.G. , An Introduction to Mathematical Treatment of Economics, 1967, Weidenfeld and Nicolson
9. Henderson, J.M. and Quandt, R.E., Microeconomic Theory : A Mathematical Approach, McGrawHill,1980
10. Dorfman, R., Samuelson, P.A. and Solow, R.M. , Linear Programming and Economic Analysis, McGraw-Hill, 1958.
11. Hadley, G. , Linear Algebra, Addison-Wesley Publishing Company, 1977

Economics Core Course III: ECO-A-CC-2-3-TH-TU

Introductory Macroeconomics

Total Marks: 100 [Theory (Th) 65 + Tutorial(Tu) 15 + Internal Assessment 10+Attendance: 10]

Total Credits: [5(Th)+1(Tu)]=6 ,

No. of Lecture hours: 75, No. of Tutorial contact hours: 15

[For Semester-II]

ECO-A-CC-2-3-TH

1. National Income Accounting 20 lecture hours

Macroeconomic data- Basic concepts of National Income accounting. The circular flow. Concepts of GNP, GDP, NNP, and NDP at market price and at factor cost. The measurement of National Income-Value Added Method and Expenditure Method. The problem of double counting. The role of Government. Concepts of Corporate Income, Corporate Savings, Personal Income, Personal Disposable Income and Personal Savings. Saving-Investment gap and its relation with budget deficit and trade surplus. National Income accounting and cost of living. Basic idea of India‘s national income.

2. Income Determination in the Short Run (Part-I) :The Simple Keynesian Model in a Closed Economy 18 lecture hours

The Simple Keynesian Model (SKM) in a Closed Economy without Government- the Keynesian

Consumption Function; the Keynesian Saving Function; income determination in SKM; stability of equilibrium; the concept of effective demand- the concept of demand-determined output ; the Simple Keynesian Multiplier; the paradox of thrift; the SKM in a Closed Economy with Government; government expenditure and tax; the government expenditure multiplier and the tax rate multiplier; the balanced budget multiplier; the budget surplus; effects of tax changes and government purchases on budget surplus; the full employment budget surplus.

3. The Classical system **18 lecture hours**

Basic ideas of Classical Macroeconomics; Say's Law and Quantity Theory of Money, Loanable fund theory; the Classical Theory of Income and Employment determination; full Employment and wage-price flexibility; Classical Dichotomy and Neutrality of Money.

4. Macroeconomic Foundations -I **19 lecture hours**

- The bond market as the mirror image of the money market-the Walras' Law. Relationship between bond price and rate of interest- the concept of Keynesian liquidity preference schedule-speculative demand for money and liquidity trap.
- Investment function: Concepts of Marginal productivity of capital, marginal efficiency of capital (MEC) and marginal efficiency of investment (MEI)- Jorgenson's neo-classical theory- Acceleration principle- fixed and variable. Multiplier-accelerator interaction.

ECO-A-CC-2-3-TU

Tutorial Contact hours: 15

Textbooks:

1. Dornbusch, Fischer and Startz, Macroeconomics, McGraw Hill, 11th edition, 2010.
2. N. Gregory Mankiw. Principles of Macroeconomics, Indian Imprint of South Western by Cengage India, 6th edition, 2015.
3. N. Gregory Mankiw. Macroeconomics, Worth Publishers, 2010.
4. Ghosh Chandana and Ghosh Ambar, Macroeconomics, PHI Learning Pvt Ltd, 2014.

References

1. Richard T. Froyen, Macroeconomics, Pearson Education Asia, 2nd edition, 2005.
2. Andrew B. Abel and Ben S. Bernanke, Macroeconomics, Pearson Education, Inc., 7th edition, 2011.
3. Venieris, Y.P. and Sebold F.D., Macroeconomics: Models and Policy, John Wiley and Sons, 1977.
4. Ackley Gardner (old), Macroeconomic Theory, Macmillan, 1961
5. Ackley Gardner(new), Macroeconomics : Theory and Policy : Macmillan,1978

6. Ghosh Chandana and Ghosh Ambar, Indian Economy : A Macro-theoretic Analysis, PHI Learning Pvt Ltd, 2016.
7. J.R.Hicks. The Social Framework: An Introduction to Economics, Clarendon Press, 3rd edition, 1960.
8. Sikdar Soumyen, Principles of Macroeconomics, Oxford University Press.
9. Economic Survey , Government of India, various issues.

Economics Core Course IV: ECO-A-CC-2-4-TH-TU

Mathematical Methods in Economics-II

Total Marks: 100 [Theory(Th) 65 + Tutorial(Tu) 15 + Internal Assessment 10+Attendance: 10]

Total Credits: [5(Th)+1(Tu)]=6 ,

No. of Lecture hours: 75, No. of Tutorial contact hours:15

[For Semester-II]

ECO-A-CC-2-4-TH

1. Function of several variables **14 lecture hours**

- Continuous and differentiable functions: partial derivatives and Hessian matrix. Homogeneous and homothetic functions.
- Euler's theorem, implicit function theorem (without proof) and its application to comparative statics problems.
- Economic applications- the idea of level curves, theories of consumer behaviour and theory of production.

2. Multi-variable optimization **35 lecture hours**

- Optimization of nonlinear functions: Convex, concave, and quasi-concave functions; Unconstrained optimization.
- Constrained optimization with equality constraints- Lagrangian multiplier method; role of Hessian determinant.
- Inequality constraints and Kuhn-Tucker Conditions.
- Value function and Envelope theorem; Economic applications – consumer behaviour and theory of production.
- Optimization of linear function: Linear programming; concept of slack and surplus variables (graphical solution only). Concept of convex set. The Duality Theorem
- Economic Applications of Linear programming

3. Difference Equations **12 lecture hours**

- Finite difference; Equations of first and 2nd orders and their solutions
- Application in Economics- Cobweb model, Multiplier-Accelerator model.

4. Differential Equations **14 lecture hours**

- Solution of Differential equations of first order and second order of linear differential equations.
- Economic application-price dynamics in a single market- multimarket supply demand model with two independent markets.
- Qualitative graphic solution to 2x2 linear simultaneous non-linear differential equation system- phase diagram, fixed point and stability. Economic applications in microeconomics and macroeconomics

ECO-A-CC-2-4-TU

Tutorial Contact hours: 15

Text:

- Alpha C. Chiang and Kavin Wainwright: Fundamental Methods of Mathematical Economics, Mc Graw Hill, 2005.

References:

1. K. Sydsaeter and P. Hammond, Mathematics for Economic Analysis, Pearson Educational Asia: Delhi, 2002.
2. Carl Simon and Lawrence Blume. Mathematics for Economists, W. W. Norton and Company, 1994
3. A. Mukherji and S. Guha: Mathematical Methods and Economic Theory, Oxford University Press, 2011.
4. Hands, D. W.: Introductory Mathematical Economics, Second Edition,2004.
5. Silberberg, E. and Suen, W.: The Structure of Economics : A Mathematical Analysis, Third edition, Mc-Graw Hill, 2001.
6. K. G. Binmore, Mathematical analysis, Cambridge University Press, 1991.
7. Archibald, G.C. and Lipsey, R.G. , An Introduction to Mathematical Treatment of Economics, 1967, Weidenfeld and Nicolson
8. Henderson, J.M. and Quandt, R.E., Microeconomic Theory : A Mathematical Approach, McGrawHill,1980.
9. Intrilligator, M.D., Mathematical Optimization and Economic Theory, Society for Industrial and Applied Mathematics, Philadelphia, 1971.
10. Allen, R.G.D., Mathematical Analysis for Economists, McMillan, London, 1967

11. Dorfman, R., Samuelson, P.A. and Solow, R.M. , Linear Programming and Economic Analysis, McGraw-Hill, 1958.
12. Dixit, A.K., Optimization in Economic Theory, Oxford University Press, 1976.

Economics Core Course V: ECO-A-CC-3-5-TH-TU

Intermediate Microeconomics –I

Total Marks: 100 [Theory(Th) 65 + Tutorial(Tu) 15 + Internal Assessment 10+Attendance: 10]

Total Credits: [5(Th)+1(Tu)]=6 ,

No. of Lecture hours: 75, No. of Tutorial contact hours:15

[For Semester- III]

ECO-A-CC-3-5-TH

Unit 1: Theories of Consumer Behaviour and Applications 17 lecture hours

1.1 Inter-temporal choice (saving and borrowing)

1.2Revealed preference

1.3. Choice under uncertainty – utility function and expected utility, risk aversion and risk preference

1.4 Applications of Consumer Behaviour in Construction of Price Indices – Laspeyers and Paasche's indices

2. Unit 2: Production and Costs 20 lecture hours

2.1 Technology – general concept of Production Function, production with one and two variable inputs,total average and marginal products, short run and long run, returns to factor and returns to scale, Isoquants, marginal rate of technical substitution, isocost line and firm's equilibrium, elasticity of substitution

2.2 Types of production functions- Cobb-Douglas, fixed-coefficient and CES functions

2.3 Cost structure- implicit cost, explicit cost, accounting cost, sunk cost, economic cost, fixed cost, variable cost, total, average and marginal cost. Determinants of short run cost, cost curves, cost minimization and expansion path, short versus long run cost curves, economies of scale.

3. Unit 3: The Firm and Perfect Market Structure 20 lecture hours

3.1 Organization, Firms and Profit Maximization

3.2 Marginal Revenue, Marginal Cost and Profit Maximization

3.3 Perfect competition- short run competitive equilibrium of the firm, short run supply curve of firm and industry, Output choice and competitive equilibrium in long run, Economic rent and profit, long-run industry supply- constant, increasing and decreasing cost.

3.4 Consumer and Producer surplus, welfare and efficiency of competitive equilibrium. Government intervention and dead weight loss, Application- Minimum prices and price supports (price ceiling and price floors)

4. Unit 4: Input Market in Perfect Competition 18 lecture hours

4.1 Basic concepts- derived demand, productivity of an input, marginal product of an input, marginal revenue product

4.2 Marginal productivity theory of distribution

4.3 Labor market-supply of labor, competitive labor markets

4.4 Land markets and rent

ECO-A-CC-3-5-TU

Tutorial Contact hours: 15

Text

1. Pindyck, Rubinfeld and Mehta, Microeconomics, Pearson

2. G.S.Maddala and E. Miller, 1989, Microeconomics, Prentice Hall, McGraw Hill International Editions

3. Goon, A.M., Gupta, M.K. and Dasgupta, B.: Fundamentals of Statistics Vol.2,The World Press Pvt. Ltd., Kolkata. (For index number only)

References

1. Hal. R Varian , Intermediate Microeconomics, A modern Approach, WW Norton and Company, 8th edition, 2010 (T)

2. Gravelle, H. and Rees ,R., Microeconomics, Prentice Hall

3. Anindya Sen, Microeconomics, OUP

4. Satya Chakrabarty, Microeconomics, Allied Publishers

5. Ferguson, C. E. and Gould, J.P., Microeconomic Theory, Aitbs Publishers and Distributors, New Delhi.

6. Lipsey, R. and Chrystal, A., 2007, Economics, OUP

Economics Core Course VI: ECO-A-CC-3-6-TH-TU

Intermediate Macroeconomics-I

Total Marks: 100 [Theory(Th) 65 + Tutorial(Tu) 15 + Internal Assessment 10+Attendance: 10]

Total Credits: [5(Th)+1(Tu)]=6 ,

No. of Lecture hours: 75, No. of Tutorial contact hours: 15

[For Semester- III]

ECO-A-CC-3-6-TH

1. **Income Determination in the Short-run (Part-II) : The IS-LM Model**

14 lecture hours

- IS-LM Model - equilibrium, stability and comparative statics. Crowding out .Effects of fiscal and monetary policies.

2. **Aggregate Demand and Aggregate Supply- the Complete Keynesian Model**

14 lecture hours

- Derivation of aggregate demand curve.
- Derivation of aggregate supply curves both in the presence and absence of wage rigidity.
- Equilibrium, stability, and comparative statics-effects of monetary and fiscal policies. Effects of wage cut.
- Unemployment equilibrium and its causes- possible solutions including real balance effect.

3. **Keynes vs. Classics** **10 lecture hours**

- Keynesian vs classical system.
- Hybrid models under Classical/Keynesian framework.
- Friedman‘s restatement of classical ideas

4. **Money Supply, Monetary Policy and Government Budgetary Operations**

17 lecture hours

- Measures of money supply with special reference to India (M_1,M_2, M_3 and M_4)
- Balance sheet view of money supplied by the banking sector as a whole
- High powered money –definition
- Balance sheet of Reserve Bank of India and High powered money
- Balance sheet of Commercial banks and basic ideas of money multiplier theory.
- Deposit multiplier, currency multiplier, reserve multiplier, credit multiplier and money multiplier in the context of the theory of money supply
- Interest sensitivity of money supply and the slope of the LM curve.

- Monetary policy – Open Market Operations, Statutory Liquidity Ratio, Bank rate, variable reserve ratio, repo rate.
- Government Budget Deficit and Deficit Financing-Indian illustration. Deficit financing and monetary policy.

5. Inflation, Unemployment and Expectations **20 lecture hours**

- The concept of Inflationary Gap.
- Demand pull vs. Cost push inflation
- Mark-up inflation
- The concept of stagflation
- Central Bank's role in controlling inflation: Monetary policy.
- Inflation and unemployment trade-off.
- Four models of aggregate supply: The Sticky-Wage Model, The Worker-Misperception Model, The Imperfect Information Model and The Sticky-Price Model.
- Deriving the Phillips Curve from Aggregate Supply Curve.
- Short run and long- run Phillips curve – role of adaptive expectations and rational expectations.
- Disinflation, Sacrifice Ratio and policy ineffectiveness.

ECO-A-CC-3-6-TU

Tutorial Contact hours: 15

Textbooks:

- Dornbusch, Fischer and Startz, Macroeconomics, McGraw Hill, 11th edition, 2010.
- N. Gregory Mankiw. Macroeconomics, Worth Publishers, 2010

References

- Richard T. Froyen, Macroeconomics, Pearson Education Asia, 2nd edition, 2005.
- Ackley Gardner (old), Macroeconomic Theory, Macmillan, 1961
- Ackley Gardner(new), Macroeconomics : Theory and Policy : Macmillan,1978
- Ghosh Chandana and Ghosh Ambar, Macroeconomics, PHI Learning Pvt Ltd, 2014
- Andrew B. Abel and Ben S. Bernanke, Macroeconomics, Pearson Education, Inc., 7th edition, 2011.
- Venieris, Y.P. and Sebold F.D. , Macroeconomics: Models and Policy, John Wiley and Sons, 1977
- Richard T. Froyen, Macroeconomics, Pearson Education Asia, 10th edition, 2016.
- William Branson. Macroeconomic Theory and Policy, Indian reprint, East West Press, 3rd edition, 2014.
- Levacic Rosalind and Rebmann Alexander, Macroeconomics: An Introduction to Keynesian and Neo-Keynesian Controversies, Palgrave Macmillan, 1982.

- Sikdar Soumyen, Principles of Macroeconomics, Oxford University Press
- Blaug Mark , Economic Theory in Retrospect, 5th Edition, Cambridge University Press, 1997
- Mueller, M. (edited), Readings in Macroeconomics, London: Holt, Rinehart and Winston, 1973.

Economics Core Course VII: ECO-A-CC-3-7-TH-TU

Statistical Methods for Economics

Total Marks: 100 [Theory(Th) 65 + Tutorial(Tu) 15 + Internal Assessment 10+Attendance: 10]

Total Credits: [5(Th)+1(Tu)]=6 ,

No. of Lecture hours: 75, No. of Tutorial contact hours: 15

[For Semester III]

ECO-A-CC-3-7-TH

1. Introduction and Overview — 6 lecture hours

- Subject-matter - the distinction between population and sample *[1 lecture hour]*
- Representation of data- graphical (line diagram, bar diagram, pie chart) and tabular method *[2 lecture hours]*
- Frequency Distribution *[3 lecture hours]*

2. Descriptive Statistics — 13 lecture hours

- Measures of central tendency(arithmetic mean, geometric mean, harmonic mean, median and mode, and their properties, Quartiles,Deciles and Percentiles) *[3 lecture hours]*
- Dispersion(range, quartile deviation, mean deviation, standard deviation, coefficient of variation, coefficient of mean deviation, coefficient of quartile deviation, Lorenz curve and Gini coefficient) *[4 lecture hours]*
- Moments, Skewness and Kurtosis (definition, computation) *[2 lecture hours]*
- Correlation and Regression (definition, computation, properties) *[4 lecture hours]*

3. Elementary Probability Theory — 10 lecture hours

- Sample spaces and events (concepts and definitions using set theory) *[2 lecture hours]*
- Axiomatic definition of probability and properties, theorem of total probability *[3 lecture hours]*
- Conditional probability, theorem of compound probability *[3 lecture hours]*
- Bayes' theorem and its applications. *[2 lecture hours]*

4. Probability Distributions — 18 lecture hours

- Random variable(discrete and continuous) *[1 lecture hour]*
- Probability distributions (pmf, pdf. Distribution functions) *[2 lecture hours]*

- Expected values of random variables (mean,variance, raw moment, central moment, moment generating functions) *[3 lecture hours]*
- Properties of commonly used discrete and continuous distributions:

  Binomial -(derivation of pmf, mean,variance, moments, moment generating functions, problems) *[3 lecture hours]*

  Poisson - (derivation of pmf, mean, variance, moments, moment generating functions, problems) *[3 lecture hours]*

  Normal - (derivation of pdf, mean, variance, moments, moment generating functions, problems) *[3 lecture hours]*
- Joint distribution functions of random variables (discrete and continuous) - joint pdf (pmf), marginal pdf (pmf)., conditional pdf (pmf) *[3 lecture hours]*

5. Sampling **14 lecture hours**

- Principal steps in a sample survey (concepts of population, sample, parameter, statistic) *[2 lecture hours]*
- Methods of sampling-

  SRSWR, SRSWOR(use of random sampling numbers) *[2 lecture hours]*

  Stratified sampling (basic concepts only) *[1 lecture hour]*

  Multi-staged sampling (basic concepts only) *[1 lecture hour]*
- Sampling distribution of sample mean and sample proportion

  Mean and standard error both inSRSWR and SRSWOR *[4 lecture hours]*

  Standard normal, chi-square, Student‘s t and F distributions – definitions, important properties (mean and variance) *[4 lecture hours]*

6. Statistical inference **14 lecture hours**

- Point estimation-Properties of a good estimator; *[4 lecture hours]*
- Basic principles of

  Ordinary Least Square, *[2 lecture hours]*

  Maximum Likelihood Method *[1 lecture hour]*

  Method of Moments; *[1 lecture hour]*
- Interval estimation.*[2 lecture hours]*
- Testing of hypothesis (basic conceptsof null hypothesis, alternative hypothesis, type I and Type II errors, power of a test, p-value) *[4 lecture hours]*

ECO-A-CC-3-7-TU

Tutorial contact hours: 15 [for revision, doubt clearing, solving problems]

Text books

- Goon, A. M, Gupta, M. K, and Dasgupta, B. Fundamentals of Statistics (Volume One, Volume two), The World Press Private Ltd
- William G. Cochran, Sampling Techniques, John Wiley, 2007

Reference books

- John E. Freund, Mathematical Statistics, Prentice Hall, 1992.
- Mood, A.M., F. A. Graybill and D.C. Boes, Introduction to the theory of statistics, McGraw Hill, 1974.

Skill Enhancement Course I: ECO-A-SEC-3-A(1)-TH

Data Analysis [DA]

Total Marks: 100 [Theory (Th) 80 + Internal Assessment 10+Attendance: 10]

Total Credits: 2,

No. of Lecture hours: 30

[For Semester III]

Unit 1: Collection and representation of data **12 lecture hours**

1.1 Collection of data (some methodological issues) *[4 lecture hours]*

1.1.1 Census

1.1.2 Sample survey

1.2 Representation of data *[2 lecture hours]*

1.3 The basics of data management in Stata / R / Eviews / SPSS / MS Excel *[6 lecture hours]*

Unit 2: Indian Official Statistics (Basic concepts) **18 lecture hours**

1. Central Statistical Office (CSO) – National Accounts Statistics (NAS), Industrial Statistics (ASI, IIP) *[6 lecture hours]*
2. National Sample Survey Office (NSSO) – Household Consumer Expenditure Survey Rounds, Employment and Unemployment Survey Rounds *[6 lecture hours]*
3. Census of India – Population Census 2011 *[4 lecture hours]*
4. Reserve Bank of India (RBI) – Handbook of Statistics on Indian Economy (Selected parts) *[2 lecture hours]*

Suggested Readings:

1. Goon, A. M, Gupta, M. K, and Dasgupta, B. *Fundamentals of Statistics (Volume One)*, The World Press Private Ltd
2. GOI, *Note on Sample Design and Estimation Procedure of NSS 68th Round*, National Sample Survey Office, Ministry of Statistics and Programme Implementation.
3. GOI, *SRS Statistical Report 2016*, Office of the Registrar General & Census Commissioner, India

Suggested Websites

www.mospi.nic.in

www.censusindia.gov.in

www.rbi.org.in

Skill Enhancement Course I: ECO-A-SEC-3-A(1)-TH

Rural Development [RD]

Total Marks: 100 [Theory(Th) 80 + Internal Assessment 10+Attendance: 10]

Total Credits: 2,

No. of Lecture hours: 30

[For Semester III]

1. **Aspects of Rural Development** **6 lecture hours**

- Concept of Rural Development
- Rural Development vs. Agricultural Development
- Role of NGOs in Rural Development
- Rural Non Farm Sector and Rural Development

2. **Panchayats and Rural Development** **5 lecture hours**

- Decentralized Planning and Participatory Development
- Role of Panchayats in Decentralized Rural Development
- Participatory Rural Appraisal
- Panchayats and Rural Development in West Bengal

3. **Rural Credit and Self Help Groups(SHGs)** **11 lecture hours**

- Role National Bank for Agriculture and Rural Development (NABARD) for promoting Rural Development
- Constraints of micro-enterprises in rural areas
- Credit needs for rural non farm sector.
- The concept of Micro credit
- Micro credit and the role of Grameen Bank
- Need for SHG for formation and features of SHG
- SHGs in India

4. **Critical Evaluation of Selected Government Programmes and Rural Development** **8 lecture hours**

- Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA) and Rural Development
- Child labour and school drop-out in rural areas. Mid-day Meal and Rural Development
- National Rural Health Mission (NRHM) and Rural Development

- Pradhan Mantri Gram Sadak Yojana (PMGSY) and Rural Development

References

1. Katar Singh , Rural Development : Principles, Policies and Management, Sage Publications, New Delhi
2. K.G. Karmakar, Rural Credit and Self-Help Groups, Sage Publications, New Delhi
3. S.Sau, Rural Industrialization –Development Trajectory in India, Farma K.L.M., Kolkata
4. Misra D. and Puri K. Indian Economy, Himalaya Publishing House
5. Datt and Sundharam (Revised by G.Datt and A. Mahajan) , Indian Economy, 70th edition, S. Chand
13. N. Narayanasami, Participatory Rural Appraisal: Principle, Methods and Applications, Sage Publications, New Delhi, 2009.
14. Vasant Desai, A Study of Rural Economics, Himalaya Publishing House, New Delhi.
15. Mahi Pal, ―Panchayati Raj and Rural governance‖, Economic and Political Weekly, Jan. 10-16, vol. XXXIX, 2004,No.2, p.13
16. Raghava, D. V. Rao, Panchayats and Rural Development, Ashish Publishing House, New Delhi, 1980.
17. Ram Reddy, Pattern of Panchayati Raj in India, Heritage Publishers, New Delhi, 2005.
18. Latest Reports on Panchayati Raj Development in West Bengal

Economics Core Course VIII: ECO-A-CC-4-8-TH-TU

Intermediate Microeconomics II

Total Marks: 100 [Theory (Th) 65 + Tutorial(Tu) 15 + Internal Assessment 10+Attendance: 10]

Total Credits: [5(Th)+1(Tu)]=6 ,

No. of Lecture hours: 75, No. of Tutorial contact hours: 15

[For Semester IV]

ECO-A-CC-4-8-TH

Unit 1: Imperfect Market Structure **40 lecture hours**

1.1 Monopoly and barriers to entry- output determination and price rule, measure and sources of monopoly power, social costs of monopoly power-deadweight loss

1.2 Pricing with market power- first, second and third degree price discrimination, multiplant monopoly

1.3 Monopolistic competition- short run and long run equilibrium, excess capacity

1.4 Oligopoly- Oligopoly equilibrium as Nash equilibrium, Cournot, Bertrand and Stackelberg Model- use of isoprofit curves and simple game theoretic interpretation. Sweezy‘s kinked demand

curve model and non-collusive equilibrium. Competition versus collusion- the Prisoners' Dilemma. Collusive Oligopoly –Cartels and Price Leadership

Unit 2: Input market under Imperfect Competition **5 lecture hours**

2.1 Monopsony, bilateral monopoly in labour market

Unit 3: General Equilibrium, Efficiency and Welfare **30 lecture hours**

3.1 General Equilibrium and Economic Efficiency- Exchange, production and welfare, Pareto Optimality, Edgeworth box and contract curve, Pareto efficiency and perfect competition

3.2 Reasons for Market failure, Pareto efficiency and market failure (externalities and public goods), property right and Coase Theorem

3.3 Markets with asymmetric information-adverse selection, moral hazards, agency problems (concepts only) **ECO-A-**

CC-4-8-TU Tutorial

Contact Hours: 15

Text

- Pindyck, Rubinfeld and Mehta, Microeconomics, Pearson

References

1. Hal. R Varian , Microeconomic Analysis, WW Norton and Company, 3rd edition, 2013
2. J Tirole, Theory of Industrial Organisation, MIT Press, 1988
3. K Binmore, Fun and Games: A text on Game Theory, OUP,1991
4. Anindya Sen, Microeconomics, OUP
5. C. Snyder and W. Nicholson, Fundamentals of Microeconomics, Cengage Learning, 2010
6. Satya Chakrabarty, Microeconomics, Allied Publishers
7. Ferguson, C. E. and Gould, J.P., Microeconomic Theory, Aitbs Publishers and Distributors, New Delhi.
8. Cohen, K.J. and Cyert, R.M. , ―Theory of the Firms: Resource Allocation in a Market Economy‖ , Prentice Hall India,1981
9. Chauhan, S.P.S. , – Microeconomics- An Advanced Treatise‖, Prentice Hall India, 2009.

Economics Core Course IX: ECO-A-CC-4-9-TH-TU

Intermediate Macroeconomics II

Total Marks: 100 [Theory(Th) 65 + Tutorial(Tu) 15 + Internal Assessment 10+Attendance: 10]

Total Credits: [5(Th)+1(Tu)]=6 ,

No. of Lecture hours: 75, No. of Tutorial contact hours: 15

[For Semester IV]

ECO-A-CC-4-9-TH

1. Basic Tenets of New Classical and New Keynesian Theories 20 lecture hours

- New Classical Theory-The concept of rational expectations and the theory of real business cycle-introductory ideas
- New Keynesian Theory- nominal rigidities and real rigidities, rigidities in interest rates and credit rationing-introductory ideas

2. Macroeconomic Foundations -II 20 lecture hours

- Consumption: Keynesian consumption function; Fisher‘s theory of optimal intertemporal choice; life-cycle and permanent income hypotheses; Dusenberry‘s relative income hypothesis; rational expectations and random-walk of consumption expenditure.
- Demand for money: Regressive Expectations and Tobin‘s portfolio choice models; Baumol‘s inventory theoretic money demand.

3. Economic Growth 35 lecture hours

- Harrod and Domar models of economic growth.
- Solow one sector growth model-golden rule- -dynamic efficiency.
- Technological progress ,
- Elements of endogenous growth theory-basic ideas-the AK model

ECO-A-CC-4-9-TU

Tutorial Contact hours: 15

Textbooks:

- N. Gregory Mankiw. Macroeconomics, Worth Publishers, 2010
- Ghosh Chandana and Ghosh Ambar, Macroeconomics, PHI Learning Pvt Ltd, 2014

References

- Richard T. Froyen, Macroeconomics, Pearson Education Asia, 2nd edition, 2005.
- Romer David , Advanced Macroeconomics, McGraw Hill Education, 4th edition, 2011.
- Ghosh Chandana and Ghosh Ambar, Economics of the Public Sector, PHI Learning Pvt Ltd, 2008

- Andrew B. Abel and Ben S. Bernanke, Macroeconomics, Pearson Education, Inc., 7th edition, 2011.
- Richard T. Froyen, Macroeconomics, Pearson Education Asia, 10th edition, 2016.
- Steven M. Sheffrin, Rational Expectations, Cambridge University Press, 2nd edition, 1996.
- William Branson. Macroeconomics , Harper and Row, 3rd edition, 1989
- Snowdon and Vane (ed), A Macroeconomics Reader, Routledge, Taylor and Francis Group.
- R. Barro. Macroeconomics, 5th edition, The MIT Press, 1989
- A.K.Sen (ed). Growth Economics, Penguin, 1970
- Barro, R.J. and Xavier Sala-i-Martin , Economic Growth,
- Errol D'Souza. Macroeconomics, Pearson Education (New Delhi), 2009.
- Dornbusch, Fischer and Startz, Macroeconomics, McGraw Hill, 11th edition, 2010.
- Laidler, E.W. ,The Demand for Money : Theories and Evidence, Dun-Donnelley Publishing Corporation, New York, 1978.

Economics Core Course X: ECO-A-CC-4-10-TH-TU

Introductory Econometrics

Total Marks: 100 [Theory(Th) 65 + Tutorial(Tu) 15 + Internal Assessment 10+Attendance: 10]

Total Credits: [5(Th)+1(Tu)]=6 ,

No. of Lecture hours: 75, No. of Tutorial contact hours: 15

[For Semester IV]

ECO-A-CC-4-10-TH

1. Nature and Scope of Econometrics 4 lecture hours

1.1 Distinction between Economic Model and Econometric model *[1 lecture hour]*

1.2 Concept of stochastic relation, Role of random disturbance in econometric model *[1 lecture hour]*

1.3 Types of data *[1 lecture hour]*

1.4 Application of Econometrics in different branches of social science *[1 lecture hour]*

2. Classical Linear Regression Model (Simple linear regression and multiple linear regression): part 1 15 lecture hours

2.1 The classical assumptions (basic interpretation) *[1 lecture hour]*

2.2 Concepts of population regression function and sample regression function *[3 lecture hours]*

2.3 Estimation of model by method of ordinary least squares (Derivation in simple linear model (SLRM) and multiple linear model (MLRM) with two regressors only) *[6 lecture hours]*

2.4. Simple correlation, partial correlation and multiple correlation (Definition, and interpretation in the context of SLRM and MLRM) *[2 lecture hours]*

2.5 Limitations of SLRM and additional complications in MLRM *[2 lecture hours]*

2.6 Economic interpretations of the estimated model *[1 lecture hour]*

3. Classical Linear Regression Model (Simple linear regression and multiple linear regression): part 2 **10 lecture hours**

3.1 Properties of the Least Squares Estimators (BLUE) in SLRM- Gauss-Markov theorem *[4 lecture hours]*

3.2 Qualitative (dummy) independent variables – intercept dummy and slope dummy (only interpretation of the model) *[3 lecture hours]*

3.3 Forecasting - Ex-post forecast and Ex-ante forecast, forecast error (only for two variable model) *[3 lecture hours]*

4. Statistical inference in linear regression model **26 lecture hours**

4.1 Use of standard normal, chi2, t, and F statistics in linear regression model *[9 lecture hours]*

4.2 Testing hypothesis *[12 lecture hours]*

Single test (t test and chi2 test)

Joint test (F test)

4.3 Goodness of fit (in terms of R^2, adjusted R^2 and F statistic), Analysis of Variance (ANOVA) *[3 lecture hours]*

4.4 Statistical significance and economic importance *[2 lecture hours]*

5. Violations of Classical Assumptions **12 lecture hours**

5.1 Multicollinearity - Consequences, Detection (Variance Inflationary Factor (VIF)) and Remedies *[4 lecture hours]*

5.2 Heteroscedasticity - Consequences, Detection (Lagrange Multiplier test) and Remedies *[4 lecture hours]*

5.3 Autocorrelation - Consequences, Detection (Durbin-Watsontest) and Remedies *[4 lecture hours]*

6. Specification Analysis **8 lecture hours**

6.1 Omission of a relevant variable *[2 lecture hours]*

6.2 Inclusion of irrelevant variable *[2 lecture hours]*

6.3 Tests of specification errors *[2 lecture hours]*

6.4 Testing for linearity and normality assumptions *[2 lecture hours]*

ECO-A-CC-4-10-TU

Tutorial Contact hours: 15

Text Books

1. Gujarati, Damodar (2004), *Basic Econometrics*, McGraw-Hill

2. Wooldridge, Jeffrey M. (2013), *Introductory Econometrics* – A Modern Approach, CENGAGE learning

Reference Books

1. Maddala, G. S. (2002), *Introduction to Econometrics*, Macmillan Publishing Company
2. Goon, A. M, Gupta, M. K, and Dasgupta, B., *Fundamentals of Statistics* (Volume One), The World Press Private Ltd

Skill Enhancement Course II: ECO-A-SEC-4-B(2)-TH

Research Methodology

Total Marks: 100 [Theory (Th) 80 + Internal Assessment 10+Attendance: 10]

Total Credits: =2,

No. of Lecture hours: 30,

[For Semester IV]

Unit 1 : Methodological Issues 1 **10 lecture hours**

- Locating the basic issues- theme based literature survey and motivation behind any study-objectives of the study-development of writing skills
- Designing the sampling frame in case of field survey- the role of pilot survey
- The role of random numbers in drawing random sample
- Methods behind preparation of questionnaire in case of field survey
- Data entry after field survey
- Tabular representation of data and graphs for data interpretation

Unit 2: Methodological Issues 2 **20 lecture hours**

- Theoretical and Empirical Research in Economics.
- Common sections of an ideal research paper in Economics.
- Illustrations of empirical research work. Reporting the regression results and interpretation of the results: the role of statistical inference.[The course instructor should focus on framing the testable hypothesis and the role of statistical inference in empirical research]
- Illustrations of theoretical research: specification of the model, closing the model, checking stability of the model for meaningful comparative static results. [The course instructor should focus on the role of stability analysis in theoretical models by showing the method of linearizing non-linear differential equations. Illustrations can be made from IS-LM model by using trace and determinant conditions of the Jacobian matrix-the role of phase diagrams]
- Role of footnotes or end notes in a research paper
- Bibliography, reference and citation

- Writing the abstract of a research paper
- Key words and JEL Classification
- Presentation of a research paper through power point. Basic rules to be followed for a good presentation. Role of diagrams, graphs, pictures and charts.

Suggested Readings

1. Goon, A. M, Gupta, M. K, and Dasgupta, B. Fundamentals of Statistics (Volumes One and Two),The World Press Private Ltd
2. C.R. Kothari : Research Methodology : Methods and Techniques (second revised edition), New Age India (P) Ltd Publishers.
3. Alpha C. Chiang and Kavin WainWright : Fundamental Methods of Mathematical Economics, McGraw Hill, 2005.[For stability analysis]

Skill Enhancement Course II: ECO-A-SEC-4-B(2)-TH

Managerial Economics

Total Marks: 100 [Theory (Th) 80 + Internal Assessment 10+Attendance: 10]

Total Credits: =2,

No. of Lecture hours: 30,

[For Semester IV]

1. Demand, Cost and Profit Analysis 6 lecture hours

- Demand for durable and non durable products, demand forecasting techniques
- Cost estimation
- Cost-volume-profit analysis (break even analysis)- objectives and assumptions; determination of breakeven point, limitations of c-v-p analysis

2. Pricing Policies and practices 3 lecture hours

- Factors governing prices, price discounts and differentials, price forecasting

3. Capital Budgeting 8 lecture hours

- What is capital budgeting, need for capital budgeting, different steps in capital budgeting, Capital budgeting appraisal methods – payback method, accounting rate of return method, net present value method, interest rate of return method, benefit cost ratio method. Capital rationing, alternative methods of financing investments

4. Cost of capital 5 lecture hours

- Cost of debt capital, cost of share capital, cost of equity capital, cost of retained earnings

5. Inventory Management **8 lecture hours**

- Inventory costs, concepts of average inventory, various inventory models- economic order quantity, optimum number of orders per year, optimum number of days supply per order.

References

- Varshney R.L., and Maheshwari K.L. – Managerial Economics, Sulatn Chand, N Delhi
- Keat P. G. and Young P.K.Y – Manegerial Economics, Pearson Education, N Delhi]
- Mehta P.L - – Managerial Economics, Sulatn Chand, N Delhi
- Samuelson W.F and Marks S,G - – Managerial Economics, Wiley Student Education
- Clarke T. International Corporate Governance, Routledge.

Economics Core Course XI: ECO-A-CC-5-11-TH-TU

International Economics

Total Marks: 100 [Theory(Th) 65 + Tutorial(Tu) 15 + Internal Assessment 10+Attendance: 10]

Total Credits: [5(Th)+1(Tu)]=6 ,

No. of Lecture hours: 75, No. of Tutorial contact hours:15

[Semester V]

ECO-A-CC-5-11-TH

1. Absolute and Comparative Advantages of Trade **9 lecture hours**

- Adam Smith's theory of absolute advantage.
- David Ricardo's theory of comparative advantage.
- Arbitrage as the basis and direction of trade; fundamental sources of cross-country price differences and arbitrage-concept of comparative advantage; externalities, regulation and perverse comparative advantage
- One factor economy, production possibility frontier, relative demand and relative supply, terms of trade, trade in the Ricardian world, determination of intermediate TOT, complete vs incomplete specialization, complete specialization and gains from trade.

2. The Building Blocks of Trade Theory **14 lecture hours**

- The concept of community indifference curve-Justification and properties.
- The need for trade indifference curves, derivation of trade indifference curves, properties of trade indifference map, Offer curves and its properties. Three important elasticities- the elasticity of offer curves, the elasticity of demand for imports, the elasticity of supply of exports. International equilibrium and offer curves, terms of trade (TOT) and stability, the Marshall-Lerner condition,
- Gains from Trade (GFT) theorem, illustration of GFT, decomposition of GFT, substitution possibilities and magnitude of GFT.

- Production structure for neo-classical trade models, role of constant returns to scale, the concept of unit isoquants, duality in the production structure, significance of the envelope condition in trade models

3. Factor Endowment and Trade (Heckscher-Ohlin-Samuelson Model) 15 lecture hours

- Heckscher-Ohlin (HO)theorem and price vs physical definitions of relative factor abundance.
- Role of homotheticity of tastes in the context of physical definition
- Factor Intensity Reversal in the context of price and physical definitions and invalidity of HO Theorem.
- Factor intensity ranking, one-to-one correspondence between commodity price ratio & factor price ratio (Stolper-Samuelson theorem), One to one correspondence between endowment ratio and production proportion (Rybczyski theorem) .
- The Factor Price Equalization Theorem. Factor price equalization and complete specialization.
- Incomplete Specialization, Factor price equalization and Factor Intensity Reversal
- Empirical studies- Leontief Paradox.

4. Applications of Neo-classical Trade Models for developing countries 10 lecture hours

- Jones (1965) Heckscher-Ohlin type 2x2(two factors-two commodities) full employment model for small open developing economies. Basic structure –significance of the assumption of constant returns to scale- the decomposability property-the capital intensity condition in physical and value terms- Implications of Stolper-Samuelson and Rybczynski theorems-the price and output magnification effects.
- Jones (1971) 3x2(three factors-two commodities) specific-factor model. Basic structure-significance of the assumption of constant returns to scale-the indecomposability property. Implications of price magnification effects in specific factor model.

5. Trade Policy 12 lecture hours

- Partial Equilibrium Analysis of Tariff - cost–benefit, Quota, Quota- Tariff equivalence & non-equivalence, monopoly effects of quota, subsidy and voluntary export restraint.
- General Equilibrium Analysis- distinction between large and small economy, welfare effects of a tariff on small country and large country. Tariff ridden offer curve, Tariff war, Optimum tariff for large economy, Metzler‘s Paradox.

6. Open Economy Macroeconomics and Balance of Payments 15 lecture hours

- Determination of equilibrium income in open economy. Foreign Trade Multiplier with & without repercussion effects.

- Balance of Payment accounts in an open economy. Autonomous and accommodating transactions.
- Fixed &Flexible Exchange Rates: adjustment of demand and supply of Foreign Exchange, Effect of devaluation, The Mundel-Fleming Model (IS LM BP model)

ECO-A-CC-5-11-TU

Tutorial Contact hours: 15

Texts

1. P. Krugman and M. Obstfeld- International Economics (8th Edition) ; Pearson Education
2. R. Caves, J. Frankel and R.W. Jones – World Trades & Payments (9th Ed); Pearson Education.
3. Rajat Acharyya- International Economics; Oxford University Press

References

- J.R. Markusen, J.R. Melvin, W.H. Kaempfer, K.E. Maskus – International Trade – Theory and Evidence, McGraw Hill
- B. Sodersten, and G. Reed (1994) : International Economics , Macmillan, London, 3rd edition.
- M. Chacoliades (1978) : International Trade: Theory and Policy, New York, McGraw- Hill
- R. Dornbusch : Open Economy Macroeconomics, Basic Books, Inc. Publishers, New York**.**
- Jones, R.W. : ‒ The Structure of Simple General Equilibrium Models‖, Journal of Political Economy, Vol 73, 1965, pp 551-572
- Jones, R.W. : ‒ A Three Factor Model in Theory, Trade and History‖, in Bhagwati. J. et al (eds) Trade, Balance of Payments and Growth, 1971, North Holland, Amsterdam.
- Chaudhuri, S. and Mukhopadhyay, U.: Foreign Direct Investment in Developing Countries: A Theoretical Evaluation, Springer, Chapter 2 only, 2014.

Economics Core Course XII: ECO-A-CC-5-12-TH-TU

Indian Economy

Total Marks: 100

[Theory (Th) 65 + Tutorial Based Term Paper (Tu) 15 + Internal Assessment 10+Attendance: 10]

Total Credits: [5(Th)+1(Tu)]=6 ,

No. of Lecture hours: 75, No. of Tutorial Based Term Paper contact hours: 15

[Semester V]

ECO-A-CC-5-12-TH

1. Economic Development since Independence **20 lecture hours**

- Growth and development under different policy regimes (from planning to market based development)
  - Objectives, achievements and failures of Planning *[4 lecture hours]*
  - Economic crisis during the late 1980s *[3 lecture hours]*

- Economic Reforms –Critical Analysis *[3 lecture hours]*

- Structural changes in the post-reforms period *[5 lecture hours]*
- Regional variation of growth and development *[5 lecture hours]*

2. Population and Human Development **15 lecture hours**

- Demographic trends and issues *[6 lecture hours]*
- Education and health:Basic problems and Government measures, Right to Education (RTE) Act 2009 *[9 lecture hours]*

3. Growth and Distribution **20 lecture hours**

- Trends in GDP and per capita GDP *[5 lecture hours]*
- Growth, poverty and inequality *[5 lecture hours]*
- Youth unemployment (School Transition to Work) *[5 lecture hours]*
- Policy perspectives in growth and distribution *[5 lecture hours]*

4. **Economic Reforms in India** **20 lecture hours**

- Banking sector reforms *[5 lecture hours]*
- Reforms in tax policy *[5 lecture hours]*
- Reforms in the external sector *[5 lecture hours]*
- Reforms in Labour market *[5 lecture hours]*

ECO-A-CC-5-12-TU

Tutorial Based Term Paper Contact Hours: 15 (for review classes, presentation by the students)

A term paper is to be prepared by the student under Tutorial Based Term Paper on any topic under the four broad themes covering the syllabus for the tutorial. Term paper should cover a literature survey of the topic along with a critical evaluation of the policy measures undertaken in the Indian context to tackle the specified problem. It should be prepared under a full time teacher of the subject belonging to the institution. All total 15 hours are allotted for a term paper. It is to be evaluated (all total 15 marks) jointly by an internal and an external examiner(if it is permitted under University rules) on the basis of the content of the term paper along with viva-voce on the term paper.

References

- Jean Dreze and AmartyaSen, 2013. An Uncertain Glory: India and its Contradictions, Princeton University Press.
- Jean Dreze and Amartya Sen: Economic Development and social opportunity, OUP

- Mihir Rakshit, 2011, Macroeconomics of Post-Reform India, OUP
- Sukhomoy Chakraborty: Development Planning: The Indian Experience, OUP
- Uma Kapila: Indian Economy since independence, Academic Foundation
- Ahluwalia and Little (ed): India‘s Economic Reforms and Development, OUP
- Joshi and Little: India‘s Economic Reforms, OUP
- Pulapre Balakrishnan, 2007, the Recovery of India: Economic Growth in the Nehru Era, Economic and Political Weekly, November.
- Panchanan Das. (2012), Wage Inequality in India - Decomposition by Sector, Gender and Activity Status, Economic and Political Weekly, 47(50), pp. 58-64
- Rakesh Mohan, 2008, ―Growth Record of Indian Economy: 1950-2008. A Story of Sustained Savings and Investment, Economic and Political Weekly, May.
- S.L. Shetty, 2007, ―India‗s Savings Performance since the Advent of Planning, in K.L. Krishna and A. Vaidyanathan, editors, Institutions and Markets in India‘s Development.
- Himanshu, 2010, Towards New Poverty Lines for India, Economic and Political Weekly, January.
- Jean Dreze and Angus Deaton, 2009, Food and Nutrition in India: Facts and Intepretations, Economic and Political Weekly, February.
- Himanshu. 2011, ―Employment Trends in India: A Re-examination, Economic and Political Weekly, September.
- Rama Baru et al, 2010, ―Inequities in Access to Health Services in India: Caste, Class and Region, Economic and Political Weekly, September.
- Geeta G. Kingdon, 2007, ―The Progress of School Education in India, Oxford Review of Economic Policy
- J.B.G. Tilak, 2007, ―Post Elementary Education, Poverty and Development in India, International Journal of Educational Development.
- T. Dyson, 2008, ―India‗s Demographic Transition and its Consequences for Development‖ in Uma Kapila, editor, Indian Economy Since Independence, 19th edition, Academic Foundation.
- Kaushik Basu, 2009, ―China and India: Idiosyncratic Paths to High Growth, Economic and Political Weekly, September.
- K. James, 2008, ―Glorifying Malthus: Current Debate on Demographic Dividend in India Economic and Political Weekly, June.
- Reetika Khera, 2011, ―India‗s Public Distribution System: Utilisation and Impact Journal of Development Studies.
- Aniruddha Krishna and DevendraBajpai, 2011, ―Lineal Spread and Radial Dissipation: Experiencing Growth in Rural India, 1992-2005, Economic and Political Weekly, September.
- Kaushik Basu and A. Maertens, Eds, 2013, The New Oxford Companion to Economics, Oxford University Press.

Discipline Specific Elective – A(1):

ECO-A-DSE-5-A(1)-TH-P Applied Econometrics [AE] *Total Marks: 100*

[Theory (Th) 50+ Practical (P) 30 + Internal Assessment 10 + Attendance: 10]

Total Credits: [4(Th)+2(P)]=6 ,

No. of Lecture hours: 60, No. of Practical hours: 60/No. Of Practical classes: 30

[Semester –V]

ECO-A-DSE-5- A(1) –TH

1. Steps in empirical research **10 lecture hours**

1.1 Use of econometric models in empirical research – some basic concepts *[5 lecture hours]*

1.2 The basic commands in Stata / R *[5 lecture hours]*

2. Regression Diagnostics and Specification **20 lecture hours**

2.1 Misspecification *[4 lecture hours]*

2.2 Functional forms *[4 lecture hours]*

2.3 Model selection *[4 lecture hours]*

2.4 Application with Stata / R *[8 lecture hours]*

3. Application of Regression Analysis **30 lecture hours**

3.1 Cross section analysis – Linear regression model with two regressors (by using survey data like NSSO with Stata / R) *[6 lecture hours]*

3.2 Time series analysis (very preliminary level) – Basic concepts of time series, Estimating linear trend (by using NAS with Stata / R) *[12 lecture hours]*

3.3 Panel data analysis – basic concepts of fixed effects model; random effects model – (Application with Indian Official Statistics using Stata / R) *[12 lecture hours]*

ECO-A-DSE-5-A(1)-P

Total Practical Hours: 60, No of Practical Classes: 30

Applications of use of softwares STATA or R will be demonstrated in the computer laboratory in practical classes and the practical examination will be conducted in the usual manner as mentioned in CSR.

Text Books

1. Christopher F. Baum, (2006), An Introduction to Modern Econometrics Using Stata, Stata Press

2. Maddala, G. S. (2002), Introduction to Econometrics, Macmillan Publishing Company

3. Wooldridge, Jeffrey M. (2013), Introductory Econometrics – A Modern Approach, CENGAGE learning

4. Hamilton L. Statistics with Stata

References

STATA USER'S GUIDE RELEASE 13, https://www.stata.com/manuals13/u.pdf

Discipline Specific Elective – A(1):

ECO-A-DSE-5-A(1)-TH-TU

Economic History of India (1857-1947) [EHI]

Total Marks: 100 [Theory(Th) 65 + Tutorial(Tu) 15 + Internal Assessment 10+Attendance: 10]

Total Credits: [5(Th)+1(Tu)]=6 ,

No. of Lecture hours: 75, No. of Tutorial contact hours: 15

[Semester- V]

ECO-A-DSE-5-A(1) –TH

1. Impact of British rule on India **30 lecture hours**

- Deindustrialization
- Commercialization of agriculture
- Economic Drain

2. Aspects of Economic Policies in British India **45 lecture hours**

- Land policy
- Policy of Discriminating Protection
- Early Industrial Development and Managing Agency System
- Currency and monetary policy
- Development of Infrastructure – Railways

ECO-A-DSE-5-A(1)-TU

Tutorial contact hours: 15

References

1. Lakshmi Subramanian, ―History of India 1707-1857‖, Orient Blackswan, 2010, Chapter 4.
2. SumitGuha, 1991, Mortality decline in early 20th century India‟, Indian Economic and Social History Review (IESHR), pp 371-74 and 385-87.
3. Tirthankar Roy, The Economic History of India 1857-1947, Oxford University Press, 3rd edition, 2011.
4. B. Chandra B. (2010): Rise and Growth of Economic Nationalism in India, HarAnand Publications,
5. J. Krishnamurty, Occupational Structure, Dharma Kumar (editor), The Cambridge Economic History of India, Vol. II, (henceforth referred to as CEHI), 2005, Chapter 6.
6. IrfanHabib, Indian Economy 1858-1914, A People‟s History of India, Vol.28, Tulika, 2006.

7. Ira Klein, 1984, ―When Rains Fail: Famine relief and mortality in British India‖, IESHR 21.
8. Jean Dreze, Famine Prevention in India in Dreze and Sen (eds.) Political Economy of Hunger, WIDER Studies in Development Economics, 1990, pp.13- 35.
9. John Hurd, Railways, CEHI, Chapter 8, pp.737-761.
10. Rajat Ray (ed.), Entrepreneurship and Industry in India, 1994.
11. AK Bagchi, ―Deindustrialization in India in the nineteenth century: Some theoretical implications Journal of Development Studies, 1976.
12. MD Morris, Emergence of an Industrial Labour Force in India, OUP 1965, Chapter 11, Summary and Conclusions.
13. K.N. Chaudhuri, Foreign Trade and Balance of Payments, CEHI, Chapter 10.
14. B.R. Tomlison, 1975, India and the British Empire 1880-1935, IESHR, Vol.XII.
15. Dharma Kumar, The Fiscal System, CEHI, Chapter 12.
16. Basudev Chatterjee, Trade, Tariffs and Empire, OUP 1992, Epilogue.
17. Daniel Thorner, Agrarian Prospect in India, 1977.
18. Visaria and P. Visaria, Population. CEHI, Chapter

Discipline Specific Elective-B(1):
ECO-A-DSE-5-B(1)-TH-TU
Comparative Economic Development (1850-1950) [CED]

Total Marks: 100 [Theory(Th) 65 + Tutorial(Tu) 15 + Internal Assessment 10+Attendance: 10]

Total Credits: [5(Th)+1(Tu)]=6 ,

No. of Lecture hours: 75, No. of Tutorial contact hours: 15

[Semester-V]

ECO-A-DSE-5-B(1)-TH

1. Strategies and Policies for Economic Development 30 lecture hours

- Laissez-faire and free trade
- Strategy of industrialization in Soviet Union.

- Ha-Joon Chang. 2002. *Kicking Away the Ladder—Development Strategy in Historical Perspective*. London: Anthem Press. Chapter 2 (excluding NICs).
- Alec Nove. 1992. *An Economic History of the USSR 1917-1991*, London: Penguin 1992, chapter 8.

2. Regions of contemporary development 45 lecture hours

- Success stories of Asia : Japan, South East Asia and China
- Crisis and failures of Latin America and Africa

- Ha-Joon Chang. 2002. *Kicking Away the Ladder—Development Strategy in Historical Perspective*. London: Anthem Press. Chapter 2, 46-51.

- Ha-Joon Chang. 2004. ―The East Asian Development Experience‖, in *Rethinking Development Economics*, edited by Ha-Joon Chang, pp. 107-124. London: Anthem Press.
- PranabBardhan, ―What Makes a Miracle: Some Myths About the Rise of China and India‖, *Boston Review*, January/February 2008; and ―Introduction: The Myths Floating Around the Giants‖, in *Awakening Giants, Feet of Clay: Assessing the Economic Rise of China and India* (Princeton: Princeton University Press, 2010.
- Gabriel Palma. 2004. ―Latin America During the Second Half of the Twentieth Century – From the ‗Age of Extremes' to the Age of ‗End-of-History' Uniformity‖, in *Rethinking Development Economics*, edited by Ha-Joon Chang, pp. 125-151. London: Anthem Press.
- Kwan Kim. 2005. ―Development Crisis in Sub-Saharan Africa: Globalization, Adjustment and the Roles of International Institutions‖, in *Global Development and Poverty Reduction*, edited by John-ren Chen and David Sapsford, pp. 294-320. Cheltenham and Northampton: Edward Elgar, 2005.

ECO-A-DSE-5-B(1)-TU

Tutorial Contact hours: 15

General References

- Ha-Joon Chang. 2003. "Kicking Away the Ladder: The "Real" History of Free Trade", *Foreign Policy*, 30 December
- Alice Amsden. Ch. 6 of *Escape from Empire: The Developing Worlds Journey through Heaven and Hell*, MIT Press.
- World Bank, ―Overview‖, in *World Development Report 2001: Attacking Poverty*, pp. 1-12.
- World Bank, ―Overview‖, in *World Development Report 2002: Building Institutions for Markets*, pp. 1-12.
- Barry Naughton. 2006. *The Chinese Economy: Transitions and Growth*. MIT Press.
- Kay, Cristobal. 2002. Why East Asia overtook Latin America: Agrarian Reform, Industrialisation and Development, *Third World Quarterly*, Vol 23.
- Mark Weisbrot, *Latin America: The End of an Era*, Center for Economic and Policy Research, December 2006
- Keith Griffin. 1999. *Alternative Strategies for Economic Development*, chapter 2, Palgrave Macmillan.
- T. Nakamura, Economic Growth in Pre-War Japan, Tr. by Robert A Feldman, Yale University Press, 1983.
- Okochi, Karsh and Levine, Workers and Employees in Japan, The Japanese Employment Relations System, University of Tokyo, 1965.
- Y. Hayami, A Century of Agricultural Growth in Pre-War Japan: Its Relevance to Asian Development, University of Minnesota Press, 1975.

- Chalmers Johnson, MITI and the Japanese Miracle: The Growth of Industrial Policy 1925-1975, Stanford University Press, 1982.
- W.W. Lockwood, Economic Development of Japan, Expanded edition, Princeton University Press, 1966.
- Dobb M., Soviet Economic Development since 1917, Universal Book Stall, New Delhi, 1995.
- Paul R. Gregory and Robert C. Stuart, Soviet Economic Structure and Performance, Harper & Row, 3rd edition, 1986.
- Rodrik D. 2007. Industrial Policy for the 21st Century, in *One Economics, Many Recipes: Globalization, Institutions, and Economic Growth*, Princeton University Press.

Discipline Specific Elective-B(1):

ECO-A-DSE-5-B(1)-TH-TU

Financial Economics [FE]

Total Marks: 100 [Theory(Th) 65+ Tutorial(Tu) 15 + Internal Assessment 10+Attendance: 10]

Total Credits: [5(Th)+1(Tu)]=6 ,

No. of Lecture hours: 75, No. of Tutorial contact hours: 15

[Semester-V]

ECO-A-DSE-5-B(1)-TH

1. Investment Theory and Portfolio Analysis 35 lecture hours

- Deterministic cash-flow streams: Basic theory of interest; discounting and present value; internal rate of return; evaluation criteria; fixed-income securities; bond prices and yields; interest rate sensitivity and duration; immunisation; the term structure of interest rates; yield curves; spot rates and forward rates.
- Single-period random cash flows: Random asset returns; portfolios of assets; portfolio mean and variance; feasible combinations of mean and variance; mean-variance portfolio analysis: the Markowitz model and the two-fund theorem; risk-free assets and the one-fund theorem.
- CAPM: The capital market line; the capital asset pricing model; the beta of an asset and of a portfolio; security market line; use of the CAPM model in investment analysis and as a pricing formula.

2. Options and Derivatives 20 lecture hours

- Introduction to derivatives and options; forward and futures contracts; options; other derivatives; forward and future prices; stock index futures; interest rate futures; the use of futures for hedging; duration-based hedging strategies; option markets; call and put options; factors affecting option

prices; put-call parity; option trading strategies: spreads; straddles; strips and straps; strangles; the principle of arbitrage; discrete processes and the binomial tree model; risk-neutral valuation.

3. Corporate Finance **20 lecture hours**

- Patterns of corporate financing: common stock; debt; preferences; convertibles; Capital structure and the cost of capital; corporate debt and dividend policy; the Modigliani- Miller theorem.

ECO-A-DSE-5-B(1)-TU

Tutorial Contact hours: 15

Text

Hull, John C., Options, Futures and Other Derivatives, Pearson Education, 6th edition, 2005.

References

- David G. Luenberger, Investment Science, Oxford University Press, USA, 1997.
- Thomas E. Copeland, J. Fred Weston and KuldeepShastri, Financial Theory and Corporate Policy, Prentice Hall, 4th edition, 2003.
- Richard A. Brealey and Stewart C. Myers, Principles of Corporate Finance, McGraw-Hill, 7th edition, 2002.
- Stephen A. Ross, Randolph W. Westerfield and Bradford D. Jordan, Fundamentals of Corporate Finance. McGraw-Hill, 7th edition, 2005.
- Burton G. Malkiel, A Random Walk Down Wall Street, W.W. Norton & Company, 2003.
- William Sharpe, Gordon Alexander and Jeffery Bailey, Investments, Prentice Hall of India, 6th edition, 2003.

Economics Core Course XIII: ECO-A-CC-6-13-TH-TU

Public Economics

Total Marks: 100 [Theory(Th) 65 + Tutorial(Tu) 15 + Internal Assessment 10+Attendance: 10]

Total Credits: [5(Th)+1(Tu)]=6 ,

No. of Lecture hours: 75, No. of Tutorial contact hours: 15

[Semester VI]

ECO-A-CC-6-13-TH

Unit 1. Government in a Market Economy **15 lecture hours**

- Market failure and externalities; public and merit goods;
- Government intervention;
- Public Expenditure for financing development

Unit 2. Choice and Public Economics **20 lecture hours**

- Characteristics of Pure Public Good; Distinction between Pure Public Good and Private Good;

- Market Failure in case of Pure Public Good Optimal provision of Public Goods - Private Provision and Public Provision of Public Goods,
- Lindahl Equilibrium,
- Voting Equilibrium.

Unit 3. The Revenue and Expenditure of the Government **20 lecture hours**

- Classification of Taxes; Canons of Taxation;
- Principles of Taxation - Benefit Principle, Equal Sacrifice Principle, Ability to Pay Principle;
- Incidence and Burden of Taxes;
- Effects of taxation on income distribution, work efforts, and on savings,
- The Laffer curve;
- Comparison between direct and indirect taxes – income and substitution effects;
- Optimal Taxation

Unit 4. Public Finance **20 lecture hours**

- Meaning and Classification of Public Expenditure - government budget and its types, government expenditure and tax multipliers, balanced budget multiplier;
- Meaning of Public Debt; Sources of Public Borrowings: internal and external borrowing; Effects of Public Debt.
- Indian Public Finance – Fiscal Federalism in India

ECO-A-CC-6-13-TU

Tutorial contact hours: 15

References:

- J. F. Due and A. F. Friedlander. Government Finance-Economics of Public Sector, AITBS Publishers and Distributors, 1994
- J. Hindriks and G. D. Myles. Intermediate Public Economics, The MIT Press; Annotated Edition, 2006.
- R.A. Musgrave and P.B. Musgrave, Public Finance in Theory & Practice, McGraw Hill Publications, 5th edition, 1989.
- Amaresh Bagchi (ed), Readings in Public Finance, OUP
- 5. J. E. Stiglitz. Economics of Public Sector,W. W Norton and Company, 3rd Edition, 2000.
- A Ghosh and C. Ghosh, Economics of the Public Sector, Prentice Hall India Learning Private Limited; 2nd Revised edition (2014)

Economics Core Course XIV: ECO-A-CC-6-14-TH-TU

Development Economics

Total Marks: 100 [Theory(Th) 65 + Tutorial(Tu) 15 + Internal Assessment 10+Attendance: 10]

Total Credits: [5(Th)+1(Tu)]=6 ,

No. of Lecture hours: 75, No. of Tutorial contact hours: 15

[Semester VI]

ECO-A-CC-6-14-TH

1. Meaning of Economic Development **10 lecture hours**

- Income Approach and Capability Approach,
- Construction and interpretation of HDI; international variations in development measures; comparing development trajectories across nations and within them.
- Dependency school of development.

2. Poverty and Inequality **15 lecture hours**

- Inequality axioms; a comparison of commonly used inequality measures.
- Gender Inequality, connections between inequality and development.
- Poverty measurement, HPI; poverty traps and path dependence of growth processes.
- Vicious Circle of Poverty Hypothesis

3. Dual Economy Models **20 lecture hours**

- The concept of surplus labour and disguised unemployment
- Peasants and Dualism with and without surplus labour
- Interdependence of agriculture and Industry (Lewis model, Ranis-Fei model)
- Rural-Urban Migration (Harris- Todaro model)

4. Population Growth and Economic Development **10 lecture hours**

- Basic concepts (Birth and Death Rates, mortality, fertility)
- Demographic transition theory
- Cost of children, externalities
- Low Level Equilibrium Trap models and their criticism-critical minimum effort theory (Nelson and Leibenstein).

5. Development Strategies **10 lecture hours**

- Balanced vs. Unbalanced Growth Theories
- Choice of Techniques

6. Political Institutions and the State **10 lecture hours**

- Definition of institutions, Evolution of Political and Economic Institutions.
- The determinants of democracy.
- Alternative institutional trajectories and their relationship with economic performance.
- Within-country differences in the functioning of state institutions. State ownership and regulation. Government failures and corruption.

ECO-A-CC-6-14-TU

Tutorial Contact hours: 15

Texts

1. Todaro and Smith: Economic Development, Pearson Education, 2009
2. Debraj Ray, Development Economics, Oxford University Press, 2009.
3. Kaushik Basu, Analytical Development Economics, OUP

References

- ParthaDasgupta, Economics, a Very Short Introduction, Oxford University Press, 2007.
- Abhijit Banerjee, Roland Benabou and Dilip Mookerjee, Understanding Poverty, Oxford University Press, 2006.
- KaushikBasu, The Oxford Companion to Economics in India, OUP, 2007.
- AmartyaSen, Development as Freedom, OUP, 2000.
- Daron Acemoglu and James Robinson, Economic Origins of Dictatorship and Democracy, Cambridge University Press, 2006.
- Robert Putnam, Making Democracy Work: Civic Traditions in Modern Italy, Princeton University Press, 1994
- Meier and Rauch (ed)- Leading Issues in Development Economics, OUP
- Hayami and Godo, Development Economics, OUP
- Thirlwall; Growth and Development. 5th Edition

Discipline Specific Elective –A(2):

ECO-A-DSE-6-A(2)-TH-TU

Money and Financial Markets [MFM]

Total Marks: 100 [Theory(Th) 65 + Tutorial(Tu) 15 + Internal Assessment 10+Attendance: 10]

Total Credits: [5(Th)+1(Tu)]=6 ,

No. of Lecture hours: 75, No. of Tutorial contact hours: 15

[Semester-VI]

ECO-A-DSE-6-A(2)-TH

1. Introduction to money and Money and Banking **5 lecture hours**

- Concept, functions, measurement; theories of money supply determination**.**

2. Financial Institutions, Markets, Instruments and Financial Innovations 17 lecture hours

- Role of financial markets and institutions; problem of asymmetric information – adverse selection and moral hazard; financial crises.
- Money and capital markets: organization, structure and reforms in India; role of financial derivatives and other innovations.
- Why banks are special Institutions? How banks act as a leveraging mechanism?

3. Financial Markets and Interest Rates Behaviour 18 lecture hours

- Determination; sources of interest rate differentials;
- Theories of term structure of interest rates; interest rates in India.

4. Banking System 20 lecture hours

- Balance sheet and portfolio management;
- Multiple Deposit Creation,
- Determinants of the Money Supply.
- Indian banking system- Changing role and structure- banking sector reforms

5. Central Banking and Monetary Policy 15 lecture hours

- Functions, balance sheet; goals, targets, indicators and instruments of monetary control;
- Monetary management in an open economy; current monetary policy of India**.**

ECO-A-DSE-6-A(2)- TU

Tutorial Contact hours: 15

Text

- F. S. Mishkin and S. G. Eakins, Financial Markets and Institutions, Pearson Education, 6th edition, 2009.

References

- F. J. Fabozzi, F. Modigliani, F. J. Jones, M. G. Ferri, Foundations of Financial Markets and Institutions, Pearson Education, 3rd edition, 2009.
- M. R. Baye and D. W. Jansen, Money, Banking and Financial Markets, AITBS, 1996.
- Rakesh Mohan, Growth with Financial Stability- Central Banking in an Emerging Market, Oxford University Press, 2011.
- L. M. Bhole and J. Mahukud, Financial Institutions and Markets, Tata McGraw Hill, 5th edition, 2011.
- M. Y. Khan, Indian Financial System, Tata McGraw Hill, 7th edition, 2011.
- N. Jadhav, Monetary Policy, Financial Stability and Central Banking in India, Macmillan, 2006.

- R.B.I. – Report of the Working Group: Money Supply Analytics and Methodology of Compilation, 1998.
- R.B.I. Bulletin, Annual Report and Report on Currency and Finance (latest).

Discipline Specific Elective-A(2):

ECO-A-DSE-6-A(2)-TH-P

Issues in Indian Economy [IIE]

Total Marks: 100

[Theory (Th) 50 + Practical (P) 30 + Internal Assessment 10+Attendance: 10]

Total Credits: [4(Th)+2(P)]=6 ,

No. of Lecture hours: 60, No. of Practical hours: 30/No. of Practical classes: 30

[Semester-VI]

ECO-A-DSE-6-A(2)-TH

1. Growth and structural changes **4 lecture hours**

- Trends in national income and per capita income- Analysis with official statistics *[2 lecture hours]*
- Structural Composition of national income and employment with NAS and NSSO data *[2 lecture hours]*

2. Macroeconomic Policies and Their Impact **15 lecture hours**

- Fiscal Policy *[3 lecture hours]*
- Trade and investment policy *[3 lecture hours]*
- Financial and monetary policies *[3 lecture hours]*
- Inflation and measures to control inflation *[3 lecture hours]*
- Labour laws and regulation *[3 lecture hours]*

3. Policies and Performance in Agriculture **15 lecture hours**

- Growth; productivity; agrarian structure and technology, capital formation *[3 lecture hours]*
- Agricultural marketing *[3 lecture hours]*
- Food security and food policy *[3 lecture hours]*
- Pricing and procurement *[3 lecture hours]*
- WTO and Indian agriculture *[3 lecture hours]*

4. Policies and Performance in Industry **12 lecture hours**

- Output, employment and productivity growth *[2 lecture hours]*
- Regional variation of industrial growth *[2 lecture hours]*
- Small scale industries- problems and prospects *[2 lecture hours]*

- Public sector; competition policy *[2 lecture hours]*
- Foreign direct investment in industry *[2 lecture hours]*
- Economic reforms and industry *[2 lecture hours]*

5. Trends and Performance in Services **14 lecture hours**

- Formal and informal sectors *[5 lecture hours]*
- Banking and insurance *[5 lecture hours]*
- Trade in services *[4 lecture hours]*

ECO-A-DSE-6-A(2)-P

Total Practical Hours: 60, Number of Practical classes: 30

Students will have to take help of primary or secondary data and will have to make statistical/econometric analysis of any problem on Indian economy as mentioned in this course (i.e. the topic will not be outside the course) on the basis of the use of statistical softwares like SPSS/STATA/R/E-VIEWS .A project report is to be prepared by the candidate analysing the results obtained from the use of any one of the above-mentioned statistical softwares. Though there is a project report, basically it is a computer laboratory based practical on the basis of which the project report will be constructed. Use of computer laboratory is essential for running the above-mentioned statistical softwares and also for handling the data. In this sense the project work is to be interpreted as a Practical (it is not a separate project paper).The project should be supervised by a full time teacher of the subject belonging to the institution. All total 60 hours (30 Practical classes) have been allotted for the practical part of the course. The norm of the examination will be similar to that of a practical examination. To be more specific, the practical examination of the project is to be conducted jointly by the supervisor and an external examiner on the basis of the content of the project report, use of the above-mentioned statistical softwares in the computer laboratory (in the form of running the regressions used in the project or by determining the various measures of descriptive statistics used in the project in front of the examiners just like that of a practical examination) and also on the basis of a viva-voce based on the candidate"s knowledge about the data set (especially data sources in case of secondary data) along with economic interpretation of the regression results. In case the student uses primary data it should be related to one of the topics covered in the course and *why primary data is used instead of secondary data* is to be justified by the student. In case of use of primary data students should have good knowledge about the sampling procedure used in collecting data. *On the day of the practical examination students should carry with them soft copy of the data set used in the project.*

References

- Shankar Acharya, 2010, ―Macroeconomic Performance and Policies 2000-8,‖ in Shankar Acharya and Rakesh Mohan, editors, India‘s Economy: Performances and Challenges: Development and Participation, Oxford University Press.
- Rakesh Mohan, 2010, ―India_s Financial Sector and Monetary Policy Reforms in Shankar Acharya and Rakesh Mohan, editors, India‘s Economy: Performances and Challenges: Development and Participation, Oxford University Press.
- Pulapre Balakrishnan, Ramesh Golait and Pankaj Kumar, 2008, ―Agricultural Growth in India Since 1991, RBI DEAP Study no. 27.
- B.N. Goldar and S.C. Aggarwal, 2005, ―Trade Liberalisation and Price-Cost Margin in Indian Industries, The Developing Economics, September.
- P. Goldberg, A. Khandelwal, N. Pavcnik and P. Topalova, 2009, ―Trade Liberalisation and New Imported Inputs, American Economic Review, Papers and Proceedings, May.
- KunalSen, 2010, ―Trade, Foreign Direct Investment and Industrial Transformation in India, ïn Premachandra Athukorala, editor, The Rise of Asia, Routledge.
- A. Ahsan, C. Pages and T. Roy, 2008, ―Legislation, Enforcement and Adjudication in Indian Labour Markets: Origins, Consequences and the Way Forward, in D. Mazumdar and S. Sarkar, editors, Globalization, Labour Markets and Inequality in India, Routledge.
- Dipak Mazumdar and SandeepSarkar, 2009, ―The Employment Problem in India and the Phenomenon of the MissingMiddle‖, Indian Journal of Labour Economics.
- J. Dennis Rajakumar, 2011, ―Size and Growth of Private Corporate Sector in Indian Manufacturing, Economic and Political Weekly, April.
- Ramesh Chand, 2010,- ―Understanding the Nature and Causes of Food Inflation,‖ Economic and Political Weekly, February.
- Bishwanath Goldar, 2011, ―Organised Manufacturing Employment: Continuing the Debate‖, Economic and Political Weekly, April.
- Panchanan Das. (2007), Economic Reform, Output and Employment Growth in Registered Manufacturing Industries in India: Testing Kaldor‘s Hypotheses, Economic and Political Weekly, 42 (39), pp. 3978-3985.
- KaushikBasu and A. Maertens, eds, 2013, The New Oxford Companion to Economics in India, Oxford University Press.
- A. Raychaudhury and P De, International Trade in Services in India: Implications for Growth and Inequality in a Globalizing World, OUP, 2012.
- India Development Reports, IGIDR

Discipline Specific Elective- B(2) :

ECO-A-DSE-6-B(2)-TH-TU

Environmental Economics [EE]

Total Marks: 100 [Theory(Th) 65 + Tutorial(Tu) 15 + Internal Assessment 10+Attendance: 10]

Total Credits: [5(Th)+1(Tu)]=6 ,

No. of Lecture hours: 75, No. of Tutorial contact hours: 15

[Semester- VI]

ECO-A-DSE-6-B(2)-TH

Unit 1. Introduction **7 lecture hours**

1.1 What is environmental economics;

1.2 Review of microeconomics and welfare economics.

1.3 Interlinkages between the economy and environment

Reference for unit 1:

Hanley N, Shogren J.F. & White B. *Environmental Economics in Theory and Practice*, Macmillan

Unit 2. Efficiency and Market Failure **18 lecture hours**

2.1 Pareto optimality and market failure in the presence of externalities

2.2 Property rights and the Coase theorem

2.3 Public goods/ bads and market failure

Reference for unit 2:

Kolstad C, *Environmental Economics*, OUP

Unit 3. The Design and Implementation of Environmental Policy **20 lecture hours**

3.1 Pigouvian Fees – Single Polluter, Multiple Polluters, Fees vs Subsidies

3.2 Regulating Pollution : Command and Control, Economic Incentives

3.3 The Basic Theory of Tradeable Pollution Permits

Reference for unit 3:

Kolstad C, *Environmental Economics*, OUP

Hanley N, Shogren J.F. & White B. *Environmental Economics in Theory and Practice*, Macmillan

Unit 4. International Environmental Problems **13 lecture hours**

4.1 Transboundary Pollution – Transboundary Pollution as a problem of international externalities

4.2 International Trade and Environment – Pollution Havens

4.3 International Environmental Agreements – Basic idea about Montereal and Kyoto Protocol and Talks on Climate Change

Reference for unit 4:

Hanley N, Shogren J.F. & White B. *Environmental Economics in Theory and Practice*, Macmillan

Kolstad C, *Environmental Economics*, OUP

Internet on Recent Environmental Agreements

Unit 5. Measuring the values of Environmental Costs and Benefits **17 lecture hours**

5.1 Concepts of Willingness to pay (WTP) and Willingness to accept compensation (WTAC), Difference between the two concepts

5.2 Direct and Indirect Methods of Valuation – Contingent valuation, Travel Cost, hedonic Pricing – basic concepts only (no econometric techniques) – when they should be used, what are the advantages and disadvantages of these methods.

Reference for unit 5:

Hanley N, Shogren J.F. & White B. *Environmental Economics in Theory and Practice*, Macmillan

ECO-A-DSE-6-B(2)-TU

Tutorial Contact hours: 15

Discipline Specific Elective –B(2):

ECO-A-DSE-6-B(2)-TH-TU

Issues in Development Economics [IDE]

Total Marks: 100 [Theory(Th) 65 + Tutorial(Tu) 15 + Internal Assessment 10+Attendance: 10]

Total Credits: [5(Th)+1(Tu)]=6 ,

No. of Lecture hours: 75, No. of Tutorial contact hours: 15

[Semester- VI]

ECO-A-DSE-6-B(2)-TH

1. Demography and Development **10 lecture hours**

- Demographic concepts; birth and death rates, age structure, fertility and mortality
- Demographic transitions during the process of development; gender bias in preferences and outcomes and evidence on unequal treatment within households
- Connections between income, mortality, fertility choices and human capital accumulation
- Migration.

2. Land, Labor and Credit Markets **20 lecture hours**

- The distribution of land ownership; land reform and its effects on productivity
- Contractual relationships between tenants and landlords
- Land acquisition; nutrition and labor productivity
- Iinformational problems and credit contracts

- Microfinance
- Inter- linkages between rural factor markets.

3. Individuals, Communities and Collective Outcomes **15 lecture hours**

- Individual behavior in social environments
- Multiple social equilibria;
- Governance in organizations and in communities;
- Individual responses to organizational inefficiency.

4. Environment and Sustainable Development **15 lecture hours**

- Defining sustainability for renewable resources
- A brief history of environmental change;
- Common-pool resources;
- Environmental externalities and state regulation of the environment;
- Market based instruments, economic activity and climate change.

5. Globalization **15 lecture hours**

- Globalization in historical perspective
- the economics and politics of multilateral agreements;
- Trade, production patterns and world inequality
- Financial instability in a globalized world.
- India in the context of global economy

ECO-A-DSE-6-B(2)-TU

Tutorial contact hours: 15

Text

- Debraj Ray, Development Economics, Oxford University Press, 2009.

References

- ParthaDasgupta, Economics, a Very Short Introduction, Oxford University Press, 2007.
- Abhijit Banerjee, Roland Benabou and Dilip Mookerjee, Understanding Poverty, Oxford University Press, 2006.
- Thomas Schelling, Micromotives and Macrobehavior, W. W. Norton, 1978.
- Albert O. Hirschman, Exit, Voice and Loyalty: Responses to Decline in Firms, Organizations and States, Harvard University Press, 1970.
- Raghuram Rajan, Fault Lines: How Hidden Fractures Still Threaten the World Economy, 2010.

- Elinor Ostrom, Governing the Commons: The Evolution of Institutions for Collective Action, CambridgeUniversity Press, 1990.
- DaniRodrik, The Globalization Paradox: Why Global Markets, States and Democracy Can‘t Coexist, Oxford University Press, 2011.
- Michael D. Bordo, Alan M. Taylor and Jeffrey G. Williamson (ed.), Globalization in Historical Perspective, University of Chicago Press, 2003

BA/BSc ECONOMICS (GENERAL) SYLLABUS,

UNIVERSITY OF CALCUTTA, UNDER CHOICE BASED CREDIT SYSTEM

[AS ON 24-05-2018]

To be effective from the academic session 2018-19

Preamble

- As the subject Economics falls under both BA and BSc two types of structures are proposed for BA/BSc Economics (General). One for BA Economics (General) and the other for BSc Economics (General).
- For any student with Honours in a subject other than Economics (say Sociology (Honours) or Political Science (Honours) or Statistics (Honours)) may opt for Economics as a Generic Elective subject. So provisions are to be kept for Economics Generic Elective for four courses (papers).
- For any BA (General) student with Core subjects other than Economics [say Political Science as Core paper (under General) and History as Core paper (under General)] may opt for Economics as a Generic Elective Course [two Generic Elective courses are to be chosen from any discipline other than the Core. Thus provision should be kept for two courses of any subject other than the Core, say Economics]. This should be treated as Generic Elective Course for BA (General) student.
- Regarding skill-enhancement course there are two groups. Group A for odd semesters like semester III and semester V and Group B for even semesters like semester IV and semester VI. As part of skill-enhancement Course under BA/BSc Economics (General) provision should be kept for two skill-enhancement courses under each of the two groups (so all total provision is to be kept for 4 courses).
- The conversion of credit to lecture hours is same as that of the Honours course. **For *five credits* of lecture hours (theory) per course there will be *five hours of teaching per week* so that for fifteen weeks all total there will be 75 lecture hours for theory classes per semester. For 1 credit tutorial classes (each of one hour) there will be all total 15 hours of tutorial classes for 15 weeks (one can refer to it a 15 tutorial contact hours). We can club „lecture hours" and „tutorial contact hours" and can refer to it as „teaching hours " . Thus for a 5 credit (Theory)+1 credit(Tutorial)= 6 credit course for 15 weeks we have 75+15=90 teaching hours.** Similarly for a 2 credit course (only theory) the teaching hours or lecture hours all total is 30. Within each course the total marks of 100 has been subdivided in the following manner. For 90 hours of teaching (Theory plus tutorial) we have

  80 marks. The remaining part (20 marks) has been divided into two equal parts: 10 marks is reserved for ***continuous internal assessment (CIA)*** and the remaining 10 marks for

attendance. Out of 80 for written examination 65 marks has been allotted and the remaining 15 marks has been allotted for tutorial examination.

- We first focus on BSc Economics (General). To illustrate the structure we start from a hypothetical example. Suppose the three general subjects opted by a student for BSc (General) are Economics, Mathematics and Statistics. Then the syllabus for Economics should be treated as the syllabus for BSc Economics (General) and it would be based on the following structure.

Table 3: Structure for BSc (General) Course covering three subjects

. Type of Course	Total Number of Courses	Number of Courses for Economics out of total number of Courses	Credit for each course	Total Credit	Total Marks
Core Course (CC)	12	4	5(Th) +1 (Tu)=6 for each course or 4(Th) +2(P) =6 for each course	Total credit for12 courses = 72	2. 12x100 =1200
Discipline Specific Elective (DSE)	6	2	5(Th) +1 (Tu)=6 for each course or 4(Th) +2(P) =6 for each course	Total credit for 6 courses =36	6x100 =600
Ability Enhancement Compulsory course (AECC)	2	Nil	2 (Th) for each course	Total credit for 2 courses =4	2x100 =200
Skill Enhancement Elective Course (SEC)	4	2	2 (Th) for each course	Total credit for 4 courses =8	4x100 =400
Total	**24**	**8**		**120**	**2400**

- In case of BSc (General) for each CC we have 100 marks, for each DSE we have 100 marks, for each AECC we have 100 marks, for each SEC we have 100 marks so that all total we have 2400 marks for BSc (General) stream (as shown in Table 3). For each semester we have 400 marks as shown in table 3.In the above table Th stands for Theory, Tu stands for tutorial and P stands for Practical.
- We next focus on BA Economics (General). To illustrate the structure we start from a hypothetical example. Suppose the two general subjects opted by a student for BA (General) are Political Science and Economics. Then the syllabus for Economics should be treated as the syllabus for BA Economics (General) and it would be based on the structure shown in table 4
- In Language Core Course (LCC) as per decision of the University there will 2 English Courses and 2 MIL Courses.
- Ability Enhancement Courses can be conducted along with the Honours students in 1st and 2nd semesters.

Table 4: Structure for BA (General) Course covering two subjects (with two different subjects under Generic Elective)

. Type of Course	Total Number of Courses	Number of Courses for Economics out of total number of Courses	Credit for each course	Total Credit	Total Marks
Core Course (CC)	8	4	5(Th) +1 (Tu)=6 for each course	. Total credit for 8 courses = 48	8x100 =800
ϑ. Language Core Course (LCC)	4	Nil	5(Th) +1 (Tu)=6 for each course	. Total credit for 4 courses = 24	4x100 =400
. Generic Elective (GE) [From any other subject other than Core]	2	. 2 GE Economics (provided none of the two Core general subjects is Economics)	5(Th) +1 (Tu)=6 for each course	. Total credit for 2 courses = 12	2x100 =200
Discipline Specific Elective (DSE)	4	. 2 can be offered from Economics from each of the two groups A and B. Candidate will have to select one from each of the two groups	5(Th) +1 (Tu)=6 for each course	. Total credit for 4 courses =24	4x100 =400
Ability Enhancement Compulsory course (AECC)	2	Nil	2 (Th) for each course	. Total credit for 2 courses =4	2x100 =200
Skill Enhancement Elective Course (SEC)	4	. 2 can be offered from Economics from each of the two groups A and B	2 (Th) for each course	. Total credit for 4 courses =8	4x100 =400
Total	**24**	**8 (without considering GE courses) + 2 GE Courses (if the general Core subjects are other than Economics)**		**120**	**2400**

- We now consider semester-wise break-up of BSc (General) and BA (General) Courses:

Table 5 : Semester-wise Break-up of BSc (General) Course covering three subjects

Semester	Types of Courses [Course codes are in bold within brackets]	Economics Course	Total Credit for all Courses for each semester	Total Marks
I	3 CC**(CC-1)**, 1AECC**(AECC-1)**	1 CC	20	400
II	3CC**(CC-2)**, 1AECC**(AECC-2)**	1CC	20	400
III	3CC**(CC-3)**, 1 SEC**(SEC-A(1))**	1CC plus 1 SEC (if any candidate considers SEC-A(1) as Economics)	20	400
IV	3CC**(CC-4)**, 1 SEC**(SEC-B(1))**	1CC plus 1 SEC (if any candidate considers SEC-B(1) as Economics)	20	400
V	3DSE**[DSE-A (1A+2A+3A)]** , 1SEC **(SEC-A(2))**	1DSE plus 1SEC(if any candidate considers SEC-A(2) as Economics)	20	400
VI	3DSE**[DSE-B (1B+2B+3B)]**, 1 SEC **(SEC-B(2))**	1DSE plus 1SEC (if any candidate considers SEC-B(2) as Economics)	20	400
Total	**24Courses**	**4 CC +2 DSE under DSE A (candidate will select one) + 2 DSE under DSE B (candidate will select one) + 2 SEC under SEC A (candidate will select one) + 2 SEC under SEC B (candidate will select one)**	**120**	**2400**

Table 6 : Semester-wise Break-up of BA (General) Course covering two subjects

Semester	Types of Courses . [Course codes are in bold within brackets]	Economics Course	Total Credit for all Courses for each semester	. Total Marks
I	2 CC **(CC-1)** , 1 GE **(GE-1)** and 1AECC **(AECC-1)**	1 CC plus 1GE(if the core is other than Economics)	20	400
II	. 2CC **(CC-2)** ,1 GE **(GE-2)**, 1AECC **(AECC-2)**	1CC plus 1GE(if the core is other than Economics)	20	400
III	2CC **(CC-3)**, 1 LCC **(L1(1))** ,1 SEC **(SEC-A(1))**	1CC plus 1 SEC (if any candidate considers SEC-A(1) as Economics)	20	400
IV	2CC **(CC-4)** , 1LCC **(L2(1))**, 1 SEC **(SEC-B(1))**	1CC plus 1 SEC (if any candidate considers SEC-B(1) as Economics	20	400
V	1 LCC **(L1(2))**, 2DSE **[DSE-A (1A+2A)],** 1SEC **(SEC-A(2))**	1DSE plus 1SEC (if any candidate considers SEC-A(2) as Economics)	20	400
VI	1 LCC**(L1(2))** , 2DSE**[DSE-B (1B+2B)]** , 1 SEC **(SEC-B(2))**	1DSE plus 1SEC (if any candidate considers SEC-B(2) as Economics)	20	400
Total	**24Courses**	**4 CC +2 DSE under DSE A (candidate will select one) + 2 DSE under DSE B (candidate will select one) + 2 SEC under SEC A (candidate will select one) + 2 SEC under SEC B (candidate will select one) + 2 GE (in case if the Core Course is other than Economics– the candidate will select one)**	**120**	**2400**

- AECC-1 refers to Communicative English/MIL. AECC-2 refers to Environmental Studies
- LCC: L1 –English Courses; L2- MIL courses. Two courses each
- SEC - Two courses from two subjects
- DSE- Two courses from two subjects in case of BA (General) .Two Courses from three subjects in case of BSc (General).[One course from each subject under each semester].
- In case of BA (General) for each CC we have 100 marks, for each LCC we have 100 marks, for each GE we have 100 marks, for each DSE we have 100 marks, for each AECC we have 100 marks and for each SEC we have 100 marks (as shown in table 4) so that all total we

have 2400 marks for BA (General) stream. For each semester we have 400 marks as shown in table 6.

- If a candidate selects one Economics paper under group-A in case of SEC then the candidate can opt for 3rd or 5th semester. If a candidate selects one Economics paper under group-B in case of SEC then the candidate can opt for 4th or 6th semester. These are shown in terms of tables 5 and 6. [See the explanations regarding DSE and SEC after table 10]
- Economics as Generic Elective can be offered for students having Honours in any subject other than Economics. The semester break-up of the course is as follows

Table 7: Semester-wise break-up of Generic Elective for students having Honours in subject other than Economics

Semester	Course
I	Generic Elective Course I (GE-I)
II	Generic Elective Course II(GE-II)
III	Generic Elective Course III(GE-III)
IV	Generic Elective Course IV (GE-IV)

- The four GE courses for students having Honours in any subject other than Economics can be treated as Core courses (CC) in first four semesters for students under BA/BSc General Courses.
- We have thus the following classification of GE and CC:

Table 8 : Semester-wise distribution of CC and GE

Semester	Name of the Course	Core Course (CC) for BA/BSc General students	GE Course for students who have Honours in sny subject other than Economics	GE (Economics) Course for BA (General) students who have Core papers other than Economics
I	Introductory Microeconomics	Core Course 1(Econ)-CC-1 (ECO-G-CC-1-1-TH-TU)	Generic Elective Course I (ECO-GE- 1-1-TH-TU)	Generic Elective Course I (ECO-G-GE-1-1-TH-TU)
II	Introductory Macroeconomics	Core Course 2(Econ)-CC-2 (ECO-G-CC-2-2-TH-TU)	Generic Elective Course II (ECO-GE-2-2-TH-TU)	Generic Elective Course II (ECO-G-GE-2-2-TH-TU)
III	Issues in Economic Development and India	Core Course 3(Econ)-CC-3 (ECO-G-CC-3-3-TH-TU)	Generic Elective Course III (ECO-GE-3-3-TH-TU)	Not Applicable
IV	Indian Economic Policies	Core Course 4(Econ)-CC-4 (ECO-G-CC-4-4-TH-TU)	Generic Elective Course IV (ECO-GE-4-4-TH-TU)	Not Applicable

- In table 8 the last column implies the two Generic Elective Courses for BA (General) students that will be offered to students who have Core Courses other than Economics. In such case the student may opt for the two Courses in Economics in the First Semester and in the Second Semester (it matches with the two Core Courses in Economics for the first two semesters). The student may take two such courses from Economics in the first and second semesters

provided his/her Core papers in BA (General) are other than Economics. No separate option has been provided for the students in choosing the courses. They will have to select from the Core papers of Economics (General) Courses provided in the First and Second Semesters.

- For the two Discipline Specific Elective (DSE) courses we suggest the following :

Table 9 : Options for two DSE (Economics) Courses –Group A and Group-B BA (General) and BSc (General)

Name of Courses under DSE-A [Candidate will have to select only one] [Relevant for 5th Semester]	**Name of the Courses under DSE-B [Candidate will have to select only one] [Relevant for 6th Semester]**
Money and Banking (MB) ECO-G-DSE-5-1A/2A-TH-TU	Public Finance (PF) ECO-G-DSE-6-1B/2B-TH-TU
Sustainable Development (SD) ECO-G-DSE-5-1A/2A-TH-TU	Economic History of India (1857-1947) (EHI) ECO-G-DSE-6-1B/2B-TH-TU

Table 10 : Options for two SEC (Economics) Courses –Group A and Group-B: BA (General) and BSc (General)

Name of the Course under SEC-A [Candidate will have to select only one] [Relevant for 3rd or 5th Semesters]	**Name of the Course for SEC-B [Candidate will have to select only one] [Relevant for 4th or 6th Semesters]**
Introductory Methods of Field Survey (IMFS) ECO-G-SEC-3-1A-TH/ECO-G-SEC-5-2A-TH	. Economic Data Analysis and Report Writing (EDARW) ECO-G-SEC-4-1B-TH/ECO-G-SEC-6-2B-TH
Elementary Rural Development (ERD) ECO-G-SEC-3-1A-TH/ECO-G-SEC-5-2A-TH	Entrepreneurship and Development (ED) ECO-G-SEC-4-1B-TH/ECO-G-SEC-6-2B-TH

- In case of semester 5 for DSE A at least two options from each discipline are to be given. Similarly in case of semester 6 for DSE-B at least two options from each discipline are to be given. In case of Economics we have given exactly two options for each group A and B. In case of BSc (General) a candidate will have to select one option from three different disciplines from each group (i.e. DSE-A ad DSE-B). These are referred to as courses DSE-A: 1A, 2A and 3A and DSE-B: 1B, 2B and 3B. [Here 1 ,2 and 3 are disciplines like Economics, Mathematics, Statistics whereas A and B are the groups]

- The structure is similar in case of BA (General) except that here a candidate will have to select one option from two different disciplines (instead of three different disciplines). These are referred to as courses DSE-A: 1A and 2A (for semester 5) and DSE-B : 1B and 2B (for semester 6) . [Here again 1 and 2 are disciplines like Economics and History whereas A and B are the groups]

- In Table 10 we have specified the options under Group A and Group B. As an example we can say that in case of BA (General) suppose the disciplines as Core Courses are History and Economics. In this case two options are given for Economics under Skill Enhancement

Course (SEC) in the form of SEC-A and SEC-B. In case of SEC-A, suppose two options from Economics and two from History are offered. Similarly, two options from Economics and two options from History are also offered under SEC-B. If a candidate opts for History from SEC- A in semester 3 then he /she must opt for Economics (any one of the two Economics options) from SEC-A in case of semester-5. Similarly if a candidate opts for Economics from SEC-B (any one of the two Economics options) in semester 4 then he/she must opt for History from SEC-B in semester 6.

- ***The SEC-A courses will be offered twice .The same courses will be taught twice: once in the 3rd Semester and again in the 5th Semester. Similarly SEC-B courses will be offered twice. The same courses will be taught twice: once in the 4th Semester and again in the 6th Semester. Examinations will be conducted both for 3rd and 5th semester students for the same Economics courses under SEC-A. Similarly, examinations will be conducted both for 4th and 6th semester students for the same Economics courses under SEC-B.***

- Based on the above-mentioned structure we have framed the syllabus in the following manner.

Core Course 1 (CC 1) BA/BSc (General) / Generic Elective Course I (GE -1) for BA/BSc Honours students [other than students having Economics (Honours)]/BA (General) Generic Elective Course I (GE-I) for students not having Economics as Core Course

Name of the Course: Introductory Microeconomics

Total Marks: 100 [Theory(Th) 65 + Tutorial(Tu) 15 + Internal Assessment 10+Attendance: 10]

Total Credits: [5(Th)+1(Tu)]=6 ,

No. of Lecture hours (Theory): 75, No. of Tutorial contact hours: 15

[For Semester-I]

ECO-G-CC-1-1-TH-TU/ ECO--GE-1-1-TH-TU/ECO-G-GE-1-1-TH-TU

ECO-G-CC-1-1-TH/ ECO--GE-1-1-TH /ECO-G-GE-1-1-TH

1. Exploring the subject matter of Economics 5 lecture hours

Why study economics? Scope and method of economics; the economic problem: scarcity and choice; the question of what to produce, how to produce and how to distribute output; science of economics; the basic competitive model; prices, property rights and profits; incentives and information; rationing; opportunity sets; economic systems; reading and working with graphs.

2. Supply and Demand: How Markets Work, Markets and Welfare

16 lecture hours

Markets and competition; determinants of individual demand/supply; demand/supply schedule and demand/supply curve; law of demand and law of supply; market versus individual

demand/supply; shifts in the demand/supply curve, demand and supply together; how prices allocate resources; elasticity of demand - own price, cross price and income elasticity of demand- total revenue, average revenue, marginal revenue and price elasticity of demand; elasticity and its application; controls on prices; taxes and the costs of taxation; consumer surplus; producer surplus and the efficiency of the markets.

3. The Households **18 lecture hours**

- Utility maximization-the cardinal approach. Total utility and marginal utility-law of diminishing marginal utility-relation between law of demand and law of diminishing marginal utility
- Utility maximization-the ordinal approach. Consumption decision and the budget constraint, consumption and income/price changes, description of preferences (representing preferences with indifference curves); properties of indifference curves; consumer s optimum choice; the price consumption curve and the income consumption curve; derivation of the demand curve from price consumption curve; income and substitution effects.

4. The Firm and Perfect Market Structure **18 lecture hours**

- Production function of a firm; total product, average product and marginal product; concept of isoquant ; returns to scale; behaviour of profit maximizing firms and the production process; the cost function, short run costs and output decisions; costs and output in the long run.
- Features of a perfectly competitive market. Short run equilibrium under perfect competition. Supply curve of a firm. Long run equilibrium under perfect competition.

5. Imperfect Market Structure **8 lecture hours**

Monopoly equilibrium- differences with perfect competition. Basic ideas of price-discriminating monopolist .

6. Input Markets **10 lecture hours**

The labour market - basic concepts - derived demand, productivity of an input; marginal productivity of labour, marginal revenue product); the land market- concepts of rent and quasi rent.

ECO-G-CC-1-1-TU/ ECO--GE-1-1-TU /ECO-G-GE-1-1-TU

Tutorial Contact Hours: 15

Text

- R.G. Lipsey. An Introduction to Positive Economics, ELBS (6^{th} edition)

Reference Books

- Mankiw, N.G. : Economics: Principles and Applications, India edition by South Western, Cengage Learning India Private Limited, 4th edition, 2007.
- Samuelson, P.A. and Nordhaus, W.D. :Economics, 19^{th} edition, McGraw Hill
- Stonier, A.W. and Hague, D.C. : A Textbook of Economic Theory, Longman Group, London.

Core Course 2 (CC 2) BA/BSc (General) / Generic Elective Course II (GE -II) for BA/BSc Honours students [other than students having Economics (Honours)]/ BA (General) Generic Elective Course II (GE-II) for students not having Economics as Core Course

Name of the Course: Introductory Macroeconomics

Total Marks: 100 [Theory(Th) 65 + Tutorial(Tu) 15 + Internal Assessment 10+Attendance: 10]

Total Credits: [5(Th)+1(Tu)]=6 ,

No. of Lecture hours (Theory): 75, No. of Tutorial contact hours: 15

[For Semester-II]

ECO-G-CC-2-2-TH-TU/ ECO--GE-2-2-TH-TU/ECO-G-GE-2-2-TH-TU

ECO-G-CC-2-2-TH / ECO--GE-2-2-TH /ECO-G-GE-2-2-TH

1. Introduction to Macroeconomics and National Income Accounting 14 lecture hours

Basic issues of macroeconomics; measurement of gross domestic product; distinction of gross domestic product with gross national product; net domestic product and net national product; net domestic product at market price and at factor cost-the concept of national income. Measurement of national income- income method and the expenditure method- circular flow of income; the concept of value added and the value added method of measuring national income; real versus nominal GDP.

2. The Simple Keynesian Model in a Closed Economy 14 lecture hours

The Keynesian consumption function and the Keynesian saving function. The Simple Keynesian Model of Income determination- the concept of effective demand-the Simple Keynesian Multiplier-the role of the government in Simple Keynesian Model

3. The Classical System 11 lecture hours

Basic ideas of classical system-Say‘s Law and Quantity Theory of Money- classical theory of income and employment determination.

4. Money Supply and Money Demand 11 lecture hours

- Supply of money; measures of money supply; high powered money, credit creation by commercial banks, tools of monetary policy.
- Demand for money-demand for money in the classical system and in the Keynesian system-the liquidity preference schedule.

5. Inflation 13 lecture hours

Demand pull and cost push inflation; inflation and its social costs; hyperinflation; trade off between inflation and unemployment –basic ideas of the Phillips Curve; anti-inflationary

monetary and fiscal policies.

6. The External Sector **12 lecture hours**

- Basis of trade: concepts of absolute advantage and comparative advantage; arguments for free trade; arguments for protection
- Balance of Payments-accounting and equilibrium; disequilibrium in balance of payments and devaluation-the role of the Marshall-Lerner condition

ECO-G-CC-2-2-TU / ECO--GE-2-2-TU /ECO-G-GE-2-2-TU

Tutorial Contact Hours: 15

Text

Sikdar Soumyen, Principles of Macroeconomics, Oxford University Press

Reference Books

- Stonier, A.W. and Hague, D.C. : A Textbook of Economic Theory, Longman Group, London
- Mankiw, N.G.: Elementary Macroeconomics, Worth Publishers, 7th edition, 2010.
- Errol D_Souza, Macroeconomics, Pearson Education, 2009.

Core Course 3 (CC 3) BA/BSc (General) / Generic Elective Course III (GE-III) for BA/BSc Honours students [other than students having Economics (Honours)]:

Name of the Course: Issues in Economic Development and India

Total Marks: 100 [Theory(Th) 65 + Tutorial(Tu) 15 + Internal Assessment 10+Attendance: 10]

Total Credits: [5(Th)+1(Tu)]=6 ,

No. of Lecture hours (Theory): 75, No. of Tutorial contact hours: 15

[For Semester-III]

ECO-G-CC-3-3-TH-TU/ ECO--GE-3-3-TH-TU

ECO-G-CC-3-3-TH / ECO--GE-3-3-TH

1. Meaning of Economic Development **25 lecture hours**

Meaning of economic development; growth vs. development; concept of human development and its measurement, population and human development; education and health sectors in India; features and causes of underdevelopment of the Indian economy; growth and development of Indian economy under different policy regimes.

2. Poverty , Inequality and Development **20 lecture hours**

Basic issues of poverty and inequality; basic ideas about measurement of poverty and inequality- the poverty line; trends and policies to eradicate poverty and income inequality in India

3. **Development of the Dual Economy and Development Strategies 15 lecture hours**

- Surplus labour and disguised unemployment-basic concepts; the Lewis model of economic development with unlimited supply of labour.
- Balanced and unbalanced growth as development strategies

4. **International Organizations and Economic Development 15 lecture hours**

- Functions of IMF and World Bank and their roles in economic development
- The World Trade Organization (WTO) and its functions. India and the WTO

ECO-G-CC-3-3-TU / ECO--GE-3-3-TU

Tutorial Contact Hours: 15

Text

- Todaro and Smith: Economic Development, Pearson Education, 2009
- Misra D. and Puri K. Indian Economy, Himalaya Publishing House

References

- Thirlwall, Growth and Development, 5th Edition
- Rakesh Mohan, 2008, ―Growth Record of Indian Economy: 1950-2008. A Story of Sustained Savings and Investment, Economic and Political Weekly, May.
- Datt and Sundharam (Revised by G. Datt and A. Mahajan) , Indian Economy, 70th edition, S. Chand
- T. Dyson, 2008, ―India_s Demographic Transition and its Consequences for Development in Uma Kapila, editor, Indian Economy Since Independence, 19th edition, Academic Foundation.
- Agarwala, A.N. and Singh, S.P. : Economics of Underdevelopment (eds), Oxford University Press, London.
- Mukherjee, Debes : Development Policies, Problems and Institutions, New Central Book Agency, Kolkata.

Core Course 4 (CC 4) BA/BSc (General) / Generic Elective Course IV (GE-IV) for BA/BSc Honours students [other than students having Economics (Honours)]:

Name of the Course: Indian Economic Policies

Total Marks: 100 [Theory(Th) 65 + Tutorial(Tu) 15 + Internal Assessment 10+Attendance: 10]

Total Credits: [5(Th)+1(Tu)]=6 ,

No. of Lecture hours (Theory): 75, No. of Tutorial contact hours: 15

[For Semester-IV]

ECO-G-CC-4-4-TH-TU/ ECO--GE-4-4-TH-TU

ECO-G-CC-4-4-TH / ECO--GE-4-4-TH

1. **Macroeconomic Policies and their Impact** **15 lecture hours**

   Fiscal Policy; trade and investment policy; financial and monetary policies; labour regulation.

2. **Policies and Performance in Agriculture** **21 lecture hours**

   Growth; productivity; agrarian structure and technology; capital formation; trade; pricing and procurement.

3. **Policies and Performance in Industry** **21 lecture hours**

   Growth; productivity; diversification; small scale industries; public sector; competition policy; foreign investment

4. **Policies and Performance of Indian Foreign Trade** **18 lecture hours**

   India‘s foreign trade: change in volume and direction of India‘s foreign trade in the post-liberalization period; Balance of Payments position of India in recent years; India‘s export and import policies.

ECO-G-CC-4-4-TU / ECO--GE-4-4-TU

Tutorial Contact Hours: 15

Text

- Misra D. and Puri K. Indian Economy, Himalaya Publishing House
- Datt and Sundharam (Revised by G.Datt and A. Mahajan) , Indian Economy, 70th edition, S. Chand

References

- Shankar Acharya, 2010, ―Macroeconomic Performance and Policies 2000-8,‖ in Shankar Acharya and Rakesh Mohan, editors, India‘s Economy: Performances and Challenges: Development and Participation, Oxford University Press.
- Rakesh Mohan, 2010, ―India_s Financial Sector and Monetary Policy Reforms, ‖ in Shankar Acharya and Rakesh Mohan, editors, India‘s Economy: Performances and Challenges: Development and Participation, Oxford University Press.

Discipline Specific Elective Course [Economics] (DSE -A) BA/BSc (General)

Name of the Course: Money and Banking (MB)

Total Marks: 100 [Theory(Th) 65+ Tutorial(Tu) 15 + Internal Assessment 10+Attendance: 10]

Total Credits: [5(Th)+1(Tu)]=6 ,

No. of Lecture hours (Theory): 75, No. of Tutorial contact hours: 15

[For Semester-V]

ECO-G-DSE-5-1A/2A-TH-TU

ECO-G-DSE-5-1A/2A-TH

25 lecture hours

1. Money Supply and Banking System with reference to India

efinition of money supply in the Indian context (M_1, M_2, M_3 and M_4) , Balance sheet of the banking sector and accounting of money supply; balance sheet of the Reserve Bank of India and the accounting interpretation of High powered money; definition of high powered money; the money multiplier theory and balance sheet of commercial banks, sterilization by Central Banks. Indian banking system-changing role and structure; Indian banking sector reforms.

2. Financial Institutions and Financial Markets 22 lecture hours

- Role of financial markets and institutions in economic development- Indian examples
- Money and capital markets: organization, structure and reforms in India; role of financial derivatives and other innovations.

3. Interest Rates 12 lecture hours

Determination; sources of interest rate differentials; theories of term structure of interest rates; interest rates in India.

4. Central Banking and Monetary Policy 16 lecture hours

Instruments of monetary control with special reference to India; concepts of statutory liquidity ratio(SLR), cash reserve ratio(CRR) and repo rate as instruments of monetary control; monetary management in an open economy; current monetary policy of India, demonetization and its impact on the Indian economy.

ECO-G-DSE-5-1A/2A-TU

Tutorial Contact Hours: 15

Texts

- F. S. Mishkin and S. G. Eakins, Financial Markets and Institutions, Pearson Education, 6th edition, 2009.
- F. J. Fabozzi, F. Modigliani, F. J. Jones, M. G. Ferri, Foundations of Financial Markets and Institutions, Pearson Education, 3rd edition, 2009.
- M. R. Baye and D. W. Jansen, Money, Banking and Financial Markets, AITBS, 1996.
- Gupta, S.B.: Monetary Planning in India, Oxford University Press, Delhi.

References

- Rakesh Mohan, Growth with Financial Stability- Central Banking in an Emerging Market,

Oxford University Press, 2011.

- L. M. Bhole and J. Mahukud, Financial Institutions and Markets, Tata McGraw Hill, 5th edition, 2011.
- M. Y. Khan, Indian Financial System, Tata McGraw Hill, 7th edition, 2011.
- N. Jadhav, Monetary Policy, Financial Stability and Central Banking in India, Macmillan, 2006.
- R.B.I. – Report of the Working Group: Money Supply Analytics and Methodology of Compilation, 1998.
- R.B.I. Bulletin, Annual Report and Report on Currency and Finance (latest).
- Economic Survey 2016-17, Government of India.

Discipline Specific Elective Course [Economics] (DSE -A) BA/BSc (General)

Name of the Course: Sustainable Development (SD)

Total Marks: 100 [Theory(Th) 65 + Tutorial(Tu) 15 + Internal Assessment 10+Attendance: 10]

Total Credits: [5(Th)+1(Tu)]=6 ,

No. of Lecture hours (Theory): 75, No. of Tutorial contact hours: 15

[For Semester-V]

ECO-G-DSE-5-1A/2A-TH-TU

ECO-G-DSE-5-1A/2A-TH

1. The Approach Towards Sustainability-Introductory ideas **15 lecture hours**

Key environmental issues and problems, economic way of thinking about these problems, circular flow of environmental pollutants and waste recycling-laws of thermodynamics, renewable and non-renewable resources-the issue of sustainability

2. The meaning of Sustainable Development **25 lecture hours**

Different definitions of sustainable development, rules of sustainable development, measures of sustainable development, sustainable management of resources-the role of property rights, stakeholders associated with sustainble management of different types of renewable resources-fishery, forestry and water, the concept of sustainable livelihood in the context of sustainable resource management.

3. Trans-boundary pollution, climate change and sustainable development

15 lecture hours

Implementation of environmental policies in developing countries and international experience; transboundary environmental problems-international meetings, protocols and treaties; economics

of climate change-basic ideas of the carbon credit market-clean development mechanism and international emission trading.

4. Sustainable Resource Management Policies in India **20 lecture hours**

Water policy, forestry policy and fishery policy of India. Basic objectives of the policies along with goals and visions.

ECO-G-DSE-5-1A/2A-TU

Tutorial Contact Hours: 15

Texts

Rabindranath Bhattacharya : ―Environmental Economics : An Indian Perspective‖, Oxford University Press.

Pearce and Turner : ‗Environmental and Natural Resource Economics', John Hopkins University Press,1991

References

- Roger Perman, Yue Ma, Michael Common, David Maddison and James McGilvray, ―Natural Resource and Environmental Economics‖, Pearson Education/Addison Wesley, 4th edition, 2011.
- Charles Kolstad, ―Intermediate Environmental Economics‖, Oxford University Press, 2nd edition, 2010.
- IPCC (Intergovernmental Panel on Climate Change), Fifth Assessment Report , 2014.
- National Water Policy 2012, Ministry of Water Resources, Government of India.
- National Forest Policy 2016 : Ministry of Environment and Forests, Government of India
- National Policy on Marine Fisheries, 2017: Ministry of Animal Husbandry, Dairying and Fisheries, Government of India.

Discipline Specific Elective Course [Economics] (DSE-B) BA/BSc (General)

Name of the Course: Public Finance (PF)

Total Marks: 100 [Theory(Th) 65 + Tutorial(Tu) 15 + Internal Assessment 10+Attendance: 10]

Total Credits: [5(Th)+1(Tu)]=6 ,

No. of Lecture hours (Theory): 75, No. of Tutorial contact hours: 15

[For Semester-VI]

ECO-G-DSE-6-1B/2B-TH-TU

ECO-G-DSE-6-1B/2B-TH

1. Theory of Public Finance **40 lecture hours**

- Overview of Fiscal Functions, Tools of Normative Analysis, Pareto Efficiency, Equity and

the Social Welfare.

- Market Failure, Public Good and Externalities.
- Elementary Theories of Product and Factor Taxation (Excess Burden and Incidence).

2. Issues from Indian Public Finance **35 lecture hours**

- Current Issues of India‘s Tax System.
- Working of Monetary and Fiscal Policies.
- Analysis of Budget and Deficits
- Fiscal Federalism in India
- State and Local Finances

ECO-G-DSE-6-1B/2B-TU

Tutorial Contact Hours: 15

Text

- Ganguly Subrata , Public Finance : A Normative Approach, Nababharat Publishers

References

- Musgrave, R.A. and P.B. Musgrave, Public Finance in Theory and Practice, Mc- Graw Hill, 1989.
- M.M Sury, Government Budgeting in India, Commonwealth Publishers, 1990.
- Shankar Acharya, ‒Thirty years of tax reform‖ in India, Economic and Political Weekly, May 2005.
- Government of India, Report of the 13th Finance Commission.
- Economic Survey, Government of India (latest).
- State Finances: A Study of Budgets, Reserve Bank of India (latest).

Discipline Specific Elective Course [Economics] (DSE-B) BA/BSc (General)

Name of the Course: Economic History of India (1857-1947) (EHI)

Total Marks: 100 [Theory(Th) 65+ Tutorial(Tu) 15 + Internal Assessment 10+Attendance: 10]

Total Credits: [5(Th)+1(Tu)]=6 ,

No. of Lecture hours (Theory): 75, No. of Tutorial contact hours: 15

[For Semester-VI]

ECO-G-DSE-6-1B/2B-TH-TU

ECO-G-DSE-6-1B/2B-TH

- **Colonial India: Background and Introduction** **10 lecture hours**

Overview of the colonial economy

- **Macro Trends** **13 lecture hours**

National Income; population; occupational structure.

- **Agriculture** **17 lecture hours**

Agrarian structure and land relations; agricultural markets and institutions – credit, commerce and technology; trends in performance and productivity; famines.

- **Railways and Industry** **20 lecture hours**

Railways; the de-industrialisation debate; evolution of entrepreneurial and industrial structure; nature of industrialisation in the interwar period; constraints to industrial breakthrough; labor relations.

- **Economy and State in the Imperial Context** **15 lecture hours** The imperial priorities and the Indian economy; drain of wealth; international trade, capital flows and the colonial economy – changes and continuities; government and fiscal policy.

ECO-G-DSE-6-1B/2B-TU

Tutorial Contact Hours: 15

Text

- Bhattacharya, Dhiresh, A Concise History of Indian Economy, Progressive Publishers, 1972

References

- Irfan Habib, Indian Economy 1858-1914, A People_s History of India, Vol.28, Tulika, 2006.
- B.R. Tomlison, 1975, India and the British Empire 1880-1935, IESHR, Vol.XII.
- Dharma Kumar, the Fiscal System, CEHI, Chapter 12.
- Basudev Chatterjee, Trade, Tariffs and Empire, OUP 1992, Epilogue.
- Daniel Thorner, Agrarian Prospect in India, 1977
- Amiya Kumar Bagchi , Private Investment in India 1900-1939, Taylor and Francis, 2000.

Skill Enhancement Course [Economics] -A Group (SEC-A) BA/BSc (General)

Name of the Course: Introductory Methods of Field Survey (IMFS)

Total Marks: 100 [Theory(Th) 80 + Internal Assessment 10+Attendance: 10]

Total Credits: 2,

No. of Lecture hours: 30

ECO-G-SEC-3-1A-TH/ECO-G-SEC-5-2A-TH

[For Semester III or Semester V]

1. **Basic ideas of economic data** **8 lecture hours**
    - Types of data-cross section, time series , pooled data, panel data etc.
    - Nature of field survey data – types of cross section data
    - Advantages and disadvantages of field survey data

- Importance of field survey data for economic analysis
- Role of pilot survey

2. Methodologies of collection of data **15 lecture hours**

- Complete enumeration vs. sample survey
- Sampling techniques : basic ideas of simple random sampling (with and without replacement), stratified random sampling, circular sampling, sampling proportional to size (mathematical proof/mathematical demonstration not required for any type of sampling)
- Practical methods of drawing random sample using random number tables.
- Prerequisites for field survey –preparation of blank tables
- Preparation of questionnaire depending on nature of survey- illustrations on the basis of preparation of hypothetical questionnaire

3. Recording of data **7 lecture hours**

- How to record data after completion of survey : use of manual methods and recording through the use of computers
- Tabular representation of data collected
- Cross checking of data after tabular representation
- Role of units of measurement

References

- Goon, A. M, Gupta, M. K, and Dasgupta, B. Fundamentals of Statistics (Volumes One and Two),The World Press Private Ltd
- Kapur J.N. and Saxena H.C. , Mathematical Statistics, Sultan Chand Publishing

Skill Enhancement Course [Economics] -A Group (SEC-A) BA/BSc (General)

Name of the Course: Elementary Rural Development (ERD)

Total Marks: 100 [Theory(Th) 80 + Internal Assessment 10+Attendance: 10]

Total Credits: 2,

No. of Lecture hours: 30

ECO-G-SEC-3-1A-TH/ECO-G-SEC-5-2A-TH

[For Semester III or Semester V]

1. Basic Issues in Rural Development **12 lecture hours**

- Rural Development vs. Agricultural Development
- Decentralized Planning and Participatory Development-the role of Panchayats
- Panchayat and Rural Development in West Bengal
- Role of NGOs in Rural Development

2. Rural Credit and Self Help Groups (SHGs) 12 lecture hours

- Constraints of micro-enterprises in rural areas
- The rural non farm sector –credit needs for rural non farm sector.
  - Concept of micro credit and the role of Grameen Bank
  - Need for SHG for formation-features of SHG
  - SHGs in India

3. Selected Government Programmes and Rural Development 6 lecture hours

- Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA)
- Mid-day Meal
- Pradhan Mantri Gram Sadak Yojana (PMGSY)

References

1. Katar Singh , Rural Development : Principles, Policies and Management, Sage Publications, New Delhi.
2. K.G. Karmakar, Rural Credit and Self-Help Groups, Sage Publications, New Delhi
3. S.Sau, Rural Industrialization –Development Trajectory in India, Farma K.L.M., Kolkata
4. Misra D. and Puri K. Indian Economy, Himalaya Publishing House
5. Datt and Sundharam (Revised by G.Datt and A. Mahajan) , Indian Economy, 70th edition, S. Chand

Skill Enhancement Course [Economics] -B -Group (SEC-B) BA/BSc (General)

Name of the Course: Economic Data Analysis and Report Writing (EDARW)

Total Marks: 100 [Theory(Th) 80 + Internal Assessment 10+Attendance: 10]

Total Credits: 2,

No. of Lecture hours: 30

ECO-G-SEC-4-1B-TH/ECO-G-SEC-6-2B-TH

[For Semester IV or Semester VI]

1. Tabular and Graphical representation of Statistical Data 6 lecture hours

- Tabular representation of data for analysis
- Graphical representation of data-use of line diagram, bar chart, divided bar chart, pie chart etc.
- Frequency distribution table: uses and implications
- Pictorial descriptions of frequency table: frequency polygon, histogram, ogive etc.

2. Basic Descriptive Statistics and its role in Data Analysis 16 lecture hours

- Measures of Central Tendency-Concept of arithmetic mean, geometric mean and harmonic mean-their uses (explicit mathematical proof of the properties of different types mean are not required).The concept of median and mode-their uses in analyzing economic data. Comparison of mean, median and mode as measures of central tendency
- Measures of dispersion: range, mean deviation, standard deviation and quartile deviation. Properties of various measures and their implications (explicit proof of properties is not required). Comparison of various measures of dispersion. Significance of the concept of coefficient of variation. Use of range, standard deviation and coefficient of variation in measuring income inequality. Basic concept of Gini coefficient and Lorenz curve.
- Introductory ideas of correlation and regression analysis.

3. Elements of Report writing 8 lecture hours

- Locating the basic issues- theme based literature survey and motivation behind any study- objectives of the study-development of writing skills
- Methodological issues: Use of tables and graphs. Use of various measures of central tendency and dispersion in analyzing the results.
- Insertion of footnotes or end notes.
- Preparation of Bibliography

References

- Goon, A. M, Gupta, M. K, and Dasgupta, B. Fundamentals of Statistics (Volume One), The World Press Private Ltd.
- A.L. Nagar and R.K. Das : Basic Statistics, 2nd edition, Oxford University Press.
- C.R. Kothari: Research Methodology: Methods and Techniques (second revised edition), New Age India (P) Ltd Publishers.

Skill Enhancement Course [Economics] -B -Group (SEC-B) BA/BSc (General)

Name of the Course: Entrepreneurship and Development (ED)

Total Marks: 100 [Theory(Th) 80 + Internal Assessment 10+Attendance: 10]

Total Credits: 2,

No. of Lecture hours: 30

ECO-G-SEC-4-1B-TH/ECO-G-SEC-6-2B-TH

[For Semester IV or Semester VI]

1. Basic issues of Entrepreneurship and Economic Development 10 lecture hours

- Basic features of Entrepreneurship
- Entrepreneurship and its linkages with economic development

- Growth of entrepreneurship in India—Role of Entrepreneurship in Economic Development.

- Planning Commission's guidelines for formulating a project report by an entrepreneur
- Problem of Rural entrepreneurship in India

2. Financial resources for new ventures of an entrepreneur 7 lecture hours

- Sources of finance---capital structure.
- Institutional support to enterprises—national small industries board – state small industries development corporation--- district industries center--- industrial estates-Indian experience

3. Growth strategies in small business 7 lecture hours

- Stages of growth,
- Types of growth strategies-Expansion, Diversification, Joint Venture, Merger and Subcontracting

4. Sickness in Small Business 6 lecture hours

- Concept of industrial sickness
- Symptoms of sickness in small business
- Causes and consequences of sickness in small business

References

- S.S Khanka--- Entrepreneurial Development, S.Chand & Company Ltd
- Bill Bolton and John Thompson ---- Entrepreneurs: Talent, Temperament and Technique, Butterworth and Heinemann.
- .David .H Holt---Entrepreneurship New Venture Creation
- Poornima M. Charantimath: Entrepreneurship Development and Small Business Enterprises (2nd Edition) Pearson.
- Misra D. and Puri K. Indian Economy, Himalaya Publishing House
- Datt and Sundharam (Revised by G.Datt and A. Mahajan) , Indian Economy, 70th edition, S. Chand

UNIVERSITY OF CALCUTTA

Notification No. CSR/ 12 /18

It is notified for information of all concerned that the Syndicate in its meeting held on 28.05.2018 (vide Item No.14) approved the Syllabi of different subjects in Undergraduate Honours / General / Major courses of studies (CBCS) under this University, as laid down in the accompanying pamphlet:

List of the subjects

Sl. No.	Subject	Sl. No.	Subject
1	Anthropology (Honours / General)	29	Mathematics (Honours / General)
2	Arabic (Honours / General)	30	Microbiology (Honours / General)
3	Persian (Honours / General)	31	Mol. Biology (General)
4	Bengali (Honours / General /LCC2 /AECC1)	32	Philosophy (Honours / General)
5	Bio-Chemistry (Honours / General)	33	Physical Education (General)
6	Botany (Honours / General)	34	Physics (Honours / General)
7	Chemistry (Honours / General)	35	Physiology (Honours / General)
8	Computer Science (Honours / General)	36	Political Science (Honours / General)
9	Defence Studies (General)	37	Psychology (Honours / General)
10	Economics (Honours / General)	38	Sanskrit (Honours / General)
11	Education (Honours / General)	39	Social Science (General)
12	Electronics (Honours / General)	40	Sociology (Honours / General)
13	English ((Honours / General/ LCC1/ LCC2/AECC1)	41	Statistics (Honours / General)
14	Environmental Science (Honours / General)	42	Urdu (Honours / General /LCC2 /AECC1)
15	Environmental Studies (AECC2)	43	Women Studies (General)
16	Film Studies (General)	44	Zoology (Honours / General)
17	Food Nutrition (Honours / General)	45	Industrial Fish and Fisheries – IFFV (Major)
18	French (General)	46	Sericulture – SRTV (Major)
19	Geography (Honours / General)	47	Computer Applications – CMAV (Major)
20	Geology (Honours / General)	48	Tourism and Travel Management – TTMV (Major)
21	Hindi (Honours / General /LCC2 /AECC1)	49	Advertising Sales Promotion and Sales Management –ASPV (Major)
22	History (Honours / General)	50	Communicative English –CMEV (Major)
23	Islamic History Culture (Honours / General)	51	Clinical Nutrition and Dietetics CNDV (Major)
24	Home Science Extension Education (General)	52	Bachelor of Business Administration (BBA) (Honours)
25	House Hold Art (General)	53	Bachelor of Fashion and Apparel Design – (B.F.A.D.) (Honours)
26	Human Development (Honours / General)	54	Bachelor of Fine Art (B.F.A.) (Honours)
27	Human Rights (General)	55	B. Music (Honours / General) and Music (General)
28	Journalism and Mass Communication (Honours / General)		

The above shall be effective from the academic session 2018-2019.

SENATE HOUSE
KOLKATA-700073
The 4th June, 2018

Paul 4/6/18
(Dr. Santanu Paul)
Deputy Registrar

B.A. Honours in Education (EDCH)
Choice Based Credit System

In the 3 years B.A. Honours in Education there will be 6 Semesters. The curriculum consists of 14 Core Courses (CC), 2 Ability Enhancement Compulsory Courses (AECC), 2 Skill Enhancement Courses (SEC) and 4 Discipline Specific Elective (DSE) courses and 4 Generic Elective (GE) Courses. Each course is of 100 Marks.

TH stands for Theory Hour, TU for Tutorial Hour and P for Practical Hour

Semester 1 = 400 Marks (20 Credit)
Semester 2 = 400 Marks (20 Credit)
Semester 3 = 500 Marks (26 Credit)
Semester 4 = 500 Marks (26 Credit)
Semester 5 = 400 Marks (24 Credit)

Semester 6 = 400 Marks (24 Credit)

Total: 2600 Marks (140 Credits)

Distribution of marks:- (Out of 100)

Attendance = 10 Marks
Internal Assessment =10 Marks
Tutorial = 15 Marks
Subjective Exam = 65 Marks
Total = 100 Marks

Semester wise Courses							
		1	**2**	**3**	**4**	**5**	**6**
Core Courses (CC)		**2**	**2**	**3**	**3**	**2**	**2**
Elective Courses	**Generic Elective (GE)**	1	1	1	1		
	Discipline Elective					**2**	**2**
Ability Enhancement	**Language / Environment**	1	1				
	Skill Based Electives			**1**	**1**		
Total Credit		**20**	**20**	**26**	**26**	**24**	**24**

Core Courses (CC):- 14 for Honours Course.

Discipline Specific Elective (DSE):- 4 for Honours Courses. Elective Courses offered under the main Discipline/Subject of study is referred to as Discipline Specific Elective. The list provided under this category is suggestive in nature and each University has complete freedom to suggest their own papers under this category.

Generic Elective (GE): 4 for Honours courses. An elective course chosen from an unrelated Discipline/Subject.

Ability Enhancement Courses (AEC):- It may be of two kinds.

- Ability Enhancement Compulsory Courses (AECC)
- Skill Enhancement Courses (SEC)

AECC courses are the courses based upon the content that leads to knowledge enhancement.

i) Environmental Studies and
ii) Communicative English/Hindi/MIL
(These are mandatory for all Disciplines)

SEC courses are value based and/or skill based. 2 for Honours Course.

Tutorial:- Topics are to be selected within the particular paper.

SEMESTER – 1

Course Code	Course Type	Credit	Marks	TH – TU - P
Core Course	CC - 1	6	100	5 – 1 – 0
Core Course	CC - 2	6	100	5 – 1 – 0
Elective - Generic	GE - 1	6	100	
AECC	AECC - 1	2	100	
		20	**400**	

1 credit = 1 hour class; Per week = 6 hours/6 credit

SEMESTER – 2

Course Code	Course Type	Credit	Marks	TH – TU - P
Core Course	CC – 3	6	100	5 – 1 – 0
Core Course	CC - 4	6	100	5 – 1 – 0
Elective - Generic	GE – 2	6	100	
AECC	AECC - 2	2	100	
		20	**400**	

1 credit = 1 hour class; Per week = 6 hours/6 credit

SEMESTER – 3

Course Code	Course Type	Credit	Marks	TH – TU - P
Core Course	CC – 5	6	100	5 – 1 – 0
Core Course	CC - 6	6	100	5 – 1 – 0
Core Course	CC - 7	6	100	5 – 1 – 0
Elective - Generic	GE – 3	6	100	
Skill Enhancement	SEC – A	2	100	2 – 0 – 0
		26	**500**	

1 credit = 1 hour class; Per week = 6 hours/6 credit

SEMESTER – 4

Course Code	Course Type	Credit	Marks	TH – TU - P
Core Course	CC – 8	6	100	5 – 1 – 0
Core Course	CC – 9	6	100	5 – 1 – 0
Core Course	CC – 10	6	100	5 – 1 – 0
Elective - Generic	GE – 4	6	100	
Skill Enhancement	SEC – B	2	100	2 – 0 – 0
		26	**500**	

1 credit = 1 hour class; Per week = 6 hours/6 credit

SEMESTER – 5

Course Code	Course Type	Credit	Marks	TH – TU - P
Core Course	CC – 11	6	100	5 – 1 – 0
Core Course	CC – 12	6	100	4 – 0 – 2
Discipline Specific Elective	DSE – A	6	100	5 – 1 – 0
	DSE – B	6	100	5 – 1 – 0
		24	**400**	

1 credit = 1 hour class; Per week = 6 hours/6 credit

SEMESTER – 6

Course Code	Course Type	Credit	Marks	TH – TU - P
Core Course	CC – 13	6	100	4 – 0 – 2
Core Course	CC – 14	6	100	5 – 1 – 0
Discipline Specific Elective	DSE – A	6	100	5 – 1 – 0
	DSE – B	6	100	5 – 1 – 0
		24	**400**	

1 credit = 1 hour class; Per week = 6 hours/6 credit

Course Title:-

Semester - 1	**CC – 1** = Introduction to Education
	CC – 2 = History of Indian Education

Semester - 2	**CC – 3** = Psychological Foundation of Education
	CC – 4 = Philosophical Foundation of Education

Semester - 3	**CC – 5** = Sociological Foundation of Education
	CC – 6 = Educational Organization, Management and Planning
	CC – 7 = Guidance and Counselling

Semester - 4	**CC – 8** = Technology in Education
	CC – 9 = Curriculum Studies
	CC – 10 = Inclusive Education

Semester - 5	**CC – 11** = Measurement and Evaluation in Education
	CC – 12 = Statistics in Education

Semester - 6	**CC – 13** = Psychology of Adjustment
	CC – 14 = Basic Concept of Educational Research

Semester - 3	**SEC – A** = Communication Skills /Skill for Democratic Citizenship

Semester - 4	**SEC – B** = Teaching Skill / Life Skill Education

Semester - 1	**AECC – 1** = English/Hindi/MIL
Semester - 2	**AECC – 2** = Environmental Studies

DSE – A **Any one from the following** **(For 5th Semester)**

- Peace and Value Education
- Educational Thought of Great Educators

DSE – A **Any one from the following** **(For 6th Semester)**

- Gender and Society
- Population Education

DSE – B **Any one from the following** **(For 5th Semester)**

- Teacher Education
- Open and Distance Learning

DSE – B **Any one from the following** **(For 6th Semester)**

- Human Rights Education
- Women Education

CC – 1 (Semester 1)
Introduction to Education

Objectives:

- To understand the meaning, nature, scope and aims of education.
- To explain the factors of education and their interrelationship.
- To become aware of different agencies of education that influence education.
- To be acquainted with the concept of child-centricism and play-way in education

Unit- I = Concept of Education

- Narrow and broader concept of education
- Meaning, nature and scope of education.
- Aims of education – individual, social, vocational and democratic.
- Aims of modern education with special reference to Delor's Commission.

Unit- 2 = Factors of Education

- Child / learner: influence of heredity and environment on the learner
- Teacher: qualities and duties of a good teacher.
- Curriculum- concept and types.
- Co-curricular activities: meaning, values and significance.
- Educational institutions: informal, formal and non-formal, their interrelation.

Unit- 3 = Agencies of Education

- Home
- School
- State
- Mass-media- television, radio, cinema and newspaper

Unit- 4 = Child Centricism and Play-way in Education

- Concept of child centricism in education
- Characteristics and significance of child centricism in education
- Concept of play and work.
- Characteristics of play way in Education, Kindergarten, Montessori, Project method.

CC – 2 (Semester 1)

History of Indian Education

Objectives:

- To be acquainted with the salient features of education in India during ancient and medieval times
- To be acquainted with the development of education in British India
- To be acquainted with the significant points of selected education commissions & national policy of education in independent India

Unit: 1 = **Education in India during ancient and medieval period**

- Vedic (aim, curriculum, teaching method, teacher-pupil relation)
- Brahmanic (")
- Buddhistic (")
- Islamic (")

Unit: 2 = **Education in India during British period (1800-1853)**

- Sreerampore trio and their contribution in the field of education
- Charter Act, Oriental-occidental controversy
- Macaulay Minute and Bentinck's resolution
- Adam's report

Unit: 3 = **Education in India during British period (1854-1946)**

- Woods Despatch, Hunter Commission
- Curzon policy regarding primary, secondary and higher education, National education movement (cause and effect)
- Basic education (concept and development)
- Sadler Commission

Unit: 4 = **Education in India after independence**

- Radhakrishnan Commission (aim, curriculum of higher education, rural university)
- Mudaliar Commission (aim, structure and curriculum of secondary education)
- Kothari Commission (aim, structure and curriculum of primary and secondary education)
- National Policy of Education, 1986, POA 1992.

CC – 3 (Semester 2)
Psychological Foundation of Education

Objectives:

- To understand the meaning of Psychology and be acquainted with it's different aspects.
- To know the patterns of different aspects of human development and relate this knowledge with education.
- To be acquainted with the cognitive approach of development and thus to understand the process and factors of cognition.

Unit: 1 = **Relation between Psychology and Education**

- Meaning and definition of Psychology
- Meaning and definition of Education
- Relation between Psychology and education
- Nature, scope and significance of educational psychology.

Unit: 2 = **Stages and types of human development and their educational significance.**

- Piaget's cognitive development theory
- Erikson's psycho-social development theory
- Kohlberg's moral development theory
- Vygotsky's social development theory and Bandura's Social Learning Theory

Unit: 3 = **Learning: concept and theories**

- Concept and characteristics of learning
- Theories: Connectionism(Trial and error, classical, operant conditioning)
- Insightful learning
- Memorization and Forgetting: Process of memorization, causes of forgetting and economical ways of improving memorization

Unit: 4 = **Intelligence**

- Concept of intelligence
- Theories of Intelligence by Spearman, Thorndike and Guilford
- Types and uses of intelligence tests
- Concept of Emotional Intelligence and E.Q

CC-4 (Semester 2)

Philosophical Foundation of Education

Objectives:

- To understand the meaning and relation of philosophy and education
- To understand the importance of philosophy in education
- To be acquainted with the Indian schools of philosophy and their impact on education
- To be acquainted with the western schools of philosophy and their impact on education
- To develop an understanding of philosophy for development of humanity

Unit 1 = **Concept of educational philosophy**

- Meaning of philosophy
- Etymological meaning of education
- Relation between philosophy and education
- Importance of philosophy in education

Unit 2 = **Indian schools of philosophy**

- Vedic school - Sankhya
- Vedic school - Yoga
- Non-vedic School - Buddhism
- Non-vedic School - Jainism

Unit 3 = **Western schools of philosophy**

- Idealism
- Naturalism
- Pragmatism
- Realism

Unit 4 = **Philosophy for development of humanity**

- Education and development of values
- Education for national integration
- Education for international understanding
- Education for promotion of peace and harmony

CC – 5 (Semester 3)

Sociological Foundation of Education

Objectives:

- To understand the relation between Sociology and Education . nature, and scope of Sociology of education.
- To explain the concept of Social Groups and Socialization process.
- To enable the students to understand the concept of Social change and Social interaction in education
- To become aware of social Communication in Education

Unit-I = Introductory Concept of Sociology of Education

- Meaning and definition of Sociology of Education
- Relation between Sociology and Education
- Nature of Sociology of Education
- Scope of Sociology of Education

Unit-2 = Social Groups

- Social Groups : meaning and definition
- Types of Social groups – Primary, Secondary and Tertiary
- Socialization Process: Concept
- Role of the family and school in Socialization process

Unit-3 = Social Change and Education

- Concept of Social Change
- Interrelation between Social change and Education
- Social stratification and Social Mobility.
- Social interaction Process

Unit-4 = Social Communication in Education

- Social Communication : Concept
- Informal agencies of social communication
- Inter relation between Culture, religion and Education.
- Inter relation between Technology, Economy and Education.

CC – 6 (Semester 3)

Educational Organization, Management and Planning

Objectives:

- To develop the concept of an ideal organization in educational institutions.
- To know the essential functions of educational management.
- To understand the different aspects of planning,

Unit: 1 = **Organization and Management**

- Concept of organization
- Concept of management
- Concept of educational organization
- Concept of school organization

Unit: 2 = **Educational organization**

- Meaning of school plant
- Elements of school plant (concepts only)
- Features of library and time-table
- Features of school medical services, workshop, computer laboratory.

Unit: 3 = **Educational Management**

- Meaning of educational management
- Objectives of educational management
- Types of educational management
- Significance of educational management

Unit:4 = **Educational Planning**

- Meaning of educational planning
- Aims and objectives of educational planning
- Steps of educational planning
- Types and significance of educational planning

CC – 7 (Semester 3)

Guidance and Counselling

Objectives:-

- To know the concept of guidance
- To know various types of Guidance
- To Know the basic concept of Counselling
- To find out the basic data necessary for Guidance

Unit I = Guidance – Meaning, Functions, Need

- Guidance – Meaning, Definitions and Functions
- Individual Guidance – Meaning, advantages and disadvantages
- Group Guidance – Meaning and Advantages and disadvantages
- Need for guidance in secondary schools and requisites of a good school guidance programme.

Unit 2 = Guidance - Educational, Vocational, Personal

- Educational Guidance- Meaning, Function at different stages of Education
- Vocational Guidance- Meaning, Function at different stages of Education
- Personal Guidance- Meaning, Importance for the Adolescents

Unit 3 = Counselling – Meaning, Techniques, Types

- Counselling - – Meaning, importance and Scope
- Techniques of Counselling- Directive, Non-Directive, Eclectic
- Individual and Group Counselling –Meaning , Importance

Unit 4 = Basic data necessary for Guidance

- Tools for collecting information on pupil: Intelligence: Concept and Test, Personality: Concept and Test, Aptitude: Concept and Test
- Cumulative Record Card
- Anecdotal Record Card

CC-8 (Semester 4)

Technology in Education

Objectives:

- To develop an understanding of educational technology
- To be acquainted with the system approach
- To develop an understanding of the use of computer in education and communication
- To get acquainted with the instructional techniques and different models of teaching
- To develop an understanding of ICT & e-learning.

Unit 1 = **Introductory concept**

- Concept of Technology
- Need and scope of educational technology
- System approach- concept and need
- Classification and components of system approach

Unit 2 = **Computer in education and communication**

- Computer and its role in education
- Basic concept of hardware and software
- Computer network and internet- its role in education
- Communication and classroom interactions- concept, element and process

Unit 3 = **Instructional techniques**

- Mass instructional technique- characteristics and types
- Personalised instructional techniques- characteristics and types
- Difference in teaching and instruction
- Models of teaching- concept, components and significance

Unit 4 = **ICT & e-learning**

- Meaning and concept of ICT, e-learning
- Nature and characteristics of e-learning
- ICT integration in teaching learning, massive open online course (MOOC)
- Different approaches- Project based learning, co-operative learning and collaborative learning

CC – 9 (Semester 4)
Curriculum Studies

Objectives:

- To develop an understanding about concept, nature, types and major approaches of curriculum
- To understand the relation among curriculum, pedagogy and assessment
- To develop an understanding about curriculum development and national curriculum frame work, 2005
- To get acquainted with content selection and selected theories in this regard
- To develop an understanding of evaluation & reform of curriculum

Unit 1 = **Introductory concept**

- Meaning, nature, scope and functions of curriculum
- Bases of curriculum: philosophical, psychological and sociological
- Major approaches to curriculum - behavioural, managerial, system, humanistic
- Types of curriculum - knowledge, experience & activity based

Unit 2 = **Content selection**

- Determinants of content selection - perspectives of knowledge, culture & need
- Curriculum and institution - instructional objectives
- Revised Bloom's taxonomy
- Bruner's theory of instruction

Unit 3 = **Curriculum development**

- Principles of curriculum construction
- Learner centred curriculum framework - concept, factors & characteristics
- Curriculum development - need, planning
- NCF, 2005

Unit 4 = **Evaluation & reform of curriculum**

- Concept & significance of curriculum evaluation
- Approaches to curriculum evaluation - formative & summative
- Models of evaluation - Stufflebeam & Taylor
- Curriculum reform - factors & obstacles

CC – 10 (Semester 4)

Inclusive Education

Objectives:-

- Understand the meaning of Inclusion and exclusion
- Know the types of exclusion and their causes
- Know how to bring about inclusion in different spheres

Unit: 1 = **Inclusion Overview**

- Meaning of Inclusion and Inclusive Society
- Exclusion and Inclusion: Conceptual overview
- Obstacles/barriers in Inclusion
- Elements necessary for creating an inclusive society

Unit: 2 = **Differently Abled**

- Concept of Impairment, Disability and Handicap
- Types of disabilities- Orthopaedic, Visual, Auditory, Cerebral Palsy, Intellectual, Autism, Learning Disability (only definition and their specific problems)
- General causes of disabilities
- Role of school and society in creating a barrier free environment

Unit: 3 = **Socially Disabled**

- Concept of SC, ST and OBC groups.
- Concept of Gender, and sexuality
- Causes of social exclusion
- Understanding social inclusion: role of education

Unit: 4 = **Educational Reforms for Inclusive Society**.

- Building an Inclusive school: desired changes in System, Structure, Practice and Culture,
- Education for a multicultural society.
- Education for peaceful co-existence
- Role of Informal agencies (like mass media etc) in building an inclusive society

CC -11 (Semester 5)

Evaluation and Measurement in Education

Objectives:-

- To develop understanding of the concepts of measurement and evaluation in education.
- To be acquainted with the process of Evaluation
- To be acquainted with different types of measuring instruments and their uses.
- To develop understanding of the concepts of validity and reliability and their importance in educational measurement.
- To be acquainted with the principles of test construction.

Unit: 1 = **Measurement and Evaluation in Education**

- Educational Measurement and Evaluation : Concept
- Scope and Need of Educational Measurement and Evaluation
- Relation between Measurement, Assessment and Evaluation.
- Scales of Measurement- Nominal, Ordinal, Interval and Ratio.

Unit: 2 = Evaluation Process

- Evaluation Process: (Formative and Summative)
- Types and steps of evaluation
- Norm-Referenced Test and Criterion Referenced Test.
- Grading and Credit system.

Unit: 3 = Tools and Techniques of Evaluation

- Concept of Tools and Techniques
- Testing tools
  i) Educational : Essay type and Objective type, Written , Oral.
  ii) Psychological: Personality Test- Types, Rorschach Ink Blot Test , Interest Test- Types , Kuder Richardson interest inventory, Intelligence Test - Types of intelligence tests , Stanford – Binet Scale,
- Non testing tools – Cumulative Record Card, Portfolio
- Techniques:
  i) Self reporting : Interview , Questionnaire
  ii) Observation.

Unit: 4 = Criteria of a Good Tool and its Construction

- Characteristics of a good tool

(i) Objectivity- Concept
(ii) Reliability- Concept, methods of determining reliability
(iii)Validity- Concept and types
(iv) Norms- Meaning & types
(v) Usability -Concept

- Steps for construction & standardization of Achievement test

CC – 12 (Semester 5)

Statistics In Education

Objectives:

- To develop the concept of statistics and to develop skill in analyzing descriptive measures
- To be acquainted with the concept of Normal Probability Curve and its uses in education
- To develop a concept of measures of relationship
- To develop the ability to organize relevant educational data and to represent educational data through graphs and to develop skill in analyzing and displaying data

Unit: 1 = Concept of Statistics and Descriptive Statistics

- Concept of Statistics. Uses of Statistics in Education, Organization and presentation of data – tabulation, graphical representation(Frequency Polygon, Histogram, Ogive, Pie)
- Meaning & measures of Central Tendency- Arithmetic Mean, Median and Mode-their Properties, Calculation and Application.
- Meaning & measures of Variability- Range, Standard Deviation and Quartile Deviation - their Properties, Calculation and Application
- Percentile and Percentile Rank - Definition, Calculation, Application, Graphical Determination

Unit: 2 = Normal Distribution and Derived Score

- Concept of Normal Distribution- Properties
- Uses of NPC in Education
- Divergence from Normality- Skewness and Kurtosis.(Concept and Calculation)
- Derived Scores- Z-Score, T Score and Standard Score (Concept, Calculation and Uses).

Unit: 3 = Measure of Relationship

- Bi-variate Distribution- Concept and types of Linear Correlation
- Scatter Diagram (only Concept)
- Uses of Correlation
- Computation of Co-efficient of Correlation by Rank Difference method and Product Moment method, Interpretation of Co-efficient of Correlation

Unit:4 = Statistics (Practical)

- Students are expected to collect relevant data (Bi-variate educational data) from their college or neighbourhood (minimum sample size must be 50) with the objective of
  - describing the nature and characteristics of the two distributions,
  - comparing two distributions and
  - finding association between two sets of data by applying the following:

Method: i) Tabulation of data

ii) Determination of central tendencies and variability (standard deviation)

iii) Graphical Representation- Bar graph, Frequency Polygon, Cumulative frequency graph.

iv) Determination of the type of association between two sets of data by drawing scatter diagram

CC – 13 (Semester 6)

Psychology of Adjustment

Objectives:

- To understand the concept of adjustment, maladjustment and some commonly found problem behavior.
- To know the multi-axial classification of mental disorders.
- To be aware about different coping strategies for stressful situation.
- To know the administration, scoring and interpretation of the psychological tests.

Unit: 1 = Adjustment, Maladjustment and Problem Behaviour

- Concept of adjustment, adjustment and adaptability
- Psychodynamic Concept of adjustment, criteria of good adjustment
- Concept of maladjustment. Causes of maladjustment, aggressiveness, delinquency, substance abuse

Unit: 2 = Multi-axial Classification of Mental Disorders

- DSM – 5 : Section 1, Section II and Section III
- Brief outline of Schizophrenia, anxiety disorder, depressive disorder and personality disorder
- Psychoanalysis, behavior therapy, cognitive therapy, and humanistic therapy.(Concept only)

Unit: 3 = Coping Strategies for Stressful Situation

- Stress and Stressors
- Personal and environmental stress
- Coping strategies for stress

Unit: 4 = Administration, Scoring and Interpretation of the following Tests (Practical)

- KNPI(Kundu Neurotic Personality Inventory)
- KIEI (Kundu Introversion Extroversion Inventory)
- Effect of Learning material on memorization

CC – 14 (Semester 6)

Basic Concept of Educational Research

Objectives:-

- Have a concept of educational research
- Learn about the various steps to be followed for conducting a research
- Learn how to write a research proposal and review research papers

Unit: 1 = Concept of Educational Research

- Definition, meaning and concept of research
- Educational research and its characteristics
- Types of Educational Research
- Problems, difficulties and ethics

Unit: 2 = Basic elements of educational research

- Literature review
- Problem selection
- Objectives, Research question and Hypothesis
- Tools of Data collection –types

Unit: 3 = Data collection procedure

- Sampling –concept and definition
- Types of sampling- Probability and non-probability
- Data reporting- Descriptive and Inferential (basic statistical procedure that come under each)
- Referencing and Bibliography

Unit: 4 = Tutorial (Project/Term Paper centric)

- Writing Research proposal (Within 1000 words) - Plan of Work– steps and review (atleast5)

SEC – A (Semester – 3)

Communication Skill

Objectives:

- To understand the basic elements of Communication
- To acquire Listening Skills
- To acquire Speaking Skills
- To acquire Reading and Writing Skills

Unit: 1 = Introduction to Communication

- Meaning, Nature and types of communication
- Principles of communication
- Process of communication: Sender, encoding, recipient, decoding and feedback
- Barriers of effective communication

Unit: 2 = Listening Skills

- Principles of listening skills
- Types of listeners
- Barriers to listening

Unit: 3 = Speaking Skills

- Verbal and non-verbal communication
- Public speaking: Extempore
- Group discussion

Unit: 4 = Reading and Writing Skills

- Previewing, skimming, and scamming
- Development of skills for correct pronunciation, reading and comprehension
- Sentence formation and punctuation

SEC – A (Semester – 3)

Skill for Democratic Citizenship

Objectives:-

- Have an idea about their duties as citizens
- Have an idea about their rights as citizens
- Have an idea about child violence and child rights
- Have an idea about domestic violence and domestic rights

Unit 1: **Rights and duties in Indian Constitution**

- Democratic rights
- Fundamental Rights
- Duties of citizenship

Unit 2 = **Protection of Children**

- Child protection - concept and need.
- Child Rights – concept, classification and need
- Legal actions –POCSO

Unit 3 = **Domestic Harmony**

- Domestic violence – definition and types
- Protection of Women from Domestic Violence Act, 2005 – basic features
- Protection of males in DVA 2005

Unit 4 = **Role of Education (Term Paper/Project Paper)**

- Awareness programmes- rallies, debates etc
- Mass media
- Seminars and workshops

o (Any one may be taken up by the college and recorded by the students on any one of the above topics)

SEC – B (Semester – 4)

Teaching Skill

Objectives:-

- To know the basic concept of Teaching
- To know the Types of Teaching
- To understand the Skills of Teaching
- To learn the Concept of Learning Design (LD)

Unit: 1 = **Understanding Teaching**

- Concept and definition of Teaching
- Nature of teaching and characteristic factors affecting teaching
- Relation between teaching and training

Unit: 2 = **Types of Teaching (Concept and Characteristics)**

- Micro-teaching and Micro lesson
- Simulated teaching
- Integrated teaching

Unit: 3 = **Skills of Teaching (Basic Concept)**

- Nature and definition of skills of teaching
- Developing teaching skills: Introducing a lesson, Questioning, Use of teaching aids, Illustration and Reinforcement
- Phases of teaching: Pre-active, Inter-active, Post-active

Unit: 4 = **Learning Design (LD)**

- Concept and importance of learning design in teaching
- Steps of learning design
- Qualities of good learning design

SEC – B (Semester – 4)
Life Skill Education

Objectives:

- To understand the meaning of life skills.
- To be acquainted with the different types of life skills.
- To find the ways in which individual's personality can be built through the development of these life skills.

Unit: 1 = **Concept of Life Skills**

- Meaning and concept of life skills.
- Origin of life skill in education.
- Development of the concept of life skills.
- Definitions and interpretation.

Unit: 2 = **Classification of life skills**

- Generic Life skills-
  a) Survival skills
  b) Negotiating skills
  c) Coping skills
- Problem specific skills
- Skills for area specific development.

Unit:3 = **Training and Techniques**

- Concept of training and techniques for life skill education
- Types of training
- Stages of life skill education

Unit:4 = **Life skills for leadership training**

- Definition of leadership training
- Styles of leadership training
- Functions of leadership training
- Training of leadership through personality building and like skills

DSE – A (Semester – 5)

Peace and Value Education

Objectives:-

- To know the concept of peace education
- To understand peace and non-violence
- To develop the concept of value education
- To understand peace, value and conflict resolution

Unit: 1 = Peace Education

- Concept and Scope of Peace Education
- Aims of peace Education
- Role of Teachers in Promoting Peace education
- NCFTE 2009 on Peace Education

Unit: 2 = Peace and Non Violence

- Factors of Violence
- Role of Peace for Non-Violence
- Gandhian principle of Non Violence
- Role of Educational Institutional in Promoting Peace education

Unit: 3 = Value Education

- Meaning , Definition, Concept of Value Education
- Classification of Values and Sources of Values
- Need For Value education in the 21st Century
- Fostering Values – Role of Home, School and Society.

Unit: 4 = Peace, Value and Conflict Resolution

- Bases of conflict
- Role of Value Education in resolving conflict

DSE – A (Semester – 5)

Educational Thought of Great Educators

Objectives:-

- To develop an understanding of educational ideas of Indian and Western Educators
- To understand pedagogical concepts given by Indian and Western educational thinkers

Unit:1 = **Western Educators(Part 1)**

- Plato
- Rousseau
- Montessori

Unit:2 = **Western Educators(Part 2)**

- Pestalozzi
- Dewey
- Ivan Illich

Unit: 3 = **Indian Educators (Part 1)**

- Vivekananda
- Rabindranath
- Gandhiji

Unit: 4 = **Indian Educators (Part 2)**

- Radhakrisnan
- Begum Rokeya
- Sister Nivedita

DSE – A (Semester – 6)

Gender and Society

Objectives:

- To understand the basic terms, concepts used in gender studies.
- To understand the gender discrimination in construction and dissemination of knowledge.
- To develop an awareness and sensitivity.

Unit: 1 = Gender Concepts

- Definition of Gender and difference with sex
- Gender Dynamics: Gender identity; Gender role and gender stereotype
- Social Construction of Gender

Unit: 2 = Gender Socialization

- Childhood, socialization and gender biases in the family and school
- Social Differentiation among women in educational context by caste, tribe, religion and region
- Gender discrimination in the management of the school and education system.

Unit: 3 = Gender roles

- Gender Roles and Relationships Matrix
- Gender based division and Valuation of Work
- Exploring Attitudes towards Gender

Unit: 4 = Gender inequality in the schools

- Gender inequality in the structure of knowledge
- Presentation of gender in the development of curriculum and text books.
- Dynamics of gender in the classroom in reference to girl friendly school, co-education and single sex schooling.

DSE – A (Semester – 6)

Population Education

Objectives:-

- To know the concept of Population Education
- To understand Population growth and its impact and responsibilities
- To understand population education and role of school

Unit: 1 = **Concept of Population Education**

- Meaning and Objectives of Population Education
- Factors influencing Population --sociological, Economic, Political, Biological and Psychological.
- Concepts Related to Population Education- Birth Rate, Death Rate, Fertility, Infant Mortality, Morbidity and Migration.
- Need for Population Education

Unit : 2 = **Population Growth and its Impact**

- Quality of life-concept and meaning
- Human Resource Development (concept)
- Population Education programmes in India
- Problems of Population Education and its Suggestive Measures

Unit : 3 = **Population Growth and Responsibilities**

- Size of Family.
- Role and responsibilities of family members.
- Female Education and Status.
- Growth of Population and Environment

Unit : 4 = **Population Education and school**

- Scope of population education in schools,
- Teacher role in creating awareness of population problems
- Role of Mass media – (Newspapers, Radio, T.V)
- Role of youth in Population Education

DSE – B (Semester – 5)

Teacher Education

Objectives:

- To understand the basic concept of teacher education.
- To explain the historical perspective and development of teacher education in India.
- To enable the students to understand the Role of the different agencies in teacher education.
- To make an idea about Some Courses for preparation of teacher

Unit: 1 = Basic concept of teacher education.

- Concept and meaning of teacher education
- Scope of Teacher Education
- Aims and objectives of Education at Elementary, Secondary and College level.
- Teacher training Vs Teacher education

Unit: 2 = Development of teacher education in India

- Historical perspective of development of teacher education in India
- Recommendations of Kothari Commission
- Recommendations of National Policy on Education regarding teacher education.
- Present System of teacher education in India.

Unit: 3 = Role of the different agencies in teacher education

- University
- NCTE
- NCERT
- NUEPA

Unit: 4 = Some Courses for preparation of teacher

- Pre service teacher education
- In service teacher education
- Orientation and Refresher courses

DSE – B (Semester – 5)

Open and Distance Learning

Objectives:

- To be acquainted with the concept of open and distance education
- To become aware of the modes and strategies of open and distance education
- To understand the relationship among non-formal, correspondence, distance and open education
- To be aware of the present status and role of multi-media in open and distance education
- To know about the different agencies, problems and remedies of open and distance education in India

Unit: 1 = **Concept of open and distance education**

- Meaning and definition of open and distance education
- Objectives and characteristics of open and distance education
- Merits and demerits of open and distance education

Unit: 2 = **Strategies of open and distance education**

- Mode and strategies of open education
- Mode and strategies of distance education
- Relationship among non-formal, correspondence, distance and open education

Unit: 3 = **Status and role of multi-media in open and distance education**

- Present status of open education in India
- Present status of distance education in India
- Role of multi-media in open and distance education

Unit: 4 = **Agencies, problems and remedies of open and distance education in India**

- Agencies of open and distance education
- Problems of open and distance education
- Measures for strengthening open and distance education in India

DSE – B (Semester – 6)

Human Rights Education

Objectives:-

- To know the basic concept of human rights
- To know the role of United Nations and human rights
- To understand enforcement mechanism in India
- To know the role of advocacy groups

Unit:1 = Basic Concept of Human Rights

- Nature and concept of Human Rights
- Human Values – Dignity, liberty, equality, justice, unity in diversity
- Meaning and significance of Human Rights Education

Unit: 2 = United Nations and Human rights

- Brief history of human rights – National and International perspectives
- Universal Declaration of human rights in brief
- United Nations and Human rights – duties and limitations

Unit: 3 = Human Rights – Enforcement Mechanism in India

- Human Rights Act – 1993
- Human Rights Commission – role and objectives
- Judicial organs – Role of Supreme court and High court in brief

Unit:4 = Role of Advocacy Groups

- Role of educational institutions
- Role of press and media
- Role of NGOs.

DSE – B (Semester – 6)

Women Education

Objectives:-

- To know the historical perspectives of Women Education
- To know the Policy Perspectives and Committees and Commissions on Women Education
- To know the role of Indian thinkers towards Women Education
- To identify major constraints of Women Education and Women Empowerment.

Unit: 1 = Historical Perspectives of Women Education

- Synoptic view of women education through the ages: Vedic, Brahmanic, Medieval Period
- Contribution of Missionaries
- Role of British Govt.

Unit: 2 = Policy Perspective, Committee and Commission on Women Education

- Constitutional provision, NPE -1968, 1986, 1992, POA-1992
- Radhakrisnan, Mudaliar and Kothari Commission
- Durgabai Deshmukh Committee, Hansraj Mehta Committee and Bhaktabatsalam Committee

Unit: 3 = Role of Indian Thinkers in promoting Women Education

- Rammohan Roy
- Vidyasagar

Unit: 4 = Major Constraints of Women Education and Women Empowerment

- Social – Psychological
- Political – Economical
- Role of women empowerment in modern society (in brief.)

B.A. Education, General (EDCG)

Choice Based Credit System

In the 3 years B.A. Program in Education there will be 6 Semesters. The curriculum consists of 12 Core Courses (CC), of which 4 core courses are to be taken from Discipline 1 (DSC – 1), 4 core courses are to be taken from Discipline 2 (DSC -2), LC(C1 – English courses, two papers, and C2 – MIL courses, two papers), 2 Ability Enhancement Compulsory Courses like Communicative English/Hindi/MIL and Environmental Studies, 2 Generic Elective courses, 2 courses from 2 subjects, Skill Enhancement Courses (SEC) and 2 Discipline Specific Elective (DSE) courses from Discipline 1 and 2 such from Discipline 2 are to be taken. Each paper is of 100 Marks. **TH stands for Lecture Hour, TU for Tutorial Hour and P for Practical Hour**.

Semester 1 = 400 Marks (20 Credit)
Semester 2 = 400 Marks (20 Credit)
Semester 3 = 400 Marks (20 Credit)
Semester 4 = 400 Marks (20 Credit)
Semester 5 = 400 Marks (20 Credit)
Semester 6 = 400 Marks (20 Credit)

Total: 2400 Marks (120 Credits)

Semester wise Courses							
		1	**2**	**3**	**4**	**5**	**6**
Core Courses (CC)	**Discipline - 1**	**CC – 1**	**CC –2**	**CC – 3**	**CC – 4**		
	Discipline - 2	CC – 1	CC – 2	CC – 3	CC – 4		
	Language (LCC)			C1 English (1)	C2 MIL (1)	C1 English (2)	C2 MIL (2)
Elective Courses	**Generic Elective**	GE - 1	GE - 2				
	Discipline Specific					**DSE – A (DSC – 1)**	**DSE – B (DSC – 1)**
						DSE – A (DSC – 2)	DSE – B (DSC – 2)
Ability Enhancement Compulsory Course		AECC - 1	AECC - 2				
Skill Enhancement Course (SEC)				**SEC – A**	**SEC – B**	**SEC – A**	**SEC – B**
Total Credit		**20**	**20**	**20**	**20**	**20**	**20**

Core:- 2 different subjects, Discipline 1 and Discipline 2

Discipline 1:- In the Subject.

Discipline 2:- Any subject other than Discipline 1

GE:- A Subject other than Discipline 1 and Discipline 2 and study two papers in Semester 1 & 2.

DSE:- 2 chosen disciplines for semester 5 and 6.

SEC:= Value based/skill based.

Language (LCC):- C1 = English 1 and English 2, C2 = MIL 1 and MIL 2

AECC – 1:- Communicative English/Hindi/Modern Indian Language

AECC – 2: Environmental Studies

Tutorial:- Topics are to be selected from the particular paper

Distribution of marks:- (Out of 100):-

Attendance = 10 Marks
Internal Assessment =10 Marks
Tutorial = 15 Marks
Subjective Exam = 65 Marks

Total = 100 Marks

SEMESTER – 1

Course Code	Course Type	Credit	Marks	TH – TU - P
Core Course (CC)	CC - 1 (Discipline – 1)	6	100	5 - 1 - 0
Core Course (CC)	CC – 1 (Discipline – 2)	6	100	
Generic Elective	GE - 1	6	100	
AECC - 1	Communicative English/Hindi//MIL	2	100	
		20	**400**	

1 credit = 1 hour class; Per week = 6 hours/6 credit

SEMESTER – 2

Course Code	Course Type	Credit	Marks	TH – TU - P
Core Course (CC)	CC – 2 Discipline – 1)	6	100	5 - 1 - 0
Core Course (CC)	CC – 2 (Discipline – 2)	6	100	
Generic Elective	GE – 2	6	100	
AECC - 2	Environmental Studies	2	100	
		20	**400**	

1 credit = 1 hour class; Per week = 6 hours/6 credit

SEMESTER – 3

Course Code	Course Type	Credit	Marks	TH – TU - P
Core Course (CC)	CC – 3 (Discipline – 1)	6	100	5 – 1 - 0
Core Course (CC)	CC – 3 (Discipline – 2)	6	100	
LCC	LCC1 English (1)	6	100	
Skill Enhancement	SEC – A	2	100	2 - 0 – 0
		20	**400**	

1 credit = 1 hour class; Per week = 6 hours/6 credit

SEMESTER – 4

Course Code	Course Type	Credit	Marks	TH – TU - P
Core Course (CC)	CC – 4 (Discipline – 1)	6	100	5 – 1 - 0
Core Course (CC)	CC – 4 (Discipline – 2)	6	100	
LCC	LCC2 - MIL (1)	6	100	
Skill Enhancement	SEC – B	2	100	2 – 0 – 0
		20	**400**	

1 credit = 1 hour class; Per week = 6 hours/6 credit

SEMESTER – 5

Course Code	Course Type	Credit	Marks	TH – TU - P
Discipline Specific (A)	DSC-1	6	100	5 – 1 – 0
Discipline Specific (A)	DSC-2	6	100	
LCC	LCC1 English (2)	6	100	
Skill Enhancement	SEC – A	2	100	2 – 0 – 0
		20	**400**	

1 credit = 1 hour class; Per week = 6 hours/6 credit

SEMESTER – 6

Course Code	Course Type	Credit	Marks	TH – TU - P
Discipline Specific (B)	DSC-1	6	100	5 – 1 – 0
Discipline Specific (B)	DSC-2	6	100	
LCC	LCC2 - MIL (2)	6	100	
Skill Enhancement	SEC – B	2	100	2 – 0 – 0
		20	**400**	

1 credit = 1 hour class; Per week = 6 hours/6 credit

Course Title:=

Semester - 1	Introduction to Education

Semester - 2	Psychological Foundation of Education

Semester – 3	Sociological Foundation of Education

Semester - 4	Inclusive Education

DSE – A = **Any one from the following two** **(FOR SEMESTER – 5)**

- ❖ Peace and Value Education
- ❖ Educational Thought of Great Educators

DSE – B = **Any one from the following two** **(FOR SEMESTER – 6)**

- ❖ Human Rights Education
- ❖ Women Education

SEC – A	• Communication Skills • Skill for Democratic Citizenship	**Semester – 3 / 5**

SEC – B	• Teaching Skill • Life Skill Education	**Semester – 4 / 6**

CC– 1/GE – 1 (Semester – 1)

Introduction to Education

Objectives:

- To understand the meaning, nature, scope and aims of education.
- To explain the factors of education and their interrelationship.
- To become aware of different agencies of education that influence education.
- To be acquainted with the concept of child-centricism and play-way in education

Unit- I = Concept of Education

- Narrow and broader concept of education
- Meaning, nature and scope of education.
- Aims of education – individual, social, vocational and democratic.
- Aims of modern education with special reference to Delor's Commission.

Unit- 2 = Factors of Education

- Child / learner: influence of heredity and environment on the learner
- Teacher: qualities and duties of a good teacher.
- Curriculum- concept and types.
- Co-curricular activities: meaning, values and significance.
- Educational institutions: informal, formal and non-formal, their interrelation.

Unit- 3 = Agencies of Education

- Home
- School
- State
- Mass-media- television, radio, cinema and newspaper

Unit- 4 = Child Centricism and Play-way in Education

- Concept of child centricism in education
- Characteristics and significance of child centricism in education
- Concept of play and work.
- Characteristics of play way in Education, Kindergarten, Montessori, Project method.

CC – 2/GE – 2 (Semester – 2)

Psychological Foundation of Education

Objectives:

- To understand the meaning of Psychology and be acquainted with it's different aspects.
- To know the patterns of different aspects of human development and relate this knowledge with education.
- To be acquainted with the cognitive approach of development and thus to understand the process and factors of cognition.

Unit: 1 = **Relation between Psychology and Education**

- Meaning and definition of Psychology
- Meaning and definition of Education
- Relation between Psychology and education
- Nature, scope and significance of educational psychology.

Unit: 2 = **Stages and types of human development and their educational significance**.

- Piaget's cognitive development theory
- Erikson's psycho-social development theory
- Kohlberg's moral development theory
- Vygotsky's social development theory and Bandura's Social Learning Theory

Unit: 3 = **Learning: concept and theories**

- Concept and characteristics of learning
- Theories: Connectionism(Trial and error, classical, operant)
- Insightful learning
- Memorization and Forgetting: Process of memorization, causes of forgetting and economical ways of improving memorization

Unit: 4 = **Intelligence**

- Concept of intelligence
- Theories of Spearman, Thorndike and Guilford
- Types and uses of intelligence tests
- Concept of Emotional Intelligence and E.Q

CC – 3/GE – 3 (Semester – 3)

Sociological Foundation of Education

Objectives:

- To understand the relation between Sociology and Education . nature, and scope of Sociology of education.
- To explain the concept of Social Groups and Socialization process.
- To enable the students to understand the concept of Social change and Social interaction in education
- To become aware of social Communication in Education

Unit-I = Introductory Concept of Sociology of Education

- Meaning and definition of Sociology of Education
- Relation between Sociology and Education
- Nature of Sociology of Education
- Scope of Sociology of Education

Unit-2 = Social Groups

- Social Groups : meaning and definition
- Types of Social groups – Primary, Secondary and Tertiary
- Socialization Process: Concept
- Role of the family and school in Socialization process

Unit-3 = Social Change and Education

- Concept of Social Change
- Interrelation between Social change and Education
- Social stratification and Social Mobility.
- Social interaction Process

Unit-4 = Social Communication in Education

- Social Communication : Concept
- Informal agencies of social communication
- Inter relation between Culture, religion and Education.
- Inter relation between Technology, Economy and Education.

CC– 4/GE – 4 (Semester – 4)

Inclusive Education

Objectives:-

- Understand the meaning of Inclusion and exclusion
- Know the types of exclusion and their causes
- Know how to bring about inclusion in different spheres

Unit: 1 = **Inclusion Overview**

- Meaning of Inclusion and Inclusive Society
- Exclusion and Inclusion: Conceptual overview
- Obstacles/barriers in Inclusion
- Elements necessary for creating an inclusive society

Unit: 2 = **Differently Abled**

- Concept of Impairment, Disability and Handicap
- Types of disabilities- Orthopaedic, Visual, Auditory, Cerebral Palsy, Intellectual, Autism, Learning Disability (only definition and their specific problems)
- General causes of disabilities
- Role of school and society in creating a barrier free environment

Unit: 3 = **Socially Disabled**

- Concept of SC, ST and OBC groups.
- Concept of Gender, and sexuality
- Causes of social exclusion
- Understanding social inclusion: role of education

Unit: 4 = **Educational Reforms for Inclusive Society**.

- Building an Inclusive school: desired changes in System, Structure, Practice and Culture,
- Education for a multicultural society,
- Education for peaceful co-existence
- Role of Informal agencies (like mass media etc) in building an inclusive society

DSE–A (Semester – 5)
Peace and Value Education

Objectives:-

- To know the concept of peace education
- To understand peace and non-violence
- To develop the concept of value education
- To understand peace, value and conflict resolution

Unit: 1 = **Peace Education**

- Concept and Scope of Peace Education
- Aims of peace Education
- Role of Teachers in Promoting Peace education
- NCFTE 2009 on Peace Education

Unit: 2 = **Peace and Non Violence**

- Factors of Violence
- Role of Peace for Non-Violence
- Gandhian principle of Non Violence
- Role of Educational Institutional in Promoting Peace education

Unit: 3 = **Value Education**

- Meaning , Definition, Concept of Value Education
- Classification of Values and Sources of Values
- Need For Value education in the 21st Century
- Fostering Values – Role of Home, School and Society.

Unit: 4 = **Peace, Value and Conflict Resolution**

- Bases of conflict
- Role of Value Education in resolving conflict

DSE–A (Semester – 5)

Educational Thought of Great Educators

Objectives:-

- To develop an understanding of educational ideas of Indian and Western Educators
- To understand pedagogical concepts given by Indian and Western educational thinkers

Unit: 1 = **Western Educators (Part 1)**

- Plato
- Rousseau
- Montessori

Unit: 2 = **Western Educators (Part 2)**

- Pestalozzi
- Dewey
- Ivan Illich

Unit: 3 = **Indian Educators (Part 1)**

- Vivekananda
- Rabindranath
- Gandhiji

Unit: 4 = **Indian Educators (Part 2)**

- Radhakrisnan
- Begum Rokeya
- Sister Nivedita

DSE–B (Semester – 6)

Human Rights Education

Objectives:-

- To know the basic concept of human rights
- To know the role of United Nations and human rights
- To understand enforcement mechanism in India
- To know the role of advocacy groups

Unit:1 = **Basic Concept of Human Rights**

- Nature and concept of Human Rights
- Human Values – Dignity, liberty, equality, justice, unity in diversity
- Meaning and significance of Human Rights Education

Unit: 2 = **United Nations and Human rights**

- Brief history of human rights – National and International perspectives
- Universal Declaration of human rights in brief
- United Nations and Human rights – duties and limitations

Unit: 3 = **Human Rights – Enforcement Mechanism in India**

- Human Rights Act – 1993
- Human Rights Commission – role and objectives
- Judicial organs – Role of Supreme court and High court (in brief)

Unit: 4 = **Role of Advocacy Groups**

- Role of educational institutions
- Role of press and media
- Role of NGOs.

DSE–B (Semester – 6)

Women Education

Objectives:-

- To know the historical perspectives of Women Education
- To know the Policy Perspectives and Committees and Commissions on Women Education
- To know the role of Indian thinkers towards Women Education
- To identify major constraints of Women Education and Women Empowerment.

Unit: 1 = **Historical Perspectives of Women Education**

- Synoptic view of women education through the ages: Vedic, Brahmanic, Medieval Period
- Contribution of Missionaries
- Role of British Govt.

Unit: 2 = **Policy Perspective, Committee and Commission on Women Education**

- Constitutional provision, NPE -1968, 1986, 1992, POA-1992
- Radhakrisnan, Mudaliar and Kothari Commission
- Durgabai Deshmukh Committee, Hansraj Mehta Committee and Bhaktabatsalam Committee

Unit: 3 = **Role of Indian Thinkers in promoting Women Education**

- Rammohan Roy
- Vidyasagar

Unit: 4 = **Major Constraints of Women Education and Women Empowerment**

- Social – Psychological
- Political – Economical
- Role of women empowerment in modern society in brief.

SEC-A (Semester – 3 / 5)

Communication Skill

Objectives:

- To understand the basic elements of Communication
- To acquire Listening Skills
- To acquire Speaking Skills
- To acquire Reading and Writing Skills

Unit: 1 = Introduction to Communication

- Meaning, Nature and types of communication
- Principles of communication
- Process of communication: Sender, encoding, recipient, decoding and feedback
- Barriers of effective communication

Unit: 2 = Listening Skills

- Principles of listening skills
- Types of listeners
- Barriers to listening

Unit: 3 = Speaking Skills

- Verbal and non-verbal communication
- Public speaking: Extempore
- Group discussion

Unit: 4 = Reading and Writing Skills

- Previewing, skimming, and scamming
- Development of skills for correct pronunciation, reading and comprehension
- Sentence formation and punctuation

SEC–A (Semester – 3 / 5)

Skill for Democratic Citizenship

Objectives:-

- Have an idea about their duties as citizens
- Have an idea about their rights as citizens
- Have an idea about child violence and child rights
- Have an idea about domestic violence and domestic rights

Unit 1: **Rights and duties in Indian Constitution**

- Democratic rights
- Fundamental Rights
- Duties of citizenship

Unit 2 = **Protection of Children**

- Child protection - concept and need.
- Child Rights – concept, classification and need
- Legal actions –POCSO

Unit 3 = **Domestic Harmony**

- Domestic violence – definition and types
- Protection of Women from Domestic Violence Act, 2005 – basic features
- Protection of males in DVA 2005

Unit 4 = **Role of Education (Term Paper/Project Paper)**

- Awareness programmes- rallies, debates etc
- Mass media
- Seminars and workshops
- (Any one may be taken up by the college and recorded by the students on any one of the above topics)

SEC–B (Semester – 4 / 6)

Teaching Skill

Objectives:-

- To know the basic concept of Teaching
- To know the Types of Teaching
- To understand the Skills of Teaching
- To learn the Concept of Learning Design (LD)

Unit: 1 = **Understanding Teaching**

- Concept and definition of Teaching
- Nature of teaching and characteristic factors affecting teaching
- Relation between teaching and training

Unit: 2 = **Types of Teaching (Concept and Characteristics)**

- Micro-teaching and Micro lesson
- Simulated teaching
- Integrated teaching

Unit: 3 = **Skills of Teaching (Basic Concept)**

- Nature and definition of skills of teaching
- Developing teaching skills: Introducing a lesson, Questioning, Use of teaching aids, Illustration and Reinforcement
- Phases of teaching: Pre-active, Inter-active, Post-active

Unit: 4 = **Learning Design (LD)**

- Concept and importance of learning design in teaching
- Steps of learning design
- Qualities of good learning design

SEC–B (Semester – 4 / 6)
Life Skill Education

Objectives:

- To understand the meaning of life skills.
- To be acquainted with the different types of life skills.
- To find the ways in which individual's personality can be built through the development of these life skills.

Unit: 1 = **Concept of Life Skills**

- Meaning and concept of life skills.
- Origin of life skill in education.
- Development of the concept of life skills.
- Definitions and interpretation.

Unit: 2 = **Classification of life skills**

- Generic Life skills-
  a) Survival skills
  b) Negotiating skills
  c) Coping skills
- Problem specific skills
- Skills for area specific development.

Unit:3 = **Training and Techniques**

- Concept of training and techniques for life skill education
- Types of training
- Stages of life skill education

Unit:4 = **Life skills for leadership training**

- Definition of leadership training
- Styles of leadership training
- Functions of leadership training
- Training of leadership through personality building and like skills

UNIVERSITY OF CALCUTTA

Notification No. CSR/ 12 /18

It is notified for information of all concerned that the Syndicate in its meeting held on 28.05.2018 (vide Item No.14) approved the Syllabi of different subjects in Undergraduate Honours / General / Major courses of studies (CBCS) under this University, as laid down in the accompanying pamphlet:

List of the subjects

Sl. No.	Subject	Sl. No.	Subject
1	Anthropology (Honours / General)	29	Mathematics (Honours / General)
2	Arabic (Honours / General)	30	Microbiology (Honours / General)
3	Persian (Honours / General)	31	Mol. Biology (General)
4	Bengali (Honours / General /LCC2 /AECC1)	32	Philosophy (Honours / General)
5	Bio-Chemistry (Honours / General)	33	Physical Education (General)
6	Botany (Honours / General)	34	Physics (Honours / General)
7	Chemistry (Honours / General)	35	Physiology (Honours / General)
8	Computer Science (Honours / General)	36	Political Science (Honours / General)
9	Defence Studies (General)	37	Psychology (Honours / General)
10	Economics (Honours / General)	38	Sanskrit (Honours / General)
11	Education (Honours / General)	39	Social Science (General)
12	Electronics (Honours / General)	40	Sociology (Honours / General)
13	English ((Honours / General/ LCC1/ LCC2/AECC1)	41	Statistics (Honours / General)
14	Environmental Science (Honours / General)	42	Urdu (Honours / General /LCC2 /AECC1)
15	Environmental Studies (AECC2)	43	Women Studies (General)
16	Film Studies (General)	44	Zoology (Honours / General)
17	Food Nutrition (Honours / General)	45	Industrial Fish and Fisheries – IFFV (Major)
18	French (General)	46	Sericulture – SRTV (Major)
19	Geography (Honours / General)	47	Computer Applications – CMAV (Major)
20	Geology (Honours / General)	48	Tourism and Travel Management – TTMV (Major)
21	Hindi (Honours / General /LCC2 /AECC1)	49	Advertising Sales Promotion and Sales Management –ASPV (Major)
22	History (Honours / General)	50	Communicative English –CMEV (Major)
23	Islamic History Culture (Honours / General)	51	Clinical Nutrition and Dietetics CNDV (Major)
24	Home Science Extension Education (General)	52	Bachelor of Business Administration (BBA) (Honours)
25	House Hold Art (General)	53	Bachelor of Fashion and Apparel Design – (B.F.A.D.) (Honours)
26	Human Development (Honours / General)	54	Bachelor of Fine Art (B.F.A.) (Honours)
27	Human Rights (General)	55	B. Music (Honours / General) and Music (General)
28	Journalism and Mass Communication (Honours / General)		

The above shall be effective from the academic session 2018-2019.

SENATE HOUSE
KOLKATA-700073
The 4th June, 2018

Paul 4/6/18
(Dr. Santanu Paul)
Deputy Registrar

University of Calcutta

Final Draft BA (Honours)-CBCS Syllabus in Political Science, 2018 (Section I)

Core Courses

[Fourteen courses; Each course: 6 credits (5 theoretical segment+ 1 for tutorial-related segment). Total: 84 credits (1400 marks).

- Each course carries 80 marks^ ^^ (plus 10 marks each for Attendance and Internal Assessment).
- Minimum 30 classes for Theory and 15 contact hours for Tutorial per module.

^End Semester Assessment for each course--- 65 marks for theoretical segment: 50 marks for subjective/descriptive questions + 15 marks for category of 1 mark-questions. Question Pattern for subjective/descriptive segment of 50 marks: 2 questions (within 100 words; one from each module) out of 4 (10 x2 = 20) + 2 questions (within 500 words; one from each module) out of 4 (15 x 2 = 30).

^^15 marks for tutorial-related segments as suggested below (any one item from each mode):

i) Written mode: upto 1000 words for one Term Paper/upto 500 words for each of the two Term Papers/ equivalent Book Review/equivalent Comprehension/equivalent Quotation or Excerpt Elaboration.

ii) Presentation Mode: Report Presentation/Poster Presentation/Field work--- based on syllabus-related and/or current topics (May be done in groups)[The modes and themes and/or topics are be decided by the concerned faculty members of respective colleges.]

- Core courses: First 2 each in Semesters 1 and 2;Next 3 each in Semesters 3 and 4; 2 each in Semesters 5 and 6. [Sequentially arranged]

IMPORTANT NOTES:

- The Readings provided below include many of those of the UGC Model CBCS Syllabus in Political Science. For further details of Course Objectives and additional references it is advised that the UGC model CBCS syllabus* concerning relevant courses and topics be provided due importance and primarily consulted.
  *Website: BA Political Science (Honours): https://www.ugc.ac.in/pdfnews/2085906_B.A-Hons.-Pol-Science.pdf
- Cited advanced texts in Bengali are not necessarily substitutes, but supplementary to the English books.
- Paper Code Format: Subject-Course-Semester-Paper Number-Paper Component.
- The format isstrictly subject to the parameters of the common structural CBCS format of the University.

List of Core Courses

1 – Understanding Political Theory: Concepts

2 - Understanding Political Theory: Approaches and Debates

3 - Constitutional Government in India

4 – Politics in India: Structures and Processes

5 – Indian Political Thought – I

6 - Comparative Government and Politics

7 – Perspectives on International Relations

8 - Indian Political Thought – II

9 – Global Politics since 1945

10 – Western Political Thought & Theory I

11 – Western Political Thought & Theory II

12 - Political Sociology

13 – Public Administration: Concepts and Perspectives

14 – Administration and Public Policy in India

[Semester-level break-up provided below]

Semester I

Understanding Political Theory: Concepts Code: PLS-A-CC-1-1-TH+TU

Module I:

1.Conceptualising politics: meaning of *political*.
2.Key concepts I: State; Nation; Sovereignty (evolution); Power and Authority--- types and linkages;
3.Key concepts II: Law. Liberty, Equality--- interrelationships.

Module II:

4. Key concepts III: Rights; Justice (with special reference to Rawls); Freedom.
5. Key concepts IV: Democracy (with special reference to David Held); Authoritarianism.
6. Key concepts V: Citizenship.

Readings:

Bhargava, R. (2008) 'What is Political Theory' in Bhargava, R and Acharya, A. (eds.) PoliticalTheory: An Introduction.pp. 2-16.
Bellamy, R. (1993) 'Introduction: The Demise and Rise of Political Theory', in Bellamy, R. (ed.) Theories and Concepts of Politics. New York: Manchester University Press, pp. 1-14.
Glaser, D. (1995) 'Normative Theory', in Marsh, D. and Stoker, G. (eds.) Theory and Methodsin Political Science. London: Macmillan, pp. 21-40.
D. Held: Political Theory Today.
D. Held: Models of Democracy.
N. Daniels: Reading Rawls.
Andrew Heywood: The Basic Political Concepts.
S. Ramaswamy: Political Theory--- Ideas and Concepts.
S.P. Verma: Modern Political Theory.
T. Ball and R. Bellamy: Twentieth Century Political Thought.
R. Bellamy: Theories and Concepts in Politics: An Introduction.
C. McKinnan: Issues in Political Theory.
Menon, Krishna. (2008) 'Justice', in Bhargava, Rajeev and Acharya, Ashok. (eds.) PoliticalTheory: An Introduction, pp. 74-86.

Understanding Political Theory: Approachesand Debates Code: PLS-A-CC-1-2-TH+TU

Module I:

1.Approaches I: Normative; Legal-Institutional; Empirical-Behavioual---Systems Analysis; Structural Functionalism.
2. Approaches II: Liberalism; Social Welfarism; Neo-Liberalism.
3. Approaches III: Postcolonial; Feminist.

Module II:

4.Marxian approach--- Dialectical Materialism and Historical Materialism.
5. Key ideas: State (focus on Relative Autonomy); Class and Class Struggle; Surplus Value; Alienation.
6. Party--- Democratic Centralism; Lenin-Rosa Luxemburg debate; Revolution--- Lenin and Mao. Hegemony and Civil Society: Gramsci.

Readings:

K. Marx and F. Engels: The Communist Manifesto.
V. I. Lenin: The State.
John Gray: Liberalism.
David McLellan: The Thought of Karl Marx.
David McLellan: Marxism after Marx.
Tom Bottomore ed.: A Dictionary of Marxist Thought.
D. Riaznov ed.: The Communist Manifesto of Marx and Engels.
M Cornforth: Dialectical Materialism.
R. Miliband: Marxism and Politics.
Laszek Kolakowski: Main Currents of Marxism (3 volumes).
Ravi Kumar: Contemporary Readings in Marxism.
Kymlicka: Multiculturalism.
Marxist Internet Archive: www.marxist.org
Gurpreet Mahajan: The Multicultural Path.
R. Young: Postcolonialism: A Very Short Introduction.
Richard Bellamy: Citizenship: A Very Short Introduction.
Margaret Walters: Feminism: A Very Short Introduction.
Arpita Mukhopadhyay: Feminisms.

For Courses I and II:
কার্ল মার্ক্স ও ফ্রিডরিশ এঙ্গেলস রচনা সংকলন
লেনিন নির্বাচিত রচনাবলী (বড়ো খণ্ড)
টম বটমোরঃ মার্ক্সীয় সমাজতত্ব (অনুবাদঃ হিমাংশু ঘোষ)
দীপক কুমার দাস (সম্পাদিত): রাজনীতির তত্বকথা (২ খণ্ড)
শোভনলাল দত্তগুপ্ত : মার্কসীয় রাষ্ট্রচিন্তা (২০০৬ সং)
ভোলানাথ বন্দ্যোপাধ্যায় : মরিস কর্নফোর্থ:দ্বন্দ্বমূলক বস্তুবাদ (অনুবাদ)
চৈতালি বসু: রাজনীতিশাস্ত্র ও অভিজ্ঞতাবাদী রাষ্ট্রতন্ত্র
রাজশ্রী বসু ও বাসবী চক্রবর্তী (সম্পা): প্রসঙ্গ মানবীবিদ্যা
অশোক সরকার: রাষ্ট্রবিজ্ঞান অভিধান
শোভনলাল দত্তগুপ্ত, রতন খাসনবিশ, সৌরীন ভট্টাচার্য: উত্তর-উপনিবেশবাদ ও মার্কসবাদ
দেবারতি সেনগুপ্ত ও পারমিতা ব্যানার্জি: পিতৃতন্ত্র কাহাকে বলে (কমলা ভাসিনের What is Patriarchy-র অনুবাদ)

Semester II

Constitutional Government in India

Code: PLS-A-CC-2-3-TH+TU

Module I:

1.Evolution of the Indian Constitution. Role of the Constituent Assembly--- debates (overview). The Preamble.
2.Citizenship. Fundamental Rights and Duties. Directive Principles.
3.Nature of Indian Federalism: Union-State Relations.
4.Union Executive: President, Vice-President: election, position, functions (focus on Emergency Powers), Prime Minister, Council of Ministers, relationship of Prime Minister and President.

Module II:

5.Union Legislature: Rajya Sabha, Lok Sabha: Organisation, Functions – Lawmaking procedure, Parliamentary procedure, Privileges, Committee system. Speaker.
6.Government in states: Governor, Chief Minister and Council of Ministers: position and functions – State Legislature: composition and functions.
7.Judiciary: Supreme Court and the High Courts: composition and functions – Judicial activism.
8.Constitutional amendment. Major recommendations of National Commission to Review the Working of the Constitution.

Readings:

Constitution of India: Government of India.
G. Austin: The Indian Constitution.
G. Austin: Working a Democratic Constitution
S.K. Chaube: The Constituent Assembly--- Springboard of a Revolution (latest edition).
M.V. Pylee: India's Constitution.
S.L. Sikri: Indian Government and Politics.
S.C. Kashyap ed.: Perspectives on the Constitution.
A.G. Noorani: Constitutional Question in India.
G. Austin, (2010) 'The Constituent Assembly: Microcosm in Action', in The IndianConstitution: Cornerstone of a Nation, New Delhi: Oxford University Press, 15th print, pp.1-25.
R. Bhargava, (2008) 'Introduction: Outline of a Political Theory of the Indian Constitution', in R. Bhargava (ed.) Politics and Ethics of the Indian Constitution, New Delhi: Oxford University Press, pp. 1-40.
D. Basu, (2012) Introduction to the Constitution of India, New Delhi: Lexis Nexis.
S. K. Chaube, (2009) The Making and Working of the Indian Constitution, Delhi: National Book Trust.
G. Austin, (2000) 'The Social Revolution and the First Amendment', in Working a DemocraticConstitution, New Delhi: Oxford University Press, pp. 69-98.
B. Shankar and V. Rodrigues, (2011) 'The Changing Conception of Representation: Issues, Concerns and Institutions', in The Indian Parliament: A Democracy at Work, New Delhi: Oxford University Press, pp. 105-173.
V. Hewitt and S. Rai, (2010) 'Parliament', in P. Mehta and N. Jayal (eds.) The OxfordCompanion to Politics in India, New Delhi: Oxford University Press, pp. 28-42.
J. Manor, (2005) 'The Presidency', in D. Kapur and P. Mehta P. (eds.) Public Institutions inIndia, New Delhi: Oxford University Press, pp.105-127.
J. Manor, (1994) 'The Prime Minister and the President', in B. Dua and J. Manor (eds.) Nehruto the Nineties: The

Changing Office of the Prime Minister in India, Vancouver: University ofBritish Columbia Press, pp. 20-47.
H. Khare, (2003) 'Prime Minister and the Parliament: Redefining Accountability in the Age of Coalition Government', in A. Mehra and G. Kueck (eds.) The Indian Parliament: AComparative Perspective, New Delhi: Konark, pp. 350-368.
U. Baxi, (2010) 'The Judiciary as a Resource for Indian Democracy', Seminar, Issue 615, pp. 61-67.
R. Ramachandran, (2006) 'The Supreme Court and the Basic Structure Doctrine' in B. Kirpal et.al (eds.) Supreme but not Infallible: Essays in Honour of the Supreme Court of India, New Delhi: Oxford University Press, pp. 107-133.
M. Singh, and R. Saxena (eds.), (2011) 'Towards Greater Federalization,' in Indian Politics:Constitutional Foundations and Institutional Functioning, Delhi: PHI Learning Private Ltd., pp.166-195.
V. Marwah, (1995) 'Use and Abuse of Emergency Powers: The Indian Experience', in B. Arora and D. Verney (eds.) Multiple Identities in a Single State: Indian Federalism in a ComparativePerspective, Delhi: Konark, pp. 136-159.
Additional Reading:
The Constitution of India: Bare Act with Short Notes, (2011) New Delhi: Universal, pp. 4-16.

ভারতীয় সংবিধান (বাংলা সংস্করণ)
দূর্গাদাস বসু – ভারতের সংবিধান পরিচয়
সুভাষ সি কাশ্যপ – আমাদের সংবিধান (অনুবাদঃ পার্থ সরকার)
অমল কুমার মুখোপাধ্যায় – ভারতীয় সংবিধানের সহজ পাঠ

Politics in India:Structures and Processes Code: PLS-A-CC-2-4-TH+TU

Module I:

1.Party system: features and trends – major national political parties in India: ideologies and programmes. Coalition politics in India: nature and trends. Political parties in West Bengal: Overview.
2.Electoral process: Election Commission: composition, functions, role. Electoral reforms.
3. Role of business groups, working class, peasants in Indian politics.

Module IV:

4.Role of (a) religion (b) language (c) caste (d) tribe.
5. Regionalism in Indian politics.
6. New Social Movements since the 1970s: (a) environmental movements (b) women's movements (c) human rights movements.

Readings:

R. Kothari, (2002) 'The Congress System', in Z. Hasan (ed.) Parties and Party Politics in India, New Delhi: Oxford University Press, pp 39-55.
E. Sridharan, (2012) 'Introduction: Theorizing Democratic Consolidation, Parties and Coalitions', in Coalition Politics and Democratic Consolidation in Asia, New Delhi: Oxford University Press.
Y. Yadav and S. Palshikar, (2006) 'Party System and Electoral Politics in the Indian States, 1952-2002: From Hegemony to Convergence', in P. deSouza and E. Sridharan (eds.) India'sPolitical Parties, New Delhi: Sage Publications, pp. 73-115.
R. Hardgrave and S. Kochanek: India: Government and Politics in a Developing Nation (Latest edition).
S. Palshikar, (2008) 'The Indian State: Constitution and Beyond', in R. Bhargava (ed.) Politicsand Ethics of the Indian Constitution, New Delhi: Oxford University Press, pp. 143-163.
Partha Chatterjee: State and Politics in India.
Sudipta Kaviraj ed.: Politics in India.

R. Kothari, (1970) 'Introduction', in Caste in Indian Politics, Delhi: Orient Longman, pp.3-25. M. Weiner, (2001) 'The Struggle for Equality: Caste in Indian Politics', in Atul Kohli (ed.) TheSuccess of India's Democracy, New Delhi: Cambridge University Press, pp. 193-225.
C. J. Nirmal ed.: Human Rights in India.
Y. Yadav, (2000) 'Understanding the Second Democratic Upsurge', in F. Frankel, Z. Hasan, and R. Bhargava (eds.) Transforming India: Social and Political Dynamics in Democracy, New Delhi: Oxford University Press, pp. 120-145.
C. Jaffrelot, (2008) 'Why Should We Vote? The Indian Middle Class and the Functioning of World's Largest Democracy', in Religion, Caste and Politics in India, Delhi: Primus, pp. 604-619.
Deshpande, (2004) 'How Gendered was Women's Participation in Elections 2004?', Economic and Political Weekly, Vol. 39, No. 51, pp. 5431-5436.
Siddhartha Guha Roy: Human Rights, Democratic Rights and Popular Protest.
G. Shah: Social Movements in India.Raka Ray and M.F. Katzenstein eds.: Social Movements in India.
S. Corbridge and J. Harris: Reinventing India: Liberalization, Hindu nationalism and Popular Democracy.
Bipan Chandra et al.: India after Independence (1947-2000).
Rajni Kothari ed.: Caste in Indian Politics.
Bharati Ray and Aparna Basu eds.: From Independence to Freedom--- Indian Women since 1947.
Fields of Protest: Women's Movement in India.
D.N. Sen: From Raj to Swaraj.
R. Chatterjee ed.: Politics India--- State-Society Interface.
Sumit Ganguly et al. eds.: The State of India's Democracy.
Z. Hasan: Politics and Party Politics in India.
B.L. Shankar and V. Rodrigues: The Indian Parliament: A Democracy at Work.
Ashutosh Varshney: India and the Politics of Developing Countries.
Achin Vanaik and Rajiv Bhargava: Understanding Contemporary India: Critical Perspectives.
A. Kohli and P. Singh eds.: The Routledge Handbook of India Politics.
N.G. Jayal and P.B. Mehta eds.: The Oxford Companion to Politics in India.
Anil Jana ed., Decentralizing Rural Governance and Development.
Z. Hasan et al eds.: India's Living Constitution.

বিপান চন্দ্রঃ সমসাময়িক ভারত বিষয়ক নিবন্ধ (অনুবাদঃ দিলীপ ভট্টাচার্য্য)
বিপান চন্দ্র, মৃদুলা মুখার্জী, আদিত্য মুখার্জীঃ ভারতবর্ষ স্বাধীনতার পরে ১৯৪৭-২০০০ (অনুবাদঃ আশীষ লাহিড়ি)
সত্যব্রত দত্ত: বাংলা বিধানসভার একশো বছর
শাশ্বতী ঘোষ: সমতার দিকে আন্দোলনে নারী
শুভেন্দু দাশগুপ্ত (সম্পা): প্রসঙ্গ মানবাধিকার
ভারতীয় সংবিধান (বাংলা সংস্করণ)

Semester III

Indian Political Thought– I Code: PLS-A-CC-3-5-TH+TU

Module I:

1 Ancient Indian Political ideas: overview.
2. Kautilya: Saptanga theory, Dandaniti, Diplomacy.
3. Medieval political thought in India: overview (with reference to Barani and Abul Fazal). Legitimacy of kingship.
4. Principle of Syncretism.

Module II:

5. Modern Indian thought: Rammohun Roy as pioneer of Indian liberalism – his views on rule of law, freedom of thought and social justice.
6. Bankim Chandra Chattopadhyay, Vivekananda and Rabindranath Tagore: views on nationalism.
7. M.K. Gandhi: views on State, Swaraj, Satyagraha.

Readings:

R.S. Sharma: Aspects of Political Ideas and Institutions in Ancient India.
Saiyid Athar Abbas Rizvi – A History of Sufism in India (Vol.2)
Amit Dey – Sufism in India
V.R. Mehta: Foundation of Indian Political Thought.
T. Pantham, and K. Deutsch (eds.), Political Thought in Modern India.
A. Altekar, (1958) 'The Kingship', in State and Government in Ancient India, 3rd edition
Advaita Ashram: Complete Works of Swami Vivekananda.
U.N. Ghosal: The History of Hindu Political Theories.
J. Bandopadhyay: Social and Political Thought of Gandhi
D.D. Kosambi: Ancient India.
Romila Thapar: From Lineages to State.
K.A. Nizami ed.: Politics and Society during the Early Medieval Period.
B. Bhattacharya: Evolution of the Political Philosophy of Gandhi.
B.R. Nanda: Gandhi and His Critics.
Partha Chatterjee: Nationalist Thought and the Colonial World.
Rabindranath Tagore: Nationalism.
Sudipta Kaviraj: The Unhappy Consciousness: Bankimchandra Chattopadhyay and the Formation of Nationalist Discourse in India.
Bidyut Chakrabarty and R.K. Pandey: Modern Indian Political Thought--- Text and Context.

সুধীন্দ্রনাথ ভৌমিক: নব্যবঙ্গে রাষ্ট্রচিন্তার ধারা
ভারতী মুখার্জী: প্রাচীন ভারতের রাষ্ট্রনৈতিক চিন্তা
নৃসিংহ প্রসাদ ভাদুড়ি: দণ্ডনীতি
সত্যব্রত চক্রবর্তী (সম্পা): ভারতবর্ষ: রাষ্ট্রভাবনা
সুমিত সরকার: আধুনিক ভারত
সরল চট্টোপাধ্যায়: ভারতীয় স্বাধীনতা সংগ্রামের ক্রমবিকাশ
মনস্বিতা সান্যাল (অনু.): ভারতীয় জাতীয়তাবাদের সামাজিক পটভূমি (A R Desai: Social Background of Indian Nationalism–র অনুবাদ)
দিলীপ কুমার বিশ্বাস: রামমোহন সমীক্ষা
তরুণ কুমার বন্দ্যোপাধ্যায়: নেতাজী সুভাষচন্দ্রের রাষ্ট্রদর্শন
দেবজ্যোতি বন্দ্যোপাধ্যায়: রবীন্দ্রনাথের জাতীয়তাবাদ-বিরোধী স্বদেশপ্রেম

Comparative Government and Politics Code: PLS-A-CC-3-6- TH+TU

Module I:

1. Evolution of Comparative Politics. Scope, purposes and methods of comparison.
Distinction between Comparative Government and Comparative Politics.
2. Major approaches to the study of comparative politics---Institutional approach (dominant schools: Systems approach and Structural Functional approach)---limitations; New Institutionalism, Political Economy--- origin and key features.
3. Development and democratization: S.P. Huntington.
4. Classification of political systems. Nature of liberal and socialist political systems; distinguishing features---conventions, rule of law (UK), separation of powers, checks and balances, judicial review (USA), democratic centralism (PRC), referendum, initiative (Switzerland).
5. Political Parties: Typology, features and roles (UK, USA, PRC and Bangladesh). Interest groups: roles (UK and USA).

Module II:

6. Unitary system: UK, Bangladesh. Federal system: USA, Russia.
7. Legislature in UK, USA and PRC: composition and functions of legislative chambers; Committee System in UK and USA
8. Executive in UK, USA, France and Russia: A comparative study of (i) Russian, French and American Presidency; (ii) British and French cabinet systems.
9. Judiciary in UK, USA and PRC (with focus on the Procuratorate): comparative study.
10. Rights of the citizens of UK, USA and PRC: A comparative study.

Readings:

Gabriel Almond et al eds.: Comparative Politics Today: A World View (latest edition).
J. Kopstein and M. Lichbach (eds.) Comparative Politics:Interest, Identities and Institutions in a Changing Global Order.
Subrata Mukherjee and S. Ramaswamy: Theoretical Foundations of Comparative Politics.
J. Bara and M Pennington eds.: Comparative Politics.
J. Kopstein and H. Lichbach eds. : Comparative Politics.
J. Harvey and S. Bather: The British Constitution.
J. Wilson: American Government.
S.E. Finer: Comparative Government.
J. Blondel: An Introduction to Comparative Politics.
The Constitution of People's Republic of China.
J. Gittings: China Changes Face: The Road from Revolution 1949-89.
S. Boyron: The Constitution of France: A Contextual Analysis.
M. Burgess: Comparative Federalism: Theory and Practice.
J. McCormick, Jr.: Comparative Politics in Transition.
R. Chatterjee: Introduction to Comparative Political Analysis.
N.K. Singh: Bangladesh--- Constitution, Law and Justice.
J. Henderson: Constitution of the Russian Federation: A Contextual Analysis.
S. P. Huntington: The Third Wave: Democratization in the Late Twentieth Century.
M. Duverger: Political Parties.

রাখহরি চ্যাটার্জীঃ তুলনামূলক রাজনীতিপরিচয়
অমিতাভ রায় (সম্পা): তুলনামুলক রাজনীতি
রাজশ্রী বসু (সম্পাদিত)–তুলনামূলক শাসনব্যবস্থা ও রাজনীতি
পঞ্চানন চট্টোপাধ্যায়: ফ্রান্সের সাধারণতন্ত্র

Perspectives on International Relations Code: PLS-A-CC-3-7-TH+TU

Module I:

1. Understanding International Relations: outline of its evolution as academic discipline.
2. Major theories: (a) Classical Realism and Neo-Realism (b) Dependency (c) World Systems theory.
3. Emergent issues: (a) Development (b) Environment (c) Terrorism (d) Migration.

Module II:

4. Making of foreign policy.
5. Indian foreign policy: major phases: 1947-1962; 1962-1991; 1991-till date.
6. Sino-Indian relations; Indo-US relations.

Readings:

M. Nicholson, International Relations: A Concise Introduction, New York: Palgrave.
Jackson and G. Sorensen, Introduction to International Relations: Theories and Approaches, 3rd Edition.
Joshua. Goldstein and J. Pevehouse, (2007) International Relations.
C. Brown and K. Ainley, (2009) Understanding International Relations
H.J. Morgenthau: Politics among Nations.
K. Booth and S. Smith, (eds), International Relations Theory Today
S.H. Hoffman: Essays in Theory and Politics of International Relations.
K.J. Holsti: International Politics: A Framework for Analysis.
J. Frankel: The Making of Foreign Policy.
J. Frankel: Contemporary International Theory and Behaviour of States.
J. Bennett: International Organizations.
J. Bandopadhyay: The Making of India's Foreign Policy.
D.A. Baldwin ed.: Neo-realism and Neo-liberalism.
M. Smith and R. Little: Perspectives on World Politics.
P.R. Viotti and M.V. Kauppi: International Relations and World Politics.
Muchkund Dubey: India's Foreign Policy: Coping with the Changing World.
Peu Ghosh: International Relations.
S.D. Muni: Indian Foreign Policy: The Democracy Dimension.
K.P. Bajpai and H.V. Panth: India's Foreign Policy--- A Reader.
Sumit Ganguly: India's Foreign Policy: Retrospect and Prospect.
V. P. Dutt: India's Foreign Policy since Independence.
V.P. Dutt: Indian Foreign Policy in a Changing World.

পুরুষোত্তম ভট্টাচার্য ও অনিন্দ্যজ্যোতি মজুমদার (সম্পা.): আন্তর্জাতিক সম্পর্কের রূপরেখা
গৌতম বসু: আন্তর্জাতিক সম্পর্ক: তত্ত্ব ও বিবর্তন

Semester IV

Indian Political Thought IICode: PLS-A-CC-4-8-TH+TU

Module I:

1. M.N. Roy: Radical Humanism.
2. Narendra Deva, Ram Manohar Lohia, Jayaprakash Narayan: Socialist ideas
3. Syed Ahmed Khan and Iqbal: views on colonialism and nationalism.

Module II:

4. Nehru: views on Socialism and Democracy. Subhas Chandra Bose: views on Socialism and Fascism.
5. Contested notions of 'nation'--- Savarkar, Jinnah.
6. Jyotiba Phule and Ambedkar on caste system and untouchability. Pandita Ramabai's views on social justice

Readings:

V. R. Mehta and T. Pantham (eds.), 'A Thematic Introduction to Political Ideas in ModernIndia: Thematic Explorations, History of Science, Philosophy and Culture in Indian civilization, Vol. 10, Part: 7, pp. xxvii-ixi.
V. Mehta and Th. Pantham (eds.), Political ideas in modern India: Thematic Explorations
S. Hay (ed.), Sources of Indian Tradition, Vol. 2.Second Edition.
T. Pantham and K.L. Deutsch: Political Thought in Modern India.
Sumit Sarkar: Modern India.
Bipan Chandra: Nationalism and Colonialism in Modern India.
A. Parel, (ed.), 'Introduction', in Gandhi, freedom and Self Rule
D. Dalton, (1982) 'Continuity of Innovation', in Indian Idea of Freedom: Political Thought ofSwami Vivekananda, Aurobindo Ghose, Rabindranath Tagore and Mahatma Gandhi.
J. Nehru: Discovery of India.
B. Zachariah, Nehru.
S. Thorat and Aryana eds.: Ambedkar in Retrospect.
J. Sharma, (2003) Hindutva: Exploring the Idea of Hindu Nationalism
Y. Meherally ed.: Narendra Deva: Socialism and National Revolution.
Ramchandra Guha: India after Gandhi.
Uma Chakrabarti: Rewriting History: The Life and Times of Pandita Ramabai.
B. K. Bhattacharya ed., Salient Ideas of Rammonohar Lohia.
Bidyut Chakrabarty and R.K. Pandey: Modern Indian Political Thought--- Text and Context.

Global Politics since 1945Code: PLS-A-CC-4-9-TH+TU

Module I:

1. Cold War and its evolution: outline.Emergence of Third World: NAM; Pan Africanism. Post-Cold War world: overview. Globalization: conceptions and perspectives.
2. Europe in transition: European Union, Brexit (overview).
3. Major institutions of global governance: World Bank, IMF, WTO--- overview. Major regional organizations: ASEAN, OPEC, SAFTA, SAARC and BRICS. West Asia and the Palestine question.

Module II:

4.India and her neighbours I: Pakistan; Bangladesh.

5. India and her neighbours II: Nepal; Bhutan; Sri Lanka.

6. UNO: background; Major organs--- General Assembly, Security Council and Secretariat (with focus on Secretary General). Role of UNO in peace-keeping, human rights, and development (Millennium Development Goals and Sustainable Development Goals).

Readings:

P. Calvocoressi: World Politics since 1945 (latest edition).
R. Mansbach and K. Taylor, (2012) Introduction to Global Politics
J. Baylis and S. Smith (eds), The Globalization ofWorld Politics: An Introduction to International Relations.
G. Ritzer: Globalization--- A Basic Text.
J.A. Moore, Jr. and J. Pubantz: The New United Nations.
S. Juyal and B. Ramesh Babu: The United Nations and World Peace.
K. Bajpai and H.C. Shukul eds.: Interpreting World Politics.
J. Baylis and S. Smith: The Globalization of World Politics.
L.M. Goodriche: The UN in Changing World.
M.S. Rajan: Essays in Non-Alignment and UN.
Alvin Y. So: Development and Social Change.
J. Haynes: Third World Politics.
Ankie Hoogvelt: Globalization and the Postcolonial World
N.O. Sullivan ed.: Terrorism, Ideology and Revolution.
D. Nayyar: Governing Globalization.
G. Ritzer: Globalization--- A Basic Text.
S.D. Muni: Responding to Terrorism in South Asia.
Peter Burnel: Politics in the Developing World.
B.C. Smith: Understanding Third World Politics.
Björn Hettne: Development Theory and the Three Worlds.

রাধারমণ চক্রবর্তী ও সুকল্পা চক্রবর্তী: সমসাময়িক আন্তর্জাতিক সম্পর্ক
পুরুষোত্তম ভট্টাচার্য ও অনিন্দ্যজ্যোতি মজুমদার (সম্পা.):আন্তর্জাতিক সম্পর্কের রূপরেখা
গৌতম বসু: আন্তর্জাতিক সম্পর্ক: তত্ত্ব ও বিবর্তন
অনীক চট্টোপাধ্যায়: ঠাণ্ডাযুদ্ধের পর আন্তর্জাতিক সম্পর্ক

WESTERN POLITICAL THOUGHT AND THEORY I

Code: PLS-A-CC-4-10-TH+TU

Module I:

1. Greek political thought: main features – Plato: justice, communism – Aristotle: state, classifications of constitutions.
2. Roman political thought: theories of Law and Citizenship – contributions of Roman thought.
3. Medieval political thought in Europe: major features.
4. Contribution of Machiavelli. Significance of Renaissance. Political thought of Reformation.

Module II:

5. Bodin: Idea of Sovereignty.
6. Hobbes: founder of science of materialist politics.

7. Locke: founder of Liberalism. views on natural rights, property and consent.
8. Rousseau: views on freedom and democracy.

Readings:

A.Skoble and T. Machan: Political Philosophy: Essential Selections.
D. Boucher and P. Kelly, (eds) Political Thinkers: From Socrates tothe Present
G. H. Sabine and T.I. Thorson: A History of Political Theory.
D. Boucher and P. Kelly: Political Thinkers: From Socrates to the Present.
S. Mukherjee and S. Ramaswamy: A history of Political Thought: From Plato to Marx.
R.G. Gettell: History of Political Thought.
B. Barker: The Political Thought of Plato and Aristotle.
Q. Skinner: Machaivelli: A Very Short Introduction.
A.K. Mukhopadhyay: Western Political Thought: from Plato to Marx.

Semester V

WESTERN POLITICAL THOUGHT AND THEORY II

Code: PLS-A-CC-5-11-TH+TU

Module I:

1. Bentham: Utilitarianism. John Stuart Mill: views on liberty and representative government.
2. Hegel: Civil Society and State.
3. T. H. Green: Freedom, Obligation.

Module II:

4. Utopian and Scientific Socialism: basic characteristics.
5. Varieties of non-Marxist socialism: Fabianism, Syndicalism, Guild Socialism.
6. Anarchism: overview.
7. Cultural Marxism: Frankfurt School (overview). Post-Marxism: emergence and basic contentions.

Readings:

A.Skoble and T. Machan: Political Philosophy: Essential Selections.
D. Boucher and P. Kelly, (eds) Political Thinkers: From Socrates tothe Present
G. H. Sabine and T.I. Thorson: A History of Political Theory.
D. Boucher and P. Kelly: Political Thinkers: From Socrates to the Present.
S. Mukherjee and S. Ramaswamy: A history of political Thought: From Plato to Marx.
R.G. Gettell: History of Political Thought.
Q. Skinner: The Foundations of Modern Political Thought (2 Volumes).
A.K. Mukhopadhyay: Western Political Thought: from Plato to Marx.
C.E.M. Joad: Political Theory.
L. Kolakowski: Main Currents of Marxism (3 Volumes).
D.K. Das and T. Chattopadhyay: Varieties of Socialism.
D. McLellan: The Thought of Karl Marx.
D. McLellan: Marxism after Marx.

S. Mukherjee and S. Ramaswamy: A History of Socialist Thought.
Frankfurt School: Internet Encyclopedia of Philosophy, http://www.iep.utm.edu/frankfur/

শোভনলাল দত্তগুপ্ত (সম্পা.:পাশ্চাত্য রাষ্ট্রভাবনা)
অমল কুমার মুখোপাধ্যায়: রাষ্ট্রদর্শনের ধারা
রামকৃষ্ণ ভট্টাচার্য: মার্কসবাদ জিজ্ঞাসা
অমৃতাভ বন্দ্যোপাধ্যায়: পাশ্চাত্য রাষ্ট্রচিন্তার ইতিহাস
সুদীপ্ত দে: গণরাজ্য (প্লেটোর Republic র অনুবাদ)
নির্মলকান্তি মজুমদার: এ্যারিস্টটলের Politics –র অনুবাদ
সুনীল বরণ বিশ্বাস: ম্যাকিয়াভেলীর Prince –র অনুবাদ
হিমাংশু ঘোষ: রাজনৈতিক তত্ত্বের ইতিহাস (J H Sabine র ভাষান্তর)
শোভনলাল দত্তগুপ্ত: মার্কসীয় রাষ্ট্রচিন্তা–মার্কস থেকে মাও সে তুং

Political Sociology Code: PLS-A-CC-5-12-TH+TU

Module I:

1. Social bases of politics. Emergence of Political Sociology.
2. Political culture and Political socialization: nature, types and agencies.
3. Political participation: concept and types.
4. Political development and social change.
5. Political Communication: Concept and structures.

Module II:

6. Social stratification and politics: caste, tribe, class, elite.
7. Gender and politics: basic issues.
8. Religion and politics: varying perspectives.
9. Military and politics: conditions and modes of intervention.
10. Electorate and electoral behaviour (with special reference to the Indian context).

Readings:

Michael Rush: Politics and Sociology.
B. Axford et al.: Politics--- An Introduction.
Tom Bottomore: Political Sociology.
Amal K. Mukhopadhyay: Political Sociology.
S. Chakraborty ed.: Political Sociology.
Tom Bottomore: Classes in Modern Society.
R. Chatterjee ed.: Religion, Politics and Communalism.
B. Lindenfeld ed.: Reader in Political Sociology.
Pradip Basu (ed.) – Political Sociology
J. Forbes: Women in Modern India.
M. Evans ed.: The Women Question.
P. Worsley: The Three Worlds: Culture and World Development.
Samuel Huntington: Political Order in a Changing Society.
G.A. Almond and J.S. Coleman eds.: The Politics of Developing Areas.

J. Manor: Rethinking Third World Politics.
J. Kantola et al eds.: The Oxford Handbook of Gender Politics.
J. Blondel: Comparative Government.
G.A. Almond and G.B. Powell, Jr.: Comparative Politics: A Developmental Approach.
S. Oates: Introduction to Media and Politics.

টম বটমোরঃ মার্ক্সীয় সমাজতত্ত্ব (অনুবাদঃ হিমাংশু ঘোষ); সত্যব্রত চক্রবর্তীঃ রাষ্ট্র, সমাজ ও রাজনীতি

Semester VI

Public Administration-- Concepts and Perspectives Code: PLS-A-CC-6-13-TH+TU

Module I:

1. Nature, Scope and Evolution of Public Administration – Private and Public Administration. Principles of Socialist Management.
2. Challenges to discipline of Public Administration and responses: New Public Administration, Comparative Public Administration, Development Administration (Indian context).
3. Major concepts of administration: (a) Hierarchy (b) Unity of Command (c) Span of Control (d) Authority (e) Centralization, Decentralization and Delegation (f) Line and Staff.
4. Public Administration in the era of globalization, liberalization and privatization. Governance: conceptual emergence--- distinction with government. e-governance: features and significance.

Module II:

5. Bureaucracy: views of Marx and Weber.
6. Ecological approach to Public Administration: Riggsian Model.
7. Administrative Processes: (a) Decision making (b) Communication and Control (c) Leadership (d) Coordination.
8. Public Policy: definition, characteristics. Models. Policy implementation.

Readings:

Nicholas Henry: Public Administration and the State.
W. Wilson, (2004) 'The Study of Administration', in B. Chakrabarty and M. Bhattacharya (eds), Administrative Change and Innovation: a Reader, New Delhi: Oxford University Press, pp. 85-101
Mohit Bhattacharya: Public Administration: Structure, Process and Behaviour.
M. Bhattacharya, Public Administration: Issues and Perspectives.
A. Avasthi and S. Avasthi: Pubic Administration.
M. Bhattacharya: Restructuring Public Administration.
B. Chakrabarty: Public Administration: From Government to Governance.
B. Chakrabarty and M. Bhattacharya eds.: Pubic Administration: A Reader.
B. Chakrabarty and M. Bhattacharya eds.: The Governance Discourse.
Shivani Singh: Governance: Issues and Challenges.
M.P. Sharma: Public Administration in Theory and Practice.
Rumki Basu: Public Administration: Concepts and Theories.
G.H. Frederickson: New Public Administration.
R. Prasad et al. eds.: Administrative Thinkers.

S.R. Maheswari: Administrative Theory.
Ramesh Arora: Comparative Public Administration.
R.K. Sapru: Development Administration.
M. Bhattacharya: New Horizons of Public Administration.
T. Dye, (1984) Understanding Public Policy, 5th Edition.
Xun Wu, M.Ramesh, Michael Howlett and Scott Fritzen, The Public Policy Primer: ManagingThe Policy Process.
Prabir Kumar De, *Public Policy and Systems*,
B. Chakrabarty and P. Chand: Public Administration in a Globalizing World: Theories and Practices.
U. Medury, Public administration in the Globalisation Era.
Additional Reading: The Oxford Handbook of Public Policy.

Administration and Public Policy in India Code: PLS-A-CC-6-14-TH+TU

Module I

1. Continuity and change in Indian administration: brief historical overview.
2. Civil Service in India (Bureaucracy): recruitment (role of UPSC, SPSC), training.
3. Organization of Union Government: Secretariat Administration: PMO, Cabinet Secretariat.
4. Organization of State Government: Chief Secretary – relations between Secretariat and Directorate.
5. District Administration: role of District Magistrate, SDO, BDO.

Module II:

6.Local Self Government: Corporations, Municipalities and Panchayats in West Bengal, structure and functions. 73rd and 74th Amendment: overview.
7. Planning: Planning Commission, National Development Council. District Planning. Changing nature of planning: NITI Ayog. Budget--- concept and significance.
8. Financial Administration: Public Accounts Committee, Estimates Committee – role of CAG.
9. Citizen and administration: functions of Lokpal and Lokayukt. Right to Information--- Citizen Charter.
10. Citizen and social welfare policies: MGNREGA; Sarva Shiksha Abhiyan (SSA); National Health Mission (NRHM).

Readings:

Bidyut Chakrabarty, Reinventing Public Administration: The Indian Experience.
S. R. Maheswari: Indian Administration.
R.B. Jain: Contemporary Issues in Indian Administration.
B. Chakrabarty and P. Chand: Indian Administration.
Noorjahan Bava, Development Policies and Administration in India.
Satyajit Singh and Pradeep K. Sharma [eds.] Decentralisation: Institutions and Politics inRural India.
Basu Rumki: Public Administration in India Mandates, Performance and FuturePerspectives.
A.Celestine: How to Read the Union Budget PRS, Centre for Policy Research, New Delhi, Available at http://www.prsindia.org/parliamenttrack/primers/how-to-read-the-union-budget-1023/
Primer on the Budget Process published by PRS, Available athttp://www.prsindia.org/parliamenttrack/primers/the-budget-process-484/
R.V. Vaidyanatha Ayyar, Public Policy Making In India, Pearson.

B. Chakrabarty and P. Chand: Public Policy: Concepts, Theory and Practice.
S. Singh and P. Sharma: Decentralization: Institutions and Politics in Rural India.
Anil Jana ed.: Decentralizing Rural Governance and Development.
P. Datta: Panchayats, Rural Development and Local Autonomy: the West Bengal Experience.
A. Mukhopadhyay: Panchayat Administration in West Bengal.

For both Courses 13 and 14:

মোহিত ভট্টাচার্য ও বিশ্বনাথ ঘোষ: জনপ্রশাসন ও পরিকল্পনা
সোমা ঘোষ: জনপ্রশাসন: তত্ত্ব ও প্রয়োগ
রাজশ্রী বসু: জনপ্রশাসন
পদ্মা রামচন্দ্রনঃ ভারতে সরকারী প্রশাসন (অনুবাদঃ সন্তোষ কুমার অধিকারী)
অসিত বসু: পশ্চিমবঙ্গে পঞ্চায়েত ব্যবস্থা
প্রভাত দত্ত: প্রসঙ্গ পঞ্চায়েত

Guidelines:

i) For very contemporary topics, such as, NITI Ayog and MGNREGA, the respective official websites may be consulted.
ii) For supplementary readings, relevant reputed websites of recognized academic credential may be legally accessed.
iii) Bengali books cited in a particular course may be used in another *related* course, if found relevant.

University of Calcutta

Final Draft BA (Honours)-CBCS Syllabus in Political Science, 2018
(Section II)

Discipline- specific Elective Category: 4 courses (8 courses provided). One from Group A and one from Group B in Semesters 5 and one from Group A and one from Group B in Semester 6.

Generic Elective Category: 4 courses(Core Courses of the General Syllabus from a subject other than Political Science. Not provided here.)

Each DSE and GE course: 6 credits (5 theoretical segment+ 1 for tutorial-related segment).

Skill Enhancement/Skill-based Category: 2 courses(4 courses provided). Each Course: 2 credits. Theoretical only (no Tutorial). Any one course from Group A in Semester 3 and any one course from Group B in Semester 4.

Ability Enhancement Compulsory Category:2 courses: Common for all. Not provided here.

- Each course carries 80 marks ^combining theoretical and tutorial segments (plus 10 marks each for Attendance and Continuous Internal Assessment).
- 6 credit course: Minimum 30 classes for Theory and 15 contact hours for Tutorial per module. 2 credit course: 30 teaching/lecture hours in total.

^End Semester Assessment--- 65 marks for theoretical segment: 50 marks for subjective/descriptive questions + 15 marks for 1 mark-questions. Question Pattern for subjective/descriptive segment of 50 marks: 2 questions (within 100 words; one from each module) out of 4 (10 x2 = 20) + 2 questions (within 500 words; one from each module) out of 4 (15 x 2 = 30).>>For Skill Enhancement Courses the last component would carry 6 questions--- 15 marks each--- out of which 3 (at least one from each module) to be attempted because such courses have no Tutorial.

- 15 marks for tutorial-related segments as suggested below (any one item from each mode): i) Written mode: upto 1000 words for one Term Paper/upto 500 words for each of the two Term Papers/ equivalent Book Review/equivalent Comprehension/equivalent Quotation or Excerpt Elaboration. ii) Presentation Mode: Report Presentation/Poster Presentation/Field work--- based on syllabus-related and/or current topics (May be done in groups) [The modes and themes and/or topics are be decided by the concerned faculty members of respective colleges.]
- Discipline-specific: 2 each (one from Group A and one from Group B) in Semesters 5 and 6.
- Generic Elective: 1 each in Semesters 1-4.**<>**Skill Enhancement: 1 each in Semesters 3 and 4.

IMPORTANT NOTES:

- The Readings provided below include many of those of the UGC Model CBCS Syllabus in Political Science. For Course Objectives and references it is advised that the UGC model CBCS syllabus* concerning relevant courses and topics be provided due importance and primarily consulted.

*Website: BA Political Science (Honours): https://www.ugc.ac.in/pdfnews/2085906_B.A-Hons.-Pol-Science.pdf

- Cited advanced texts in Bengali are not necessarily substitutes, but supplementary to English books.
- Paper Code Format: Subject Code-Course Code-Semester Code-Paper Number-Paper Component.
- The format is strictly subject to the parameters of the common structural format of CU CBCS.

Honours in Political Science

List of Discipline-specific Elective Courses:

- Gender and Politics
- Understanding South Asia
- Indian Foreign Policy in a Globalising World
- Development Process and Social Movements in Contemporary India
- Public Policy in India
- Understanding Global Politics
- Citizenship in a Globalising World
- Human Rights in a Comparative Perspective

List of Skill Enhancement Courses:

- Democratic Awareness through Legal Literacy
- Understanding the Legal System
- Legislative Practices and Procedures
- Elementary Aspects of Social Research

Discipline-specific Electives:

Gender and Politics

Code: PLS-A-DSE-5-A(1)-TH+TU

Module I

I. Groundings
1. Patriarchy
a. Sex-Gender Debates
b. Public and Private
c. Power
2. Feminism
3. Family, Community, State
a. Family
b. Community
c. State

Module II

II. Movements and Issues
1. History of the Women's Movement in India
2. Violence against women
3. Work and Labour
a. Visible and Invisible work
b. Reproductive and care work
c. Sex work

Readings:

I. Groundings
1. Patriarchy
T. Shinde, (1993) 'Stree Purusha Tulna', in K. Lalitha and Susie Tharu (eds), *Women Writing in India,* New Delhi, Oxford University Press, pp. 221-234.
a. Sex Gender Debates
Readings:
V Geetha, (2002) *Gender,* Kolkata, Stree, pp. 1-20
b. Public and Private
Readings:
M. Kosambi, (2007) *Crossing the Threshold,* New Delhi, Permanent Black, pp. 3-10; 40-46
c. Power
Readings:
N. Menon, (2008) 'Power', in R. Bhargava and A. Acharya (eds), *Political Theory: An Introduction,* Delhi: Pearson, pp.148-157
2. Feminism
Readings:
B. Hooks, (2010) 'Feminism: A Movement to End Sexism', in C. Mc Cann and S. Kim (eds), *The Feminist Reader: Local and Global Perspectives,* New York: Routledge, pp. 51-57
R. Delmar, (2005) 'What is Feminism?', in W. Kolmar & F. Bartkowski (eds) *Feminist Theory: A Reader,* pp. 27-37
3.Family, Community and State

a.Family

Readings:

R. Palriwala, (2008) 'Economics and Patriliny: Consumption and Authority within the Household' in M. John. (ed) *Women's Studies in India,* New Delhi: Penguin, pp. 414-423

b. Community

Readings:

U. Chakravarti, (2003) *Gendering Caste through a Feminist Len,* Kolkata, Stree, pp. 139-159.

c. State

C. MacKinnon, 'The Liberal State' from *Towards a Feminist Theory of State,* Available at http://fair-use.org/catharine-mackinnon/toward-a-feminist-theory-of-the-state/chapter-8, Accessed: 19.04.2013.

Additional Readings:

K. Millet, (1968) *Sexual Politics,* Available at http://www.marxists.org/subject/women/authors/millett-kate/sexual-politics.htm, Accessed: 19.04.2013.

N. Menon (2008) 'Gender', in R. Bhargava and A. Acharya (eds), *Political Theory: AnIntroduction,* New Delhi: Pearson, pp. 224-233

R. Hussain, (1988) 'Sultana's Dream', in *Sultana's Dream and Selections from the SecludedOnes – translated by Roushan Jahan,* New York: The Feminist Press

S. Ray 'Understanding Patriarchy', Available at http://www.du.ac.in/fileadmin/DU/Academics/course_material/hrge_06.pdf, Accessed: 19.04.2013.

S. de Beauvoir (1997) *Second Sex,* London: Vintage.

Saheli Women's Centre, (2007) *Talking Marriage, Caste and Community: Women's Voicesfrom Within,* New Delhi: monograph

II. Movements and Issues

1. History of Women's Movement in India

Readings:

I. Agnihotri and V. Mazumdar, (1997) 'Changing the Terms of Political Discourse: Women'sMovement in India, 1970s-1990s', *Economic and Political Weekly*, 30 (29), pp. 1869-1878.

R. Kapur, (2012) 'Hecklers to Power? The Waning of Liberal Rights and Challenges toFeminism in India', in A. Loomba *South Asian Feminisms,* Durham and London: DukeUniversity Press, pp. 333-355

2. Violence against Women

Readings:

N. Menon, (2004) 'Sexual Violence: Escaping the Body', in *Recovering Subversion,* New Delhi:Permanent Black, pp. 106-165

3. Work and Labour

a. Visible and Invisible work

Readings:

P. Swaminathan, (2012) 'Introduction', in *Women and Work,* Hyderabad: Orient Blackswan,pp.1-17

b. Reproductive and care work

Reading:

J. Tronto, (1996) 'Care as a Political Concept', in N. Hirschmann and C. Stephano, *Revisioningthe Political*, Boulder: Westview Press, pp. 139-156

c. Sex work

Readings:

Darbar Mahila Samanwaya Committee, Kolkata (2011) 'Why the so-called Immoral Traffic(Preventive) Act of India Should be Repealed', in P. Kotiswaran, *Sex Work,* New Delhi,Women Unlimited, pp. 259-262

N. Jameela, (2011) 'Autobiography of a Sex Worker', in P. Kotiswaran, *Sex Work,* New Delhi:Women Unlimited, pp. 225-241

Additional Readings:

C. Zetkin, 'Proletarian Woman', Available at
http://www.marxists.org/archive/zetkin/1896/10/women.htm, Accessed: 19.04.2013.
F. Engles, *Family, Private Property and State*, Available at
http://readingfromtheleft.com/PDF/EngelsOrigin.pdf, Accessed: 19.04.2013.
J. Ghosh, (2009) *Never Done and Poorly Paid: Women's Work in Globalising India,* Delhi:Women Unlimited
Justice Verma Committee Report, Available at http://nlrd.org/womens-rightsinitiative/
justice-verma-committee-report-download-full-report, Accessed: 19.04.2013.
N. Gandhi and N. Shah, (1992) *Issues at Stake – Theory and Practice in the Women'sMovement,* New Delhi:
Kali for Women.
V. Bryson, (1992) *Feminist Political Theory,* London*:* Palgrave-MacMillan, pp. 175-180; 196-200.
M. Mies, (1986) 'Colonisation and Housewifisation', in *Patriarchy and Accumulation on a*
World Scale London: Zed, pp. 74-111, Available at
http://caringlabor.wordpress.com/2010/12/29/maria-mies-colonization-andhousewifization/,
R. Ghadially, (2007) *Urban Women in Contemporary India,* Delhi: Sage Publications.
S. Brownmiller, (1975) *Against our Wills,* New York: Ballantine.
Saheli Women's Centre (2001) 'Reproductive Health and Women's Rights, Sex Selection and
feminist response' in S Arya, N. Menon, J. Lokneeta (eds), *Nariwadi Rajneeti,* Delhi, pp. 284-306.
V. Bryson (2007) *Gender and the Politics of Time,* Bristol: Polity Press.

Understanding South Asia

Code: PLS-A-DSE-5-A(2)-TH+TU

Module I

I. South Asia- Understanding South Asia as a Region
(a) Historical and Colonial Legacies
(b) Geopolitics of South Asia
II. Politics and Governance
Regime types: democracy, authoritarianism, monarchy
(b) Emerging constitutional practices: forms of government in India, Nepal, Bhutan, Sri Lanka and Pakistan

Module II

III. Socio-Economic Issues
(a) Identity politics: challenges and impacts (case studies of
India, Nepal, Sri Lanka)
IV. Regional Issues and Challenges
(a) South Asian Association for Regional Cooperation (SAARC): problems and prospects
(b)Terrorism: Political and Social Consequences in South Asia;
(c) Refugee crisis.

Readings:

Hewitt, V. (1992) 'Introduction', in The International Politics of South Asia. Manchester:
Manchester University Press, pp.1-10.
Hewitt, V. (2010) 'International Politics of South Asia' in Brass, P. (ed.) Routledge Handbook
of South Asian Politics. London: Routledge, pp.399-418.
Muni, S.D. (2003) 'South Asia as a Region', South Asian Journal, 1(1), August-September, pp.

1-6

Baxter, C. (ed.) (1986) The Government and Politics of South Asia. London: Oxford University Press, pp.376-394.
Baxter, C. (2010) 'Introduction', Brass, P. (ed.) Routledge Handbook of South Asian Politics. London: Routledge, pp.1-24

II. Politics and Governance

De Silva, K.M. (2001)'The Working of Democracy in South Asia', in Panandikar, V.A (ed.) Problems of Governance in South Asia. New Delhi: Centre for Policy Research & Konark Publishing House, pp. 46-88.
Wilson, J. (2003) 'Sri Lanka: Ethnic Strife and the Politics of Space', in Coakley, J. (ed.) The Territorial Management of Ethnic Conflict. Oregon: Frank Cass, pp. 173-193.
Mendis, D. (2008) 'South Asian Democracies in Transition', in Mendis, D. (ed.) Electoral Processes and Governance in South Asia. New Delhi: Sage, pp.15-52.
Subramanyam, K. (2001) 'Military and Governance in South Asia', in V.A (ed.) Problems of Governance in South Asia. New Delhi: Centre for Policy Research & Konark Publishing House, pp.201-208.
Hachethi, K. and Gellner, D.N.(2010) 'Nepal : Trajectories of Democracy and Restructuring of the State', in Brass, P. (ed.) Routledge Handbook of South Asian Politics. London: Routledge, pp. 131-146.
Kukreja, V. 2011. 'Federalism in Pakistan', in Saxena R. (ed.) Varieties of Federal Governance. New Delhi: Foundation Books, pp. 104-130.
Jha, N.K. (2008) 'Domestic Turbulence in Nepal: Origin, Dimensions and India's Policy Options', in Kukreja, V. and Singh, M.P. (eds.) Democracy, Development and Discontent in South Asia. New Delhi: Sage, pp. 264-281.
Burki, S.J. (2010) 'Pakistan's Politics and its Economy', in Brass, P. (ed.) Routledge Handbook of South Asian Politics. London: Routledge, pp. 83-97.
Kaul, N. (2008)'Bearing Better Witness in Bhutan', Economic and Political Weekly, 13 September, pp. 67-69.

III. Socio-Economic Issues

Phadnis, U.(1986) 'Ethnic Conflicts in South Asian States', in Muni, S.D. et.al. (eds.) Domestic Conflicts in South Asia : Political, Economic and Ethnic Dimensions. Vol. 2. New Delhi: South Asian Publishers, pp.100-119.
Kukreja, V. (2003) Contemporary Pakistan. New Delhi: Sage, pp. 75-111 and 112-153.

IV. Regional Issues and Challenges

Narayan, S. (2010) 'SAARC and South Asia Economic Integration', in Muni, S.D. (ed.) Emerging dimensions of SAARC. New Delhi: Foundation Books, pp. 32-50.
Muni, S.D. and Jetley, R. (2010) 'SAARC prospects: the Changing Dimensions', in Muni, S.D. (ed.) Emerging dimensions of SAARC. New Delhi: Foundation Books, pp. 1-31.
Baral, L.R. (2006) 'Responding to Terrorism: Political and Social Consequences in South Asia', in Muni, S.D. (ed.) Responding to terrorism in South Asia. New Delhi: Manohar, pp.301-332.
Muni, S.D. (2006) 'Responding to Terrorism: An Overview', in Muni, S.D. (ed.) Responding to terrorism in South Asia. New Delhi: Manohar, pp.453-469.
Hoyt, T.D. (2005) 'The War on Terrorism: Implications for South Asia', in Hagerty, D.T. (ed.) South Asia in World Politics. Lanham: Roman and Littlefield Publishers, pp.281-295.
Lama, M. (2003) 'Poverty, Migration and Conflict: Challenges to Human Security in South Asia', in Chari, P.R. and Gupta, S. (eds.) Human Security in South Asia: Gender, Energy, Migration and Globalisation. New Delhi: Social Science Press, pp. 124-144
Acharya, J. and Bose, T.K. (2001) 'The New Search for a Durable Solution for Refugees: South Asia', in Samaddar, S. and Reifeld, H. (eds.) Peace as Process: Reconciliation and Conflict Resolution in South Asia. New Delhi: Vedams ,pp-137-157

Additional Readings

Baxter, C. (ed.) (1986) The Government and Politics of South Asia. London: Oxford University Press.
Rizvi, G. (1993) South Asia in a Changing International Order. New Delhi: Sage.
Thakur, R. and Wiggin, O.(ed.) (2005) South Asia and the world. New Delhi: Bookwell.
Hagerty, D.T.(ed.) (2005) South Asia in World Politics, Oxford: Rowman and Littlefield.
Samaddar, R. (2002) 'Protecting the Victims of Forced Migration: Mixed Flows and Massive Flows', in Makenkemp, M. Tongern, P.V. and Van De Veen, H. (eds.) Searching for Peace in Central and South Asia. London: Lynne Reinner.
Kukreja, V. and Singh, M.P. (eds) (2008) Democracy, Development and Discontent in SouthAsia. New Delhi: Sage.

Indian Foreign Policy in a Globalising World

Code: PLS-A-DSE-5-B (1)-TH+TU

Module I

I. India's Foreign Policy: From a Postcolonial State to an Aspiring Global Power
2. India's Relations with the USA and USSR/Russia
3. India's Engagements with China

Module II

4. India in South Asia: Debating Regional Strategies
5. India's Negotiating Style and Strategies: Trade, Environment and Security Regimes
6. India in the Contemporary Multipolar World

Readings:

I. India's Foreign Policy: From a Postcolonial State to an Aspiring Global Power

S. Ganguly and M. Pardesi, (2009) 'Explaining Sixty Years of India's Foreign Policy', in India Review, Vol. 8 (1), pp. 4–19.
Ch. Ogden, (2011) 'International 'Aspirations' of a Rising Power', in David Scott (ed.), Handbook of India's International Relations, London: Routeledge, pp.3-31
W. Anderson, (2011) 'Domestic Roots of Indian Foreign Policy', in W. Anderson, Trysts with Democracy: Political Practice in South Asia, Anthem Press: University Publishing Online.
J. Bandhopadhyaya, (1970) The Making of India's Foreign Policy, New Delhi: Allied Publishers.

II: India's Relations with the USA and USSR/Russia

S. Mehrotra, (1990) 'Indo-Soviet Economic Relations: Geopolitical and Ideological Factors', in India and the Soviet Union: Trade and Technology Transfer, Cambridge University Press: Cambridge, pp. 8-28.
R. Hathaway, (2003) 'The US-India Courtship: From Clinton to Bush', in S. Ganguly (ed.), India as an Emerging Power, Frank Cass: Portland.
A. Singh, (1995) 'India's Relations with Russia and Central Asia', in International Affairs, Vol. 71 (1): 69-81.
M. Zafar, (1984), 'Chapter 1', in India and the Superpowers: India's Political Relations with the Superpowers in the 1970s, Dhaka, University Press.
H. Pant, (2008) 'The U.S.-India Entente: From Estrangement to Engagement', in H. Pant, Contemporary Debates in Indian Foreign and Security Policy: India Negotiates Its Rise in the International System, Palgrave Macmillan: London.
D. Mistry, (2006) 'Diplomacy, Domestic Politics, and the U.S.-India Nuclear Agreement', in Asian Survey, Vol. 46 (5), pp. 675-698.

III: India's Engagements with China

H. Pant, (2011) 'India's Relations with China', in D. Scott (ed.), Handbook of India's International Relations, London: Routeledge, pp. 233-242.
A. Tellis and S. Mirski, (2013) 'Introduction', in A. Tellis and S. Mirski (eds.), Crux of Asia: China, India, and the Emerging Global Order, Carnegie Endowment for International Peace: Washington.
S. Raghavan, (2013) 'Stability in Southern Asia: India's Perspective', in A. Tellis and S. Mirski (eds.), Crux of Asia: China, India, and the Emerging Global Order, Carnegie Endowment for International Peace: Washington.
Li Li, (2013) 'Stability in Southern Asia: China's Perspective', in A. Tellis and S. Mirski (eds.), Crux of Asia: China, India, and the Emerging Global Order, Carnegie Endowment for International Peace: Washington.
IV: India in South Asia: Debating Regional Strategies
S. Muni, (2003) 'Problem Areas in India's Neighbourhood Policy', in South Asian Survey, Vol. 10 (2), pp. 185-196.
S. Cohen, (2002) India: Emerging Power, Brookings Institution Press.V. Sood, (2009) 'India and regional security interests', in Alyssa Ayres and C. Raja Mohan (eds), Power realignments in Asia: China, India, and the United States, New Delhi: Sage.
M. Pardesi, (2005) 'Deducing India's Grand Strategy of Regional Hegemony from Historical and Conceptual Perspectives', IDSS Working Paper, 76,
D. Scott, (2009) 'India's "Extended Neighbourhood" Concept: Power Projection for a Rising Power', in India Review, Vol. 8 (2), pp. 107-143 112
V: India's Negotiating Style and Strategies: Trade, Environment and Security Regimes
S. Cohen, (2002) 'The World View of India's Strategic Elite', in S. Cohen, India: Emerging Power, Brookings Institution Press, pp. 36-65.
A. Narlikar, (2007) 'All that Glitters is not Gold: India's Rise to Power', in Third World Quarterly, Vol. 28 (5) pp. 983 – 996.
N. Dubash, (2012) 'The Politics of Climate Change in India: Narratives of Enquiry and Cobenefits', Working Paper, New Delhi: Centre for Policy Research. N. Jayaprakash, (2000) 'Nuclear Disarmament and India', in Economic and Political Weekly, Vol. 35 (7), pp. 525-533.
P. Bidwai, (2005) 'A Deplorable Nuclear Bargain', in Economic and Political Weekly, Vol. 40 (31), pp. 3362-3364.
A. Anant, (2011) 'India and International Terrorism', in D. Scott (ed.), Handbook of India's International Relations, London: Routledge, pp. 266-277.

VI: India in the Contemporary Multipolar World
R. Rajgopalan and V. Sahni (2008), 'India and the Great Powers: Strategic Imperatives, Normative Necessities', in South Asian Survey, Vol. 15 (1), pp. 5–32.
C. Mohan, (2013) 'Changing Global Order: India's Perspective', in A. Tellis and S. Mirski (eds.), Crux of Asia: China, India, and the Emerging Global Order, Carnegie Endowment for International Peace: Washington.
A. Narlikar, (2006) 'Peculiar Chauvinism or Strategic Calculation? Explaining the Negotiating Strategy of a Rising India', in International Affairs, Vol. 82 (1), pp. 59-76.
P. Mehta, (2009) 'Still Under Nehru's Shadow? The Absence of Foreign Policy Frameworks in India', in India Review, Vol. 8 (3), pp. 209–233.

Development Process and Social Movements in Contemporary India

Code: PLS-A-DSE-5-B(2)-TH+TU

Module I

I. Development Process since Independence
a. State and planning
b. Liberalization and reforms
II. Industrial Development Strategy and its Impact on the Social Structure

a. Mixed economy, privatization, the impact on organized and unorganized labour
b. Emergence of the new middle class
III. Agrarian Development Strategy and its Impact on the Social Structure
a. Land Reforms, Green Revolution
b. Agrarian crisis since the 1990s and its impact on farmers

Module II

IV. Social Movements
Social movements and New Social movements
Approaches to the study of social movements: Marxist theory, Gandhian theory, Resource Mobilisation theory, Relative Deprivation theory
V. Globalisation and Social Movements in India (18classes)
Environmental movements
Tribal movements
Women's movements
Civil rights movements

Readings:

I. The Development Process since Independence

A. Mozoomdar, (1994) 'The Rise and Decline of Development Planning in India', in T. Byres(ed.) *The State and Development Planning in India*. Delhi: Oxford University Press, pp. 73-108.
A. Varshney, (2010) 'Mass Politics or Elite Politics? Understanding the Politics of India'sEconomic Reforms' in R. Mukherji (ed.) *India's Economic Transition: The Politics of Reforms*,Delhi: Oxford University Press, pp 146-169.
P. Chatterjee, (2000) 'Development Planning and the Indian State', in Zoya Hasan (ed.), *Politics and the State in India*, New Delhi: Sage, pp.116-140.
P. Patnaik and C. Chandrasekhar, (2007) 'India: Dirigisme, Structural Adjustment, and theRadical Alternative', in B. Nayar (ed.), *Globalization and Politics in India*. Delhi: OxfordUniversity Press, pp. 218-240.
P. Bardhan, (2005) 'Epilogue on the Political Economy of Reform in India', in *The PoliticalEconomy of Development in India*. 6th impression, Delhi: Oxford University Press.
T. Singh, (1979) 'The Planning Process and Public Process: a Reassessment', *R. R. KaleMemorial Lecture*, Pune: Gokhale Institute of Politics and Economics.

II. Industrial development strategy and its impact on social structure

Readings:

A. Aggarwal, (2006) 'Special Economic Zones: Revisiting the Policy Debate', in *Economic and Political Weekly*, XLI (43-44), pp.4533-36.
B. Nayar (1989) *India's Mixed Economy: The Role of Ideology and its Development*, Bombay:Popular Prakashan.
F. Frankel, (2005) 'Crisis of National Economic Planning', in *India's Political Economy (1947-2004): The Gradual Revolution*, Delhi: Oxford University Press, pp. 93-340.
L. Fernandes, (2007) *India's New Middle Class: Democratic Politics in an Era of EconomicReform*, Delhi: Oxford University Press.
S. Shyam, (2003) 'Organizing the Unorganized', in *Seminar*, [Footloose Labour: A Symposiumon Livelihood Struggles of the Informal Workforce, 531] pp. 47-53.
S. Chowdhury, (2007) 'Globalization and Labour', in B. Nayar (ed.) *Globalization and Politicsin India*, Delhi: Oxford University Press, pp.516-526.

V. Chibber, (2005) 'From Class Compromise to Class Accommodation: Labor's Incorporationinto the Indian Political Economy' in R. Ray, and M.F. Katzenstein (eds.) *SocialMovements inIndia*, Delhi: Oxford University Press, pp 32-60.

III. Agrarian development strategy and its impact on social structure

Readings:

A. Desai, (ed.), (1986) *Agrarian Struggles in India after Independence*, Delhi: OxfordUniversity Press, pp. xi-xxxvi.
F. Frankel, (1971) *India's Green Revolution: Economic Gains and Political Costs*, Princetonand New Jersey: Princeton University Press.
F. Frankel, (2009) *Harvesting Despair: Agrarian Crisis in India*, Delhi: Perspectives, pp. 161-169.
J. Harriss, (2006) 'Local Power and the Agrarian Political Economy' in Harriss, J. (ed) *Power Matters: Essays on Institutions, Politics, and Society in India*, Delhi. Oxford University Press,pp. 29-32.
K. Suri, (2006) 'Political economy of Agrarian Distress', in *Economic and Political Weekly*,XLI(16) pp. 1523-1529.
P. Joshi, (1979) *Land Reforms in India: Trends and Perspectives*, New Delhi: Allied publishers.
P. Appu, (1974) 'Agrarian Structure and Rural Development', in *Economic and PoliticalWeekly*, IX (39), pp.70 – 75.
P. Sainath, (2010) 'Agrarian Crisis and Farmers', Suicide', *Occasional Publication*22, NewDelhi: India International Centre (IIC).
M. Sidhu, (2010) 'Globalisation vis-à-vis Agrarian Crisis in India', in R. Deshpande and S.Arora, (eds.) *Agrarian Crises and Farmer Suicides (Land Reforms in India Series),* New Delhi:Sage, pp. 149-174.
V. Sridhar, (2006) 'Why Do Farmers Commit Suicide? The Case Study of Andhra Pradesh', in *Economic and Political Weekly*, XLI (16).

IV. Social Movements

G. Shah, (ed.), (2002) *Social Movements and the State*. New Delhi: Sage Publications.
R. Singh (2001), *Social Movements, Old and New:A Post-Modernist Critique*, New Delhi: Sage
P. Wignaraja (ed.), (1993), *New Social Movements in the South:Empowering the People*, New Delhi: Vistar
V. Globalisation and Social Movements in India

Readings:

G. Haragopal, and K. Balagopal, (1998) 'Civil Liberties Movement and the State in India', in M. Mohanty, P. Mukherji and O. Tornquist, (eds.) *People's Rights*: *Social Movements and the State in the Third World* New Delhi: Sage, pp. 353-371.
M. Mohanty, (2002) 'The Changing Definition of Rights in India', in S. Patel, J. Bagchi, and K. Raj (eds.) *Thinking Social Sciences in India: Essays in Honour of Alice Thorner* Patel, NewDelhi: Sage.
G. Omvedt, (2012) 'The Anti-caste Movement and the Discourse of Power', in N. Jayal (ed.) *Democracy in India*, New Delhi: Oxford India Paperbacks, sixth impression, pp.481-508.
P. Ramana, (2011) 'India's Maoist Insurgency: Evolution, Current Trends and Responses', in M. Kugelman (ed.) *India's Contemporary Security Challenges*, Woodrow Wilson International Centre for Scholars Asia Programme, Washington D.C., pp.29-47.
A. Ray, (1996) 'Civil Rights Movement and Social Struggle in India', in *Economic and Political Weekly*, XXI (28). pp. 1202-1205.
A. Roy, (2010) 'The Women's Movement', in N.Jayal and P. Mehta (eds.) *The OxfordCompanion to Politics in India*, New Delhi: Oxford University Press, pp.409-422.
N. Sundar, (2011) 'At War with Oneself: Constructing Naxalism as India's Biggest SecurityThreat', in M. Kugelman (ed.) *India's Contemporary Security Challenges*, Woodrow WilsonInternational Centre for Scholars Asia Programme, Washington D.C., pp.46-68.
M. Weiner, (2001) 'The Struggle for Equality: Caste in Indian Politics', in A.Kohli. (ed.) *TheSuccess of India's Democracy*, Cambridge: CUP, pp.193-225.

S. Sinha, (2002) 'Tribal Solidarity Movements in India: A Review', in G. Shah. (ed.) *SocialMovements and the State*, New Delhi: Sage, pp. 251-266.

Additional Readings:

S. Banerjee, (1986) 'Naxalbari in Desai', in A.R. (ed.) *Agrarian Struggles in India AfterIndependence*. Delhi: Oxford University Press, pp.566-588.

B. Nayar, (ed.), (2007) *Globalization and Politics in India*. Delhi: Oxford University Press.S. Roy and K. Debal, (2004) *Peasant Movements in Post-Colonial India: Dynamics ofMobilization and Identity*, Delhi: Sage.

G. Omvedt, (1983) *Reinventing Revolution, New Social Movements and the SocialistTradition in India*, New York: Sharpe.

G. Shah, (ed.), (2002) *Social Movements and the State*. New Delhi: Sage Publications.

G. Shah, (2004) *Social Movements in India: A Review of Literature*, New Delhi: SagePublications.

G. Rath, (ed.), (2006) *Tribal development in India: The Contemporary Debate*, New Delhi:Sage Publications.

J. Harris, (2009) *Power Matters: Essays on Institutions, Politics, and Society in India*. Delhi:Oxford University press.

K. Suresh, (ed.), (1982) *Tribal Movements in India*, Vol I and II, New Delhi: Manohar(emphasis on the introductory chapter).

M. Mohanty, P. Mukherji and O.Tornquist, (1998) *People's Rights: Social Movements andthe State in the Third World*. New Delhi: Sage Publications.

M. Rao, (ed.), (1978) *Social Movements in India*, Vol. 2, Delhi: Manohar.

N. Jayal, and P. Mehta, (eds.), (2010) *The Oxford Companion to Politics in India*, Delhi:OxfordUniversity Press.

P. Bardhan, (2005) *The Political Economy of Development in India*, 6th impression, Delhi:Oxford University Press.

R. Mukherji, (ed.), (2007) *India's Economic Transition: The Politics of Reforms*, Delhi: OxfordUniversity Press.

R, Ray and M. Katzenstein, (eds.), (2005) *Social Movements in India*, Delhi: Oxford UniversityPress.

S. Chakravarty, (1987) *Development Planning: The Indian Experience*, Delhi: OxfordUniversity Press.

Public Policy in India

Code: PLS-A-DSE-6-A(3)-TH+TU

Module I

1.Introduction to Policy Analysis
2. The Analysis of Policy vis-à-vis the Theories of State

Module II

3. Political Economy and Policy: Interest Groups and Social Movements.
4. Ideology and Policy: Nehruvian Vision, Economic Liberalisation and recent developments

Readings:

I Introduction to Policy Analysis

Jenkins, B. (1997) 'Policy Analysis: Models and Approaches' in Hill, M. (1997) *The PolicyProcess: A Reader* (2nd Edition). London: Prentice Hall, pp. 30-40.

Dye, T.R. (2002) *Understanding Public Policy*. Tenth Edition. Delhi: Pearson, pp.1-9, 32-56 and 312-329.

Sapru, R.K.(1996) *Public Policy : Formulation, Implementation and Evaluation*. New Delhi: Sterling Publishers, pp. 26-46.

Wildavsky, A.(2004), ' Rescuing Policy Analysis from PPBS' in Shafritz, J.M. & Hyde, A.C. (eds.) *Classics of Public Administration*. 5th Edition. Belmont: Wadsworth, pp.271-284.

II. The Analysis of Policy in the Context of Theories of State

Dunleavy, P. and O'Leary, B. (1987) *Theories of the State*. London: Routledge.

McClennan, G. (1997) 'The Evolution of Pluralist Theory' in Hill, M. (ed.) *The Policy Process:A Reader.* 2nd Edition. London: Prentice Hall, pp. 53-61.
Simmie, J. & King, R. (eds.) (1990) *The State in Action: Public Policy and Politics.* London: Printer Publication, pp.3-21 and 171-184.
Skocpol, T. et al (eds.) (1985) *Bringing the State Back In.* Cambridge: Cambridge University Press, pp. 3-43 and 343-366.
Dye, T.R. (2002) *Understanding Public Policy*. 10th Edition. Delhi: Pearson, pp.11-31.

III. Political Economy and Policy: Interest Groups and Social Movements.

Lukes, S. (1986) *Power.* Basil: Oxford, pp. 28-36.
Lukes, S. (1997) 'Three Distinctive Views of Power Compared', in Hill, M. (ed.), *The Policy Process: A Reader.* 2nd Edition. London: Prentice Hall, pp. 45-52.
Giddens, A. (1998) *The Third Way: The Renewal of Social Democracy.* Cambridge: Polity Press, pp. 27-64 and 99-118.

IV. Ideology and Policy: Nehruvian Vision, Economic Liberalisation and recent developments

Basu Rumki (2015) Public Administration in India Handates, Performance and Future Perspectives, New Delhi, Sterling Publishers
Self, P. (1993) *Government by the Market? The Politics of Public Choice*. Basingstoke: MacMillan, pp. 1-20,70-105,113-146,198-231 and 262-277.
Girden,E.J.(1987) 'Economic Liberalisation in India: The New Electronics Policy' in *AsianSurvey*. California University Press. Volume 27, No.11. Available at -www.jstor.org/stable/2644722.

Understanding Global Politics

Code: PLS-A-DSE-6-A(4)-TH+TU

Module I

I. What Makes the World What it is
a. The Sovereign State System

i Evolution of the state system
ii The concept of Sovereignty

b. The Global Economy
i Discussing the Bretton Woods Institutions and WTO
ii Ideological underpinnings
iii Transnational Economic Actors

c. Identity and Culture

ii. What Drives the World Apart
a.Global Inequalities
b.Violence: Conflict, War and Terrorism

III. Why We Need to Bring the World Together

a.Global Environment b. Global Civil Society

Readings:

I. What Makes the World What it is? a. The Sovereign State System

S. Elden, (2009) 'Why Is The World Divided Territorially?', in J. Edkins and M. Zehfuss (eds.) *Global Politics: A New Introduction*, New York: Routledge, pp. 192-219.

M. Shapiro, (2009) 'How Does The Nation- State Work?', in J. Edkins and M. Zehfuss (eds.) *Global Politics: A New Introduction*, New York: Routledge, pp. 220-243.

R. Mansbach and K.Taylor, (2012) 'The Evolution of the Interstate System and Alternative Global Political Systems', *Introduction to Global Politics*, 2nd edition, New York: Routledge, pp. 34-68.

D. Armstrong, (2008) 'The Evolution of International Society', in J. Baylis, S. Smith, and P. Owens (ed.) *The Globalization of World Politics: An Introduction to International Relations,* New York: Oxford University Press, pp. 36-52.

N. Inayatullah and D. Blaney, (2012) 'Sovereignty' in B. Chimni and S. Mallavarapu (ed.) *International Relations: Perspectives For the Global South*, New Delhi: Pearson, pp. 124-134.

b. The Global Economy

Readings:

V. Peterson**,** (2009) 'How Is The World Organized Economically?', in J. Edkins and M. Zehfuss (eds.) *Global Politics: A New Introduction*, New York: Routledge, pp. 271- 293.

Bourke, (2009) 'Why Does Politics Turn Into Violence?', in J. Edkins And M. Zehfuss (eds.), *Global Politics: A New Introduction*, New York: Routledge, pp. 370-396.

Bajpai, (2012) 'Global Terrorism', in B. Chimni and S. Mallavarapu (ed.), *InternationalRelations: Perspectives For the Global South*, New Delhi: Pearson, pp. 312-327.

R. Mansbach, and K. Taylor, (2012) 'The Causes of War and the Changing Nature Of Global Politics', in *Introduction to Global Politics,* 2nd edition, New York: Routledge, pp. 248-283.

R. Collin and P. Martin, 'Kinds Of Conflict: The World When Things Go Wrong', in *AnIntroduction To World Politics: Conflict And Consensus On A Small Planet*, London: Rowman& Littlefield Publishers, pp. 267-425.

III. Why We Need to Bring the World Together? a. Global Environment

Readings:

S. Dalby, (2009) 'What Happens If We Do not Think In Human Terms?', in J. Edkins and M. Zehfuss (eds.), *Global Politics: A New Introduction*, New York: Routledge, pp. 45-69.

R. Collin and P. Martin, (2013) 'The Greening of A Blue Planet', in *An Introduction To WorldPolitics: Conflict And Consensus On A Small Planet*, Maryland: The Rowman & LittlefieldPublication Group, pp. 527-570.

A. Heywood, (2011) 'Global Environmental Issues', in *Global Politics,* London: Palgrave, 2011, pp. 383-411.

N. Carter, (2007) *The Politics of Environment: Ideas, Activism, Policy*, 2nd edition, Cambridge: Cambridge University Press, pp 13-81.

b. Global Civil Society

Readings:

Zehfuss, (2009) 'What Can We Do To Change The World?', in J. Edkins and M. Zehfuss (eds.), *Global Politics: A New Introduction* , New York: Routledge, pp. 483-501.

N. Chandhoke, (2011) 'The Limits of Global Civil Society,' Available at www.gcsknowledgebase.org/wp-content/uploads/2002chapter2.pdf, Accessed: 19.04.2013.

K. Mingst and J. Snyder (eds.), (2011) 'Transnational Issues', in *Essential Readings In WorldPolitics,* 4th Edition, New York: W. W. Norton And Company, pp. 574-626.

M. Keck and K. Sikkink, (2007) 'Transnational Activist Networks,' in Robert J. Art and R. Jervis (eds.) *International Politics: Enduring Concepts and Contemporary Issues,* 8th Edition, London: Pearson, pp. 532-538.

M. Naim, (2007) 'The Five Wars Of Globalization', in R. Art and R. Jervis (eds.) *InternationalPolitics: Enduring Concepts And Contemporary Issues,* 8th Edition, London: Pearson, pp. 558-566.

S. Mallaby, (2007) 'NGOs: Fighting Poverty, Hurting the Poor', in R. Art and R. Jervis (eds.)

International Politics: Enduring Concepts and Contemporary Issues, 8th edition, New York:Pearson, pp. 539-545.
G. Lexter and S. Halperin (eds.), (2003) *Global Civil Society and Its Limits,* New York: Palgrave, pp. 1-21.

Citizenship in a Globalising World

Code: PLS-A-DSE-6-B(3)-TH+TU

This course will explore theories of citizenship, the historical development of the concept and its practice of in an increasingly globalizing world.

Module I

1. Classical conceptions of citizenship
2. The Evolution of Citizenship and the Modern State

Module II

3. Citizenship and Diversity
4. Citizenship beyond the Nation-state: Globalization and global justice
5. The idea of cosmopolitan citizenship

Essential Readings

- Acharya, Ashok. (2012) *Citizenship in a Globalising World*. New Delhi: Pearson.
- Beiner, R. (1995) *Theorising Citizenship*. Albany: State University of New York Press.
- Held, David (1995), *Democracy and the Global Order: From the Modern State toCosmopolitan Governance* (Stanford: Stanford University Press).
- Kymlicka, Will (1999), "Citizenship in an Era of Globalization: A Response to Held," in Ian Shapiro and Casiano Hacker-Cordon (eds.), *Democracy's Edges* (Cambridge, UK: Cambridge University Press).
- Oliver, D. and D. Heater (1994). *The Foundations of Citizenship*. London, Harvester Wheatsheaf.
- Scholte, Jan Aart (2000), *Globalization: A Critical Introduction* (New York: St. Martin's).
- Zolo, Danilo (1997), *Cosmopolis: Prospects for World Government* (Cambridge, UK: Polity Press).

Human Rights in a Comparative Perspective

Code: PLS-A-DSE-6-B(4)-TH+TU

Module I

Human Rights: Theory and Institutionalization

Understanding Human Rights: Three Generations of Rights
Institutionalization: Universal Declaration of Human Rights
Rights in National Constitutions: South Africa and India

Issues:

Torture: USA and India; Surveillance and Censorship: China and India; Terrorism and Insecurity of Minorities: USA and India

Module II

Structural Violence:

Caste and Race: South Africa and India

Gender and Violence: India and Pakistan
Adivasis/Aboriginals and the Land Question: Australia and India

READING LIST

Human Rights: Theory and Institutionalization

Essential Readings:

I. Hoffman and P. Graham, (2006) 'Human Rights', *Introduction to Political Theory*, Delhi, Pearson, pp. 436-458.

SAHRDC (2006) 'Introduction to Human Rights'; 'Classification of Human Rights: An Overview of the First, Second, and Third Generational Rights', in *Introducing Human Rights*, New Delhi: Oxford University Press.

The Constitution of the Republic of South Africa, Chapter 2: Bill of Rights.

The Constitution of India, Chapter 3: Fundamental Rights

Issues

Torture: USA and India

Essential Readings:

M. Lippman, (1979) 'The Protection of Universal Human Rights: The Problem of Torture' *Universal Human Rights*, Vol. 1(4), pp. 25-55

J. Lokaneeta, (2011) 'Torture in the TV Show 24: Circulation of Meanings'; 'Jurisprudence on Torture and Interrogations in India', in *Transnational Torture Law, Violence, and State Powerin the United States and India,* Delhi: Orient Blackswan,

D. O'Byrne, (2007) 'Torture', in *Human Rights: An Introduction***,** Delhi: Pearson, pp. 164-197.

Surveillance and Censorship: China and India

Essential Readings:

D. O'Byrne, (2007) 'Censorship', in *Human Rights: An Introduction***,** Delhi: Pearson, pp. 106-138.

D. Lyon, (2008) Surveillance Society, Talk for Festival del Diritto, Piacenza, Italia, September 28, pp.1-7.

Fu Hualing, (2012) 'Politicized Challenges, Depoliticized Responses: Political Monitoring in China's Transitions', paper presented at a conference on States of Surveillance: Counter-Terrorism and Comparative Constitutionalism, at the University of New South Wales, Sydney, 13-14 December.

U. Singh, (2012) 'Surveillance Regimes in India', paper presented at a conference on States of Surveillance: Counter-Terrorism and Comparative Constitutionalism, at the University of New South Wales, Sydney, 13-14 December.

Terrorism and Insecurity of Minorities: USA and India

Essential Readings:

E. Scarry, (2010) 'Resolving to Resist', in *Rule of Law, Misrule of Men***,** Cambridge: Boston Review Books**,** MIT, pp.1-53.

M. Ahmad, (2002) 'Homeland Insecurities: Racial Violence the Day after September 11', *Social Text*, 72, Vol. 20(3), pp. 101-116.

U. Singh, (2007) 'The Unfolding of Extraordinariness: POTA and the Construction of Suspect Communities', in *The State, Democracy and Anti-terror Laws in India***,** Delhi: Sage Publications, pp.165-219

Structural Conflicts

Caste and Race: South Africa and India

Essential Readings:

A. Pinto, (2001) 'UN Conference against Racism: Is Caste Race?', in *Economic and PoliticalWeekly*, Vol. 36(30)

D. O'Byrne, (2007) 'Apartheid', in *Human Rights: An Introduction,* Delhi: Pearson, pp. 241-262.

R. Wasserstorm, (2006), 'Racism, Sexism, and Preferential Treatment: An approach to the Topics', in R.

Goodin and P. Pettit, *Contemporary Political Philosophy: an Anthology*, Oxford: Blackwell, pp-549-574
R. Wolfrum, (1998) 'Discrimination, Xenophobia and Racism' in J. Symonides, *Human Rights:New Dimensions and Challenges*, Aldershot, Ashgate/UNESCO, pp.181-198.

Gender and Violence: India and Pakistan

Essential Readings:

A. Khan and R. Hussain, (2008), 'Violence Against Women in Pakistan: Perceptions and Experiences of Domestic Violence', *Asian Studies Review*, Vol. 32, pp. 239 – 253

K. Kannabiran (2012) 'Rethinking the Constitutional Category of Sex', in *Tools of Justice:Non-Discrimination and the Indian Constitution*,New Delhi, Routledge, pp.425-443

Adivasis/Aboriginals and the Land Question: Australia and India

Essential Readings:

H. Goodall, (2011) 'International Indigenous Community Study: Adivasi Indigenous People in India', in A. Cadzow and J. Maynard (eds.),*Aboriginal Studies,* Melbourne: Nelson Cengage Learning, pp.254-259.
K. Kannabiran, (2012) 'Adivasi Homelands and the Question of Liberty', in *Tools of Justice:Non-Discrimination and the Indian Constitution*, New Delhi: Routledge, pp.242-271.
N. Watson (2011) 'Aboriginal and Torres Strait Islander Identities' in A. Cadzow and J. Maynard (eds.),*Aboriginal Studies*, Melbourne: Nelson Cengage Learning, pp.43-52.
W. Fernandes (2008) 'India's Forced Displacement Policy and Practice. Is Compensation up to its Functions?', in M. Cernea and H. Mathus (eds), *Can Compensation PreventImpoverishment? Reforming Resettlement through Investments and Benefit-Sharing*,pp.181-207, New Delhi: Oxford University Press.

Additional Readings:

A. Laws and V. Iacopino, (2002) 'Police Torture in Punjab, India: An Extended Survey', in *Health and Human Rights,* Vol. 6(1), pp. 195-210
D. O'Byrne, (2007) 'Theorizing Human Rights', in *Human Rights: An Introduction,* Delhi, Pearson, pp.26-70.
J. Morsink, (1999) *The Universal Declaration of Human Rights: Origins, Drafting and Intent*, Philadelphia: University of Pensylvania Press, pp. ix-xiv
J. Nickel, (1987) *Making Sense of Human Rights: Philosophical Reflections on the UniversalDeclaration of Human Rights*,Berkeley: University of California Press.
J. Goldman, (2005) 'Of Treaties and Torture: How the Supreme Court Can Restrain the Executive', in *Duke Law Journal*, Vol. 55(3), pp. 609-640.
J. Tsutsui and C. Wotipka, (2004) Global Civil Society and the International Human Rights Movement: Citizen Participation in Human Rights International Nongovernmental Organizations, in *Social Forces*, Vol. 83(2), pp. 587-620.
J. Rabben, (2001) Amnesty International: Myth and Reality, in *Agni*, No. 54, Amnesty International Fortieth Anniversary pp. 8-28

K. Mohanty, (2010) 'In Pursuit of People's Rights: An Introduction', in M. Mohanty et al., *Weapon of the Oppressed: Inventory of People's Rights in India*, New Delhi: Danish Books,pp.1-11
M. Cranston, (1973) *What are Human Rights?* New York: Taplinger
M. Ishay, (2004) *The History of Human Rights: From Ancient Times to the Globalization Era*, Delhi: Orient Blackswan.
R. Sharan, (2009) 'Alienation and Restoration of Tribal Land in Jharkhand in N Sundar (ed.) *Legal Grounds*, New Delhi: Oxford University Press, pp. 82-112
Text of UDHR available at http://www.un.org/en/documents/udhr/index.shtml
U. Baxi, (1989) 'From Human Rights to the Right to be Human: Some Heresies', in S. Kothari and H. Sethi (eds.), *Rethinking Human Rights*, Delhi: Lokayan, pp.181-166.

Skill Enhancement Courses

Democratic Awareness through Legal Literacy

Code: PLS-A-SEC-3-A(1)-TH

Module I

1. Laws relating to Criminal jurisdiction-provisions relating to filing an FIR, arrest, bail, search and seizure and some understanding of the questions of evidence and procedure in the Criminal Procedure Code.
2. Offences under IPC.
3. India: Personal laws. Customary Laws
4. Laws relating to Dowry, sexual harassment and violence against women.

Module II

5. Laws relating to consumer rights.
6. Right to Information.
7. Laws relating to Cybercrimes.
8. Anti-terrorist laws: Implications for security and human rights.

Readings:

Pandey, (2008) 'Laws Relating to Criminal Justice: Challenges and Prospects', in K. Sankaran and U. Singh, *Towards Legal Literacy,* New Delhi: Oxford University Press, pp.61-77.SAHRDC, (2006)'Reporting a Crime: First Information Report', in *Oxford Handbook of Human Rights and Criminal Justice in India - The system and Procedure*, New Delhi:Oxford University Press, pp.16-26.

SAHRDC, (2006) 'Bail', in *Oxford Handbook of Human Rights and Criminal Justice in India - The system and Procedure*, New Delhi: Oxford University Press, pp.59-71.

SAHRDC, (2006) 'Detention', in *Oxford Handbook of Human Rights and Criminal Justice in India - The system and Procedure*. New Delhi: Oxford University Press, pp.72-84.

P. Mathew, (2003) *Your Rights if you are Arrested,* New Delhi. Indian Social Institute.

P. Mathew, (2002) *The Law on Atrocities Against Scheduled Castes and Scheduled Tribes,* New Delhi: Indian Social Institute.

K. Saxena, (2011) 'Dalits', in M. Mohanty et al., *Weapon of the Oppressed, Inventory of People's Rights in India*. Delhi: Danish Books, Pp.15-38

K. Saxena, (2011) 'Adivasis', in M. Mohanty et al., *Weapon of the Oppressed, Inventory of People's Rights in India*, Delhi: Danish Books, Pp.39-65.

S. Durrany, (2006) *The Protection of Women From Domestic Violence Act 2005*, New Delhi: Indian Social Institute.

V. Kumari, (2008) 'Offences against Women', in K, Sankaran and U. Singh (eds.) *Towards Legal Literacy,* New Delhi: Oxford University Press.

P. D. Mathew (2004) *The Measure to Prevent Sexual Harassment of Women in Work Place.* New Delhi: Indian Social Institute.

D. Srivastva, (2007) 'Sexual Harassment and Violence against Women in India: Constitutional and Legal Perspectives', in C. Kumar and K. Chockalingam (eds) *Human Rights, Justice, and Constitutional Empowerment*, Delhi: Oxford University Press.

S. Naib, (2013) 'Right to Information Act 2005', in *The Right to Information in India,* New Delhi: Oxford University Press, Available at

http://www.humanrightsinitiative.org/publications/rti/guide_to_use_rti_act_2005_English2012_light_Aspire.pdf.

Bare Acts**:**
Consumer Protection Act, 1986, Available at http://chdslsa.gov.in/right_menu/act/pdf/consumer.pdf.
Criminal law Amendment Act, 2013, Available at http://egazette.nic.in/WriteReadData/2013/E_17_2013_212.pdf , Accessed: 10.04.2013.
Protection of Women Against Domestic Violence Act, 2005, Available at http://wcd.nic.in/wdvact.pdf.
Right to Information Act, 2005, Available at http://righttoinformation.gov.in/rti-act.pdf.
Scheduled Castes and Scheduled Tribes Prevention of Atrocities Act, 1989, Available at http://tribal.nic.in/writereaddata/linkimages/poaact989E4227472861.pdf.
Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act 2006, Available at http://tribal.gov.in/writereaddata/mainlinkFile/File1033.pdf.
The Persons with Disabilities (Equal Opportunities, Protection of Rights, Full Participation) Act, 1995, Available at http://bhind.nic.in/Sparsh_disability%20act%201995.pdf.
The Right of Children to Free and Compulsory Education Act, 2009, Available at http://www.delta.org.in/form/rte.pdf.
The Sexual Harassment of Women at Workplace (Prevention, Prohibition and Redressal) Bill, 2012**,** Available at http://164.100.24.219/BillsTexts/LSBillTexts/PassedLoksabha/144C_2010_LS_Eng.pdf.
Criminal Law Amendment Act, 2013**,** Available at mha.nic.in/pdfs/TheCrimnalLaw030413.pdfFile Format: PDF/Adobe Acrobat – Quick View.

Understanding the Legal System

Code: PLS-A-SEC-3-A(2)-TH

Module I

1) Outline of the legal system in India
2) System of Courts/tribunals and their jurisdiction in India-Criminal and civil courts, writ jurisdiction.
3) Specialized Courts such as juvenile courts, mahila courts and tribunals.

Module II

4) Role of the police and executive in criminal law administration.
5) Alternate dispute mechanisms such as Lok Adalats, non-formal mechanisms.

Readings:
Creating Legal Awareness, edited by Kamala Sankaran and Ujjwal Singh (Delhi: OUP, 2007)
S..K. Agarwala, *Public Interest Litigation in India*, K.M. Munshi Memorial Lecture, Second Series, Indian Law Institute, Delhi, 1985.
Asha Bajpai, *Child Rights in India : Law, Policy, and Practice*, Oxford University Press, New Delhi,2003
B.L. Wadhera, *Public Interest Litigation - A Handbook*, Universal, Delhi, 2003.
P.C. Rao and William Sheffiled *Alternate Dispute Resolution: What it is and How it Works*, Universal Law Books and Publishers, Delhi, 2002
V.N. Shukla's *Constitution of India* by Mahendra P. Singh, Eastern Book Co. 10th edition.

Parmanand Singh, *'Access to Justice and the Indian Supreme Court'*, 10 & 11 Delhi Law Review 156, 1981-82.
J. Kothari, (2005) 'Criminal Law on Domestic Violence', *Economic and Political Weekly,* Vol. 40(46), pp. 4843-4849.
H. Mander, and A. Joshi, *The Movement for Right to Information in India, People's Power for the Control of Corruption*. Available at http://www.rtigateway.org.in/Documents/References/English/Reports/12.%20An%20article%20on%20RTI%20by%20Harsh%20Mander.pdf.
P. Mathew, and P. Bakshi, (2005) '*Indian Legal System'*, New Delhi: Indian Social Institute.
P. Mathew, and P. Bakshi, (2005) '*Women and the Constitution'*, New Delhi: Indian Social Institute.
N. Menon, (2012) 'Sexual Violence', in *Seeing Like a Feminist* New Delhi: Zubaan and Penguin, pp. 113-146.
M, Mohanty et al. (2011) *Weapon of the Oppressed, Inventory of People's Rights in India*. Delhi: Danish Books.
Centre for Good Governance, (2008) *Right to Information Act, 2005: A Citizen's Guide*, Available at http://www.rtigateway.org.in/Documents/Publications/A%20CITIZEN'S%20GUIDE.pdf,
Pandey, (2004) *Rights of the Consumer*. New Delhi: Indian Social Institute.
Pandey, (2008) 'Laws Relating to Criminal Justice: Challenges and Prospects', in K. Sankaran and U. Singh, *Towards Legal Literacy,* New Delhi: Oxford University Press, pp.61-77.
SAHRDC, (2006)'Reporting a Crime: First Information Report', in *Oxford Handbook of Human Rights and Criminal Justice in India - The system and Procedure*, New Delhi: Oxford University Press, pp.16-26.
SAHRDC, (2006) 'Bail', in *Oxford Handbook of Human Rights and Criminal Justice in India- The system and Procedure*, New Delhi: Oxford University Press, pp.59-71.
SAHRDC, (2006) 'Detention', in *Oxford Handbook of Human Rights and Criminal Justice in India- The system and Procedure*. New Delhi: Oxford University Press, Pp.72-84.
P. Mathew, (2003) *Your Rights if you are Arrested,* New Delhi. Indian Social Institute

Legislative Practices and Procedures

Code: PLS-A-SEC-4-B(1)-TH

Module I

1) Members of Parliament: Powers and Privileges-Constituency Work.
2) State legislative Assemblies: Powers and functions.
3) Functionaries of rural and urban local self-government from Zila Parishad, Municipal Corporation to Panchayat/ Ward.

Module II

4) How a bill becomes a law, role of standing committees in reviewing a bill, legislative consultants, the framing of rules and regulations.
5) Types of committees.
6) Role of committees in reviewing government finances, policy, programmes and legislation.
7) Powers and functions of people's representative at different tiers of governance

Readings:

M. Madhavan, and N. Wahi, (2008) Financing of Election Campaigns PRS, Centre for Policy Research, New Delhi, Available at: http://www.prsindia.org/uploads/media/conference/Campaign_finance_brief.pdf, Accessed: 19.04.2013 S.

Vanka, (2008) Primer on MPLADS, Centre for Policy Research, New Delhi, Available at http://www.prsindia.org/parliamenttrack/primers/mplads-487/, Accessed: 19.04.2013 129 H. Kalra, (2011) Public Engagement with the Legislative Process PRS, Centre for Policy Research, New Delhi, Available at: http://www.prsindia.org/administrator/uploads/media/Conference%202011/Public%20Eng agement%20with%20the%20Legislative%20Process.pdf, Accessed: 19.04.2013. Government of India (Lok Sabha Secretariat), (2009) Parliamentary Procedures (Abstract Series), Available at http://164.100.47.132/LssNew/abstract/index.aspx, Accessed: 19.04.2013

The legislative process

Readings:

Government of India, (Ministry of Parliamentary Affairs), (2009) Legislation, Parliamentary Procedure, Available at http://mpa.nic.in/Manual/Manual_English/Chapter/chapter- 09.htm, Accessed: 19.04.2013 Government of India, (Ministry of Parliamentary Affairs) (2009), Subordinate Legislation, Parliamentary Procedure, Available at: http://mpa.nic.in/Manual/Manual_English/Chapter/chapter-11.htm Accessed: 19.04.2013 D. Kapur and P. Mehta, (2006) 'The Indian Parliament as an Institution of Accountability', Democracy, Governance and Human Rights, Programme Paper Number 23, United Nations Research Institute for Social Development, Available at: http://www.unrisd.org/UNRISD/website/document.nsf/240da49ca467a53f80256b4f005ef2 45/8e6fc72d6b546696c1257123002fcceb/$FILE/KapMeht.pdf, Accessed: 19.04.2013 O. Agarwal and T. Somanathan, (2005) 'Public Policy Making in India: Issues and Remedies', Available at: http://www.cprindia.org/admin/paper/Public_Policy_Making_in_India_14205_TV_SOMANA THAN.pdf, Accessed: 19.04.2013 B. Debroy, (2001) 'Why we need law reform' Seminar January.

Legislative Committees

Readings:

P. Mehta, 'India's Unlikely Democracy: The Rise of Judicial Sovereignty', Journal of Democracy, Vol. 18(2), pp.70-83. Government link: http://loksabha.nic.in/; http://rajyasabha.nic.in/; http://mpa.nic.in/ K. Sanyal, (2011) Strengthening Parliamentary Committees PRS, Centre for Policy Research, New Delhi, Available at: http://www.prsindia.org/administrator/uploads/media/Conference%202011/Strengthening %20Parliamentary%20Committees.pdf, Accessed: 19.04.2013

Elementary Aspects of Social Research

Code: PLS-A-SEC-4-B(2)-TH

Module I

1. Fundamental issues in Research Methodology: concepts, variables, proposition and hypotheses; hypothesis construction and verification; measurement – scales; ethics in social research.

2. Research design: definition, purpose of research, unit of analysis, fallacy (ecological fallacy and fallacy of reductionism), factors affecting research design.

3. Sources and techniques of data collection -- qualitative and quantitative; Sampling –different types; Basic statistical methods – types of statistics; measures of central tendencies and measures of dispersion; graphic representation of data.

Module II

4. Participatory field research: Modes and methods of participant observation; advantages and limitations; Case study: definition; types; steps involved in the method; uses. Focus group method: nature and uses; role of the researcher.

5. Survey method: Definition, types; techniques of survey research: Pilot survey; interviewing – techniques; different types; qualities of a good interviewer; questionnaire – framing a questionnaire; problem of non-response; advantages and disadvantages of survey method.

6. Aggregate data analysis: Sources of aggregate data; uses of aggregate data; advantages of aggregate data; fallacy of inference. Experimental design: key concepts in experimental design; steps and planning the research; issues of equivalence and validity; classical experimental design.

[The Course may be supplemented with the use of computers though it is not obligatory].

Readings:

R. Kumar, Research Methodology: A Step-by-Step Guide for Beginners, Sage, 2010.
W.L. Neuman, Social Research Methods: Qualitative and Quantitative Approaches, Pearson.
D. E. McNabb, (2004) Research Methods for Political Science- Quantitative and Qualitative Methods, New Delhi: Prentice-Hall of India Pvt. Ltd.
R. Chatterjee, (1979) Methods of Political Enquiry, Calcutta: The World Press Pvt. Ltd., 1979.

University of Calcutta

Final Draft BA (General)-CBCS Syllabus in Political Science, 2018

Core Courses* (4 courses provided). Discipline-specific Elective (4 courses provided); Skill Enhancement(4 courses provided).[Students will also have to take courses from other subject/s]

*Core Courses mentioned hereunder are to be treated as the Generic Elective Courses of students pursuing Honours in a subject *other than Political Science*.

- ^Each coursecarries 80 marks--- theoretical and tutorial (plus 10 marks each for Attendance and Internal Assessment).
- 6 credit course:Minimum 30 classes for Theory and 15 contact hours for Tutorial per module. 2 credit course: 30 teaching/lecture hours in total.
- Core, DSE (and GE) Course: 6 credits (5 Theoretical + 1 Tutorial-related).
- Skill Enhancement/Skill-based Courses: 2 credits (no Tutorial).

^End SemesterAssessment--- 65 marks for theoretical segment: 50 marks for subjective/descriptive questions + 15 marks for the category of 1 mark-questions.Question Pattern for subjective/descriptive segment of 50 marks: 2 questions (within 100 words; one from each module) out of 4 (10 x2 = 20) + 2 questions (within 500 words; one from each module) out of 4 (15 x 2 = 30).>>For Skill Enhancement Courses the last component would carry 6 questions--- 15 marks each--- out of which 3 (at least one from each module) to be attempted because such courses have no Tutorial.

15 marks for tutorial-related segments as suggested below (any one item from each mode):

Any one of the following modes: i) Written mode: upto 1000 words for one Term Paper/upto 500 words for each of the two Term Papers/ equivalent Book Review/equivalent Comprehension/equivalent Quotation or Excerpt Elaboration. ii) Presentation Mode: Report Presentation/Poster Presentation/Field work--- based on syllabus-related and/or current topics (May be done in groups)[The modes and themes and/or topics are be decided by the concerned faculty of respective colleges.]

- **Core Courses in Semesters I-IV; Discipline-specific courses in Semesters V and VI; Skill Enhancement courses in Semesters III-VI.**

IMPORTANT NOTES:

- The Readings provided below (except Bengali books) include those of the UGC Model CBCS Syllabus in Political Science. For Course Objectives and references it is advised that the UGC model CBCS syllabus* concerning relevant courses and topics be provided due importance and primarily consulted.

*BA General https://www.ugc.ac.in/pdfnews/0693504_BA-with-Pol-Science-.pdf

- Bengali books are not necessarily substitutes, but supplementary to the English books.
- The format isstrictly subject to the parameters of the Common Structural Format of the University.

General (Political Science) Courses

Core:

Introduction to Political Theory

Comparative Government and Politics

Government and Politics in India

International Relations

DSE:

Public Administration

Indian Foreign Policy

Feminism: Theory and Practice

Human Rights: Theory and Indian Context

SEC:

Legal Literacy

Elementary Dimensions of Research

Understanding the Legal System

Basic Research Methods

Core Courses

Introduction to Political Theory Code: PLS-G-CC-1-1-TH+TU

Module I

1. Political Science: nature and scope; Different approaches--- Normative, Behavioural, Post-Behavioural, Marxist, Feminist.
2. State: Contract theory; Idealist theory; Liberal theory; Marxist theory; Gandhian theory. Sovereignty of the State: Monistic and Pluralist theories. Doctrine of Popular Sovereignty.
3. Foundational concepts: Law; Right; Liberty; Equality--- meanings, sources, interrelationships.
4. Key concepts: Nationalism and Internationalism—meanings and features; Democracy--- meaning and nature.

Module II

5. Marxism: Dialectical and Historical Materialism; Class and Class Struggle; Theory of Revolution; Lenin's Theory of Imperialism.
6. Fascism: meaning, features, significance.
7. Political parties and interest groups: functions and role; Methods of representation: territorial, functional, proportional.

Readings:

R. Bhargava and A. Acharya eds., Political Theory: An Introduction.
Mohit Bhattacharya and Amal Roy: Political Theory: Ideas and Institutions.
S. Ramasway: Political Theory: Ideas and Concepts.
O. P Gauba: An Introduction to Political Theory.
J. C. Johari: Political Theory
S.P. Verma: Modern Political Theory.
Maurice Cornforth: Dialectical Materialism.
Robin Goodfellow: Marxism in a Nutshell.
Tom Bottomore ed.: A Dictionary of Marxist Thought.
V. I. Lenin: Imperialism--- The Highest Stage of Capitalism.
Margaret Walters: Feminism: A Very Short Introduction.

মোহিত ভট্টাচার্য, বিশ্বনাথ ঘোষঃ আধুনিক রাষ্ট্রবিজ্ঞান
অনাদি কুমার মহাপাত্রঃ রাষ্ট্রবিজ্ঞান
হিমাচল চক্রবর্তীঃ রাষ্ট্রবিজ্ঞান
সত্যসাধন চক্রবর্তী, নির্মলকান্তি ঘোষঃ রাষ্ট্রবিজ্ঞান
দেবাশীষ চক্রবর্তীঃ রাষ্ট্রতত্ব ও প্রতিষ্ঠান
এমিল বার্নসঃ মার্কসবাদ(What is Marxism-এরঅনুবাদ)
ভোলানাথ বন্দ্যোপাধ্যায়ঃ দ্বন্দ্বমূলক বস্তুবাদ(মরিস কর্নফোর্থের Dialectical Materialism-এর অনুবাদ)
রাজশ্রী বসু ও বাসবী চক্রবর্তী (সম্পা): প্রসঙ্গ মানবীবিদ্যা

Comparative Government and Politics Code: PLS-G-CC-2-2-TH+TU

Module I

1 Political System: Liberal-democratic, Authoritarian .Socialist – forms of Political Systems: Unitary and Federal, Parliamentary and Presidential.

2. U.K.: (a) Basic features with major focus on Conventions and rule of Law.
(b) Legislature: composition and functions with major focus on the concept of parliamentary sovereignty. (c) Executive: composition and functions of the Cabinet with major focus on the role of the Prime Minister – the concept of Cabinet Dictatorship; (d) Role of the Crown;(e) Party system – role of the Opposition.

3. U.S.A.: (a) Basic features (b) US federalism (c) Bill of rights (d) Legislature: composition and functions with major focus on the Presiding Officers and Committee System; (e) The Executive: The President: election, powers and functions. US Cabinet: composition and functions; (f) Supreme Court: composition and functions; (g) Party system.

Module II

4. PRC (1982 Constitution):(a) Significance of the Revolution (b) Basic features with special reference to General Principles(c) Communist Party: structure, functions, role (d) Rights and Duties of Citizen (e) The National Government: i) The Executive: President, Premier, State Council, ii) The Legislature: National People' Congress ,Standing Committee iii) The Judiciary.
5. Salient features of the Constitutions of Bangladesh,France,Switzerland.

Readings:

S. A. Palekar: Comparative Government and Politics.
J. C. Johari: Major Modern Political Systems.
The Constitution of the People's Republic of China (1982)
D.C. Bhattacharya: Modern Political Constitutions.
A.C. Kapoor and K.K. Misra: Select Constitutions.

নিমাই প্রামাণিকঃ নির্বাচিত আধুনিক শাসন ব্যবস্থার রূপরেখা
হিমাচল চক্রবর্তীঃ তুলনামূলক রাজনীতি ও শাসন ব্যবস্থা
অনাদি কুমার মহাপাত্রঃ নির্বাচিত শাসন ব্যবস্থা ও রাজনীতি
নির্মলকান্তি ঘোষঃ নির্বাচিত তুলনামূলক শাসন ব্যবস্থা ও রাজনীতি
দিনেশচন্দ্র ভট্টাচার্যঃ তুলনামূলক রাজনীতি ও বিদেশের শাসন ব্যবস্থা

Government and Politics in India Code: PLS-G-CC-3-3-TH+TU

Module I

1. Evolution of the Constitution (brief). The Preamble; Fundamental Rights. Directive Principles;
2. Union-State Relations – nature of federalism.
3. Union Executive: President, Vice-President, Prime Minister, Council of Ministers.
4. Union Legislature: Lok Sabha and Rajya Sabha--- organisation, functions, law Making procedure, Privileges, Committee System, Speaker.

5. The Judiciary: Supreme Court and High Courts--- composition and functions; Judicial Activism in India.
6. Constitutional amendment procedure.

Module II

7. Government in States: Governor; Council of Ministers and the Chief Minister; State Legislature: composition and functions.
8. Local Government: rural and urban. Significance of 73rd and 74th Amendments.
9. Election Commission and election reforms.
10. Party System in India: national political parties: Ideologies and programmes. Recent trends in India: rise of regional political parties; coalition politics.
11. Regionalism: Nature, roots, types.
12. Varieties of social and political movements: a) caste; tribe; b) religion; c) environment; d) women's movements.

Readings:

B. Chakrabarty and K. P. Pandey: Indian Government and Politics.
H. Abbas et al.: Indian Government and Politics.
D. Basu: Introduction to the Constitution of India.
M. V. Pylee: India's Constitution.
Subhas Kashyap: Our Constitution.
M.P. Singh and R. Saxena: Indian Politics: Contemporary Issues
J. C. Johari: Indian Government and Politics (2 Vols.)
Rajinder Singh: Social Movements in India.
Devki Jain Ed., Indian Women.

অমল কুমার মুখোপাধ্যায় ও ভোলানাথ বন্দ্যোপাধ্যায়ঃ সাম্প্রতিক ভারতীয় রাজনীতি ও প্রশাসন
নিমাই প্রামাণিকঃ ভারতের শাসন ব্যবস্থা ও রাজনীতি
অনাদি কুমার মহাপাত্রঃ ভারতের শাসন ব্যবস্থা ও রাজনীতি
নির্মলকান্তি ঘোষঃ ভারতের শাসন ব্যবস্থা ও রাজনীতি
অনাদি কুমার মহাপাত্রঃ ভারতের রাজনীতিক ব্যবস্থা প্রকৃতি ও প্রয়োগ
প্রভাত দত্তঃ প্রসঙ্গ পঞ্চায়েত
হিমাংশু ঘোষঃ সমকালীন ভারতীয় রাজনীতি ও প্রশাসন
শাশ্বতী ঘোষ: সমতার দিকে আন্দোলনে নারী

International Relations Code: PLS-G-CC-4-4-TH+TU

Module I

1. International Relations as a field of study. Approaches:
(a) Classical Realism (Hans Morgenthau) and Neo-Realism (Kenneth Waltz)
(b) Neo-Liberalism: Complex Interdependence (Robert O. Keohane and Joseph Nye)
(c) Structural Approaches: World Systems Approach (Immanuel Wallerstein) and Dependency School (Andre Gunder Frank)
(d) Feminist Perspective (J. Ann Tickner)
2. Cold War:(a) Second World War & Origins of Cold War; (b) Phases of Cold War: First Cold War; Rise and Fall of Detente Second Cold War.

Module II

3. End of Cold War and Collapse of the Soviet Union

(b) Post Cold- War Era and Emerging Centers of Power (European Union, China, Russia and Japan)

4. India's Foreign Policy

(a) Basic Determinants (Historical, Geo-Political, Economic, Domestic and Strategic); (b) India's Policy of Non-Alignment; (c) India as emerging Power

Readings:

William, P., Goldstein, D. M. and Shafritz, J. M. (eds.): Classic Readings of InternationalRelations.
Goldstein, J. and Pevehouse, J.C.: International Relations.
Art, R. J. and Jervis, R. (eds.): International Politics: Enduring Concepts andContemporary Issues.
Jackson, R. and Sorenson, G.: Introduction to International Relations: Theories andApproaches.
Tickner, J. A.: Gendering World Politics: Issues and Approaches in the Post-Cold WarEra.
Baylis, J. and Smith, S. (eds.): The Globalization of World Politics: An Introduction toInternational Relations.
Wenger, A. and Zimmermann, D. (eds.): International Relations: From the Cold WorldWar to the Globalized World.
Vanaik, A.: India in a Changing World: Problems, Limits and Successes of Its ForeignPolicy. .
Basu, Rumki (ed.): International Politics: Concepts theories and Issues, New Delhi.
Mewmillians, W.C. and Piotrowski, H.: The World since 1945: A History ofInternational Relations.
Smith, M., Little, R. and Shackleton, M. (eds.): Perspectives on World Politics.
Ganguly, S. (ed.): India's Foreign Policy: Retrospect and Prospect.

গৌতম বসু: আন্তর্জাতিক সম্পর্ক: তত্ব ও বিবর্তন
রাধারমণ চক্রবর্তী ও সুকল্পা চক্রবর্তী: সমসাময়িক আন্তর্জাতিক সম্পর্ক
পুরুষোত্তম ভট্টাচার্য ও অনিন্দ্যজ্যোতি মজুমদার (সম্পা):আন্তর্জাতিক সম্পর্কের রূপরেখা
রুমকী বসু ও অঞ্জনা ঘোষঃ সম্মিলিত জাতিপুঞ্জ
অনীক চট্টোপাধ্যায়: ঠাণ্ডাযুদ্ধের পর আন্তর্জাতিক সম্পর্ক
নির্মলকান্তি ঘোষঃ আন্তর্জাতিক সংগঠন ও জাতিপুঞ্জ
গৌরীপদ ভট্টাচার্যঃ আন্তর্জাতিক সম্পর্ক
শক্তি মুখার্জী, ইন্দ্রাণী মুখার্জীঃ আন্তর্জাতিক সম্পর্ক

Discipline-specific Electives

The choice is between Courses in 1A and 1B and between Courses in 2A and 2B--- one each from the two segments offered.

Public Administration Code: PLS-G-DSE-A-5-1A-TH+TU

Module I

1. Nature and Scope of Public Administration.
2. Key Concepts: Hierarchy; Unity of Command; Span of Control; Authority; Centralization and Decentralization; Line and Staff; Communication and Control; Delegation; Decision-making;Coordination and Leadership.
3. Major Approaches: New Public Administration; Comparative Public Administration; Development Administration; New Public Management.

Module II

4. Bureaucracy: Views of Weber and Marx.
5.Public Policy: Formulation and Implementation.
6. Major Programmes (basic features and objectives): MGNREGA; Sarva Shiksha Abhiyan; National Rural Health Mission.

Readings:

Mohit Bhattacharya: Public Administration: Structure, Process and Behaviour.
A. Avasthi and S. Avasthi: Pubic Administration.
M. Bhattacharya: Restructuring Public Administration.
M.P. Sharma: Public Administration in Theory and Practice.
Rumki Basu: Public Administration: Concepts and Theories.
Sapru, R.K. Public Policy: Formulation, Implementation and Evaluation. New Delhi: Sterling Publishers.

মোহিত ভট্টাচার্য ও বিশ্বনাথ ঘোষ: জনপ্রশাসন ও পরিকল্পনা
সোমা ঘোষ: জনপ্রশাসন: তত্ত্ব ও প্রয়োগ
রাজশ্রী বসু: জনপ্রশাসন

Indian Foreign Policy Code: PLS-G-DSE-A-5-1B-TH+TU

Module I

1. Foreign Policy: meaning and determinants.

2. National Interest as key concept in foreign policy.

3. Instruments of foreign policy: diplomacy; propaganda; military.

Module II

4. Evolution of Indian foreign policy.

5. Basic principles of Indian foreign policy.

6. India and her neighbours: Bangladesh; Pakistan; Nepal; Sri Lanka.

Readings:

K.K Ghai, *International Relations: Theory and Practice of International Politics*
Vinay Kumar Malhotra, *International Relations*, Fourth edition, Vikas Publications.
Peu Ghosh, *International Relations*, Pretince Hall Publishers.
Pushpesh Pant, *International Relations in the Twenty-first Century*, Tata McGraw Hill Publishers.
Prakash Chander and Prem Aroa, *International Relations and Comparative Politics*, Cosmos Bookhive Publicaitons.
Aneek Chatterjee, *Neighbours, Major Powers and Indian Foreign Policy*, Orient Blackswan.
Prem Arora, *Foreign Policy of India*, Cosmos Bookhive Publishers.

Feminism: Theory and Practice Code: PLS-G-DSE-B-6-2A-TH+TU

Module I

1. Distinction between sex and gender. Biologism and Social Constructivism.

2. Patriarchy and Feminism.

3. Theoretical foundation: Liberal; Socialist; Marxist; Radical Feminism; New Feminist ideas

Module II

4. Traditional historiography and Feminist critiques.

5. Social reform movements and position of women: Indian context.

6. Gender relations in family: consumption; entitlement; property rights.

Readings:

B. Hooks, (2010) 'Feminism: A Movement to End Sexism', in C. Mc Cann and S. Kim (eds), *The Feminist Reader: Local and Global Perspectives,* New York: Routledge, pp. 51-57

R. Delmar, (2005) 'What is Feminism?', in W. Kolmar & F. Bartkowski (eds) *Feminist Theory: A Reader,* pp. 27-37.

U. Chakravarti, (2003) *Gendering Caste through a Feminist Len,* Kolkata, Stree, pp. 139-159.

C. MacKinnon, 'The Liberal State' from *Towards a Feminist Theory of State,* Available at http://fair-use.org/catharine-mackinnon/toward-a-feminist-theory-of-the-state/chapter-8

N. Menon (2008) 'Gender', in R. Bhargava and A. Acharya (eds), *Political Theory: An Introduction,* New Delhi: Pearson, pp. 224-233.

রাজশ্রী বসু ও বাসবী চক্রবর্তী (সম্পা): প্রসঙ্গ মানবীবিদ্যা

Human Rights: Theory and Indian Context Code: PLS-G-DSE-B-6-2B-TH+TU

Module I

1. History of the idea of human rights; Evolution of generations of human rights.
2. Universal Declaration of Human Rights: provisions and significance.
3. UN and human rights: charters; UN Human Rights Commission; Vienna Declaration and Programme of Action.

Module II

4. Indian Constitution and the foundation of rights.
5. National and State Human Rights Commissions: structure and functions.
6. Human rights in India: problems and remedies.

Readings:

Universal Declaration of Human Rights, www.un.org/en/udhrbook/pdf/udhr_booklet_en_web.pdf

Alok Kumar Meena, *Human Rights in India: Concepts and Concerns*, India: Pointer Publishers.
S.C. Joshi, *Human Rights: Concepts, Issues and Laws*, India: Akansha Publishing House.
Amit Bhattacharya and Bimal Kanti Ghosh (eds.), *Human Rights in India, Historical Perspective and Challenges Ahead*.
D. O'Byrne, (2007) 'Theorizing Human Rights', in *Human Rights: An Introduction,* Delhi, Pearson.
M. Ishay, (2004) *The History of Human Rights: From Ancient Times to the Globalization Era*, Delhi: Orient Blackswan.

Skill Enhancement Courses

[The choice lies between Courses 1 and 2 of Section A and Courses 1 and 2 of Section B. One particular course in Gr. A --- between PLS-G-SEC-3/5-A(1)-TH and PLS-G-SEC-3/5-A(2)-TH is to be chosen either in Sem-III or in Sem-V. One particular course in Gr. B--- between PLS-G-SEC-4/6-B(1)-TH and PLS-G-SEC-4/6-B(2)-TH is to be chosen either in Sem IV or in Sem VI]

Legal Literacy Code: PLS-G-SEC-3-A(1)-TH

Module I

1. Legal Issues of Criminal Jurisdiction: History, Definition and Concept, Major Processes— Detention, Arrest, Bail, Search and Seizure.
2. Indian Penal Code: History, Definition. Major Aspects—Protection of Primary and Secondary Personal Rights, Criminal Conspiracy, Offences against the State, Offences related to Marriage.
3. Personal Laws: Laws related to Marriage (examples from Hindu, Islam and Christian Laws).

Module II

4. Consumer Rights Laws: Definition of Consumer Rights, Process of filing a complaint. Right to Information Act: provisions; importance.

5. Anti-Terror Laws: Meaning, Terrorist and Disruptive Activities (Prevention) (TADA) Act 1987, 2002 and Prevention of Terrorism (POTA) Act 2002.

6.Human Rights Laws: Meanings, Universal Declaration of Human Rights (UDHR), Human Rights Act of 1993, Issues of rights of Children and Women.

Readings:

K. Sankaran and U. Singh, *Towards Legal Literacy,* New Delhi: Oxford University Press, 2008. Articles on Laws relating to criminal justice and offences against Women.
Oxford Handbook of Human Rights and Criminal Justice in India- The system and Procedure. New Delhi: Oxford University Press, 2006. Relevant articles on FIR, Detention, Bail.
M. Mohanty et al., *Weapon of the Oppressed, Inventory of People's Rights in India*, Delhi: Danish Books, 2011. Articles on Adivasis and Dalits.
S. Durrany, *The Protection of Women From Domestic Violence Act 2005*, New Delhi: Indian Social Institute, 2006.
V. Kumari, (2008) 'Offences Against Women', in K, Sankaran and U. Singh (eds.) *Towards Legal Literacy,* New Delhi: Oxford University Press.

P. D. Mathew,(2004)*The Measure to Prevent Sexual Harassment of Women in Work Place.* New Delhi: Indian Social Institute.
D. Srivastva, (2007) 'Sexual Harassment and Violence against Women in India: Constitutional and Legal Perspectives', in C. Kumar and K. Chockalingam (eds) *HumanRights, Justice, and Constitutional Empowerment*, Delhi: Oxford University Press.
S. Naib, (2013) 'Right to Information Act 2005', in *The Right to Information in India,* New Delhi: Oxford University Press, Available at http://www.humanrightsinitiative.org/publications/rti/guide_to_use_rti_act_2005_English2012_light_Aspire.pdf.
Bare Acts**:**

Consumer Protection Act, 1986, http://chdslsa.gov.in/right_menu/act/pdf/consumer.pdf.
Criminal law Amendment Act, 2013, http://egazette.nic.in/WriteReadData/2013/E_17_2013_212.pdf 10.04.2013.
Protection of Women Against Domestic Violence Act, 2005, http://wcd.nic.in/wdvact.pdf.
Right to Information Act, 2005, http://righttoinformation.gov.in/rti-act.pdf.
Scheduled Castes and Scheduled Tribes Prevention of Atrocities Act, 1989, http://tribal.nic.in/writereaddata/linkimages/poaact989E4227472861.pdf.
Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act 2006, http://tribal.gov.in/writereaddata/mainlinkFile/File1033.pdf.
The Persons with Disabilities (Equal Opportunities, Protection of Rights, Full Participation) Act, 1995, http://bhind.nic.in/Sparsh_disability%20act%201995.pdf.
The Right of Children to Free and Compulsory Education Act, 2009, http://www.delta.org.in/form/rte.pdf.
*The Sexual Harassment of Women at Workplace (Prevention, Prohibition and Redressal) Bill, 2012***,** http://164.100.24.219/BillsTexts/LSBillTexts/PassedLoksabha/144C_2010_LS_Eng.pdf.
Criminal Law Amendment Act, 2013**,** mha.nic.in/pdfs/TheCrimnalLaw030413.pdfFile Format: PDF/Adobe Acrobat –Quick View

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Elementary Dimensions of Research

Code: PLS-G-SEC-4-B(1)-TH

Module I

1. Concepts, variables (dependent and independent), propositions and hypothesis.
2. Research design: definition, purpose of research, units of analysis, fallacies.
3. Ethics in research---issues and problems.
4. Research Report writing.

Module II

4. Sources and Techniques of data collection – quantitative and qualitative data
5. Sampling: definition, probability and non-probability. Scales and Measurement
6. Statistical method of data analysis: descriptive and inferential (Overview). Graphic representation of data (Bar graph, Histogram, Pie Chart)

Readings:

R. Kumar, Research Methodology: A Step-by-Step Guide for Beginners, Sage pub., 2010.
W.L. Neuman, Social Research Methods: Qualitative and Quantitative Approaches, Pearson.
R. Chatterjee, (1979) Methods of Political Enquiry, Calcutta: The World Press Pvt. Ltd.

Understanding the Legal System Code: PLS-G-SEC-5-A(2)-TH

Module I

1. Historical background, procedures of Supreme Court and High Court in India (special focus on writ jurisdictions), Judicial Activism and Judicial Restraint.
2. Public Interest Litigation (PIL): Meaning, major features and Scope, principles, Major Guidelines for admitting PIL.
3. Administrative Tribunals: Concepts and major Features, tribunals for other matters.

Module II

4. Subordinate Courts: Constitutional provisions, structure and jurisdiction, National Legal Services Authority, Lok Adalats, Family Courts and Gram Nyayalayas.
5. Elections Laws: Representation of People Act 1950, Representation of People Act 1951, Delimitation Act 2002.
6. Other Constitutional Dimensions: Anti-defection Laws (major provisions of 91st Amendment Act, 2003), Co-operative Societies (provisions of 97th Amendment Act), Mahila Courts.

Readings:

Creating Legal Awareness, edited by Kamala Sankaran and Ujjwal Singh (Delhi: OUP, 2007)
Asha Bajpai, *Child Rights in India: Law, Policy, and Practice*, Oxford University Press, New Delhi,2003.
B.L. Wadhera, *Public Interest Litigation - A Handbook*, Universal, Delhi, 2003.
P.C. Rao and William Sheffiled *Alternate Dispute Resolution: What it is and How it Works*, Universal Law Books and Publishers, Delhi, 2002
J. Kothari, (2005) 'Criminal Law on Domestic Violence', *Economic and Political Weekly,* Vol. 40(46), pp. 4843-4849.
H. Mander, and A. Joshi, *The Movement for Right to Information in India, People's Power for the Control of Corruption*, http://www.rtigateway.org.in/Documents/References/English/Reports/12.%20An%20article%20on%20RTI%20by%20Harsh%20Mander.pdf.
M, Mohanty et al. (2011) *Weapon of the Oppressed, Inventory of People's Rights in India*. Delhi: Danish Books.
Centre for Good Governance, (2008) *Right to Information Act, 2005: A Citizen's Guide*, http://www.rtigateway.org.in/Documents/Publications/A%20CITIZEN'S%20GUIDE.pdf
K. Sankaran and U. Singh, *Towards Legal Literacy,* New Delhi: Oxford University Press, 2008.
Oxford Handbook of Human Rights and Criminal Justice in India- The system and Procedure, New Delhi: Oxford University Press. Relevant articles.

Basic Research Methods Code: PLS-G-SEC-6-B(2)-TH

Module I

1. Case study.

2. Survey Approach: Interviewing- different types and forms, qualities of a good interviewer; Preparing questionnaire, types of questionnaire. Pilot Survey.
3. Focus Groups: role of researcher; uses and abuses.

Module II

4. Experimental research: types. Aggregate Data analysis: sources, utility and limitations.
5. Content Analysis: major issues.
6. Participant observation: modes, advantages and disadvantages.

Readings:

R. Chatterjee, (1979) Methods of Political Enquiry, Calcutta: The World Press Pvt. Ltd.
D. E. McNabb, (2004) Research Methods for Political Science- Quantitative and Qualitative Methods, New Delhi: Prentice-Hall of India Pvt. Ltd.

UNIVERSITY OF CALCUTTA

Notification No. CSR/ 12 /18

It is notified for information of all concerned that the Syllabi of different subjects in Undergraduate Honours / General / Major courses of studies (CBCS) under this University, as laid down in the accompanying pamphlet:

List of the subjects

Sl. No.	Subject	Sl. No.	Subject
1	Anthropology (Honours / General)	29	Mathematics (Honours / General)
2	Arabic (Honours / General)	30	Microbiology (Honours / General)
3	Persian (Honours / General)	31	Mol. Biology (General)
4	Bengali (Honours / General /LCC2 /AECC1)	32	Philosophy (Honours / General)
5	Bio-Chemistry (Honours / General)	33	Physical Education (General)
6	Botany (Honours / General)	34	Physics (Honours / General)
7	Chemistry (Honours / General)	35	Physiology (Honours / General)
8	Computer Science (Honours / General)	36	Political Science (Honours / General)
9	Defence Studies (General)	37	Psychology (Honours / General)
10	Economics (Honours / General)	38	Sanskrit (Honours / General)
11	Education (Honours / General)	39	Social Science (General)
12	Electronics (Honours / General)	40	Sociology (Honours / General)
13	English ((Honours / General/ LCC1/ LCC2/AECC1)	41	Statistics (Honours / General)
14	Environmental Science (Honours / General)	42	Urdu (Honours / General /LCC2 /AECC1)
15	Environmental Studies (AECC2)	43	Women Studies (General)
16	Film Studies (General)	44	Zoology (Honours / General)
17	Food Nutrition (Honours / General)	45	Industrial Fish and Fisheries – IFFV (Major)
18	French (General)	46	Sericulture – SRTV (Major)
19	Geography (Honours / General)	47	Computer Applications – CMAV (Major)
20	Geology (Honours / General)	48	Tourism and Travel Management – TTMV (Major)
21	Hindi (Honours / General /LCC2 /AECC1)	49	Advertising Sales Promotion and Sales Management –ASPV (Major)
22	History (Honours / General)	50	Communicative English –CMEV (Major)
23	Islamic History Culture (Honours / General)	51	Clinical Nutrition and Dietetics CNDV (Major)
24	Home Science Extension Education (General)	52	Bachelor of Business Administration (BBA) (Honours)
25	House Hold Art (General)	53	Bachelor of Fashion and Apparel Design – (B.F.A.D.) (Honours)
26	Human Development (Honours / General)	54	Bachelor of Fine Art (B.F.A.) (Honours)
27	Human Rights (General)	55	B. Music (Honours / General) and Music (General)
28	Journalism and Mass Communication (Honours / General)		

The above shall be effective from the academic session 2018-2019.

SENATE HOUSE
KOLKATA-700073
The 4th June, 2018

Paul 4/6/18
(Dr. Santanu Paul)
Deputy Registrar

Semester-wise Course for B.A. (Honours)

	Sem-1	Sem-2	Sem-3	Sem-4	Sem-5	Sem-6
Core Course (CC)	2TH+2TU CC-1&2	2TH+2TU CC-3&4	3TH+3TU CC-5,6&7	3TH+3TU CC-8,9&10	2TH+2TU CC-11&12	2TH+2TU CC-13&14
Generic Elective (GE)	1TH+1TU GE-1	1TH+1TU GE-2	1TH+1TU GE-3	1TH+1TU GE-4		
Discipline Specific Elective (DSE)					2TH+2TU DSE-A(1) B(1)	2TH+2TU DSE-A(2) B(2)
Ability Enhancement Compulsory Course (AECC)	1TH+0TU AECC-1	1TH+0TU AECC-2				
Skill Enhancement Course (SEC)			1TH+0TU SEC-A(1)	1TH+0TU SEC-B(2)		
Total No. of Courses and Marks	4 x 100 = 400	4 x 100 = 400	5 x 100 = 500	5 x 100 = 500	4 x 100 = 400	4 x 100 = 400
Total Credits	20	20	26	26	24	24

TH = Theory T = Tutorial

- ❖ CC/GE/DSE : Each theory and Tutorial Course have 5 and 1 Credit(s) respectively
- ❖ GE : Covering two subjects with two courses each; any subject in any semester; CC of a different subject in general course is to be treated as GE for Honours Course
- ❖ DSE/SEC : Group (A&B) for specified semesters
- ❖ AECC/SEC : Each Course has 2 Credits
- ❖ AECC-1 : Communicative English / MIL; AECC-2 : Environmental Studies

University of Calcutta

BA (Honours)-CBCS Syllabus in Philosophy, 2018

A. Core Courses [Fourteen courses; Each course: 6 credits (5 theoretical segment+ 1 for tutorial-related segment). Total: 84 credits (Th 5×15weeks=75 ; Tutorial 1×15 weeks= 15)]
B. Discipline Specific Elective[Four courses; Each course: 6 credits (5 theoretical segment+ 1 for tutorial-related segment). Total: 24 credits(Th 5×15weeks=75 ; Tutorial 1×15 weeks= 15)]
C. Generic Elective [Four courses; Each course: 6 credits (5 theoretical segment+ 1 for tutorial-related segment). Total: 24 credits (Th 5×15weeks=75 ; Tutorial 1×15 weeks= 15)]
   Core courses of 'General Syllabus' will be treated as Generic Elective of 'Honours Syllabus'.
D. Skill Enhancement [Two courses; Each course: 2 credits (No Tutorial segment). Total: 04 credits (2×15weeks =30)

- Each course (CC & DSE)carries 80 marks and Minimum 80 classes.
- 65 marks for theoretical segment: 55 marks for descriptive questions + 10 marks for 1 mark questions.
- Skill Enhancement course carries 80 marks and minimum 50 classes: 80 marks for theoretical segment, there is no tutorial segment.
- Question Pattern for descriptive segment of 55 marks: 5 short questions out of 8 (5x5 = 25) + 2 questions out of 4(15 x 2 = 30).
- 15 marks for tutorial [The topics (within the syllabus) are to be decided by the concerned faculty of respective colleges.]

IMPORTANT NOTES:

- Cited advanced texts in Bengali are not necessarily substitutes, but supplementary to the English books.

- The format is subject to the common structural CBCS format of the University.

- The Skill enhancement course, based on the UGC Guidelines, have the common goal of developing specific skills of students of the discipline for better employment opportunities.

Core Course
Semester 1
PHI-A-CC-1 Indian philosophy - I
PHI-A-CC-2 History of western Philosophy - I
Semester 2
PHI-A-CC-3 Indian philosophy - II
PHI-A-CC-4 History of Western Philosophy- II
Semester 3
PHI-A-CC- 5 Philosophy of Mind
PHI-A-CC-6 Social and Political philosophy
PHI-A-CC-7 Philosophy of Religion
Semester 4
PHI-A-CC-8 Western Logic – I
PHI-A-CC-9 Western Logic – II
PHI-A-CC-10 Epistemology and Metaphysics (Western)
Semester 5
PHI-A-CC-11 Indian Logic and Epistemology – I
PHI-A-CC-12 Ethics (Indian)
Semester 6
PHI-A-CC-13 Indian Logic and Epistemology – II
PHI-A-CC-14 Ethics (Western Ethics)

Discipline Specific Elective :

Semester 5

PHI-A-DSE-A(1)(Any one from the following options)
a) Western logic – I

b) Normative and Meta Ethics

c) Philosophy of language (Indian)

PHI-A-DSE-B(1)
(Any one text from the following texts)
a) An Enquiry Concerning Human Understanding – D. Hume
b) The Problems of Philosophy – B. Russell
c) Vedāntasāra- Sadananda Yogindra Saraswati
d) Śrimadbhagabadgīta

Semester 6

PHI-A-DSE-A(2)(Any one from the following options)

a) Western Logic -II

b) Applied Ethics

c) Philosophy of Language (Western)

PHI-A-DSE-B(2)

(Any one philosophical system from four philosophical systems of contemporary Indian thought)

a) Swami Vivekananda
b) Rabindranath Tagore
c) Sri Aurobindo
d) M.K. Gandhi

Skill Enhancement Elective Course :

Semester 3

PHI-A-SEC-A (Any one from the following options)

a) Logical Reasoning and Application: Indian and Western

b) Man and Environment

Semester 4

PHI-A-SEC-B(Any one from the following options)

a) Emerging Trends of Thought

b) Philosophy of Human Rights

SEMESTER-I

Core Course

PHI-A-CC-1
Indian Philosophy – I (6 Credits per week)

a) Introduction: Division of Indian Philosophical Schools:Āstika and Nāstika.
b) Cārvāka School—Epistemology, Metaphysics, Ethics.
c) Jainism—Concept of Sat, Dravya, Paryāya, Guṇa. Anekāntavāda, Syādvāda and Saptabhanginaya.
d) Buddhism— Four noble Truths, Theory of Dependent Origination (Pratītyasamutpādavāda), Definition of Reality (Arthakriyākāritvamsattvam), Doctrine of Momentariness, (Kṣanabhangavāda), Theory of no-soul (Nairātmyavāda), Four Schools of Buddhism (Basic tenets).
e) Nyāya –Pramā and Pramāṇa, Pratyakṣa (Definition), Sannikarṣa, Classification ofPratyakṣa: Nirvikalpaka, Savikalpaka, Laukika, Alaukika.
f) Anumiti, Anumāna (Definition), vyāpti, parāmarśa, Classification of Anumāna: pūrvavat, śesavat, smānyatodṛsta, kevalānvayī, kevalavyātirekī, anvayavyātirekī, svārthānumāna, parārthānumāna, Upamāna (definition), Śabda (definition).
g) Vaiśeṣika—Seven Padārthas, dravya, guṇa, karma, sāmānya, viśeṣa, samavāya, abhāva.

Suggested Readings:
English:

• Outlines of Indian Philosophy: M. Hiriyanna
• A Critical Survey of Indian Philosophy: C.D. Sharma
• An Introduction to Indian Philosophy: D. M. Dutta & S.C. Chatterjee
• Classical Indian Philosophy: J.N. Mohanty
• History of Indian Philosophy: S.N. Dasgupta
• Indian Philosophy (Vol. I & II): S. Radhakrishnan
• Indian Philosophy (Vol. I & II): J.N. Sinha
• Studies on the Carvaka/Lokayata: Ramakrishna Bhattacharya
• The Central Philosophy of Buddhism: T.R.V. Murti
• Yogacara Idealism: A.K.Chatterjee
• An Introduction to Madhyamika Philosophy: Jaydev Singh
• Reflections on Indian Philosophy: K.P. Sinha
• Philosophy of Jainism: K.P. Sinha
• Nyaya Theory of Knowledge: S.C. Chatterjee
• Six Ways of Knowing: D.M. Dutta
• Nyaya-Vaisesika Metaphysics: Sadananda Bhaduri

Bengali:

• Bharatiya Darshan: Debabrata Sen
• Bharatiya Darshan: Nirodbaran Chakraborty
• Sayan Madhaviya Sarva Darshan Samgraha: Satyajyoti Chakraborti
• Lokayata Darshan: Debiprasad Chattopadhyay

• Carvakacarca: Ramakrisna Bhattacharya
• Carvaka Darshan: Panchanan Sastri
• Carvaka Darshan: Amit Kumar Bhattacharya
• Bauddha Dharma O Darshan: Swami Vidyaranya
• Bauddha Darshan: Panchanan Sastri
• Gautama Buddher Darshan o Dharma: Sukomol Choudhury
• Bauddha Darshan: Amit Kumar Bhattacharya
• Ksanabhangavada: Bidhubhusan Bhattacharya
• Jainadarshaner Digdarshan: Satindra Chandra Bhattacharya
• Nyaya Darshan: Phanibhushan Tarkavagisha
• Nyaya Paricaya: Phanibhushan Tarkavagisha
• Nyaya-Vaisesika Darshan: Karuna Bhattacharya
• Nyaya Tattva Parikrama: Kalikrishna Bandyopadhyaya

Core Course

PHI-A-CC-2 History of Western Philosophy – I (6 Credits per week)

a) Pre Socratic Philosophy: Thales, Heraclitus, Parmenides, Empedocles, Anaxagoras, Democritus, Protagoras.
b) Plato**:** Theory of Knowledge, Theory of Forms.
c) Aristotle **:** Critique of Plato's theory of Forms, Doctrine of four causes, Form and Matter.
d) St. Thomas Aquinas: Faith and Reason, Essence and Existence.
e) Descartes: Cartesian method of doubt, Cogito ergo sum, Criterion of truth, Types of ideas, Proofs for the existence of God, Mind- body dualism , Proofs for the existence of the external world.
f) Spinoza: Doctrine of substance, Attributes and Modes, Existence of God, Pantheism ,Three orders of knowing.
g) Leibniz: Monads, Truths of reason, Truths of facts, Innateness of ideas, Some metaphysical principles : Law of Identity of indiscernibles, Law of sufficient reason, Law of continuity, Doctrine of Pre-established harmony.

Suggested Readings:

English:

•The Greek Philosophers from Thales to Aristotle: W. K. C. Guthrie
• A History of Western Thought : G. Skirbekk & N. Gilje
A Critical History of Greek Philosophy: W.T. Stace
• Encyclopedia of Philosophy: P. Edwards (ed.)
• A History of Philosophy: F. Copleston, vols. I, II, IV, V, VI
• History of Western Philosophy: B. Russell
• History of Modern Philosophy: R. Falckenberg
• A Critical History of Modern Philosophy: Y.H. Masih

• A History of Philosophy: F. Thilly
• A History of Modern Philosophy: W.K. Wright
• A Critical History of Western Philosophy: D.J. O'Connor
• A History of Philosophy from Descartes to Wittgenstein: R. Scruton
• The Fundamental Questions of Philosophy: A.C. Ewing
• A Brief History of Western Philosophy: A. Kenny
• The Works of Descartes: Haldane & Ross (eds.)
• Descartes: The Project of Pure Enquiry: B. Williams
• Descartes: A. Kenny
• Spinoza: Leon Roth
• Leibniz:An Introduction to His Philosophy: N. Rescher
• The Rationalists: J. Cottingham

Bengali:

• Paschatya Darshaner Itihas: Tarak Candra Roy (pratham o dvitiya khanda)
• Paschatya Darshaner Itihas: Kalyan Chandra Gupta
• Paschatya Darshaner Itihas: Susanta Chakraborty
• Paschatya Darshaner Itihas: Samarendra Bhattacharya (pratham o dvitiya khanda)
• Paschatya Darshaner Itihas (Plato o Aristotle): N.B. Chakraborty
• Paschatya Darshaner Itihas (Plato o Aristotle): Debabrata Sen
• Paschatya Darshaner Itihas(Adhunik Yuga-Yuktivada (Descartes), Spinoza,Leibniz:):Chandrodaya Bhattacharya

SEMESTER 2

Core course

PHI-A-CC-3 Outlines of Indian Philosophy – II (6 Credits per week)

a) Sāmkhya—Satkāryavāda, Nature of Prakṛti , its constituents and proofs for its existence. Nature of Puruṣa and proofs for its existence, plurality of puruṣas, theory of evolution.
b) Yoga—Citta, Cittavṛtti, Cittabhūmi. Eight fold path of Yoga, God.
c) Mīmāmsā (Prābhakara and Bhātta) :Anvitāvidhānvāda and Abhihitānvayavāda, Arthāpatti and Anupalabdhi as sources of knowledge
d) Advaita Vedānta—Sankara's view of Brahman, Saguṇa and Nirguṇa Brahman, Three grades ofSattā: prātibhāsika, vyavahārika and pāramārthika, Jīva, Jagat and Māyā.
e) Viśistādvaita—Rāmānuja's view of Brahman, Jīva, Jagat. Refutation of the doctrine of Māyā.

Suggested Readings:

English:

• Outlines of Indian Philosophy: M. Hiriyanna
• A Critical Survey of Indian Philosophy: C.D. Sharma
• An Introduction to Indian Philosophy: D. M. Dutta & S.C. Chatterjee
• Classical Indian Philosophy: J.N. Mohanty
• History of Indian Philosophy: S.N. Dasgupta
• Indian Philosophy (Vol. I & II): S. Radhakrishnan
• Indian Philosophy (Vol. I & II): J.N. Sinha
• Six Ways of Knowing: D.M. Dutta
• The Doctrine of Maya: A.K. Roychoudhuri
• Self and Falsity in Advaita Vedanta: A.K. Roychoudhuri
•The Word and the world: Bimal Krishna Matilal
•Logic, Language and Reality: Bimal Krishna Matilal

Bengali:

• Bharatiya Darshan: Debabrata Sen
• Bharatiya Darshan: Nirodbaran Chakraborty
• Sayan Madhaviya Sarva Darshan Samgraha: Satyajyoti Chakraborti
• Samkhya Darshan: Bhupendranath Bhattacharya
• Samkhya Darshaner Vivarana: Bidhubhushan Bhattacharya
• Samkhyamata Samiksa: Yogendranath Bagchi
• Samkhya Tattva Kaumudi: Narayan Chandra Goswami
• Samkhya-Patanjal Darshan: Kanakprabha Bandyopadhyaya
• Patanjal Darshan: Purnachandra Vedantachanchu
• Purva Mimamsa Darshan: Sukhamoy Bhattacharya
• Vedanta Darshan: Roma Choudhury
• Vedanta Darshan: Advaitavada: Ashutosh Sastri
• Mayavada: Pramatha Nath Tarkabhushan
• Vedanta Darshan: Swami Vidyaranya

Core Course

PHI-A-CC-4 History of Western Philosophy – II (6 Credits per week)

a) Locke **:** Refutation of innate ideas, The origin and formation of ideas, Simple and Complex ideas, Substance, Modes and Relations, Nature of knowledge and its degrees, Limits of knowledge, Primary and Secondary qualities, Representative Realism.
b) Berkeley: Refutation of Abstract ideas. Criticism of Locke's distinction between Primary and Secondary qualities, Immaterialism, *Esse-est-percipi*, Role of God.
c) Hume: Impression and ideas, Association of ideas, Distinction between Judgements concerning Relations of Ideas and Judgements concerning Matters of fact, Theory of causality, Theory of Self and Personal Identity, Scepticism.

d) Kant **:** Conception of Critical Philosophy, Distinction between A priori and A posteriori Judgements, Distinction between Analytic and Synthetic Judgements. Synthetic A priori Judgements, General problem of the Critique, Copernican Revolution in Philosophy ;Transcendental Aesthetic **:** Space & Time—Metaphysical & Transcendental expositions of the Ideas of Space & Time.

Suggested Readings:

English:

•The Greek Philosophers from Thales to Aristotle: W. K. C. Guthrie
• A Critical History of Greek Philosophy: W.T. Stace
• Encyclopedia of Philosophy: P. Edwards (ed.)
• A History of Philosophy: F. Copleston, vols. I, II, IV, V, VI
• History of Western Philosophy: B. Russell
• History of Modern Philosophy: R. Falckenberg
• A Critical History of Modern Philosophy: Y.H. Masih
• A History of Philosophy: F. Thilly
• A History of Modern Philosophy: W.K. Wright
• A Critical History of Western Philosophy: D.J. O'Connor
• A History of Philosophy from Descartes to Wittgenstein: R. Scruton
• The Fundamental Questions of Philosophy: A.C. Ewing
A Brief History of Western Philosophy: A. Kenny
An Essay Concerning Human Understanding: J. Locke
• John Locke: R. Aron
• Berkeley: G. Pitcher
• The Works of George Berkeley: T.E. Jessop & A.R. Luce (eds.) 8 Vols
• An Enquiry Concerning Human Understanding-D. Hume: J. N. Mohanty (ed)
• A Treatise on Human Nature: D. Hume
• Locke, Berkeley, Hume: J. Bennett
• Locke, Berkeley, and Hume: C.R. Morris
• A Critique of Pure Reason-Immanuel Kant: N.K. Smith(tr. & ed.)
• Kant's Metaphysics of Experience: H.J. Paton Vols I & II
• The Philosophy of Kant: J. Kemp
• Kant: Paul Guyer
• A Handbook to Kant's Critique of Pure Reason: Rashvihari Das
• Kant: S. Körner
Kant: Allen W. Wood
•Lectures on Kant's Critique of Pure Reason: J.N. Mohanty

Bengali:

• Paschatya Darshaner Itihas: Tarak Candra Roy (pratham o dvitiya khanda)
• Paschatya Darshaner Itihas: Kalyan Chandra Gupta
• Paschatya Darshaner Itihas: Susanta Chakraborty

• Paschatya Darshaner Itihas: Samarendra Bhattacharya (pratham o dwitiya khanda)
• Paschatya Darshaner Itihas(Plato o Aristotle): N.B. Chakraborty
• Paschatya Darshaner Itihas(Plato o Aristotle): Debabrata Sen

•Paschatya Darshaner Itihas:Ikshanvada(Locke,Berkeley,Hume): Chandrodaya Bhattacharya
• Paschatya Darshaner Itihas:(Locke,Berkeley,Hume): N.B. Chakraborty
• Hume-er Enquiry-Ekti Upasthapana: Ramaprasad Das
• Kanter Darshan-Tattva o Prayog: Prahlad Kumar Sarkar (ed.)
• Kanter Darshan:Rasvihari Das
• Kanter Shuddha Prajnar Bichar: Mrinal Kanti Bhadra

SEMESTER -3

Core Course

PHI-A-CC-5-Philosophy of Mind (6 Credits per week)

a) Psychology: Definition, Nature and Scope.
b) Methods of Psychology: Introspection, Extrospection, Experimental Methods—variables—dependent & independent, Controls in experiment, Limitations of experimental method.
c) Sensation and perception: Nature of sensation, Nature of perception, Relation between sensation and perception, Gestalt theory of perception. Illusion and Hallucination.
d) Learning: Theories of Learning—Trial and error theory, Thorndike's laws of learning, Gestalt theory, Pavlov's theory of conditioned response, B.F. Skinner's theory of Operant Conditioning (reinforcement, extinction, punishment).
e) Philosophical Theories of Mind: Interactionism, Double-aspect theory, Philosophical Behaviorism, Materialism- mind-brain identity theory, The Person theory (Strawson).
f) Consciousness: Levels of mind—Conscious, Sub-conscious, Unconscious, Proofs for the existence of Unconscious, Freud's theory of Dream.
g) Intelligence : Measurement of intelligence, IQ, Measurement of IQ, Binet-Simon test.
h) Personality: Types, Factors and Traits of Personality.

Suggested Readings:

English:

• A Textbook of Psychology: Pareshnath Bhattacharya
• Introduction to Psychology: G.T. Morgan, R. A. King Jr.
• A Modern Introduction to Psychology: Rex Knight & M. Knight
• A Manual of Psychology: G.F. Stout

• Psychology: Woodworth & Marquis
• Science and Human Behaviour: B.F. Skinner
• About Behaviorism: B.F. Skinner
• General Psychology: G.D. Boaz
• General Psychology: G. Murphy
• Psychology: W. James
• A Textbook of Psychology: E.B. Titchener
• Principles of Psychology: W. James
• Introduction to Psychology: N.L. Muna
• A Materialist Theory of Mind: D.M. Armstrong (Ch.s 1,5,& 6)
• Philosophy of Mind: J. Heil
• Philosophy of Mind: J. Shaffer (Ch.s 2,3&4)
• An Introduction to Philosophy of Mind: C.J. Lowe (Ch.s 2&3)

Bengali:

• Monovidya: Priti Bhushan Chattopadhyay
• Monovidya: Pareshnath Bhattacharya
• Monovidya: Ira Sengupta
• Monovidya: Samarendra Bhattacharya
• Monosamiksha: M. N. Mitra O Pushpa Mishra
• Monodarshan-Sarirvada O Tar Vikalap: M. N. Mitra O P. Sarkar (Sampadito)
• Monovijñana Prasanga: Saradindu Bandyopadhyay
• Adhunik Monovijñana: Ira Sengupta
• Shikshashrayi Monovidya: Sushil Roy
• Monodarshan: Arabinda Basu O Nibedita Chakraborty

Core Course

PHI-A-CC-6-Social and Political Philosophy (6 Credits per week)

a) Nature and Scope of i) Social Philosophy ii) Political Philosophy iii)Relation between Social and Political Philosophy.
b) Primary concepts: Society, community, association, institution, family: nature, different forms of family, role of family in the society.
c) Social Class and Caste: Principles of class and caste, Marxist conception of class, Varṇāśrama dharma.
d) Theories regarding the relation between individual and society:
   i) Individualistic theory
   ii) Organic theory
   iii) Idealistic theory
e) Secularism—its nature, Secularism in India.
f) Social Change: Nature, Relation to social progress, Marx-Engles on social change, Gandhi on social change.

g) Political Ideals: Nature of Democracy and its different forms, Direct and Indirect democracy, Liberal democracy, Democracy as a political ideal, Socialism: Utopian and Scientific, Anarchism.

Suggested Readings:

English:

•Philosophy: A Guide through the subject: A.C. Grayling (Ed.)
• Individuals: An Essay in Descriptive Metaphysics: P.F. Strawson
• The Concept of Person and Other Essays: A.J. Ayer
• Fundamentals of Sociology: P. Gisbert
• Outlines of Social Philosophy: J.S. Mackenzie
• Problems of Political Philosophy: D.D. Raphael
• Society: R.M. MacIver & C.H. Page
• Sociology: M. Ginsberg
• Sociology: Tom Bottomore
• Sociology: S.N. Shankar Rao
• Sociology: D.C. Bhattacharya
• Sociology: P.B. Kar
• Guide to Modern Thought: C.E.M. Joad
• Introduction to Modern political Theory: C.E.M. Joad
• The Evolution of Political Philosophy of Gandhi: Buddhadeb Bhattacharya
• Social and Political Thought of Gandhi: Jayantanuja Bandyopadhyay
• The Philosophy of Mahatma Gandhi: D.M. Dutta
• The Philosophy of Sarvodaya: K.S. Bharathi
• Communist Manifesto: Karl Marx & Frederick Engels
• Socialism: Utopian and Scientific: F. Engels
• Open Society and Its Enemies: Karl Popper
• The Open Philosophy and the Open Society: M. Cornforth
• Religion in India: T.N. Madan (ed.)
• Religion and Society: S. Radhakrishnan
• Secularism in the Present Indian Society, Amal Kumar Mukhopadhyay in Bulletin of the Ramakrishna Mission Institute of Culture, Vol. LVII, No. 11
• Secularism and Its Critics: Rajeev Bhargava (ed.)
• Civil Society and Its Institutions: Andre Beteille
• Unraveling the Nation: Sectarian Conflict and India's Secular Identity: Kaushik Basu & Sanjay Subramaniyam (eds.)
• India as A Secular State: D.E. Smith
• Political Thought: C.L. Wayper
• Political Philosophy: An Introduction: W.T. Blackstone
• Political Philosophy: East and West: Krishna Roy
• Political Philosophy: V.P. Verma
• Essays in Social and Political Philosophy: Krishna Roy & Chhanda Gupta (eds.)
• Western Political Thought: Brian R. Nelson

• Western Political Thought: From Plato to Marx: Shefali Jha

Bengali:

• Samaj Darshan Dipika: Pritibhushan Chattopadhyay
• Samaj Tattva: Parimal Bhushan Kar
• Samaj Tattva: T. Bottomore
• Bisay Samaj Tattva: Anadi Kumar Mahapatra
• Samajdarshan O Rashtradarshaner Parichoy: A.K. Mahapatra O P. Mukherjee
• Rashtradarshaner Dhara: Amal kumar Mukhopadhyay
• Samaj O Rajnaitikdarshan: Sandip Das
• Samyabader Istehar : Marx O Engels
• Samajtantra: Kalpanik O Baijnanik: F. Engels
• Marxiya Rashtrachinta: Shovan Lal Dutta Gupta
• Sarvodaya Andoloner Itihas: Gurudas Bandyopadhyay
• Gandhi Rachanasambhar: M.K. Gandhi
• Bharater Dharmanirapekshatar Sankat, Bholanath Bandyopadhyay in Essays on Science and Society: Biplab Chakraborti
• Dharmanirapekshata Birodhi Istahar: Ashis Nandy.

Core Course
PHI-A-CC-7-Philosophy of Religion (6 Credits per week)

a) Nature and scope of Philosophy of Religion. Doctrine of karma and rebirth, doctrine of liberation, (Hindu, Bauddha and Jaina views).
b) The Philosophical teachings of the Holy Quran: God the ultimate Reality, His attributes, His relation to the world and man.
c) Some basic tenets of Christianity: The doctrine of Trinity, The theory of Redemption .
d) Religious Pluralism, Inter-religious dialogue and Possibility of Universal Religion.
e) Arguments for the existence of God: Cosmological, Telelogical and Ontological arguments, Nyāya arguments.
f) Grounds for Disbelief in God: Sociological theory (Durkheim), Freudian theory, Cārvāka, Bauddha and Jaina views .
g) The Peculiarity of Religious Language: The doctrine of analogy, Religious statements as Symbolic, Religious language as Non-Cognitive (Randal's view), the language game theory (D.Z. Phillip).

Suggested Readings:

English:

• Philosophy of Religion: J. Hick
• An Introduction to the Philosophy of Religion: Brian Davies
• Indian Philosophy of Religion: A. Sharma

• Comparative Religion: P.B. Chatterjee
• Comparative Religion: Eric J. Sharpe
• Patterns in Comparative Religion: M. Eliade (Ch I, Sec. I)
• Atheism in Indian Philosophy: D.P. Chattopadhyay
• Essays in Indian Philosophy (pp-145-169): Sukharanjan Saha (ed.)
• Studies in Nyaya-Vaisesika Theism (pp-102-137,139-159): Gopika Mohan Bhattacharya
• The Religions of the World: R.K.M. Institute of Culture
• Encyclopedia Britannica, Vol. I
• Encyclopedia of Islam, Vols. I & II
• Indian Religions: S. Radhakrishnan
• Foundations of Living Faith: H.D. Bhattacharya
• Aspects of Hindu Morality: Saral Jhingram
• A History of Muslim Philosophy (Vols.I &II): M.M. Sharif
• Islam and Secularism: Sayed Muhammad Al-Naquib Al-Attas
• The History of Philosophy in Islam-T.J. de Boer: E. Jones (tr.)
• The Holy Quran: Mohammad Yusuf Ali (tr.)
• The Spirit of Islam: Syed Amir Ali
• The Meaning of the Glorious Koran: M. Pickthall
• A History of Islamic Philosophy: M. Fakhry
• The Spirit of Islam's Message, Muhammad Qamaruddin in Religions of the People of India:S.R. Saha (ed.)
• Cultural Heritage of Islam: Osman Ghani
• Old Testament: R. Kittel (ed.)
• New Testament: Kilpatrick
• The Doctrine of the Trinity: R.S. Franks
• The Doctrine of the Trinity: Loenard Hodgson
• The Idea of the Holy: R. Otto
• A Brief Account of the Religion of the Hindus: Srilekha Dutta in Religions of the People ofIndia: S.R. Saha (ed.)
• Dharma in Hinduism: An Ideal Religion: Tapan Kumar Chakraborty in Religions of thePeople of India: S.R. Saha (ed.)
• Jainism-A Religion of Non-Theistic Humanism: Tushar Sarkar in Religions of the People ofIndia: S.R. Saha (ed.)
• Essays in Analytical Philosophy (Ch.VII): Gopinath Bhattacharya
• Buddhism in India and Abroad: Anukul Bandyopadhyay

SEMESTER 4

Core course

PHI-A-CC-8- Western Logic –I (6 Credits per week)

a) Logic and Arguments, Deductive and Inductive Arguments, Argument forms and arguments, Statement forms and statement, Truth and Validity.

Categorical propositions and classes: quality, quantity and distribution of terms, Translating categorical propositions into standard form.

b) Immediate inferences: Conversion, Obversion and Contraposition, Traditional square of opposition and Immediate Inferences based thereon; Existential Import, symbolism and Diagrams for categorical propositions.
c) Categorical Syllogism: Standard Form categorical Syllogism; The Formal nature of Syllogistic Argument, Rules and Fallacies, General Rules; To test Syllogistic Arguments for validity (by applying general rules for syllogism); To solve problems and prove theorems concerning syllogism.
d) Boolean Interpretation of categorical propositions; Review of the Traditional Laws of Logic concerning immediate inference and syllogism; Venn Diagram Technique for Testing Syllogisms, Hypothetical and Disjunctive Syllogisms, Enthymeme, The Dilemma.
e) Induction: Argument by Analogy, Appraising Analogical Arguments, Refutation by Logical Analogy.
f) Causal Connections: Cause and Effect, the meaning of "Cause"; Induction by Simple Enumeration; Mill's Method of Experimental Inquiry; Mill's Method of Agreement, Method of Difference, Joint Method of Agreement and Difference, Method of Residues, Method of Concomitant Variations; Criticism of Mills Methods, Vindication of Mill's Methods.
g) Science and Hypothesis: Explanations; Scientific and Unscientific, Evaluating Scientific Explanations; The pattern of Scientific Investigation; Crucial Experiments and Ad Hoc Hypotheses.
h) Probability: Alternative Conception of Probability; The Probability Calculus; Joint Occurrences; Alternative Occurrences.

Suggested Readings:

English:

• Introduction to Logic (13th edn.): I.M. Copi & C. Cohen
• Symbolic Logic: I.M. Copi
• Methods of Logic (Part I, Ch.s 5,7,9): W.V.O. Quine
• Introduction to Logic and Scientific Method: Cohen & Nagel
• Logic: Informal, Symbolic and Inductive: Chhanda Chakraborty
• Logic: Stan Baronett & Madhuchhanda Sen
• The Elements of Logic: Stephen Barkar
• Understanding Symbolic Logic: Virginia Klenk
• Logic- A Comprehensive Introduction; S.D. Guttenplan & M. Tamney
• Logic & Philosophy- A Modern Introduction: Howard Kahne
• Logic- A First Course: A.E. Blumberg

Bengali:

• Nabya Yuktibijnana(Pratham theke caturtha khanda): Ramaprasad Das
• Sanketik Yuktibijnana:Ramaprasad Das

• Samsad Yuktibijnana Abhidhan: Ramaprasad Das O Subirranjan Bhattacharya

Core Course
PHI-A-CC-9-Western Logic – II (6 Credits per week)

a) Symbolic Logic**:** The value of special symbols; Truth-Functions; Symbols for Negation, Conjunction, Disjunction, Conditional Statements and Material Implication; Material Equivalence and Logical Equivalence; Dagger and stroke functions; inter-definability of truth functors.
b) Tautologous, Contradictory and Contingent Statement-Forms; the Paradoxes of MaterialImplication; The Three Laws of Thought.
c) Determining the logical character of statement form and statements by
i) The Method of Truth-table.
ii) The Method of Resolution [dot notation excluded]
d) Testing Argument Form and Argument for validity by
i) The Method of Truth-table.
ii) The Method of Resolution (Fellswoop & Full Sweep)[dot notation excluded].
e) The Method of Deduction: Formal Proof of Validity: Difference between Implicational Rules and the Rules of Replacement; Construction of Formal Proof of Validity by using nineteen rules; Proof of invalidity by assignment of truth-values.
f) Quantification Theory**:** Need for Quantification Theory, Singular Propositions;Quantification; Translating Traditional subject predicate proposition into the logical notation of propositional function and quantifiers.
g) Quantification Rules and Proving Validity; Proving Invalidity for arguments involving quantifiers.

Suggested Readings:

English:

• Introduction to Logic (13th edn.): I.M. Copi & C. Cohen
• Symbolic Logic: I.M. Copi
• Methods of Logic (Part I, Ch.s 5,7,9): W.V.O. Quine
• Introduction to Logic and Scientific Method: Cohen & Nagel
• Logic: Informal, Symbolic and Inductive: Chhanda Chakraborty
• Logic: Stan Baronett & Madhuchhanda Sen
• The Elements of Logic: Stephen Barkar
• Understanding Symbolic Logic: Virginia Klenk
• Logic- A Comprehensive Introduction; S.D. Guttenplan & M. Tamney
• Logic & Philosophy- A Modern Introduction: Howard Kahne
• Logic- A First Course: A.E. Blumberg

Bengali:

• Nabya Yuktibijnana (Pratham theke caturtha khanda): Ramaprasad Das
• Sanketik Yuktibijnana: Ramaprasad Das
• Samsad Yuktibijnana Abhidhan: Ramaprasad Das O Subirranjan Bhattacharya

Core Course

PHI-A-CC-10-Epistemology and Metaphysics (Western) (6 Credits per week)

a) Concepts, Truth
b) Sources of Knowledge
c) Some Principal uses of the verb "To know", Conditions of Propositional Knowledge, Strongand weak senses of "know"
d) Analytic truth and logical possibility
e) The apriori
f) The Problem of Induction
g) Cause and Causal Principles
h) Realism, Idealism
i) Phenomenalism
j) Substance and Universal

Suggested Readings:

English:

- An Introduction to Philosophical Analysis—John Hospers
- The Problem of Knowledge: A.J. Ayer
- Language, Truth and Logic: A.J. Ayer
- Readings in Philosophical Analysis: J. Hospers
- The Central Questions of Philosophy: A.J. Ayer
- Theory of Knowledge: A.J. Woozley
- An Introduction to Philosophy: Shibapada Chakraborty

Bengali:

• Darshanik Jijnasa (Bagarthatattva): Ramaprasad Das
• Darshanik Jijnasa (Jnanatattva-Jnaner Svarup): Ramaprasad Das
• Darshanik Jijnasa (Jnanatattva): Ramaprasad Das
• Darshanik Jijnasa (Paratattva O Bhauto Jagater Jnana): Ramaprasad Das
• Darshanik Bishlesaner Ruparekha (Pratham O dvitiya khanda): Samarikanta Samanta
• Paschatya darshaner Ruparekha: Ramaprasad Das O Shibapada Chakraborty

SEMESTER 5

Core Course

PHI-A-CC-11-Nyāya Logic and Epistemology –I (6Credits per week)

a) Definition of buddhi or jñāna (cognition), its two kinds; Definition of smṛti; Two kinds of smṛti (memory); Definition of anubhava, its division into veridical (yathārtha) and non-veridical (ayathārtha);Three kinds of non-veridical anubhava; Definitions clarified in Tarkasaṁgraha Dīpikā.
b) Four-fold division of pramā and pramāṇa. Definition of "Karaṇa" (special causal condition) and "kāraṇa" (general causal condition). The concept of anyathāsiddhi (irrelevance) and its varieties.The definition of kārya (effect). Kinds of cause: samavāyi, a-samavāyi and nimitta kāraṇa (definitions and analysis).
c) Definition of pratyakṣa and its two-fold division : nirvikalpaka and savikalpaka jñāna. Evidence for the actuality of nirvikalpaka.
d) Sannikarṣa and its six varieties. Problem of transmission of sound; The claim of "anupalabdhi" as a distinctive pramāṇa examined.

Suggested Readings:

English:

• Tarkasamgraha with Dipika: Gopinath Bhattacharya
• Tarkasamgraha: M.R. Bodas & Y.V. Athalye (tr. &ed.)
• The Elements of Indian Logic and Epistemology: Chanrodaya Bhattacharya
• A Primer of Indian Logic: Kuppuswami Shastri
• Fundamental Questions of Indian Metaphysics & Logic: S.K. Maitra
• The Nyaya Theory of Knowledge: S.C. Chatterjee

Bengali:
• Tarkasamgraha with Dipika: Narayan Chandra Goswami
• Tarkasamgraha with Dipika: Indira Mukhopadhyay
• Tarkasamgraha with Dipika: Panchanan Shastri
• Tarkasamgraha with Dipika: Kanailal Poddar

Core Course
PHI-A-CC-12-Ethics (Indian) (6 Credits per week)

a) Introduction: Concerns and Presuppositions, Concept of Sthitaprañjna, Karmayoga: (Gīta) Puruṣārthas and their inter-relations.
b) Meaning of Dharma, Concept of Ṛṇa and Ṛta. Classification of Dharma: sādhāraṇadharma and Asādhārana dharma,Varnāsrama dharma.
c) Vidhi and Niṣedha.
d) Buddhist Ethics: Pañcaśīla, Brahmavihārabhāvanā (Bauddha) Anuvrata, Mahāvrata, Ahimsā.
e) Jaina Ethics: anubtrata, mahabrata.

f) Mimamsa Ethics: nittya naimittika karma and kāmya karma, the imperative in kāmya karmas and in kāmya karmas involving himsā.

Suggested Readings:

English:

• The Fundamentals of Hinduism-A Philosophical Study: S.C. Chatterjee
• The Ethics of the Hindus: S.K. Maitra
• An Outline of Hinduism: T.M.P. Mahadevan
• Classical Indian Ethical Thought: K.N. Tewari
• Ethics in the Gita-An Analytical Study (pp-119-145): Rajendra Prasad
• Ethics in the Vedas, Satya prakash Singh in Historical-Developmental Study of
ClassicalIndian Philosophy,[History of Science, Philosophy and Culture in Indian Civilisation(Vol.XII, Part 2)]: Rajendra Prasad (ed.)
• Rta, Satya, Tattva, Tathya, Samiran Chandra Chakraborty in Philosophical ConceptsRelevant to Sciences in Indian Tradition,[History of Science, Philosophy and Culture inIndian Civilisation(Vol. VIII, Part 4)]: P.K. Sen (ed.)
• Development of Moral Philosophy in India; Surama Dasgupta
• Ethical Philosophies of India: I.C. Sharma
• Studies on the Purusarthas: P.K. Mahapatra (ed.)
• A Critical Survey of Indian Philosophy: C.D. Sharma
• Indian Philosophy (Vo. I): J.N. Sinha
• Philosophy of Hindu Sadhana: N.K. Brahma

Bengali:

• Nitividya: Mrinal Kanti Bhadra
• Nitividyar Tattvakatha: Somnath Chakraborty
• Nitishastra: Dikshit Gupta
• Dharma Darshan: A. Bandyopadhyay o K.C. Gupta
• Dharma Darshan: Rabindranath Das
• Nitividya: Sibapada Chakraborty
• Pashchatya Darshaner Itihas (Pratham o dwitiya khanda): S. Radhakrishnan
• Sarvadarshanasamgraha: Satyajyoti Chakraborty (Pratham Khanda)
• Dharmadarshanser Katipoy Samasya: Dilip Kumar Mohanta
• Dharma Darshan: Sushil Kumar Chakraborty
• Bharatiya Dharmaniti: Amita Chattopadhyay (Sampadita)
• Bharatiya Darshane Nirishvarvada: B.B. Purakayastha (pp-39-50,56-66)
• Bharatiya Darshaner Drishtite Muktir Swarup: Chandana Das

SEMESTER 6

Core Course

PHI-A-CC-13-Nyaya Logic and Epistemology –II (6 Credits per week)

a) Definiton of anumāna, anumiti and parāmarśa. Analysis of pakṣatā. Definition of vyāpti;Vyāptigraha.
b) Definition of pakṣadharmatā—svārthānumiti and parārthānumiti; Analysis of pañcāvayavi Nyāya. Necessity of parāmarśa. Three kinds of linga or hetu: kevalānvayi, kevalayatirekī and anvayavyatirekī. Definiton of pakṣa, Sa-pakṣa and vipakṣa with illustrations. Marks of sat hetu.
c) Hetvābhāsa-two types of definition. Five kinds of hetvābhāsa: (1) "Savyabhicāra and its three kinds-defined and illustrated; (2) "Viruddha" defined and illustrated: (3) "Satpratipakṣa" defined and illustrated; (4) Three kinds of "Asiddha" enumerated; (a) āśrayāsiddhi (b) svarūpāsiddhi and (c) vyāpyatvāsiddhi. Vyāpyatvāsiddhi defined as"sopādhika hetu". Upādhi and its four kinds (definition and illustration) (5) "Bādhita" (definition and illustration).
d) "Upamāna pramāṇa" :Definition and analysis."Śabda pramāṇa" : Definition and analysis. "Śakti" (the direct signifying power), the padapadārtha- sambandha considered as Īśvara-saṁketa, Controversy between the Mīmāṃsakas and the Naiyāyikas regarding the nature of Śakti as universal or particular.
e) "Śaktigraha" (ascertainment of the meaning-relation), lakṣaṇa, varieties of lakṣaṇa, Analysis of "Gauṇī-vṛtti" (the secondary signifying power of a term), "Vyānjanā-vṛtti" (the suggestive power of a term) analysed as a kind of śakti or lakṣaṇā.
f) The question of lakṣanā-bīja tātparya, The concept of "yoga-rūḍhi". The three conditions of "śābda-bodha"—ākānkṣā, yogyatā and sannidhi. Two kinds of statements distinguished— Vaidika and Laukika.
g) "Arthāpatti" as a distinctive pramāṇa: Controversy between the Mīmāṃsakas and the Naiyāyikas.
h) The theory of prāmānya:the issue between svataḥ-prāmānyavāda and parataḥ-prāmānyavāda regarding utpatti and jñapti; The Prābhākara theory of akhyāti.

Suggested Readings:

English:

• Tarkasamgraha with Dipika: Gopinath Bhattacharya
• Tarkasamgraha: M.R. Bodas & Y.V. Athalye (tr. &ed.)
• The Elements of Indian Logic and Epistemology: Chanrodaya Bhattacharya
• A Primer of Indian Logic: Kuppuswami Shastri
• Fundamental Questions of Indian Metaphysics & Logic: S.K. Maitra
• The Nyaya Theory of Knowledge: S.C. Chatterjee

Bengali:

• Tarkasamgraha with Dipika: Narayan Chandra Goswami
• Tarkasamgraha with Dipika: Indira Mukhopadhyay
• Tarkasamgraha with Dipika: Panchanan Shastri
• Tarkasamgraha with Dipika: Kanailal Poddar

Core Course

PHI-A-CC-14-Ethics (Western) (6 Credits per week)

A. Nature and Scope of Ethics, Classification of Ethics: a) Prescriptive, b) Meta Ethics, c)Applied Ethics.
B. Moral and Non-moral actions, Object of Moral Judgement—Motive and Intention
C. Moral Theories: Plato and Aristotle
D. Standards of Morality: Hedonism—Ethical, Psychological. Utilitarianism: Act-utilitarianism, Rule-utilitarianism. Deontological Theories: Act-Deontological Theories, Rule-Deontological Theories—Kant's Theory
E. Theories of Punishment

Suggested Readings:

English:
• History of Philosophy-Eastern and Western: (Vol. I & II): S. Radhakrishnan
• Principles of Ethics: P.B. Chatterjee
• A Manual of Ethics: J.S. Mackenzie
• Ethics: W. Frankena
• An Introduction to Ethics: W. Lillie
• Ethics-Theory and Practice: J. Thiroux (Chs II & III)
• Ethics-Theory and Practice: Y.V. Satyanaryana
• Moral Reasons: J. Nuttal
• Human Conduct: J. Hospers
• Ethics-The Fundamentals: Julia Driver
• An Introduction to Kant's Ethics: R. Sullivan
• Nicomachean Ethics: Aristotle
• Philosophical Ethics-An Introduction to Moral Philosophy: T.L. Beauchamp (ed.)
• Virtue Ethics: Rosalind Hursthouse (Ch. III)
• Karma,Causation and Retributive Morality: Rajendra Prasad

Bengali:
• Nitividya: Mrinal Kanti Bhadra
• Nitividyar Tattvakatha: Somnath Chakraborty

• Nitishastra: Dikshit Gupta
• Nitividya: Samarendra Bhattacharya
• Nitividya: Sibapada Chakraborty
• Pashchatya Darshaner Itihas (Pratham o dwitiya khanda): S. Radhakrishnan
• Dharma Darshan: A. Bandyopadhyay o K.C. Gupta
• Dharma Darshan: Rabindranath Das
• Dharmadarshanser Katipoy Samasya: Dilip Kumar Mohanto
• Dharma Darshan: Sushil Kumar Chakraborty
• Bharatiya Dharmaniti: Amita Chattopadhyay (Sampadita)
• Bharatiya Darshane Nirishvarvada: B.B. Purakayastha (pp-39-50,56-66)
• Bharatiya Darshaner Drishtite Muktir Swarup: Chandana Das
• Sarvadarshanasamgraha: Satyajyoti Chakraborty (Pratham Khanda)

B. DISCIPLINE SPECIFIC ELECTIVE COURSE

Semester 5

PHI-A-DSE-A(1)(Any one from the following options)

a) Western Logic- I (6 Credits per week)

1) I.M. Copi: Symbolic Logic (fifth edn.) [Sections 3.4, 3.5, 3.6 and 3.7, 3.8 and Appendix B]
2) R.Jeffery: Formal Logic—Its scope and Limits (first edn.) [Ch IV and VI]
3) W.V.O. Quine: Methods of Logic (third edn.) [Ch.s 18, 19 and 21]
4) D. P. Suppes: Introduction to Logic (Indian edn.) [Ch.9,Section 9.1 to 9.7]

Suggested Readings:
English:

- Copi, I.M., Symbolic Logic

Bengali:

- Sanketik Yuktivijnan (Vakyakalan O Vidheyakalan): Ramaprasad Das
- Sabdajijnasa-Sabder Prakar o Prakriti: Ramaprasad Das
- Yukhtivaijnanik Paddhati: Ramaprasad Das

b)Normative and Meta ethics (6 Credits per week)

1) Postulates of morality
2) Virtue Ethics
3) Concept of value: Types of values, subjectivity/objectivity of values, moral skepticism
4) Distinction between normative and meta ethics

5) Meta-ethics: Nature of meta-ethics, Emotivism (A.J. Ayer's view), Intuitionism (Moore"s view), Prescriptivism (R.M. Hare's view)

Suggested Readings:
English:

• Ethics-The Fundamentals: Julia Driver
• Ethics-Theory and Practice: J. Thiroux (Chs II & III)
• Ethics-Theory and Practice: Y.V. Satyanaryana
• Moral Reasons: J. Nuttal
• Moral Reasons: James Rachels
• Philosophical Ethics-An Introduction to Moral Philosophy: T.L. Beauchamp (ed.)
• Virtue Ethics: R. Crisp & M. Stole (eds.)
• Virtue Ethics: Rosalind Hursthouse (Ch. III)
• Elements of Moral Philosophy: James Rachels
• Modern Moral Philosophy: W.D. Hudson
• Ethics Since 1900: Mary Warnock
• Introductory Ethics: Fred Feldman
• Ethics: W. Frankena
• Identity and Violence: Amartya Sen
• Twentieth Century Ethics: Roger Hancock
• Aspects of Hindu Morality: Saral Jhingram
• Practical Ethics: Peter Singer (Chs V,VII,VIII,X)
• A Companion to Ethics: Peter Singer (Chs 14,19,22)
• Man and Nature: G.F. MacLean (ed.)
• Language, Truth and Logic: A.J. Ayer
• The language of Morals: R.M. Hare

Bengali:
• Nitishastra: Dikshit Gupta
• Nitividya: Sanjib Ghosh
• Nitividyar Tattvakatha: Somnath Chakraborty
•Nitibidya- Shibapada Chakraborty

c)Philosophy of Language (Indian)(6 Credits per week)

1) Definition and classification of pada
2) Introduction of concepts of āsatti, yogyatā, tātparya, ākāṁṣā
3) Different types of lakṣaṇā
4) śābdabodha
5) anvitābhidhānvāda and avihitānvayavāda.

Suggested Readings:

English:

- Tarkasaṁgraha: Annaṁbhatta

- Tarkasamgraha: M.R. Bodas & Y.V. Athalye (tr. &ed.)
- The Elements of Indian Logic and Epistemology: Chandrodaya Bhattacharya
- A Primer of Indian Logic: Kuppuswami Shastri
- Fundamental Questions of Indian Metaphysics & Logic: S.K. Maitra
- The Nyaya Theory of Knowledge: S.C. Chatterjee

Bengali:

- Tarkasamgraha with Dipika: Narayan Chandra Goswami
- Tarkasamgraha with Dipika: Indira Mukhopadhyay
- Tarkasamgraha with Dipika: Panchanan Shastri
- Tarkasamgraha with Dipika: Kanailal Poddar

PHI-A-DSE-B(1) Classical Texts (Any one from the following options)

a) An Enquiry Concerning Human Understanding -D. Hume (6 Credits per week)

- Chapter 1—3
- Chapter 4—6
- Chapter 7- 9
- Chapter 10--- 12.

Suggested Readings:

English:

- An Enquiry Concerning Human Understanding-D. Hume: J.N. Mohanty (intr.)
- The Philosophy of David Hume: Pabitra Kumar Roy
- The Philosophy of David Hume: N.K. Smith
- Hume's Theory of Causality: Tapan Kumar Chakraborty
- Hume: V.C. Chappell (ed.)

Bengali:

- Hume-er Enquiry-Ekti Upasthapana: Ramaprasad Das
- Hume -er Darshan – Prahlad Kumar Sarkar (Ed.)

b) The Problems of Philosophy-- Bertrand Russell (6 Credits per week)

- Chapter 1—3
- Chapter 4—6
- Chapter 7- 9
- Chapter 10--- 12.

Suggested Readings:

English:

- Russell and Moore – An Analytical Heritage: A.J. Ayer
- Russell: A.J. Ayer
- Russell : Mark Sainsbury
- The Philosophy of B. Russell : Schlipp (ed)
- Russell – A Short Introduction: A.C. Grayling

Bengali:

- Darshaner Samasya: Debika Saha
- Darshan Samasya:Sushil Kumar Chakrabarty

c) Vedāntasāra: Sadananda Yogindra Saraswati(6 Credits per week)

1. Mangalācaraṇa
2. Vedānter Paricaya
3. From anubandha catuṣtaya to relation between Iśvara and Prājña
4. Origin of Sthūla Bhūta to Brahma- sākṣātkāra
5. Śravana o ṣaḍbidhalinganirupaṇa to jibanmuktir śeṣ phala

Suggested Readings:
English:

- A History of Indian Philosophy: S. N. Dasgupta

Bengali:

- Vedantasara : Upendranath Mukhopadhaya
- Vedantasara: Medha Caitanya
- Vedantasara: Kalibar Vedanta Vagish
- Vedantasara: Bipadbhanjan Pal
- Vedantasara- Advaitavada :Ashutosh Shastri
- Vedantasara: Swami Nikhilananda (Eng Version)

d) Śrimadbhagabadgīta (6 credits per week)

1. A. Karmayoga (third chapter)
2. B. Guṇatrayabibhāga (fourteenth chapter)

Suggested Readings:
English:

- Ethics in the Gita- An Analytical Study : Rajendra Prasad
- Central Theme of Gita : Swami Ranganathananda

Bengali:

- Śrimadbhagabadgīta: Madhusudan Saraswati
- Śrimadbhagabadgīta: Atul Chandra Sen
- Śrigīta: Jagadish Chandra Ghosh

- Gitanibandha: Sri Aurobindo
- Śrimadbhagabadgīta: Swami Jagadiswarananda(Tran.)
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Semester 6

PHI-A-DSE-A(2) (Any one from the following options)

a) Western Logic – II(6 Credits per week)

1) H.W.B. Joseph: An Introduction to Logic [Ch.s II & IV]
   [Terms and their principal distinctions, The Predicables]
2) H.W.B. Joseph: An Introduction to Logic [Ch. V]

[The Rules of Definition and Division:Classification and Dichotomy]

Suggested Readings:
English:

- Copi, I.M., Symbolic Logic

Bengali:

- Sanketik Yuktivijnan (Vakyakalan O Vidheyakalan): Ramaprasad Das
- Sabdajijnasa-Sabder Prakar o Prakriti: Ramaprasad Das
- Yukhtivaijnanik Paddhati: Ramaprasad Das
- Samsad Yuktivijnan Abhidhan: Ramaprasad Das o Subirranjan Bhattacharya

b)Applied ethics (6 Credits per week)

1. Nature and scope of applied ethics.
2. Killing: Suicide, Euthanasia, Animal killing.
3. Poverty, Affluence and Morality.
4. War and Violence: Terrorism.
5. Right: Nature and Value of Human Rights—Discrimination on the basis of race, caste andreligion.
6. The Ethics of Care.
7. Value beyond sentient beings, Reverence for life, Deep Ecology, Concepts of Kinship Ethics.
8. Ecological Concern in Indian thoughts: Jaina and Bauddha views.

Suggested Readings:
English:

• Ethics-The Fundamentals: Julia Driver
• Ethics-Theory and Practice: J. Thiroux (Chs II & III)
• Ethics-Theory and Practice: Y.V. Satyanaryana
• Moral Reasons: J. Nuttal
• Moral Reasons: James Rachels

• Philosophical Ethics-An Introduction to Moral Philosophy: T.L. Beauchamp (ed.)
• Elements of Moral Philosophy: James Rachels
• Theories of Rights: J. Waldron (ed.)
• Human Rights: Alan Gewirth
• Modern Moral Philosophy: W.D. Hudson
• Ethics Since 1900: Mary Warnock
• Introductory Ethics: Fred Feldman
• Ethics: W. Frankena
• Identity and Violence: Amartya Sen
• Twentieth Century Ethics: Roger Hancock
• Aspects of Hindu Morality: Saral Jhingram
• Practical Ethics: Peter Singer (Chs V,VII,VIII,X)
• Applied Ethics: Peter Singer (ed.)
• A Companion to Ethics: Peter Singer (Chs 14,19,22)
• A Companion to Bio-Ethics: Peter Singer & H. Kuhse (eds.)
• Human Rights-An Introduction: D.J. O'Byrne
• Man and Nature: G.F. MacLean (ed.)
• Human Rights, Gender and the Environment: Manisha Preya, Krishna Menon, MadhulikaBanerjee
• Gender: G. Geetha
• A Short Introduction to Feminist Theory: Rinita Mazumdar
• Feminist Thought: Shefali Moitra
• Justice and Care: Essential Readings in Feminist Ethics: Virginia Held (ed.)
• Language, Truth and Logic: A.J. Ayer
• The language of Morals: R.M. Hare

Bengali:

• Nitishastra: Dikshit Gupta
• Vyavaharik Nitivijnan: N. Nandy & M. Bal
• Nitividya: Sanjib Ghosh
• Nitividyar Tattvakatha: Somnath Chakraborty
• Tattvagata Nitividya o Vyavaharik Nitividya: Samarendra Bhattacharya
• Vyavaharik Nitividya-Peter Singer: Pardip Kumar Roy (tr.)
• Prayogik Nitividya: A.S.M. Abdul Khalek
•Nitibidya- Shibapada Chakraborty

c) Philosophy of Language (Western)(6 Credits per week)

1) Syntax, Semantics, Pragmatics.
2) Word-meaning, Definitions.
3) Vagueness.
4) Sentence-meaning.
5) Testability and Meaning.

Suggested Readings:

English:

- The Philosophy of Language **:** A.P.Martinich
- An Introduction to Philosophical Analysis : John Hospers
- The Central Questions of Philosophy: A.J. Ayer
- Theory of Knowledge: A.J. Woozley

- The Problem of Knowledge: A.J. Ayer
- Language, Truth and Logic: A.J. Ayer
- Readings in Philosophical Analysis: J. Hospers
- An Introduction to Philosophy: Shibapada Chakraborty

Bengali:

- Darshanik Jijnasa (Bagarthatattva): Ramaprasad Das
- Darshanik Jijnasa (Jnanatattva-Jnaner Svarup): Ramaprasad Das
- Darshanik Jijnasa (Jnanatattva): Ramaprasad Das
- Darshanik Jijnasa (Paratattva o Bhauto Jagater Jnana): Ramaprasad Das
- Darshanik Bishlesaner Ruparekha (Pratham O dvitiya khanda): Samarikanta Samanta
- Paschatya darshaner Ruparekha: Ramaprasad Das o Shibapada Chakraborty

PHI-A-DSE-B(2)
Contemporary Indian Philosophy (Any one from the following options)

a) Swami Vivekananda (6 Credits per week)

1. Real nature of man.
2. Nature of Religion.
3. Ideal of Universal Religion.
4. Concept of Practical Vedanta.

Suggested Readings:
English:
• Contemporary Indian Philosophy: T.M.P. Mahadevan & G.V. Saroja
• Contemporary Indian Philosophy: Basant Kumar Lal
• Contemporary Indian Philosophy: Binoy Gopal Roy
• Practical Vedanta (Vol.II,pp-291-358): Swami Vivekananda
• Swami Vivekananda as a Philosopher: J.L. Shaw
• The Philosophy of Swami Vivekananda: Pradip Kumar Sengupta
• The Complete Works of Swami Vivekananda (Vol.I,pp-333-343 & II,pp-70-87,375-396):Mayavati Memorial Edition
• The Philosophy of Vivekananda: Govinda Dev
Bengali:

- Patraboli : Swami Vivekananda

b)Rabindranath Tagore (6 Credits per week)

1. Reality and God.
2. Nature of Man.
3. Surplus in man.
4. Nature of Religion.
5. Tagore's Humanism.

Suggested Readings:
English:

- Contemporary Indian Philosophy: T.M.P. Mahadevan & G.V. Saroja
- Contemporary Indian Philosophy: Basant Kumar Lal
- Contemporary Indian Philosophy: Binoy Gopal Roy
- Religion Of Man: Rabindranath Tagore
- The Philosophy of Rabindranath Tagore : Binay Gopal Roy
- Philosophy of Rabindranath Tagore: S. Radhakrishnan

Bengali:

- Rabindra Rachanabali (Khanda 12,pp-532-545,567-614): Janmashatbarshiki Samskaran
- Rabindra Darsan: Sachindranath Gangopadhyay, Pabitra Kumar Roy, Nripendranath Bandyopadhyay

c) Sri Aurobindo (6 Credits per week)

1. Reality as Sat-Cit-Ānanda
2. Nature of Creation, the World process: Descent or involution, Maya and Lila, Ascent orevolution.
3. Integral Yoga.

Suggested Readings:
English:

• Contemporary Indian Philosophy: T.M.P. Mahadevan & G.V. Saroja
• Contemporary Indian Philosophy: Basant Kumar Lal
• Contemporary Indian Philosophy: Binoy Gopal Roy
• Life Divine: Sri Aurobindo
• Synthesis of Yoga: Sri Aurobindo
• Integral Yoga: Sri Aurobindo
• Among the Great: Dilip Kumar Roy (Chapter on Sri Auribindo)
• Towards Supermanhood-The Philosophy of Sri Aurobindo: P.B. Chatterjee
• The Philosophy of Sri Aurobindo: Ramnath Sharma
• An Introduction to the Philosophy of Sri Aurobindo: S.K. Maitra
• Guide to Sri Aurobindo's Philosophy: K.D. Acharya
• Future Evolution of Man-The Divine Life Upon Earth: Sri Aurobindo
• Sri Aurobindo-The Prophet of Life Divine: Haridas Choudhuri
• Sri Aurobindo's Concept of the Superman: Chittaranjan Goswami

Bengali:

- Visva-Vivek: Asit kumar Bandyopadhyay, Sankari Prasad Basu, Sankar
- Manavjatir Bhabiswat Bibartan: Sri Aurobindo Ghosh
- Sri Aurobindo Katha: manmatho Mukhopadhyaya
- Divya Jivan: Srimat Anirban
- Yogo-samannay: Srimat Anirban
- Sri Aurobindo Janmo Satabarshiki Smarak Grantha: Sri Aurobindo Patha Mandir

d) M.K.Gandhi(6 Credits per week)

1. God and Truth.
2. Nature of Man.
3. Non-Violence
4. Satyāgraha
5. Swaraj
6. Theory of Trusteeship

Suggested Readings:

English:

• Contemporary Indian Philosophy: T.M.P. Mahadevan & G.V. Saroja
• Contemporary Indian Philosophy: Basant Kumar Lal
• Contemporary Indian Philosophy: Binoy Gopal Roy
• Hind Swaraj: M.K. Gandhi
• Trusteeship; M.K. Gandhi
• Selections from Gandhi: N.K. Bose
• Contemporary Indian Philosophy: S,Radhakrishnan& J.H. Murihead (eds.)
• The Evolution of Political Philosophy of Gandhi: Buddhadeb Bhattacharya
• Social and Political Thought of Gandhi: Jayantanuja Bandyopadhyay
• The Philosophy of Mahatma Gandhi: D.M. Dutta
• The Philosophy of Sarvodaya: K.S. Bharathi
• Gandhi's Political Philosophy: Bhikhu Parekh

Bengali:

• Sarvodaya Andoloner Itihas: Gurudas Bandyopadhyay
• Gandhi Parikrama: Sailesh Kumar Bandyopadhyay
• Gandhi Rachanasambhar: M.K. Gandhi

SKILL ENHANCEMENT COURSE

Semester 3

PHI-A-SEC- A (any one from the following options)

a)Logical Reasoning and application : Indian and Western (2 Credits per week)

1.The main objective of logical reasoning.
2.Reasoning in practice:
(i). Fallacy of relevance, Fallacies of ambiguity, Fallacies of weak induction, Avoiding fallacies
(ii)Different kinds of Hetvābhāsa-s after Nyāya system
(iii)Logical applications of the concept of pakṣatā
(iv)Functional applications of ordinary operative relations between sense-organs and respective objects .

3.Logic and the Law:
(i) Laws, courts and arguments
(ii) Language in the law
(iii)The functions of legal Language
(iv) Fallacies in the law
(v) Definitions in the law

4.Inductive reasoning in Law
(i)The method of Inquiry in Law
(ii)Causation in Legal reasoning
(iii)Analogical Reasoning in legal argument
(iv)Probability in legal argument

5. Deductive Reasoning in Law
(i)Determining the correct rule of Law
(ii)Identifying, formulating, and applying rules of law
(iii)The law of libel
(iv)Logic is right reasoning

Suggested Readings:
English:

- Introduction to Logic (9th Edition) : I. M. Copi & C. Cohen, Prentice Hall of India Pvt. Ltd., New Delhi, 1999.
- The Elements of Logic (5th Edition): S.F.Barker, McGraw-Hill Book Company, 1988.
- Introduction to Logic : P.J. Hurley, Wadsworth, 2007.
- The Concept of Logical Fallacies: Nandita Bandyopadhaya

Bengali:

- Tarkasaṁgraha: Annaṁbhatta
- Tarkasaṁgraha: M.R. Bodas & Y.V. Athalye (tr. &ed.)
- Tarkasaṁgraha with Dipika: Narayan Chandra Goswami
- Tarkasaṁgraha with Dipika: Indira Mukhopadhyay
- Tarkasaṁgraha with Dipika: Panchanan Shastri
- Tarkasaṁgraha with Dipika: Kanailal Poddar

b)Man and Environment (2 Credits per week)

a) Classical Indian Attitude to Environment

i) The Upanisadic world-view, ii) Tagore's understanding of nature, iii) The post-Upanisadic view of nature

b)Respect for Nature

i) The attitude of respect, ii) Bio-centric outlook to nature, iii) Ethical standards and rules that follow from the attitude of respect to nature, iv) The idea of inherent worth of nature.

c)Intrinsic Value of nature

i)Moore's talk of 'intrinsic properties', ii) Chilsom's idea of intrinsic value, iii) Attfield on the intrinsic value of nature, iv) Callicott's idea of intrinsic value of nature, v) Rolston III on intrinsic value of nature, vi) intrinsic value and objective value

d)Deep Ecology and its Third World Critique

i)Arne Naess on Deep Ecology, ii) Ramchandra Guha's critique of Deep Ecology

e)Eco-feminism

i)Understanding nature and the feminine, ii) Dualisms in Western tradition, iii) Masculinity, humanity and nature.

Suggested Readings

English:

1. 'Attitudes to Nature' John Passmore , Environmental Ethics (ed.) Robert Elliot, Oxford University Press, Oxford, 1998

2.Sadhana (first Chapter), Rabindranath Tagore, Macmillan, New York, 1915

3.Respect for Nature: A Theory of Environmental Ethics (Select Parts), Paul Taylor, Princeton University Press, Princeton, 1986

4. 'Intrinsic value, Environmental Obligation and Naturalness', Robert Elliot, Monist, 1975
5. 'The Shallow and the Deep, Long-Range Ecology Movements: A Summary', Arne Naess, Inquiry, 1973

6.Nature, Self and Gender: Feminism, Environmental Philosophy and the Critique of Rationalism, Val Plumwood, Environmental Ethics (ed.) Robert Elliot, Oxford University Press, Oxford, 1998

Bengali:

7.Paribesh o Naitikata, Nirmalya Narayan Chakraborty, Progressive Book Forum, Kolkata, 2002

Semester 4

PHI-A-SEC- B(any one from the following options)

a) Emerging trends of thought(2 Credits per week)
(any two from the following)

A. Business Ethics

B.Environmental Philosophy

C.Feminist Philosophy

D. Peace Studies

E.Recent trends in ethics

A. Business Ethics

1. Why Study Business Ethics?
   i)Ethical Issues in business
   ii) Ethical principles in business
2. Environment and Business Ethics
   i)Business ethics and environmental values
   ii)Ethics of conserving depletable resources
3. Ethics in Management
   i)Management by Value Programmes: a qualitative appraisal
   ii) Ethical vision of Management : A Vedantic outline

Suggested Reading:

English:

- Business Ethics(7th edition) : Manuel G. Velasquez (Chapter 1,2&5)

- Ethics in Management : S. K. Chakraborty (Chapter 1&5)
- Management by Values -towards cultural congruence : S.K.Chakraborty
- Management Ethics-integrity at work: J.A.Patrick & John F. Quinn
- Business Ethics and Corporate Governance, Pearson Education India
- Business Ethics-an introduction to the ethics of values:Lucjan Klimsza

B. Environmental Philosophy

Suggested Readings:
English :

1. 'Attitudes to Nature'John Passmore,, Environmental Ethics (ed.) Robert Elliot, Oxford University Press, Oxford, 1998
2. Respect for Nature: A Theory of Environmental Ethics (Select Parts),Paul Taylor, Princeton University Press, Princeton, 1986
3. 'Intrinsic value, Environmental Obligation and Naturalness', Robert ElliotMonist, 1975
4. 'The Shallow and the Deep, Long-Range Ecology Movements: A Summary',Arne Naess, Inquiry, 1973
5. Nature, Self and Gender: Feminism, Environmental Philosophy and the Critique of Rationalism, Val Plumwood, Environmental Ethics (ed.) Robert Elliot, Oxford University Press, Oxford, 1998

Bengali:

6. Paribesh o Naitikata,Nirmalya Narayan Chakraborty, Progressive Book Forum, Kolkata, 2002

C.Feminist Philosophy
Suggested Readings:
English:

1) Feminist Thought: A Comprehensive Introduction, Rosemarie Tong ,Vol 1&2, Third Edition, Westview Press, 2009

2) Feminist Thought, Shefali Moitra, Munshiram Manoharlal Publishers Pvt .Ltd in association with Centre of Advanced Study in Philosophy, Jadavpur University, Kolkata, 2002

3) The Second Sex, Simone De Beauvoir, Vintage Books, London, 2001

4) A Companion to Feminist Philosophy (ed. Alison, M, Jaggar and Iris Marion Young), Willey-Blackwell, 1999

5) Feminist Knowledge (RLE Feminist Theory) Critique and Construct,(ed.Sneja Gunew),Routledge Library Editions,2014

6) Representing Reason: Feminist Theory and Formal Logic, (in ed.Rachel Jaffe Falmange and Marjorie Hans), Rowman and Littlefield Publisher, 2002

Bengali:

7) Narivad,Rajasree Basu, Paschimbanga Rajya Pustak Parshad,Kolkata,2012.(Bengali)

8) Naitikata o Narivad, Shefali moitra ,New age Publishers Pvt Ltd,Kolkata,2003.(Bengali)

D. Peace Studies

Suggested Readings:
English:

1) Introduction to Peace Studies, David P. Barash , Belmont: Wadsworth, 1991.

2) 'International Relations', in The English Writings of RabindranathTagore: A Miscellany, (ed) Sisir Kumar Das, New Delhi: Sahitya Akademi, reprint 2006.

3) Handbook of Peace and Conflict Studies, Charles Webel and Johan Galtung(eds.): Routledge, London and New York, 2007

E.Recent Trends in Ethics

Suggested Readings:
English:

1. John F. Fitzgibbon: Ethics: Fundamental Principles of Moral philosophy, University Press of America, 1983

2. Moral Dilemmas, Christopher W. Gowans (ed): Oxford University Press, Oxford, 1987

3. Walter Sinnott-Armstrong: Moral Dilemma, Basil Blackwell, U.S.A., 1988

4. Daniel Statman (ed.): Moral Luck, State University of New York Press, New York, 1993

5. Bernard Williams: Moral Luck Philosophical Papers 1973-1980, CambridgeUniversityPress, Cambridge, 1981

6. Justine D'Arms & Daniel Jacobson (ed): Moral Psychology & Human Agency Philosophical Essays on the Science of Ethics, Oxford University Press, Oxford, 2014

7. Paul Katsafanas: Agency and the Foundations of Ethics—Netzschean Constitutivism, Oxford University Press, Oxford, 2013

8. John Matin Fischer and Mark Ravizza (ed): Perspectives on Moral Responsibility, Cornell University Press, Ithaca and Landon, 1993.

b) Philosophy of Human Rights (2 Credits per week)

1. A Definition and Nature of Human Rights
2. The Idea of Human Rights: Its Origins and Historical Developments during Ancient period, Modern period and Contemporary period
3. The Idea of Natural Law and Natural Rights: Thomas Hobbes and John Locke.
4. The Natural Rights Tradition: Some Reactions from Jeremy Bentham, Edmund Burke and Thomas Paine
5. Natural Right, Fundamental Right and Human Right
6. Preamble, Fundamental Rights and Duties (Indian Constitution)
7. Contemporary Perspectives: Joel Feinberg—Basic Rights

Suggested Readings:
English:

- Patrick Hayden (ed.): The Philosophy of Human Rights, Paragon House, St. Paul, First Edition, 2001.
- Morton E. Winston (ed.): The Philosophy of Human Rights, Wadsworth Publishing Co. Belmont, California, 1989.
- Jeremy Waldron (ed.): Theories of Rights, Oxford University Press, Oxford, 1984
- Ashwani Peetush and Jay Drydyk: Human Rights*: India and West*, Oxford University Press, New Delhi, 2015.
- James Nickel: Making Sense of Human Rights, Blackwell Publishing, Oxford, 2007.
- Henry Shue: Basic Rights: Subsistence, Affluence and U. S. Foreign Policy, Princeton University Press, Princeton, 1980.
- Gary, B. Herbert: Philosophical History of Human rights, Transaction Publishers, New Jersey, 2002.
- Michael Freeden: Rights, Worldview Publications, New Delhi, 1998.

- Lynn Hunt: Inventing Human Rights: A History, Norton & Company, New York, 2007.
- Jack Donnelly: Universal Human rights in Theory and Practice, Manas Publications, New Delhi, 2013.

Semester-wise Course for B.A.(General)

	Sem-1	Sem-2	Sem-3	Sem-4	Sem-5	Sem-6
Core Course (CC)	2TH+2TU CC-1	2TH+2TU CC-2	2TH+2TU CC-3	2TH+2TU CC-4		
Language (LCC)			1TH+1TU LCC1(1)	1TH+1TU LCC2(1)	1TH+1TU LCC1(2)	1TH+1TU LCC2(2)
Generic Elective (GE)	1TH+1TU GE-1	1TH+1TU GE-2				
Discipline Specific Elective (DSE)					2TH+2TU DSE-A (1A+2A)	2TH+2TU DSE-B (1B+2B)
Ability Enhancement Compulsory Course (AECC)	1TH+0TU AECC-1	1TH+0TU AECC-2				
Skill Enhancement Course (SEC)			1TH+0TU SEC-A	1TH+0TU SEC-B	1TH+0TU SEC-A	1TH+0TU SEC-B
Total No. of Courses and Marks	4 x 100 = 400	4 x 100 = 400	4 x 100 = 400	4 x 100 = 400	4 x 100 = 400	4 x 100 = 400
Total Credits	20	20	20	20	20	20

TH = Theory T = Tutorial

- ❖ CC/LCC/GE/DSE : Each Theory and Tutorial Course have 5 and 1 Credit(s) respectively
- ❖ CC : 4 Courses each form 2 subjects (one course from each subject under each semester)
- ❖ LCC : LCC1-English courses; LCC2-MIL/Alternative English
- ❖ GE : Two courses from one subject different from core subjects including LCC
- ❖ DSE : 2 Courses each from 2 subjects
- ❖ AECC/SEC : Each Course has 2 Credits
- ❖ AECC-1 : Communicative English / MIL; AECC-2 : Environmental Studies

University of Calcutta

BA (General)-CBCS Syllabus in Philosophy, 2018

A. Core Courses [Four courses; Each course: 6 credits (5 theoretical segment+ 1 for tutorial-related segment). Total: 24 credits (Th 5×15weeks=75 ; Tutorial 1×15 weeks= 15)]
B. Discipline Specific Elective [Four courses; Each course: 6 credits (5 theoretical segment+ 1 for tutorial-related segment). Total: 24 credits (Th 5×15weeks=75 ; Tutorial 1×15 weeks= 15)]
C. Generic Elective [Two courses; Each course: 6 credits (5 theoretical segment+ 1 for tutorial-related segment). Total: 12 credits (Th 5×15weeks=75 ; Tutorial 1×15 weeks= 15)]
   Core couses of 'General syllabus' will be treated as Generic Elective (GE) of 'Honours Syllabus'.
D. Skill Enhancement [Two courses from each subject; Each course: 2 credits (No Tutorial segment). Total: 04 credits (2×15weeks =30)

- Each course (CC& DSE) carries 80 marks and Minimum 80 classes (SEC-60).
- 65 marks for theoretical segment: 55 marks for descriptive questions + 10 marks for 1 mark questions.
- Skill Enhancement course carries 80 marks and minimum 50 classes: 80 marks for theoretical segment, there is no tutorial segment.
- Question Pattern for descriptive segment of 55 marks: 5 short questions out of 8 (5x5 = 25) + 2 questions out of 4(15 x 2 = 30).
- 15 marks for tutorial [The topics (within the syllabus) are to be decided by the concerned faculty of respective colleges.]

IMPORTANT NOTES:

- Cited advanced texts in Bengali are not necessarily substitutes, but supplementary to the English books.

- The format is subject to the common structural CBCS format of the University.

- The Skill enhancement course, based on the UGC Guidelines, have the common goal of developing specific skills of students of the discipline for better employment opportunities.

Semester 1
PHI-G-CC-1 Indian Epistemology and Metaphysics
Semester 2
PHI-G-CC-2 Western Epistemology and Metaphysics
Semester 3
PHI-G-CC-3 Western Logic
Semester 4
PHI-G-CC-4 Philosophy of Mind

Discipline Specific Elective
Semester 5
PHI-G-DSE-A(Any one from the following options)
a)Ethics : Indian and Western
b)Social and Political Philosophy

Semester 6
PHI-G-DSE-B (Any one from the following optoions)
a)Applied Ethics and Philosophy of Religion.
b)Contemporary Indian Thought

Skill Enhancement Elective course:

PHI-G-SEC-A(Any one from the following options either in Semester 3 or in Semester 5)
a)Logical Reasoning and Application
b)Business Ethics

PHI-G-SEC-B (Any one from the following options either in Semester 4 or in Semester 6)
a)Man and Environment
b)Value Education

Semester 1

PHI-G-CC-1Indian Epistemology and Metaphysics (6 Credits per week)

A. Cārvāka Epistemology: Perception as the only source of knowledge; Refutation of Inference and Testimony as source of knowledge.

B. Nyāya Epistemology: The nature of perception; laukikasannikarṣa; Determinate (savikalpaka) and Indeterminate (nirvikalpaka): anumāna; sādhya, pakṣa, hetu,vyāpti, parāmarśa and vyāptigraha. Svārthānumitiand parārthānumiti, pañcāvayavīnyāya.

C. Vaiśeṣika Metaphysics: Categories – dravya, guna, karma, sāmānya, viśeṣa, samavāya and abhāva.

D. Advaita Metaphysics: Brahman, māyā, The relation between jīva and Brahman.

Suggested Readings:

English:

•A Critical Survey of Indian Philosophy: C.D. Sharma

•An Introduction to Indian Philosophy: D. M. Dutta & S.C. Chatterjee

Bengali:

•Bharatiya Darshan: Nirodbaran Chakraborty

•Lokayata Darshan: Debiprasad Chatoopadhyay

•Nyaya-Vaisesika Darshan: Karuna Bhattacharya

•Bharatiya Darshan: Samarendra Bhattacharya

Semester 2

PHI-G-CC-2 Western Epistemology and Metaphysics (6 Credits per week)

A. Different senses of 'Know'. Conditions of Propositional Knowledge, Origin of Concepts. Concept Rationalism-Views of Descartes and Leibniz, Concept Empiricism –Views of Locke, Berkeley and Hume.

B. Theories of the origin of Knowledge:Rationalism, Empiricism, Kant's Critical Theory.
C. Realism: Naive Realism, Locke's Representative, Realism, Subjective Idealism (Berkeley).
D. Causality: Entailment Theory, RegularityTheory.
E. Mind- Body Problem: Interactionism, Parallelism and the Identity Theory.

Suggested Readings:

English:

- An Introduction to Philosophical Analysis: J. Hospers
- An Introduction to Philosophy: Shibapada Chakraborty

Bengali:

- Paschatya Darshan O Yuktivijnan: Ramaprasad Das
- Pashchatya Darshaner Ruparekha: Ramaprasad das o Sibapada Chakrabarty
- Paschatya Darshan O Yuktivijnan: Samir Kumar Chakrabarty
- Paschatya Darshan: Samarendra Bhattacharyya

Semester 3

PHI-G-CC-3Western Logic (6 Credits per week)

A. Introductory topics: Sentence, proposition, argument, truth and validity.
B. Aristotelian classification of categorical propositions, distribution of terms. ExistentialImport, Booleaninterpretation of categorical propositions. Immediate inference. Immediate inference based on the square of opposition, conversion, obversion and contraposition.
C. Categorical syllogism: Figure, mood, rules for validity, Venn Diagram method of testing validity, fallacies.
D. Symbolic Logic: Use of symbols, Truth-functions: Negation, Conjunction, disjunction, implication, equivalence.
E. Tautology, Contradiction, Contingent statement forms. Construction of truth-table, using truth-tables for testing the validity of arguments and statement forms.

F. Mill's methods of experimental inquiry.

Suggested Readings

English:

- Introduction to Logic (13th edn): I.M. Copi and C. Cohen

Bengali:

- Paschatya Darshan O Yuktivijnan: Ramaprasad Das
- Paschatya Darsan O Yuktivijnan: Samir Kumar Chakrabarty

Semester 4

PHI-G-CC-4Philosophy of Mind. (6 Credits per week)

A. Sensation: What is sensation? Attributes of sensation. Perception: What is perception? Relation between sensation and perception, Gestalt theory of perception, illusion and hallucination.
B. Consciousness: Conscious, Subconscious,Unconscious,Evidence for the existence of the Unconscious, Freud's theory of dream.
C. Memory: Factors of memory, Laws of association, Forgetfulness. Learning: The trialand Error theory, Pavlov's Conditioned Responsetheory, Gestalt theory.
D. Intelligence: Measurement of Intelligence, I.Q.,Testof Intelligence, Binnet-Simon test.

Suggested Readings

English:

- A Textbook of Psychology: Pareshnath Bhattacharya
- Introduction to Psychology: G.T.Morgan
- A Modern Introduction to Psychology: Rex Knight & M. Knight

Bengali:

- Manovidya: Priti Bhusan Chattopadhyay
- Manividya: Paresh Nath Bhattacharya
- Manovidya: Ira Sengupta

Semester 5

PHI-G-DSE-A

Any one from the following options

a)Ethics: Indian and Western(6Credits per week)

A. Four Purusarthās – dharma, artha, kāma and mokṣa and their interrelation. Karma (Sakāma&Niṣkāma), CārvākaEthics.
B. Buddhist Ethics: The Four Noble Truths and theEight-FoldPath.
C. Moral and Non-Moral Actions, Object of Moral Judgement.
D. Teleological Ethics: Utilitarianism (Bentham and Mill) Deontological Ethics: Kant's Moral Theory.
E. Theories of Punishment.

Suggested Readings:
English:

- The Fundamentals of Hinduism- A Philosophical Study:S. C. Chatterjee
- The Ethics of Hindus: S.K. Maitra
- Principles of Ethics: P.B. Chatterjee
- A Mannual of Ethics: J. S. Mackenzie
- Ethics: W. Frankena
- An Introduction to Ethics: W. Lillie

Bengali:

- Nitishastra: Dikshit Gupta
- Nitividya: Somnath Chakraborty
- Nitividya: Samarendra Bhattacharya
- Nitividyar Tattvakatha: Somnath Chakraborty
- Nitividya: Sanjib Ghosh

b)Social and Political Philosophy (6 Credits per week)

A. Relation between Social Philosophy and Political Philosophy
B. Primary Concepts: Society, Community, Association, Institution, Family.
C. Social Class and Caste: Principles of Class and Caste; Marxist conception of class; ClassAttitudes and Class consciousness
D. Social Codes and Sanctions; Custom and Law; Culture and Civilisation.
E. Social Changes: Marx and Gandhi.
F. Political Ideals: Democracy: Its Different Forms. Socialism: Utopian and Scientific Socialism.

Suggested Readings:
English:

- Fundamentals of Sociology : P. Gisbert
- Outlines of Social Philosophy : J. S. Mackenzie
- Problems of Political Philosophy : D. D. Raphael

- Society : R. M. MacIver & C. H. Page
- Sociology : M. Ginsberg
- Sociology : Tom Bottomore
- Sociology : S. N. Shankara Rao
- Sociology : D. C. Bhattacharya
- Sociology : P.B. Kar
- Guide to Modern Thought : C. E. M. Joad
- Introduction to Modern Political Theory: C.E.M. Joad
- The Evolution of Political Philosophy of Gandhi: Buddhadeb Bhattacharya
- Social and Political Thought of Gandhi: Jayantanuja Bandyopadhyay
- Religion in India: T.N.Madan(ed.)
- Religion and society: S. Radhakrishnan
- Secularisim in the present Indian Society: Amal Kumar Mukherjee
- Secularism and its Critics: Rajeev Bhargava(ed.)
- Unravelling the Nation-Secular conflict and india's Secular Identity: Kaushil Basu & Sanjay Subramaniyam (ed.)
- India as a Secular State: D.E. Smith
- The Philosophy of Mahatma Gandhi: D. M. Dutta
- The Philosophy of Sarvodaya: K. S. Bharathi
- Communist Manifesto: Karl Marx & Frederick Engels
- Socialism- Utopian and Scientific: F. Engels
- Open Society and Its Enemies: Karl Popper
- The Open Philosophy and The Open Society: M. Cornforth
- Political Thought: C. L. Wayper
- Political Philosophy- An introduction W. T. Blackstone
- Western Political Thought: Brian R. Nelson

Bengali:

- Samaj Darshan Dipika: Pritibhusan Chattopadhyay
- Samaj Tattva: Parimal Bhusan Kar
- Samaj Tattve: T. Bottomore
- Bisay Samaj Darshan: Anadi Kumar Mahapatra
- Samjdarshan O Rashtradarshaner Parichoy: A. K. MahapatraO P.Mukherjee
- Rashtradarshaner Dhara: Amal Kumar Mukhopadhyay
- Samyabader Istehar: Marx O Engels
- Samajtantra-Kalponik O Baijnanik: F. Engels
- Marxiya Rashtrachinta: Shovan Lal Dutta Gupta
- Sarvodaya Andoloner Itihas: Gurudas Bandyopadhyay
- Gandhi Rachanasambhar: M.K.Gandhi

Semester 6

PHI-G-DSE-B
Any one from the following optoions
a)Applied Ethics and Philosophy of Religion. (6 Credits per week)

A. Concepts of Applied Ethics.
B. Killing: Suicide, Euthanasia.
C. Famine, Affluence and Morality.
D. Environmental Ethics: Value Beyond Sentient Beings, Reverence for life, Deep Ecology.
E. Nature & Concerns of Philosophy of Religion. Argument for the existence of God: Cosmological argument, Ontological argument and Teleological argument.
F. Problem of Evil and Suffering.
G. Grounds for disbelief in God: Sociological theory of Durkheim, Freudian Theory, CārvākaView.

Suggested Readings:
English:

- Practical Ethics: Peter Singer
- Applied Ethics: Peter Singer (ed)
- Philosophy of Religion: M. Edwards
- The Idea of God: Pringle Patison
- Atheism in Indian Philosophy: D. P. Chatterjee
- Philosophy of Religion: J. Hick
- An Introduction to the Philosophy of Religion: Brian Davies
- Indian Philosophy of Religion: A. Sharma

Bengali:

- Vyavaharik Nitivijnan: N. Nandy & M. Bal
- Dharma Darshan: A. Bandyopadhyay O K.C. Gupta
- Dharma Darshan : Rabindranath Das
- Dharma Darshan: Sushil Kumar Chakraborty
- Bharatiya Dharmaniti: Amita Chattopadhyay (Sampadita)
- Bharatiya Darshane Nirishvarvada: B. B. Purakayastha (pp39-50,56-66)

b)Contemporary Indian Thought (6 Credits per week)

i)Swami Vivekananda: Nature of Man, Nature of Religion, Ideal of

universal religion, Practical Vedānta

ii)M.K. Gandhi : Nature of man, non-violence, satyāgraha, theory of trusteeship

iii)B.R. Ambedkar: Critique of social evils, Dalit movement

Suggested Readings:

English:

- Practical Vedanta(Vol II, pp. 291—358): Swami Vivekananda
- Swami Vivekananda as a Philosopher: J.L. Shaw
- The Philosophy of Swami Vivekananda : Pradip Kumar Sengupta
- The Philosophy of Mahatma Gandhi: D.M.Dutta
- The Philosophy of Sarvodaya: K.S. Bharati
- Gandhi's Political Philosophy: Bhikhu Parekh
- Dr.Ambedkar –Life & Mission: Dhananjoy Keer
- Social Philosophy of B. R. Ambedkar: D.R. Jatava

Bengali:

- Chintanayak Vivekananda:Swami Lokeshwarananda(ed)
- Visva—Vivek: Asit Kr Bandyopadhyay, Shankari Prasad Basu, Shankar.
- Sarvodaya Andoloner Itihas: Gurudas Bandyopadhyay
- Gandhi Parikrama: Sailesh Kumar Bandyopadhyay

Skill Enhancement Elective course

PHI-G-SEC-A(Any one from the following options either in Semester 3 or in Semester 5)

a)Logical Reasoning and Application (2 Credits per week)

1.The main objective of logical reasoning.

2. Definitions: Pakṣa, sādhya, hetu, sapakṣa and Vipakṣa.

3.Construction of kevalānvayī, kevalavyātirekī anvayvyātirekī anumiti.

4.Hetvābhāsa and its different kinds, detection of hetvābhāsa.

5.Reasoning in practice:

i)Fallacy of relevance, Fallacies of ambiguity, Fallacies of weak induction, Avoiding fallacies

ii)Logical applications of the concept of pakṣatā

iii)Functional applications of ordinary operative relations between sense-organs and respective objects.

6.Inductive reasoning in Law

(i) The method of Inquiry in Law

(ii) Causation in Legal reasoning
(iii) Analogical Reasoning in legal argument
(iv) Probability in legal argument.

7.Deductive Reasoning in Law
(i) Determining the correct rule of Law
(ii) Identifying, formulating, and applying rules of law.
(iii) The law of libel
(iv) Logic is right reasoning

Suggested Readings:
English:

- Introduction to Logic (9th Edition) : I. M. Copi & C. Cohen, Prentice Hall of India Pvt. Ltd., New Delhi, 1999.
- The Elements of Logic (5th Edition): S.F.Barker, McGraw-Hill Book Company, 1988.
- Introduction to Logic : P.J. Hurley, Wadsworth, 2007.
- Tarkasaṁgraha: Annaṁbhatta
- Word and the World: B.K. Matilal
- Tarkasaṁgraha: M.R. Bodas & Y.V. Athalye (tr. &ed.)
- The Concept of Logical Fallacies: Nandita Bandyopadhaya

Bengali:

- Tarkasaṁgraha with Dipika: Narayan Chandra Goswami
- Tarkasaṁgraha with Dipika: Indira Mukhopadhyay
- Tarkasaṁgraha with Dipika: Panchanan Shastri
- Tarkasaṁgraha with Dipika: Kanailal Poddar

b)Business Ethics

1.Why Study Business Ethics?
i)Ethical Issues in business
ii) Ethical principles in business
2.Environment and Business Ethics
i)Business ethics and environmental values
ii)Ethics of conserving depletable resources
3.Ethics in Management
i)Management by Value Programmes: a qualitative appraisal
ii) Ethical vision of Management : A Vedantic outline

Suggested Reading:
English:
1.Business Ethics(7th edition) : Manuel G. Velasquez (Chapter 1,2&5)
2.Ethics in Management : S. K. Chakraborty (Chapter 1&5)
3.Management by Values -towards cultural congruence : S.K.Chakraborty

4.Management Ethics-integrity at work: J.A.Patrick & John F. Quinn
5.Business Ethics and Corporate Governance, Pearson Education India
6.Business Ethics-an introduction to the ethics of values:Lucjan Klimsza

PHI-G-SEC-B (Any one from the following options either in Semester 4 or in Semester 6)

a)Man and Environment (2 Credits per week)

A. Classical Indian Attitude to Environment

i) The Upanisadic world-view, ii) Tagore's understanding of nature, iii) The post-Upanisadic view of nature

B. Respect for Nature

i) The attitude of respect, ii) Bio-centric outlook to nature, iii) Ethical standards and rules that follow from the attitude of respect to nature, iv) The idea of inherent worth of nature.

C. Intrinsic Value of nature

B. Moore's talk of 'intrinsic properties', ii) Chilsom's idea of intrinsic value, iii) Attfield on the intrinsic value of nature, iv) Callicott's idea of intrinsic value of nature, v) Rolston III on intrinsic value of nature, vi) intrinsic value and objective value

D. Deep Ecology and its Third World Critique

i)Arne Naess on Deep Ecology, ii) Ramchandra Guha's critique of Deep Ecology

E. Eco-feminism

i) Understanding nature and the feminine, ii) Dualisms in Western tradition, iii) Masculinity, humanity and nature.

Suggested Readings
English:

1. 'Attitudes to Nature'John Passmore , Environmental Ethics (ed.) Robert Elliot, Oxford University Press, Oxford, 1998
2. Sadhana (first Chapter), Rabindranath Tagore, Macmillan, New York, 1915

3. Respect for Nature: A Theory of Environmental Ethics (Select Parts),Paul Taylor, Princeton University Press, Princeton, 1986
4. 'Intrinsic value, Environmental Obligation and Naturalness',Robert Elliot, Monist, 1975
5. 'The Shallow and the Deep, Long-Range Ecology Movements: A Summary',Arne Naess, Inquiry, 1973
6. Nature, Self and Gender: Feminism, Environmental Philosophy and the Critique of Rationalism,Val Plumwood, Environmental Ethics (ed.) Robert Elliot, Oxford University Press, Oxford, 1998

Bengali:

7. Paribesh o Naitikata,Nirmalya Narayan Chakraborty, Progressive Book Forum, Kolkata, 2002

b)Value Education (2 Credits per week)

a) Meaning, Characteristics, significance and objectives of Value education
b) Values in different contexts: Individual, Social, Cultural, Moral and Global and Spiritual.
c) Meaning and Characteristics of Peace education
d) Aims and Objectives of Peace Education
e) Types of peace education
f) Peace and Value Education in Global Perspective.

Suggested Readings:

English:

- Introduction to Peace Studies: David P. Barash Belmont
- 'International Relations', in The English Writings of Rabindranath Tagore: A Miscellany, (ed) Sisir Kumar Das: Rabindra Nath Tagore.
- Handbook of Peace and Conflict Studies: Charles Webel and Johan Galtung(eds.).
- Peace and Value Education: Babu Muthuja.
- Philosophy of Value: Aditya Mohanty

Principal
Vijaygarh Jyotish Ray College
Kolkata-700 032