RAYAGADA AUTONOMOUS COLLEGE
RAYAGADA

PROPOSED SYLLABUS AND SCHEME OF EXAMINATION
FOR
+3 Sc. BOTANY HONOURS

UNDER CHOICE BASED CREDIT SYSTEM (CBCS)

FOR THE SESSION:

2018-2019
2019-2020
2020-2021

BOARD OF STUDIES IN BOTANY
RAYAGADA AUTONOMOUS
COLLEGE RAYAGADA: 765001

Syllabus for +3 (Hons.) BOTANY, Choice Based Credit System

SEMESTER	COURSE OPTED	COURSE NAME	Credits	Marks
SEMESTER-I	Ability Enhancement Compulsory Course-I	English communications	2	50
	Core course-I(Theory)	Microbiology and Phycology	4	75
	Core Course-I(Practical)	Microbiology and Phycology	2	25
	Core course-II (Theory)	Biomolecules and Cell Biology	4	75
	Core course-II (Practical)	Biomolecules and Cell Biology	2	25
	Generic Elective -1(Theory)	GE-1 - Biodiversity (Microbes, Algae, Fungi & Archegoniate)	4	75
	Generic Elective -1 (Practical)	GE-1 - Biodiversity (Microbes, Algae, Fungi & Archegoniate)	2	25
SEMESTER-II	Ability Enhancement Compulsory Course-II	Environmental Science	2	50
	Core course-III(Theory)	Mycology and Phytopathology	4	75
	Core course-III (Practical)	Mycology and Phytopathology	2	25
	Core course-IV(Theory)	Archegoniate	4	75
	Core course-IV (Practical)	Archegoniate	2	25
SEMESTER - III	Core course-V(Theory)	Anatomy of Angiosperms	4	75
	Core course-V(Practical)	Anatomy of Angiosperms	2	25
	Core course-VI (Theory)	Economic Botany	4	75
	Core course-VI (Practical)	Economic Botany	2	25
	Core course-VII (Theory)	Genetics	4	75
	Core course-VII (Practical)	Genetics	2	25
	SECC-I	Communicative English	2	50

Syllabus for +3 (Hons.) BOTANY, Choice Based Credit System

SEMESTER	COURSE OPTED	COURSE NAME	Credits	Marks
SEMESTER - IV	Core course-VIII (Theory	MolecularBiology	4	75
	Core course-VIII (Practical)	MolecularBiology	2	25
	Core course-IX (Theory)	Plant Ecology& Phytogeography	4	75
	Core course-IX (Practical)	Plant Ecology& Phytogeography	2	25
	Core Course- X (Theory)	Plant Systematics	4	75
	Core Course- X (Practical)	Plant Systematics	2	25
	Generic Elective-2 (Theory)	Economic Botany and Plant Biotechnology	4	75
	Generic Elective-2 (Practical)	Economic Botany and Plant Biotechnology	2	25
	SECC-2	Quantitative and Logical Thinking	2	50
SEMESTER- V	Core-XI (Theory)	Reproductive Biology of Angiosperms	4	75
	Core course-XI (Practical)	Reproductive Biology of Angiosperms	2	25
	Core-XII (Theory)	Plant Physiology	4	75
	Core course-XII (Practical)	Plant Physiology	2	25
	Discipline Specific Elective - 1(Theory)	Stress Biology	4	75
	Discipline Specific Elective - 1(Practical)	Stress Biology	2	25
	Discpline Specific Elective – 2(Theory)	Plant Breeding	4	75
	Discpline Specific Elective – 2(Practical)	Plant Breeding	2	25

Syllabus for +3 (Hons.) BOTANY, Choice Based Credit System

SEMESTER	COURSE OPTED	COURSE NAME	Credits	Marks
SEMESTER -VI	Core course-XIII (Theory)	Plant Metabolism	4	75
	Core course-XIII (Practical)	Plant Metabolism	2	25
	Core course-XIV (Theory)	Plant Biotechnology	4	75
	Core course-XIV (Practical)	Plant Biotechnology	2	25
	Discipline Specific Elective – 3(Theory)	Natural resources & Management	4	75
	Discipline Specific Elective – 3(Practical)	Natural resources & Management	2	25
	Discipline Specific Elective – 4and DSE Practical	Biostatistics	4	75
		Biostatistics	2	25

CBCS MARKS&TIME DISTRIBUTION PATTERN

1. In Core or Generic or other courses, Papers carrying the full marks of 100, holding 15 Marks for MidSem., 60 Marks in Semester examination and 25 Marks in Practical examination.
2. In Skill Enhanced Compulsory Courses, papers carrying the full Marks of 50, holding 10 Marks for MidSem, 40 marks in Semester examination.
3. In the Papers of full marks 100, the Semester examination will be of 60 full marks for 03 hours duration.
4. In the papers of full Marks 50, the Semester examination will be of full marks 40 for 02 hours duration.
5. In term end Semester Examination- Section A carries objective questions with 4 marks each for the 20 % of the full marks meant for the term end examinations in a paper. Section B comprises of 4 long questions from 4 different units in a paper each carrying equal marks.

CORE COURSES
SEMESTER I

Core Course I: Microbiology and Phycology – 100 marks

(Credits-6: Theory-4, Practical-2)
[75 marks (Mid Sem 15 + End Sem 60)]
Lectures: 60 [40 Theory + 20 Practical classes]

Unit-I	Introduction to microbial world, microbial nutrition, growth and metabolism. **Viruses:** Discovery, physiochemical and biological characteristics; classification(Baltimore), general structure with special reference to viroids and prions; replication (general account), DNA virus (T-phage), lytic and lysogenic cycle; RNA virus (TMV). Economic importance of viruses,with reference to vaccine production, role in research, medicine and diagnostics, as causal organisms of plant diseases. **Bacteria:** Discovery, general characteristics, types-archaebacteria, eubacteria, wall-lessforms (mycoplasma and spheroplasts), cell structure, nutritional types, reproduction-vegetative, asexual and recombination. Economic importance of bacteria.
Unit-II	**Algae:** General characteristics: distribution; range of thallus organization; Cell structureand components; cell wall, pigment system, reserve food, flagella; and methods of reproduction; classification of algae given by Fritsch,significant contributions of important phycologists (F.E. and M.O.P. Iyengar). Economic importance of algae. **Cyanophyta:** General characteristics: distribution, cell structure, ultrastucture, heterocyst,reproduction; Morphology and life-cycle of *Oscillatoria* and *Nostoc;* Economic importance of Cyanophyta.
Unit-III	**Rhodophyta:** General characteristics, occurrence, range of thallus organization, cellstructure and reproduction. Morphology and life-cycle of *Polysiphonia.* **Phaeophyta:** Characteristics, occurrence, range of thallus organization, cell structure andreproduction. Morphology and life-cycles of *Fucus.*
Unit-IV	**Xanthophyta:** General characteristics; range of thallus organization; Occurrence,morphology and life-cycle of *Vaucheria.* **Chlorophyta:** General characteristics, occurrence, range of thallus organization, cellstructure and reproduction. Morphology and life-cycles, *Volvox, Oedogonium,Coleochaete.* **Charophyta:** General characteristics; occurrence, morphology, cell structure and life-cycleof *Chara*; evolutionary significance.

SEMESTER I
Core Course I
Microbiology and Phycology
Practical

Microbiology	1. Electron micrographs/Models of viruses – T-Phage and TMV, Line drawings/ Photographs of Lytic and Lysogenic Cycle. 2. Types of Bacteria to be observed from temporary/permanent slides/photographs. Electron micrographs of bacteria, binary fission, endospore, conjugation, root Nodule. 3. Gram staining. 4. Endospore staining with malachite green using the (endospores taken from soil bacteria).
Phycology	Study of vegetative and reproductive structures of *Nostoc, Chlamydomonas*(electron micrographs), Volvox, *Oedogonium,Coleochaete, Chara, Vaucheria, Ectocarpus, Fucus and Polysiphonia,Procholoron*through electron micrographs, temporary preparations and permanent slides.

Suggested Readings

1. Lee, R.E. (2008). Phycology, Cambridge University Press, Cambridge.4th edition.
2. Prescott, L.M., Harley J.P., Klein D. A. (2005). Microbiology, McGraw Hill, India.6th edition.
3. Kumar, H.D. (1999). Introductory Phycology.Affiliated East-West Press, Delhi.
4. Sahoo, D. (2000). Farming the ocean: seaweeds cultivation and utilization.Aravali International, NewDelhi.
5. Campbell, N.A., Reece J.B., Urry L.A., Cain M.L., Wasserman S.A. Minorsky P.V., Jackson R.B. (2008). Biology, Pearson Benjamin Cummings, USA.8th edition.
6. Pelczar, M.J. (2001) Microbiology, 5th edition, Tata McGraw-Hill Co, New Delhi.

SEMESTER I

Core Course II: Biomolecules and Cell Biology – 100 marks

(Credits-6: Theory-4, Practical-2)
[75 marks (Mid Sem 15 + End Sem 60)]
Lectures: 60 [40 Theory + 20 Practical classes]

Unit-I	**Biomolecules:** Types and significance of chemical bonds; Structure and properties of water; pH and buffers. **Carbohydrates:** Nomenclature and classification; monosaccharide, Disaccharides, Oligosaccharides and polysaccharides. **Lipids:** Definition and major classes of storage and structural lipids. Storage lipids. Fatty acids structure and functions. Essential fatty acids. Triglyceride structure, functions and properties. **Proteins:** Structure of amino acids; Peptide bonds; Levels of protein structure-primary, secondary, tertiary and quarternary; Isoelectric point; Protein denaturation and biological roles of proteins. **Nucleic acids:** Structure of nitrogenous bases; Structure and function of nucleotides; Types of nucleic acids; Structure of A, B, Z types of DNA;Types of RNA; Structure of tRNA.
Unit-II	**Bioenergenetics:** Laws of thermodynamics, concept of free energy, endergonic and exergonic reactions, coupled reactions, redox reactions.ATP: structure and its role as an energy currency molecule. **Enzymes:** Structure of enzyme: holoenzyme, apoenzyme, cofactors, coenzymes and prosthetic group; Classification of enzymes; Features of active site, substrate specificity, mechanism of action (activation energy, lock and key hypothesis, induced - fit theroy), Michaelis – Menten equation, enzyme inhibition and factors affecting enzyme activity.
Unit-III	**The cell:** Cell as a unit of structure and function; Characteristics of prokaryotic and eukaryotic cells; Origin of eukaryotic cell (Endosymbiotic theory). **Cell wall and plasma membrane:** Chemistry, structure and function of cell wall. Overview of membrane structure and function; fluid mosaic model; Chemical composition of membranes; Membrane transport – Passive, active and facilitated transport, endocytosis and exocytosis. **Cell organelles:** Chloroplast, mitochondria and peroxisomes**:** Structural organization; Function; Semiautonomous nature of mitochondria and chloroplast. Endoplasmic Reticulum, Golgi Apparatus, Lysosomes, Vacuoles
Unit-IV	**Nucleus;** Structure-nuclear envelope, nuclear porecomplex, nuclear lamina, molecular organization of chromatin; nucleolus. **Cytoskeleton:** Role and structure of microtubules, microfilaments and intermediary filament **Cell division:** Eukaryotic cell cycle and regulation, different stages of mitosis and meiosis

SEMESTER I
Core Course II
Biomolecules and Cell Biology
Practical

1. Qualitative tests for carbohydrates, reducing sugars, non-reducing sugars, lipids and proteins.
2. Study of plant cell structure with the help of epidermal peel mount of Onion/*Rhoeo/Crinum*.
3. Demonstration of the phenomenon of protoplasmic streaming in *Hydrilla* leaf.
4. Measurement of cell size by the technique of micrometry.
5. Counting the cells per unit volume with the help of haemocytometer. (Yeast/pollen grains).
6. Study of cell and its organelles with the help of electron micrographs.
7. Study the phenomenon of plasmolysis and deplasmolysis.
8. Study different stages of mitosis and meiosis using aceto carmine and acetoorcine method.

Suggested Readings

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. Karp, G. (2010). Cell Biology, John Wiley & Sons, U.S.A. 6th edition.
7. Hardin, J., Becker, G., Skliensmith, L.J. (2012). Becker's World of the Cell, Pearson Education Inc. U.S.A. 8th edition.
8. Cooper, G.M. and Hausman, R.E. 2009 The Cell: A Molecular Approach. 5th edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.
9. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. 2009 The World of the Cell. 7th edition.Pearson Benjamin Cummings Publishing, San Francisco

Semester-II

Core Course III: Mycology and Phytopathology – 100 marks

(Credits-6: Theory-4, Practical-2)
[75 marks (Mid Sem 15 + End Sem 60)]
Lectures: 60 [40 Theory + 20 Practical classes]

Unit-I	**Introduction to true fungi:** Definition, General characteristics; Affinities with plants and animals; Thallus organization; Cellwall composition; Nutrition; Classification,Economic importance of fungi**.** **Chytridiomycetes:** General account, life cycle with reference to *Synchytrium* **Zygomycota:** General characteristics; Ecology; Thallus organisation; Life cycle with reference to *Rhizopus*.
Unit-II	**Ascomycota:** General characteristics (asexual and sexual fruiting bodies); Ecology; Life cycle, Heterokaryosis and parasexuality; life cycle and classification with reference to *Saccharomyces, Aspergillus*, *Alternaria*and *Neurospora, .* **Basidiomycota:** General characteristics; Ecology; Life cycle and Classification with reference to black stem rust on wheat *Puccinia*(Physiological Specialization), loose and covered smut (symptoms only),*Agaricus*; Bioluminescence and Mushroom cultivation.
Unit-III	**Oomycota:** General characteristic; Ecology; Life cycle and classification with reference to *Phytophthora, Albugo.* **Symbiotic associations:** Lichen – Occurrence; General characteristics; Growth forms and range of thallus organization; Nature of associations of algal and fungal partners; Reproduction.Mycorrhiza-Ectomycorrhiza, Endomycorrhiza and their significance.
Unit-IV	**Phytopathology:** Terms and concepts; General symptoms; Geographical distribution of diseases; etiology; symptomology; Host-Pathogen relationships;disease cycle and environmental relation; prevention and control of plant diseases, and role of quarantine. Bacterial diseases – Citrus canker and angular leaf spot disease of Cotton.Viral diseases – Tobacco Mosaic viruses, vein clearing. Fungal diseases – Early blight of potato, Black stem rust of wheat, white rust of crucifers.

Semester-II
Core Course III
Mycology and Phytopathology
Practical

1. Introduction to the world of fungi (Unicellular, coenocytic/septate mycelium, asocarps&basidiocarps).
2. *Rhizopus*: study of asexual stage from temporary mounts and sexual structures through permanent slides.
3. *Aspergillus*and *Penicillium*: study of asexual stage from temporary mounts. Study of Sexual stage from permanent slides/photographs.
4. *Peziza*: sectioning through ascocarp.
5. *Alternaria:* Specimens/photographs and temporary mounts.
6. *Puccinia*: Herbarium specimens of Black Stem Rust of Wheat and infected Barberryleaves; sections/ mounts of spores on wheat and permanent slides of both the hosts.
7. *Agaricus*: Specimens of button stage and full grown mushroom; sectioning of gills of*Agaricus*, fairy rings and bioluminescent mushrooms to be shown.
8. *Albugo:* Study of symptoms of plants infected with *Albugo*; asexual phase study throughsection/ temporary mounts and sexual structures through permanent slides.
9. Lichens: Study of growth forms of lichens (crustose, foliose and fruticose) on different substrates. Study of thallus and reproductive structures (soredia and apothecium) through permanent slides. Mycorrhizae: ectomycorrhiza and endomycorrhiza(Photographs)
10. Phytopathology: Herbarium specimens of bacterial diseases; Citrus Canker; Viral diseases: TMV, Fungal diseases: Early blight of potato, and White rust of crucifers.

Suggested Readings

1. Agrios, G.N. 1997 Plant Pathology, 4th edition, Academic Press, U.K.
2. Alexopoulos, C.J., Mims, C.W., Blackwell, M. (1996). Introductory Mycology, John Wiley & Sons (Asia) Singapore. 4th edition.
3. Webster, J. and Weber, R. (2007). Introduction to Fungi, Cambridge University Press, Cambridge. 3rd edition.
4. Sethi, I.K. and Walia, S.K. (2011). Text book of Fungi and Their Allies, Macmillan Publishers India Ltd.
5. Sharma, P.D. (2011). Plant Pathology, Rastogi Publication, Meerut, India.

Semester-II

Core Course IV: Archegoniate – 100 marks

(Credits-6: Theory-4, Practical-2)
[75 marks (Mid Sem 15 + End Sem 60)]
Lectures: 60 [40 Theory + 20 Practical classes]

Unit-I	**Introduction:** Unifying features of archegoniates; Transition to land habit; Alternation of generations. **Bryophytes:** General characteristics; Adaptations to land habit; Classification; Range of thallus organization
Unit-II	**Type Studies- Bryophytes**;Classification (up to*family*; Reproduction and evolutionary trends in Riccia, Marchantia, Anthoceros and Sphagnum (developmental stages not included). Ecological andeconomic importance of bryophytes with special reference to*Sphagnum*.
Unit-III	**Pteridophytes:** General characteristics, classification. Classification (up to family), morphology, anatomy and reproduction of *Psilotum*, *Selaginella*, *Equisetum* and *Pteris*.(Developmental details not to be included).Apogamy, and apospory, heterosporyandseed habit, telome theory, stellar evolution.Ecological and economic importance.
Unit-IV	**Gymnosperms:** General characteristics, classification (up to family), morphology, anatomy and reproduction of *Cycas*, *Pinus,* and*Gnetum*. (Developmental details not to be included). Ecological and economic importance. **Fossils:**Geographical time scale, fossils and fossilization process. Morphology, anatomy and affinities of *Rhynia,Lepidodendron,*

Semester-II
Core Course IV
Archegoniate
Practical

1. ***Riccia***– Morphology of thallus.
2. ***Marchantia***- Morphology of thallus, whole mount of rhizoids & Scales, vertical sectionofthallus through Gemma cup, whole mount of Gemmae (all temporary slides), vertical section of Antheridiophore, Archegoniophore, longitudinal section of Sporophyte(all permanent slides).
3. ***Anthoceros***- Morphology of thallus, dissection of sporophyte (to show stomata, spores,pseudoelaters, columella) (temporary slide), vertical section of thallus (permanent slide).
4. ***Pellia, Porella***- Permanent slides.
5. ***Sphagnum***- Morphology of plant, whole mount of leaf (permanent slide only).
6. ***Funaria***- Morphology, whole mount of leaf, rhizoids, operculum, peristome, annulus,spores (temporary slides); permanent slides showing antheridial and archegonial heads, longitudinal section of capsule and protonema.
7. ***Psilotum***- Study of specimen, transverse section of synangium (permanent slide).
8. ***Selaginella***- Morphology, whole mount of leaf with ligule, transverse section of stem,whole mount of strobilus, whole mount of microsporophyll and megasporophyll (temporary slides), longitudinal section of strobilus (permanentslide).
9. ***Equisetum***- Morphology, transverse section of internode, longitudinal section ofstrobilus, transverse section of strobilus, whole mount of sporangiophore, whole mount of spores (wet and dry) (temporary slide), transverse section of rhizome (permanent slide).
10. ***Pteris***- Morphology, transverse section of rachis, vertical section of sporophyll, wholemount of sporangium, whole mount of spores (temporary slides), transverse section of rhizome, whole mount of prothallus with sex organs and young sporophyte(permanent slide).
11. ***Cycas***- Morphology (coralloid roots, bulbil, leaf), whole mount of microsporophyll,transverse section of coralloid root, transverse section of rachis, vertical section of leaflet, vertical section of microsporophyll, whole mount of spores(temporary slides), longitudinal section of ovule, transverse section of root(permanent slide).
12. ***Pinus***- Morphology (long and dwarf shoots, whole mount of dwarf shoot, male andfemalecones), transverse section of Needle, transverse section of stem, longitudinal section of transverse section of male cone, whole mount of microsporophyll, whole mount of Microspores (temporary slides), longitudinal section of female cone, tangential longitudinal section & radial longitudinal sections stem (permanent slide).
13. ***Gnetum***- Morphology (stem, male & female cones), transverse section of stem, verticalsection of ovule (permanent slide)
14. **Botanical excursion.**

Suggested Readings

1. Vashistha, P.C., Sinha, A.K., Kumar, A. (2010). Pteridophyta. S. Chand. Delhi, India.
2. Bhatnagar, S.P. &Moitra, A. (1996). Gymnosperms. New Age International (P) Ltd Publishers, New Delhi, India
3. Parihar, N.S. (1991). An introduction to Embryophyta: Vol. I. Bryophyta. Central Book Depot. Allahabad.
4. Raven, P.H., Johnson, G.B., Losos, J.B., Singer, S.R. (2005). Biology.Tata McGraw Hill, Delhi.
5. Vander-Poorteri 2009 Introduction to Bryophytes. COP.

Semester-III

Core Course V: Anatomy of Angiosperms – 100 marks

(Credits-6: Theory-4, Practical-2)
[75 marks (Mid Sem 15 + End Sem 60)]
Lectures: 60 [40 Theory + 20 Practical classes]

Unit-I	**Introduction and scope of Plant Anatomy:** Applications in systematics, forensics and pharmacognosy**.** **Tissues:** Classification of tissues; Simple and complex tissues (no phylogeny); cytodifferentiation of tracheary elements and sieve elements;Pits and plasmodesmata; Wall ingrowths and transfer cells, adcrustation and incrustation,Ergastic substances.
Unit-II	**Stem:** Organization of shoot apex (Apical cell theory, Histogen theory, Tunica Corpus theory, continuing meristematic residue, cytohistological zonation); Types of vascular bundles; Structure of dicot and monocot stem. **Leaf:** Origin, development, arrangement and diversity in size and shape of leaves;Structure of dicot and monocot leaf, Kranz anatomy. **Root:** Structure of dicot and monocot root;Organization of root apex (Apical cell theory, Histogen theory, Korper-Kappe theory); Quiescentcentre; Root cap;
Unit-III	**Vascular Cambium:** Structure, function and seasonal activity of cambium; Secondary growth in root and stem. **Wood:** Axially and radially oriented elements; Types of rays and axial parenchyma; Cyclic aspects and reaction wood; Sapwood and heartwood; Ring and diffuse porous wood; Early and late wood,tyloses; Dendrochronology. **Periderm:** Development and composition of periderm,rhytidome and lenticels.
Unit-IV	**Adaptive and Protective Systems** Epidermal tissue system, cuticle, epicuticular waxes, trichomes(uni-and multicellular, glandular and nonglandular, two examples of each), stomata (classification); Adcrustation and incrustation;Anatomical adaptations of xerophytes and hydrophytes. **Secretory System:**Hydathodes, cavities, lithocysts and laticifers.

Semester-III
Core Course V
Anatomy of Angiosperms
Practical

1. Study of anatomical details through permanent slides/temporary stain mounts/macerations/ museum specimens with the help of suitable examples.
2. Apical meristem of root, shoot and vascular cambium.
3. Distribution and types of parenchyma, collenchyma and sclerenchyma.
4. Xylem: Tracheary elements-tracheids, vessel elements; thickenings; perforation plates; xylem fibres.
5. Wood: ring porous; diffuse porous; tyloses; heart- and sapwood.
6. Phloem: Sieve tubes-sieve plates; companion cells; phloem fibres.
7. Epidermal system: cell types, stomata types; trichomes: non-glandular and glandular.
8. Root: monocot, dicot, secondary growth.
9. Stem: monocot, dicot - primary and secondary growth; periderm; lenticels.
10. Leaf: isobilateral, dorsiventral, C4 leaves (Kranz anatomy).
11. Adaptive Anatomy: xerophytes, hydrophytes.
12. Secretory tissues: cavities, lithocysts and laticifers.

Suggested Readings

1. Dickison, W.C. (2000). Integrative Plant Anatomy.Harcourt Academic Press, USA.
2. Fahn, A. (1974). Plant Anatomy.Pergmon Press, USA.
3. Mauseth, J.D. (1988). Plant Anatomy. The Benjammin/Cummings Publisher, USA.
4. Esau, K. (1977). Anatomy of Seed Plants. John Wiley & Sons, Inc., Delhi.

Semester-III

Core Course VI: Economic Botany – 100 marks

(Credits-6: Theory-4, Practical-2)
[75 marks (Mid Sem 15 + End Sem 60)]
Lectures: 60 [40 Theory + 20 Practical classes]

Unit-I	**Origin of Cultivated Plants:** Concept of Centres 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 germplasmdiversty.
Unit-II	**Cereals :**Wheat and Rice (origin, morphology, processing & uses), Nutritional values of cerials, millets and pulses brief account of millets(*Pannicetum*, *Sorghum Eleusine*). **Legumes:** General account of Chick pea, Pigeon pea, their origin, cultivation and processing, Importance to man and ecosystem. **Sugars & Starches:** Morphology and processing of sugarcane, roducts and by-products of sugarcane industry. Potato – morphology, propagation & uses.
Unit-III	**Spices:** Listing of important spices, their family and part used, economic importance with specialreference to fennel, saffron, clove and black pepper **Oils & Fats:** General description, classification, extraction, their uses and health implications groundnut, coconut, linseed,soybean and mustard (Botanical name, family & uses) **Essential Oils:** General account, extraction methods, comparison with fatty oils & their uses.
Unit -IV	**Drug-yielding plants:** Therapeutic and habit-forming drugs with special reference to C*inchona, Digitalis, Papaver*and*Cannabis.*Tobacco (Morphology, processing, uses and health hazards) **Biofuel plants:** Bioethanol (maiz and sugarcane) Biodiesel (*Jatrophacarcus*)cultivation and and processing **Natural Rubber:** Para-rubber: tapping, processing and uses. **Timber plants:** General account with special reference to teak and pine. **Fibres:** Classification based on the origin of fibres, Cotton and Jute(morphology, extraction and uses).

Semester-III
Core Course VI
Economic Botany
Practical

1. Cereals: Rice (habit sketch, study of paddy and grain, starch grains, micro-chemical tests).
2. Legumes: Soya bean, Groundnut, (habit, fruit, seed structure, micro-chemical tests).
3. Sugars & Starches: Sugarcane (habit sketch; cane juice- micro-chemical tests), Potato(habit sketch, tuber morphology, T.S. tuber to show localization of starch grains, w.m. starch grains, micro-chemical tests).
4. Spices: Black pepper, Fennel and Clove (habit and sections).
5. Beverages: Tea (plant specimen, tea leaves), Coffee (plant specimen, beans).
6. Oils & Fats: Coconut- T.S. nut, Mustard–plant specimen, seeds; tests for fats in crushedseeds.
7. Essential oil-yielding plants: Habit sketch of*Rosa*, V*etiveria, Santalum* and*Eucalyptus*(specimens/photographs).
8. Rubber: specimen, photograph/model of tapping, samples of rubber products.
9. Drug-yielding plants: Specimens of *Digitalis, Papaver*and*Cannabis.*
10. Tobacco: specimen and products of Tobacco.
11. Woods: Tectona, Pinus: Specimen, Section of young stem.
12. Fibre-yielding plants: Cotton (specimen, whole mount of seed to show lint and fuzz;whole mount of fibre and test for cellulose), Jute (specimen, transverse section of stem, test for lignin on transverse section of stem and fibre).

Suggested Readings

1. Kochhar, S.L. (2012). Economic Botany in Tropics, MacMillan & Co. New Delhi, India.
2. Wickens, G.E. (2001). Economic Botany: Principles & Practices. Kluwer Academic Publishers, The Netherlands.
3. Chrispeels, M.J. and Sadava, D.E. (2003). Plants, Genes and Agriculture. Jones & Bartlett Publishers.

Semester-III

Core Course VII: Genetics – 100 marks

(Credits-6: Theory-4, Practical-2)
[75 marks (Mid Sem 15 + End Sem 60)]
Lectures: 60 [40 Theory + 20 Practical classes]

Unit-I	**Mendelian genetics and its extension** Mendelism: History; Principles of inheritance; Chromosome theory of inheritance; Autosomes and sex chromosomes; Probability and pedigree analysis**:** Incomplete dominance and codominance; Multiple alleles, Lethal alleles, Epistasis, Pleiotropy, Recessive and Dominant traits, Extrachromosomal Inheritance; Maternal effects-shell coiling in snail; Infective heredity- Kappa particles in *Paramecium.,*epigentics, autosomes and sex chromosomes**:** chromosome morphology and karyotype
Unit-II	**Linkage, crossing over and chromosome mapping:** Linkage and crossing over-Cytological basis of crossing over; Recombination frequency, two factor and three factor crosses; Interference and coincidence; Numericals based on gene mapping; Sex Linkage.
Unit-III	**Variation in chromosome number and structure:** Deletion, Duplication, Inversion, Translocation, Position effect, Euploidy and Aneuploidy, induction of polyploidy. **Gene mutations:** Types of mutations; spontaneous and induced Molecular basis of Mutations; Mutagens – physical and chemical (Base analogs, deaminating, alkylating and intercalating agents); Detection of mutations: CIB method. Role of Transposons in mutation.DNA repair mechanisms
Unit-IV	**Gene and gene concept:** Classical vs molecular concepts of gene; Cis-Trans complementation test for functional allelism. **Population and evolutionary genetics:** Allele frequencies, Genotype frequencies, Hardy-Weinberg Law, role of natural selection, mutation, genetic drift**.**

Semester-III
Core Course VII
Genetics
Practical

1. Meiosis through temporary squash preparation.
2. Mendel's laws through seed ratios. Laboratory exercises in probability and chi-square analysis.
3. Chromosome mapping using test cross data.
4. Pedigree analysis for dominant and recessive autosomal and sex linked traits with floral chart.
5. Incomplete dominance and gene interaction through seed ratios (9:7, 9:6:1, 13:3, 15:1, 12:3:1, 9:3:4).
6. Blood Typing: ABO groups & Rh factor.
7. Study of aneuploidy: Down's, Klinefelter's and Turner's syndromes.
8. Photographs/Permanent Slides showing Translocation Ring, Laggards and Inversion Bridge.

Suggested Readings

1. Gardner, E.J., Simmons, M.J., Snustad, D.P. (1991). Principles of Genetics, John Wiley & sons, India. 8th edition.
2. Snustad, D.P. and Simmons, M.J. (2010). Principles of Genetics, John Wiley & Sons Inc., India. 5th edition.
3. Klug, W.S., Cummings, M.R., Spencer, C.A. (2012). Concepts of Genetics. Benjamin Cummings, U.S.A. 10th edition.
4. Griffiths, A.J.F., Wessler, S.R., Carroll, S.B., Doebley, J. (2010). Introduction to Genetic Analysis. W. H. Freeman and Co., U.S.A. 10th edition.

Semester-IV

Core Course VIII: Molecular Biology – 100 marks

(Credits-6: Theory-4, Practical-2)
[75 marks (Mid Sem 15 + End Sem 60)]
Lectures: 60 [40 Theory + 20 Practical classes]

Unit-I	**Nucleic acids : Carriers of genetic information:** Historical perspective; DNA as the carrier of genetic information (Griffith's, Hershey & Chase, Avery, McLeod & McCarty. **The Structures of DNA and RNA / Genetic Material:** 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; Organization of DNAProkaryotes, Viruses, Eukaryotes. RNA Structure, Chromatin structure- Euchromatin, Heterochromatin,Organisation of eukaryotic chromsosme, Nucleosome,
Unit-II	**DNA replication:** General principles – bidirectional, semi-conservative and semi discontinuous replication, Enzymes involved in DNA replication. Prokaryotic and eukaryotic DNA polymerases, Mechanism of DNA replication of prokaryotes and eukaryotes, telomere shortening and telomerase**,** inhibitors of replication
Unit-III	**Central dogma and genetic code:** Key experiments establishing-The Central Dogma (Adaptor hypothesis and discovery of mRNAtemplate), Genetic code (deciphering & salient features**)**. **Mechanism of Transcription:** Transcription in prokaryotes; Transcription in eukaryotes, RNA polymerase, initiation, elongation and termination of transcription principles of transcriptional regulation in prokaryotes and eukaryotes: transcription factors; Gene silencing.
Unit-IV	**Processing and modification of RNA:** Split genes-concept of introns and exons, removal of introns, splicing pathways, RNA splicing ;group I & group II intron splicing, alternative splicing eukaryotic mRNA processing(5' cap, 3' polyA tail). **Translation (Prokaryotes and eukaryotes):** Ribosome structure and assembly,mRNA,charging of tRNA,aminoacyltRNAsynthetases,elongation and termination of polypeptides; Fidelity of translation; Inhibitors of protein synthesis. **Gene regulation**: Operon concept, induction and repression: Lac operon and Trp operon;and in Eukaryotes.

Semester-IV
Core Course VIII
Molecular Biology
Practical

1. Preparation of LB medium and raising *E.Coli.*
2. Isolation of genomic DNA from *E.Coli.*
3. DNA isolation and RNA estimation by orcinol method.
4. DNA estimation by diphenylamine reagent/UV Spectrophotometry.
5. Study of DNA replication mechanisms through photographs (Rolling circle, Theta replication and semi-discontinuous replication).
6. Study of structures of prokaryotic RNA polymerase and eukaryotic RNA polymerase II through photographs.
7. Photographs establishing nucleic acid as genetic material (Messelson and Stahl's, Avery et al, Griffith's, Hershey & Chase's and

8. Study of the following through photographs: Assembly of Spliceosome machinery; Splicing mechanism in group I & group II introns; Ribozyme and Alternative splicing.

Suggested Readings

1. Watson J.D., Baker, T.A., Bell, S.P., Gann, A., Levine, M., Losick, R. (2007). Molecular Biology of the Gene, Pearson Benjamin Cummings, CSHL Press, New York, U.S.A. 6th edition.
2. Snustad, D.P. and Simmons, M.J. (2010). Principles of Genetics. John Wiley and Sons Inc., U.S.A. 5th edition.
3. Klug, W.S., Cummings, M.R., Spencer, C.A. (2009). Concepts of Genetics. Benjamin Cummings. U.S.A. 9th edition.
4. Russell, P. J. (2010). iGenetics- A Molecular Approach. Benjamin Cummings, U.S.A. 3rd edition.
5. Griffiths, A.J.F., Wessler, S.R., Carroll, S.B., Doebley, J. (2010). Introduction to Genetic Analysis. W. H. Freeman and Co., U.S.A. 10th edition.

Semester-IV

Core Course IX: Plant Ecology and Phytogeography – 100 marks

(Credits-6: Theory-4, Practical-2)
[75 marks (Mid Sem 15 + End Sem 60)]
Lectures: 60 [40 Theory + 20 Practical classes]

Unit-I	**Introduction:** Basic concepts of ecology; Levels of organization. Inter-relationships between the living world and the environment, the components and dynamism, homeostasis. **Climatic factors:** Environmental complex, interaction of ecological factors; Light factor; temperature factor; atmospherics –gases; wind factor; fire factor. **Soil factor:** Importance; origin; formation; composition; physical; chemical and biological components; soil profile; role of climate in soil development. **Water:** Importance, states of water in the environment; atmospheric moisture; Precipitation types (rain, fog, snow, hail, dew); Hydrological Cycle; Water in soil; Ecological groups of plants and their adaptations (Hydrophytes, Xerophytes)
Unit-II	**Biotic interactions:** Trophic organization, basic source of energy, autotrophy, heterotrophy; symbiosis, commensalism, parasitism; Trophic organization; food chains and webs; ecological pyramids; biomass, standing crop. **Population ecology** Characteristics and Dynamics .Ecological Speciation
Unit-III	**Plant communities** Concept of ecological amplitude; Habitat and niche; Characters: analytical and synthetic; Ecotone and edge effect; Dynamics: succession – processes, types; climax concepts.
Unit-IV	**Functional aspects of ecosystem** Principles and models of energy flow;Production and productivity; Ecological efficiencies; Biogeochemical cycles; Cycling of Carbon, Nitrogen and Phosphorus. **Phytogeography** Principles; Continental drift; Theory of tolerance; Endemism; Brief description of major terrestrial biomes (one each from tropical, temperate & tundra); Phytogeographical division of India; Local Vegetation.

Semester-IV
Core Course IX
Plant Ecology and Phytogeography

Practical

1. Study of instruments used to measure microclimatic variables: Soil thermometer, maximum and minimum thermometer, anemometer, psychrometer/hygrometer, rain gauge and lux meter.
2. Determination of pH of various soil and water samples (pH meter, universal indicator/Lovibond comparator and pH paper)
3. Analysis for carbonates, chlorides, nitrates, sulphates, organic matter and base deficiency from two soil samples by rapid field tests.
4. Determination of organic matter of different soil samples by Walkley & Black rapid titration method.
5. Comparison of bulk density, porosity and rate of infiltration of water in soils of three habitats
6. Determination of dissolved oxygen of water samples from polluted and unpolluted sources.
7. (a). Study of morphological adaptations of hydrophytes and xerophytes (four each).
(b). Study of biotic interactions of the following: Stem parasite (*Cuscuta*), Root parasite(*Orobanche*) Epiphytes, Predation (Insectivorous plants).
8. Determination of minimal quadrat size for the study of herbaceous vegetation in the college campus, by species area curve method (species to be listed).
9. Quantitative analysis of herbaceous vegetation in the college campus for frequency and comparison with Raunkiaer's frequency distribution law.
10. Quantitative analysis of herbaceous vegetation for density and abundance in the college campus.
11. Field visit to familiarise students with ecology of different sites.

Suggested Readings

1. Odum, E.P. (2005). Fundamentals of ecology.Cengage Learning India Pvt. Ltd., New Delhi. 5th edition.
2. Singh, J.S., Singh, S.P., Gupta, S. (2006). Ecology Environment and Resource Conservation. AnamayaPublications, New Delhi, India.
3. Sharma, P.D. (2010). Ecology and Environment.Rastogi Publications, Meerut, India. 8th edition.
4. Wilkinson, D.M. (2007). Fundamental Processes in Ecology: An Earth Systems Approach. OxfordUniversity Press. U.S.A.
5. Kormondy, E.J. (1996). Concepts of ecology. PHI Learning Pvt. Ltd., Delhi, India. 4th edition.

Semester-IV

Core Course X: Plant Systematics – 100 marks

(Credits-6: Theory-4, Practical-2)
[75 marks (Mid Sem 15 + End Sem 60)]
Lectures: 60 [40 Theory + 20 Practical classes]

Unit-I	**Significance of Plant systematics** Introduction to systematics; Plant identification, Classification, Nomenclature. Evidences from palynology, cytology, phytochemistry and molecular data. Field inventory; Functions of Herbarium; Important herbaria and botanical gardens of the world and India; E-flora; Documentation: Flora, Monographs, Journals; Keys: Single access and Multi-access. **Taxonomic hierarchy** Concept of taxa (family, genus, species); Categories and taxonomic hierarchy; Species concept (taxonomic, biological, evolutionary).
Unit-II	**Botanical nomenclature** Principles and rules (ICN); Ranks and names; Typification, author citation, valid publication, rejection of names, principle of priority and its limitations; Names of hybrids. **Systems of classification**Major contributions of Theophrastus, Bauhin, Tournefort, Linnaeus, Adanson, de Candolle, Bessey, Hutchinson, Takhtajan and Cronquist; Classification systems of Bentham and Hooker (up to series) and Engler and Prantl (up to orders). Brief reference of Angiosperm Phylogeny Group (APG III) classification.
Unit-III	**Study of Angiosperms families:**Ranunculaceae, Brassicaceae, Myrtaceae, Umbelliferae, Asteraceae, Solanaceae, Lamiaceae, Euphorbiaceae, Liliaceae, Cyperaceae, Poaceae
Unit-IV	**Phylogeny of Angiosperms and cladistics::**Terms and concepts (primitive and advanced, homologyand analogy, parallelism and convergence, monophyly, Paraphyly, polyphyly and clades). Origin and evolution of angiosperms; Co-evolution of angiosperms and animals; Methods of illustrating evolutionary relationship (phylogenetic tree, cladogram and phenogram).

Semester-IV
Core Course X
Plant Systematics

Practical

1. Study of vegetative and floral characters of the following families (Description, V.S. flower, section of ovary, floral diagram/s, floral formula/e and systematic position according to Bentham & Hooker's system of classification):
Ranunculaceae - *Ranunculus, Delphinium*
Brassicaceae - *Brassica, Alyssum / Iberis* Myrtaceae
- *Eucalyptus, Callistemon* Umbelliferae -
Coriandrum /Anethum / Foeniculum
Asteraceae - *Sonchus/Launaea, Vernonia/Ageratum, Eclipta/Tridax*
Solanaceae - *Solanumnigrum/Withania*
Lamiaceae - *Salvia/Ocimum*
Euphorbiaceae - *Euphorbia hirta/E.milii, Jatropha*
Liliaceae - *Asphodelus/Lilium/Allium*
Poaceae - *Triticum/Hordeum/Avena*
2. Field visit (local) – Subject to grant of funds from the university.
3. Mounting of a properly dried and pressed specimen of any wild plant with herbarium label(to be submitted in the record book)

Suggested Readings

1. Singh, G. (2012). *Plant Systematics:* Theory and Practice. Oxford & IBH Pvt. Ltd., New Delhi. 3rdedition.
2. Jeffrey, C. (1982). An Introduction to *Plant Taxonomy.*Cambridge University Press, Cambridge.
3. Judd, W.S., Campbell, C.S., Kellogg, E.A., Stevens, P.F. (2002). Plant Systematics-A Phylogenetic Approach.Sinauer Associates Inc., U.S.A. 2nd edition.
4. Maheshwari, J.K. (1963). *Flora* of Delhi. CSIR, New Delhi.
5. Radford, A.E. (1986). Fundamentals of *Plant Systematics*.Harper and Row, New York.

Semester-V

Core Course XI: Reproductive Biology of Angiosperms – 100 marks

(Credits-6: Theory-4, Practical-2)
[75 marks (Mid Sem 15 + End Sem 60)]
Lectures: 60 [40 Theory + 20 Practical classes]

Unit-I	**Introduction:** History (contributions of G.B. Amici, W. Hofmeister, E. Strasburger, S.G.Nawaschin, P. Maheshwari, B.M. Johri, W.A. Jensen, J. Heslop-Harrison) and scope. **Anther and Pollen biology:** Anther wall: Structure and functions, microsporogenesis,Microgametogenesis; Pollen wall structure Pollen wall proteins; Pollen viability, storage and germination.
Unit-II	**Ovule:** Structure; Types; Special structures–endothelium, obturator, aril, caruncle andhypostase; Female gametophyte– megasporogenesis (monosporic, bisporic and tetrasporic) and megagametogenesis. (details of *Polygonum* type); Organization and ultrastructure of mature embryo sac
Unit-III	**Pollination and fertilization:** Pollination types and significance; adaptations; structure ofstigma and style; path of pollen tube in pistil; double fertilization. **Self-incompatibility:** Basic concepts (interspecific, intraspecific, homomorphic,heteromorphic, GSI and SSI); Methods to overcome self- incompatibility: mixed pollination, bud pollination, stub pollination; *in vitro* fertilization
Unit-IV	**Embryo, Endosperm and Seed:** Structure and types; General pattern of development of dicot and monocot embryo and endosperm; Suspensor: structure and functions; Embryo endosperm relationship; Nutrition of embryo; Unusual features; Embryo development in *Paeonia*. Seed structure, importance and dispersal mechanisms**Polyembryony and apomixes:** Introduction; Classification; Causes and applications.

Semester-V
Core Course XI
Reproductive Biology of Angiosperms
Practical

1. Anther: Wall and its ontogeny; Tapetum (amoeboid and glandular); MMC, spore tetrads, uninucleate, bicelled and dehisced anther stages through slides/micrographs, male germ unit (MGU) through photographs and schematic representation.
2. Pollen grains: Fresh and acetolyzed showing ornamentation and aperture, psuedomonads, polyads, pollinia (slides/photographs,fresh material), ultrastructure of pollen wall(micrograph); Pollen viability: Tetrazoliumtest.germination: Calculation of percentage germination in different media using hanging drop method.
3. Ovule: Types-anatropous, orthotropous, amphitropous/campylotropous, circinotropous, unitegmic, bitegmic; Tenuinucellate and crassinucellate; Special structures: Endothelium, obturator, hypostase, caruncle and aril (permanentslides/specimens/photographs).
4. Female gametophyte through permanent slides/ photographs: Types, ultrastructure of mature egg apparatus.
5. Intra-ovarian pollination; Test tube pollination through photographs.
6. Endosperm: Dissections of developing seeds for endosperm with free-nuclearhaustoria.
7. Embryogenesis: Study of development of dicot embryo through permanent slides; dissection of developing seeds for embryos at various developmental stages; Study of suspensor through electron micrographs.

Suggested Readings

1. Bhojwani, S.S. and Bhatnagar, S.P. (2011). The Embryology of Angiosperms, Vikas Publishing House.Delhi. 5th edition.
2. Shivanna, K.R. (2003). Pollen Biology and Biotechnology.Oxford and IBH Publishing Co. Pvt. Ltd.Delhi.
3. Raghavan, V. (2000). Developmental Biology of Flowering plants, Springer, Netherlands.
4. Johri, B.M. l (1984). Embryology of Angiosperms, Springer-Verlag, Netherlands.

Semester-V

Core Course XII: Plant Physiology – 100 marks

(Credits-6: Theory-4, Practical-2)
[75 marks (Mid Sem 15 + End Sem 60)]
Lectures: 60 [40 Theory + 20 Practical classes]

Unit-I	**Plant-water relations:** Water Potential and its components, water absorption by roots,pathway of water movement, symplast, apoplast, transmembrane pathways, root pressure, guttation. Ascent of sap cohesion-tension theory. Transpiration and factors affecting transpiration, mechanism of stomatal movement.
Unit-II	**Mineral nutrition:** Essential and beneficial elements, macro and micronutrients, mineraldeficiency symptoms, roles of essential elements, chelating agents. **Nutrient Uptake:** Soil as a nutrient reservoir, transport of ions across cell membrane,passive absorption, electrochemical gradient, facilitated diffusion, active absorption, role of ATP, carrier systems,proton ATPase pump and ion flux, uniport, co-transport, symport, antiport.
Unit-III	**Translocation in the phloem:** Experimental evidence in support of phloem as the site ofsugar translocation. Pressure–Flow Model; Phloem loading and unloading; Source–sink relationship. **Plant growth regulators:** Discovery, chemical nature (basic structure), bioassay andphysiological roles of Auxin, Gibberellins, Cytokinin, Abscisic acid, Ethylene, Brassinosteroids and Jasmonic acid.
Unit-IV	**Physiology of flowering:** Photoperiodism, flowering stimulus, florigen concept,vernalization, seed dormancy. **Phytochrome, crytochromes and phototropins:** Discovery, chemical nature, role inphotomorphogenesis, low energy responses (LER) and high irradiance responses (HIR), mode of action.

Semester-V
Core Course XII
Plant Physiology
Practical

1. Determination of osmotic potential of plant cell sap by plasmolytic method.
2. Determination of water potential of given tissue (potato tuber) by weight method.
3. Study of the effect of wind velocity and light on the rate of transpiration in excised twig/leaf.
4. Calculation of stomatal index and stomatal frequency from the two surfaces of leaves of a mesophyte and xerophyte.
5. To calculate the area of an open stoma and percentage of leaf area open through stomata in a mesophyte and xerophyte (both surfaces).
6. To study the phenomenon of seed germination (effect of light).
7. To study the induction of amylase activity in germinating barley grains.

Demonstration experiments

1. To demonstrate suction due to transpiration.
2. Fruit ripening/Rooting from cuttings (Demonstration).
3. Bolting experiment/*Avena*coleptile bioassay (demonstration).

Suggested Readings

1. Hopkins, W.G. and Huner, A. (2008). Introduction to Plant Physiology.John Wiley and Sons. U.S.A. 4th edition.
2. Taiz, L., Zeiger, E., MØller, I.M. and Murphy, A (2015). Plant Physiology and Development.Sinauer Associates Inc. USA. 6th edition.
3. Bajracharya D. (1999).Experiments in Plant Physiology-A Laboratory Manual.Narosa Publishing House, New Delhi.

Semester-VI

Core Course XIII: Plant Metabolism – 100 marks

(Credits-6: Theory-4, Practical-2)
[75 marks (Mid Sem 15 + End Sem 60)]
Lectures: 60 [40 Theory + 20 Practical classes]

Unit-I	**Concept of metabolism:** Introduction, anabolic and catabolic pathways, regulation ofmetabolism **Carbon assimilation:** Historical background, photosynthetic pigments, role ofphotosynthetic pigments, antenna molecules and reaction centres, photochemical reactions, photosynthetic electron transport, PSI, PSII, Q cycle, CO_2 reduction, photorespiration, C4pathways; Crassulacean acid metabolism; Factors affecting CO2 reduction.
Unit-II	**Carbon Oxidation:** Glycolysis, pentose phosphate pathway, TCAcycle,mitichondrial electron transort (ETC), factors affecting respiration. Mechanism of ATP synthesis, substrate level phosphorylation, chemiosmotic mechanism (oxidative and photophosphorylation), ATP synthase, role of uncouplers. Carbohydrate metabolism: Synthesis and catabolism of sucrose and starch.
Unit-III	**Lipid metabolism:** Synthesis and breakdown of triglycerides, β-oxidation, glyoxylatecycle, gluconeogenesis and its role in mobilisation of lipids during seed germination, α oxidation. .
Unit-IV	**Nitrogen metabolism :**Nitrate assimilation, biological nitrogen fixation (examples oflegumes and non-legumes); Physiology and biochemistry of nitrogen fixation; Ammonia assimilation and transamination.

Semester-VI
Core Course XIII
Plant Metabolism

Practical

1. Chemical separation of photosynthetic pigments.
2. Experimental demonstration of Hill's reaction.
3. To study the effect of light intensity on the rate of photosynthesis.
4. Effect of carbon dioxide on the rate of photosynthesis.
5. To compare the rate of respiration in different parts of a plant.
6. To demonstrate activity of Nitrate Reductase in germinationg leaves of different plant sources.
7. To study the activity of lipases in germinating oilseeds and demonstrate mobilization of lipids during germination.
8. Demonstration of fluorescence by isolated chlorophyll pigments.
9. Demonstration of absorption spectrum of photosynthetic pigments.

Suggested Readings

1. Hopkins, W.G. and Huner, A. (2008). Introduction to Plant Physiology.John Wiley and Sons. U.S.A. 4th edition.
2. Taiz, L., Zeiger, E., MØller, I.M. and Murphy, A (2015). Plant Physiology and Development. Sinauer Associates Inc. USA. 6th edition.
3. Harborne, J.B. (1973). Phytochemical Methods.John Wiley & Sons. New York.

Semester-VI

Core Course XIV: Plant Biotechnology – 100 marks

(Credits-6: Theory-4, Practical-2)
[75 marks (Mid Sem 15 + End Sem 60)]
Lectures: 60 [40 Theory + 20 Practical classes]

Unit-I	**Plant Tissue Culture:** Historical perspective; Composition of media; Nutrient andhormone requirements (role of vitamins and hormones); Totipotency; Organogenesis; Embryogenesis (somatic and zygotic); Protoplast isolation, culture and fusion; Tissue culture applications (micropropagation, androgenesis, virus elimination, secondary metabolites.
Unit-II	**Recombinant DNA technology:** Restriction endonucleases (History, Types I-IV,biological role and application); Cloning Vectors: plasmid, Lambda phage, Cosmid, YAC. **Gene Cloning :** PCR, Recombinant DNA, Bacterial Transformation and selection ofrecombinant clones, PCR mediated gene cloning; Gene Construct; construction of genomic and cDNA libraries, screening DNA libraries to obtain gene of interest by genetic selection, colony hybridization.
Unit-III	**Methods of gene transfer:** *Agrobacterium*-mediated, Direct gene transfer byElectroporation, Microinjection, Microprojectile bombardment; Selection of transgenics , selectable marker and reporter genes (Luciferase, GUS, GFP).
Unit-IV	**Applications of Biotechnology:** Pest resistant (Bt-cotton); herbicide resistant plants(Round Up Ready soybean); Transgenic crops with improved quality traits (FlavrSavr tomato, Golden rice); Role of transgenics in bioremediation ,Superbug; edible vaccines; Industrial enzymes (Protease, Lipase); Gentically Engineered Products/Geneticalymodified food; Biosafety

Semester-VI
Core Course XIV
Plant Biotechnology
Practical

1. (a) Preparation of MS medium.
(b) Demonstration of *in vitro* sterilization and inoculation methods using leaf and nodal explants of tobacco, *Datura*, *Brassica* etc.

2. Study of anther, embryo and endosperm culture, micropropagation, somatic embryogenesis & artificial seeds through photographs.
3. Isolation of protoplasts.
4. Construction of restriction map of circular and linear DNA from the data provided.
5. Study of methods of gene transfer through photographs: *Agrobacterium*-mediated, direct gene transfer by electroporation, microinjection, microprojectile bombardment.
6. Study of steps of genetic engineering for production of Bt cotton, Golden rice, FlavrSavrtomato through photographs.
7. Isolation of plasmid DNA.
8. Restriction digestion and gel electrophoresis of plasmid DNA.

Suggested Readings

1. Bhojwani, S.S. and Razdan, M.K., (1996). Plant Tissue Culture: Theory and Practice. Elsevier Science Amsterdam.The Netherlands.
2. Glick, B.R., Pasternak, J.J. (2003). Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington.
3. Bhojwani, S.S. and Bhatnagar, S.P. (2011). The Embryology of Angiosperms.Vikas Publication House Pvt. Ltd., New Delhi. 5th edition.
4. Snustad, D.P. and Simmons, M.J. (2010). Principles of Genetics. John Wiley and Sons, U.K. 5th edition.
5. Stewart, C.N. Jr. (2008). Plant Biotechnology & Genetics: Principles, Techniques and Applications.
6. Chawla, H.S. (2010). Introduction to Plant Biotechnology.Oxford& IBH Publishing Co.Pvt.Ltd., New John Wiley & Sons Inc. U.S.A.Delhi.
7. Singh, B. D. (2010) Biotechnology: Expanding Horizon. Kalyani Publishers. New Delhi.

DISCIPLINE SPECIFIC ELECTIVE COURSES

Semester-V

Discipline Specific Elective – I (DSE-I)
Stress Biology– 100 marks

(Credits-6: Theory-4, Practical-2) [75 marks (Mid Sem 15 + End Sem 60)] Lectures: 60 [40 Theory + 20 Practical classes]

Unit-I	**Defining plant stress:** Acclimation and adaptation.
Unit-II	**Environmental factors:** Water stress; Salinity stress, High light stress; Temperaturestress; Hypersensitive reaction; Pathogenesis related (PR) proteins; Systemic acquired resistance; Mediation of insect and disease resistance by jasmonates.
Unit-III	**Stress sensing mechanisms in plants:** Calcium modulation, Phospholipid signaling,Reactive oxygen species (ROS), production and scavenging mechanisms
Unit-IV	**Developmental and physiological mechanisms that protect plants against environmental stress:** Adaptation in plants; Changes in root: shoot ratio; Aerenchynadevelopment; Osmotic adjustment; Compatible solute production.

Semester-V
(DSE-I) Practical

- Quantitative estimation of peroxidase activity in the seedlings in the absence and presence of salt stress.
- Superoxide activity in seedlings in the absence and presence of salt stress.
- Zymographic analysis of peroxidase.Zymographic analysis of superoxide dismutase activity.
- Quantitative estimation and zymographic analysis of catalase.
- Quantitative estimation and zymographic analysis of glutathione reductase.
- Estimation of superoxide anions.

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1. **Suggested Readings**

2. Hopkins, W.G. and Huner, A. (2008). Introduction to Plant Physiology. John Wiley and Sons. U.S.A. 4th edition.Taiz, L., Zeiger, E., MØller, I.M. and Murphy, A (2015). Plant Physiology and Development. Sinauer Associates Inc. USA. 6th edition.

Semester-V
DISCIPLINE SPECIFIC ELECTIVE -II(DSE-II)
Plant Breeding-100 marks

(Credits-6: Theory-4, Practical-2)
[75 marks (Mid Sem 15 + End Sem 60)]
Lectures: 60 [40 Theory + 20 Practical classes]

Unit I	**Plant Breeding:** Introduction and objectives. Breeding systems: modes ofreproduction in crop plants. Important achievements and undesirable consequences of plant breeding
Unit II	**Methods of crop improvement:** Introduction: Centres of origin and domestication of crop plants, plant genetic resources; Acclimatization; Selection methods: For self pollinated, cross pollinated and vegetatively propagated plants; Hybridization: For self, cross and vegetatively propagated plants – Procedure, advantages and limitations.
Unit III	**Quantitative inheritance:** Concept, mechanism, examples of inheritance of Kernel colour in wheat.monogenicvs polygenic Inheritance.
Unit IV	**Inbreeding depression and heterosis:** History, genetic basis of inbreeding depression and heterosis; Applications. **Crop improvement and breeding:** Roles of polyploidy and mutation in cropimprovement; Distant hybridization, role of biotechnology in crop improvement.

Semester-V(DSE-II)

Practical	Practical related to theory

Suggested Readings

1. Singh, B.D. (2005). Plant Breeding: Principles and Methods. Kalyani Publishers. 7th edition.
2. Chaudhari, H.K. (1984). Elementary Principles of Plant Breeding. Oxford – IBH. 2ndedition.
3. Acquaah, G. (2007). Principles of Plant Genetics &Breeding.Blackwell Publishing.

Semester-VI
DISCIPLINE SPECIFIC ELECTIVE- III(DSE-III)

Natural Resource Management –100 Marks

(Credits-6: Theory-4, Practical-2)
[75 marks (Mid Sem 15 + End Sem 60)]
Lectures: 60 [40 Theory + 20 Practical classes]

Unit-I	**Natural resources:** Definition and types. Sustainable utilization: concept, approaches (economic, ecological and socio-cultural).
Unit-II	**Land:** Utilization (agricultural, pastoral, horticultural, silvicultural); Soil degradationand management. **Water:** Fresh water (rivers, lakes, groundwater, aquifers, watershed); Marine; Estuarine;Wetlands; Threats and management strategies.
Unit-III	**Biological Resources:** Biodiversity-definition and types; Significance; Threats;Management strategies; Bioprospecting; IPR; CBD; National Biodiversity Action Plan.
Unit-IV	**Forests:** Definition, Cover and its significance (with special reference to India); Majorand minor forest products; Depletion; Management. **Energy:** Renewable and non-renewable sources of energy; Waste management; Nationaland international efforts in recourse management and conservation

Semester-VI
(DSE-III)
Practical

- Estimation of solid waste generated by a domestic system (biodegradable and non - biodegradable) and its impact on land degradation.
- Collection of data on forest cover of specific area.
- Measurement of dominance of woody species by DBH (diameter at breast height) method.
- Calculation and analysis of ecological footprint.
- Ecological modeling.

Suggested Readings

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.
3. Rogers, P.P., Jalal, K.F. and Boyd, J.A. (2008). An Introduction to Sustainable Development. Prentice Hall of India Private Limited, New Delhi.

Semester-VI
DISCIPLINE SPECIFIC ELECTIVE - IV(DSE-IV)

Biostatistics–100 Marks

(Credits-6: Theory-4, Practical-2)
[75 marks (Mid Sem 15 + End Sem 60)]
Lectures: 60 [40 Theory + 20 Practical classes]

Unit-I	**Biostatistics :**Definition - statistical methods - basic principles. Variables - measurements, functions, limitations and uses of statistics.
Unit-II	**Collection of data primary and secondary:** Types and methods of data collectionprocedures - merits and demerits. Classification - tabulation and presentation of data - sampling methods
Unit-III	**Measures of central tendency:** Mean, median, mode, geometric mean - merits &demerits. Measures of dispersion - range, standard deviation, mean deviation, quartile deviation - merits and demerits; Co- efficient of variations.
Unit-IV	**Correlation:** Types and methods of correlation, regression, simple regression equation,fitting prediction, similarities and dissimilarities of correlation and regression Hypothesis - simple hypothesis - student 't' test - chi square test.

Semester-VI
Practical/Lab work (DSE-IV)

- Calculation of mean, standard deviation and standard error
- Calculation of correlation coefficient values and finding out the probability
- Calculation of 'F' value and finding out the probability value for the F value.

Suggested Readings

1. Biostatistic, Danniel, W.W., 1987.New York, John Wiley Sons.
2. An introduction to Biostatistics, 3rd edition, Sundarrao, P.S.S and Richards, J. Christian Medical College, Vellore
3. Statistical Analysis of epidemiological data, Selvin, S., 1991. New York University Press.
4. Statistics for Biologists, Campbell, R.C., 1998.Cambridge University Press.

GENERIC ELECTIVE COURSES

Semester-I

Generic Elective – I (GE-I)
Biodiversity (Microbes, Algae, Fungi and Archegoniate) – 100 marks

(Credits-6: Theory-4, Practical-2)
[75 marks (Mid Sem 15 + End Sem 60)]
Lectures: 60 [40 Theory + 20 Practical classes]

Unit-I	**Microbes:** Viruses - Discovery, general structure, replication (general account), DNA virus (T-phage); Lytic and lysogenic cycle, RNA virus (TMV); Economic importance. Bacteria - Discovery, General characteristics and cell structure; Reproduction - vegetative, asexual and recombination (conjugation, transformation and transduction); Economic importance.
Unit-II	**Algae:** General characteristics; Ecology and distribution; Range of thallus organization and reproduction; Classification of algae; Morphology and life-cycles of the following: *Nostoc, Chlamydomonas, Oedogonium, Vaucheria, Fucus, Polysiphonia* Economic importance of algae.
	Fungi: Introduction- General characteristics, ecology and significance, range of thallus organization, cell wall composition, nutrition, reproduction and classification; True Fungi- General characteristics, ecology and significance, life cycle of *Rhizopus*(Zygomycota) *Penicillium, Alternaria* (Ascornycota), *Puccinia, Agaricus*(Basidiomycota); Symbiotic Associations-Lichens: General account, reproduction and significance; *Mycorrhiza*: ectomycorrhiza and endomycorrhiza and their significance.
Unit-III	**Archegoniate**: Introduction to Archegoniate Unifying features of archegoniates, Transition to land habit, Alternation of generations. **Bryophytes :**General characteristics, adaptations to land habit, Classification, Range of thallus organization. Classification (up to family), morphology, anatomy and reproduction of *Marchantia* and *Funaria*. (Developmental details not to be included). Ecology and economic importance of bryophytes with special mention of *Sphagnum.*
Unit-IV	**Pteridophytes:** General characteristics, classification, Early land plants (*Rhynia*). Classification (up to family), morphology, anatomy and reproduction of *Selaginella, Equisetum* and*Pteris*. (Developmental details not to be included). Heterospory and seed habit, stelar evolution. Ecological and economical importance of Pteridophytes. **Gymnosperms**: General characteristics, classification. Classification (up to family),morphology, anatomy and reproduction of *Cycas* and *Pinus*. (Developmental details not to be included).Ecological and economical importance.

Semester-I
Generic Elective - I

Practical

1. Types of Bacteria to be observed from temporary/permanent slides/photographs.
   - bacteria, binary fission, endospore, conjugation, root Nodule
2. Gram staining
3. Endospore staining with malachite green using the (endospores taken from soil bacteria)
4. Study of vegetative and reproductive structures of *Nostoc*, *Chlamydomonas* (electron micrographs), Volvox, *Oedogonium*,*Coleochaete*, *Chara*, *Vaucheria*, *Fucus and*Polysiphonia, temporary preparations and permanent slides.
5. Study of vegetative and reproductive structures of ***Marchantia, Funaria,Rhynia, Selaginella, Equisetum and Pteris***(Permanent slide or temporary slides or livespeciemen.)
6. ***Cycas***- Morphology (coralloid roots, bulbil, leaf), whole mount of microsporophyll, transverse section of coralloid root, transverse section of rachis, vertical section of leaflet, vertical section of microsporophyll, whole mount of spores (temporary slides), longitudinal section of ovule, transverse section of root (permanent slide).
7. ***Pinus***- Morphology, transverse section of Needle, transverse section of stem, longitudinalsection of / transverse section of male cone, whole mount of microsporophyll, longitudinal section of female cone, tangential longitudinal section &radial longitudinal sections stem (permanent slide).
8. ***Gnetum***- Morphology (stem, male & female cones), transverse section of stem, verticalsection of ovule (permanent slide)

Suggested Readings

1. Kumar, H.D. (1999). Introductory Phycology.Affiliated East-West.PressPvt. Ltd. Delhi. 2nd edition.
2. Tortora, G.J., Funke, B.R., Case, C.L. (2010). Microbiology: An Introduction, Pearson Benjamin Cummings, U.S.A. 10th edition.
3. Sethi, I.K. and Walia, S.K. (2011). Text book of Fungi & Their Allies, MacMillan Publishers Pvt. Ltd., Delhi.
4. Alexopoulos, C.J., Mims, C.W., Blackwell, M. (1996). Introductory Mycology, John Wiley and Sons(Asia), Singapore. 4th edition.
5. Raven, P.H., Johnson, G.B., Losos, J.B., Singer, S.R., (2005). Biology. Tata McGraw Hill, Delhi, India.
6. Vashishta, P.C., Sinha, A.K., Kumar, A., (2010). Pteridophyta, S. Chand. Delhi, India.
7. Bhatnagar, S.P. and Moitra, A. (1996). Gymnosperms. New Age International (P) Ltd Publishers, New Delhi, India.
8. Parihar, N.S. (1991). An introduction to Embryophyta. Vol. I. Bryophyta. Central Book Depot, Allahabad.

Semester-IV

Generic Elective –II (GE-II)
Economic Botany and Plant Biotechnology– 100 marks

(Credits-6: Theory-4, Practical-2)
[75 marks (Mid Sem 15 + End Sem 60)]
Lectures: 60 [40 Theory + 20 Practical classes]

Unit-I	**Origin of Cultivated Plants:** Concept of centres of origin, their importance withreference to Vavilov's work , Cereals: wheat, Origin, morphology and uges Legumes: General account with special reference to Gram and soyabean Spices :General account with special reference to clove and black pepper (Botanical name, family, part used)
Unit-II	**Beverages:** Tea (morphology, processing, uses); Oils and Fats**:** General descriptionwith special reference to groundnut **Fibre Yielding Plants:** General description with special reference to Cotton (Botanicalname, family, part used)
Unit-III	**Introduction to plant biotechnology, Plant tissue culture:** Micropropagation; haploidproduction through androgenesis and gynogenesis; brief account of embryo and endosperm culture with their applications
Unit-IV	**Recombinant DNA Techniques:** Blotting techniques: Northern, Southern and Western Blotting, DNA Fingerprinting; Molecular DNA markers i.e. RAPD, RFLP, SNPs; DNA sequencing, PCR and Reverse Transcriptase-PCR.

Semester-IV
(GE-II)Practical

1. Study of economically important plants : Wheat, Gram, Soyabean, Black pepper, Clove

Tea, Cotton, Groundnut through specimens, sections and microchemical tests
2.Familiarization with basic equipments in tissue culture.
3. Study through photographs: Anther culture, somatic embryogenesis, endosperm and embryo culture; micropropagation.

Suggested Readings

1. Kochhar, S.L. (2011). Economic Botany in the Tropics, MacMillan Publishers India Ltd., New Delhi. 4th edition.
2. Bhojwani, S.S. and Razdan, M.K., (1996). Plant Tissue Culture: Theory and Practice.
3. Elsevier Science Amsterdam. The Netherlands. Glick, B.R., Pasternak, J.J. (2003). Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington.

SYLLABUS

FOR B.Sc. (CHEMISTRY HONS)

DEPARTMENT OF CHEMISTRY

RAYAGADA AUTONOMOUS COLLEGE, RAYAGADA

under

Choice Based Credit System (CBCS)

(Applicable from the academic session 2018-2021)

CBCS Course Structure for B.Sc. (Chemistry Honours) Total Credits: 140

	SEM – I	SEM – II	SEM – III	SEM – IV	SEM – V	SEM – VI
Core	Core – 1(6) Core – 2(6)	Core – 3(6) Core – 4(6)	Core – 5(6) Core – 6(6) Core – 7(6)	Core – 8(6) Core – 9(6) Core – 10(6)	Core – 11(6) Core – 12(6)	Core – 13(6) Core – 14(6)
Generic Elective	GE – 1(6) Subject – 1 (Paper - 1)	GE – 2(6) Subject – 1 (Paper - 2)	GE – 3(6) Subject – 2 (Paper - 1)	GE – 4(6) Subject – 2 (Paper - 2)	DSE – 1(6) DSE – 2(6)	DSE – 3(6) DSE – 4(6)
Ability Enhancement Course	ENV. ST. (2)	MIL (2) Communication	SEC – 1(2) Communicative English	SEC – 2 (2) Quantitative and Logical Thinking		
Total	20	20	26	26	24	24

SEMESTER-I

C-1: INORGANIC CHEMISTRY- I

Credits-6: (Theory-4, Practical-2)

Atomic structure (Unit – I)

Bohr's theory, its limitations and atomic spectrum of hydrogen atom. Wave mechanics: de Broglie equation, Heisenberg's Uncertainty Principle and its significance, Schrodinger's wave equation, significance of Ψ and Ψ^2: Quantum numbers and their significance. Normalized and orthogonal wave functions. Sign of wave functions. 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, Hunds rule of maximum multiplicity, Aufbau's principle and its limitations.

Periodicity of elements (Unit – II)

Periodicity of elements: s, p, d, f block elements, the long form of periodic table. Detailed discussion of the following properties of the elements, with reference to s & p-block.

(a) Effective nuclear charge, shielding or screening effect, Slater rules, variation of effective nuclear charge in periodic table. (b) Atomic radii (van der Waals) (c) Ionic and crystal radii.

(d) Covalent radii (octahedral and tetrahedral) (e) Ionization enthalpy, Successive ionization enthalpies and factors affecting ionization energy. Applications of ionization enthalpy.(f) Electron gain enthalpy, trends of electron gain enthalpy. (g) Electronegativity, Paulings/Mullikens electronegativity scales. Variation of electronegativity with bond order, partial charge, hybridization, group electronegativity. Sandersons electron density ratio.

Chemical bonding-I (Unit-III)

(i) Ionic bond: General characteristics, types of ions, size effects, radius ratio rule and its limitations. Packing of ions in crystals. Born-Land equation with derivation. Madelung constant, Born-Haber cycle and its application, Solvation energy. (ii) Covalent bond: Lewis structure, Valence Bond theory (Heitler-London approach). Energetics of hybridization, equivalent and non-equivalent hybrid orbitals,Bent's Rule, Resonance and resonance energy, Molecular orbital theory. Molecular orbital diagrams of diatomic and simple polyatomic molecules N_2; O_2; C_2; B_2; F_2; CO; NO; and their ions; Valence shell electron pair repulsion theory (VSEPR), shapes of simple molecules and ions containing lone pairs and bond pairs of electrons, multiple bonding (and bond approach) and bond lengths. Covalent character in ionic compounds, polarizing power and polarizability. Fajans rules and consequences of polarization. Ionic character in covalent compounds: Bond moment and dipole moment. Percentage ionic character from dipole moment and electronegativity difference.

Chemical Bonding-II (Unit-IV)

(i) Metallic Bond: Qualitative idea of valence bond and band theories. Semiconductors and insulators. (ii) Weak Chemical Forces: van der Waals forces, ion-dipole forces, dipole-dipole interactions, induced dipole interactions, Instantaneous dipole-induced dipole interactions. Repulsive forces, Hydrogen bonding (theories of hydrogen bonding, valence bond treatment) Effects of chemical force, melting and boiling points, solubility energetics of dissolution process.

Oxidation-reduction Redox equations, standard electrode potential and its application to inorganic reactions. Principles involved in some volumetric analyses (iron, copper and manganese).

Reference:

- Day, M.C. and Selbin, J. Theoretical Inorganic Chemistry, ACS Publications 1962.
- Lee, J.D. Concise Inorganic Chemistry, ELBS, 1991.
- Douglas, B.E. and Mc Daniel, D.H., Concepts & Models of Inorganic Chemistry, Oxford, 1970. Atkins, P.W. & Paula, J. Physical Chemistry, Oxford Press, 2006.

PRACTICAL: C-1 LAB

(A) Titrimetric Analysis:

(i) Calibration and use of apparatus.

(ii) Preparation of solutions of different Molarity/Normality of titrants.

(B) Acid-Base Titrations:

(i) Estimation of carbonate and hydroxide present together in mixture.

(ii) Estimation of carbonate and bicarbonate present together in a mixture.

(iii) Estimation of free alkali present in different soaps/detergents.

(C) Oxidation-Reduction Titrimetry:

(i) Estimation of Fe(II) and oxalic acid using standardized KMnO4 solution.

(ii) Estimation of oxalic acid and sodium oxalate in a given mixture.

(iii) Estimation of Fe(II) with $K_2Cr_2O_7$ using internal (diphenylamine, anthranilic acid) and external indicator.

Reference:

Vogel, A.I. A Textbook of Quantitative Inorganic Analysis, ELBS.

C-2: PHYSICAL CHEMISTRY- I

Credits-6: (Theory-4, Practical-2)

Gaseous state (Unit-I)

Kinetic molecular model of a gas: postulates and derivation of the kinetic gas equation; collision frequency; collision diameter; mean free path and viscosity of gases, including their temperature and pressure dependence, relation between mean free path and coefficient of viscosity; variation of viscosity with temperature and pressure. Maxwell distribution and its use in evaluating molecular velocities (average, root mean square and most probable) and average kinetic energy, law of equipartition of energy, degrees of freedom and molecular basis of heat capacities. Behaviour of real gases: Deviations from ideal gas behaviour, compressibility factor, Z, and its variation with pressure for different gases. Causes of deviation from ideal behaviour. van der Waals equation of state, its derivation and application in explaining real gas behaviour. Isotherms of real gases and their comparison with van der Waals isotherms, continuity of states, critical state, relation between critical constants and van der Waals constants, law of corresponding states.

Liquid state (Unit-II)

(i) Qualitative treatment of the structure of the liquid state; physical properties of liquids; vapour pressure, surface tension and coefficient of viscosity, and their determination. Effect of addition of various solutes on surface tension and viscosity. Explanation of cleansing action of detergents. Temperature variation of viscosity of liquids and comparison with that of gases.

Solid state (Unit- III)

Nature of the solid state, law of constancy of interfacial angles, law of rational indices, Miller indices, elementary ideas of symmetry, symmetry elements and symmetry operations, seven crystal systems and fourteen Bravais lattices; X-ray diffraction, Braggs law, a simple account of rotating crystal method and powder pattern method. Analysis of powder diffraction patterns of NaCl, CsCl and KCl. Defects in crystals.

Ionic equilibria (Unit-IV)

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- and diprotic acids.

Salt hydrolysis-calculation of hydrolysis constant, degree of hydrolysis and pH for different salts. Buffer solutions; derivation of Henderson equation and its applications; buffer capacity, buffer range, buffer action and applications of buffers in analytical chemistry and biochemical processes in the human body. Solubility and solubility product of sparingly soluble salts applications of solubility product principle. Qualitative treatment of acid base titration curves(calculation of pH at various stages). Theory of acid base indicators; selection of indicators and their limitations.

Reference:

- Atkins, P. W. & Paula, J. de Atkins Physical Chemistry Ed., Oxford University Press (2006).
- Ball, D. W. Physical Chemistry Thomson Press, India (2007).
- Castellan, G. W. Physical Chemistry 4th Ed. Narosa (2004).
- Mortimer, R. G. Physical Chemistry 3rd Ed. Elsevier: NOIDA, UP (2009). Principles of Physical Chemistry, Puri, Sharma, Pathania, Vishal Pub. Co.

PRACTICAL: C-2 LAB

Surface tension measurements.

(a) Determine the surface tension by (i) drop number (ii) drop weight method.

(b) Study the variation of surface tension of detergent solutions with concentration.

Viscosity measurement using Ostwalds viscometer.

(a) Determination of viscosity of aqueous solutions of (i) polymer, (ii) ethanol, and (iii) sugar at room temperature.

(b) Study the variation of viscosity of sucrose solution with the concentration of solute.

pH metry.

(a) Study the effect on pH of addition of HCl/NaOH to solutions of acetic acid, sodium acetate and their mixtures.

(b) Preparation of buffer solutions of different pH

(i) Sodium acetate-acetic acid,

(ii) Ammonium chloride-ammonium hydroxide.

(c) pH metric titration of (i) strong acid vs. strong base, (ii) weak acid vs. strong base.

(d) Determination of dissociation constant of a weak acid.

Reference:

- Khosla, B.D.; Garg, V.C. & Gulati, A. Senior Practical Physical Chem, R. Chand & Co., New Delhi (2011).
- Garland, C.W., Nibler, J.W. & Shoemaker, D.P. Experiments in Physical Chem 8th Ed.; McGraw-Hill, New York (2003).
- Halpern, A.M. & McBane, G.C. Experimental Physical Chem 3rd Ed.; W.H. Freeman & Co., New York (2003).

SEMESTER-II

C-3: ORGANIC CHEMISTRY-I

Credits-6: (Theory-4, Practical-2)

Basics of Organic Chemistry (Unit-I)

Electronic Displacements: Inductive, electromeric, resonance and mesomeric effects, hyper conjugation and their applications; Dipole moment; Organic acids and bases; their relative strength. Homolytic and Heterolytic fission with suitable examples. Curly arrow rules; Electrophiles and Nu-cleophiles; Nucleophlicity and basicity; Types, shape and their relative stability of carbocations, carbanions, free radicals and carbenes. Introduction to types of organic reactions and their mechanism: Addition, Elimination and Substitution reactions.

Carbon-Carbon Sigma Bonds

Chemistry of alkanes: Formation of alkanes, Wurtz Reaction, Wurtz-Fittig Reactions, Free radical substitutions: Halogenation - relative reactivity and selectivity.

Stereochemistry (Unit-II)

Fischer Projection, Newmann and Sawhorse Projection formulae; Geometrical isomerism: cis-trans and, syn-anti isomerism E/Z notations with C.I.P rules. Optical Isomerism: Optical Activity, Specific Rotation, Chirality/Asymmetry, Enantiomers, Molecules with one and two chiral-centres, Distereoisomers, meso structures, Racemic mixture and resolution. Relative and absolute configuration: D/L and R/S designations.

Chemistry of Aliphatic Hydrocarbons (Unit-III)

A. Carbon-Carbon pi bonds:

Formation of alkenes and alkynes by elimination reactions, Mechanism of E1, E2, E1cb reactions. Saytze and Hofmann eliminations. Reactions of alkenes: Electrophilic additions their mechanisms (Markownikov/Anti-Markownikov addition), mechanism of oxymercuration-demercuration, hydroborationoxidation, ozonolysis, reduction (catalytic and chemical), syn and anti-hydroxylation (oxidation). 1,2- and 1,4-addition reactions in conjugated dienes and, Diels-Alder reaction; Allylic and benzylic bromination and mechanism, e.g. propene, 1-butene, toluene, ethyl benzene. Reactions of alkynes: Acidity, Electrophilic and Nucleophilic additions. Hydration to form carbonyl compounds, Alkylation of terminal alkynes.

B. Cycloalkanes and Conformational Analysis

Types of cycloalkanes and their relative stability, Baeyer strain theory, Conformation analysis of alkanes (ethane and n-butane): Relative stability with energy diagrams. Energy diagrams of cyclohexane: Chair, Boat and Twist boat forms.

Aromatic Hydrocarbons (Unit-IV)

Aromaticity: Huckel's rule, aromatic character of arenes, cyclic carbocations/carbanions and hetero-cyclic compounds with suitable examples. Electrophilic aromatic substitution: halogenation, nitration, sulphonation and Friedel-Crafts alkylation/acylation with their mechanism. Directing effects of the groups.

Reference:

- Finar, I. L. Organic Chemistry (Volume 2): Stereochemistry and the Chemistry of Natural Products), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education)
- Morrison, R. N. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
- Eliel, E. L. & Wilen, S. H. Stereochemistry of Organic Compounds; Wiley: London, 1994.

- Kalsi, P. S. Stereochemistry Conformation and Mechanism; New Age International, 2005
- Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).

PRACTICAL: C-3 LAB

1. Checking the calibration of the thermometer.
2. Purification of organic compounds by crystallization using the following solvents:
   Water
   Alcohol
   Alcohol-Water
3. Determination of the melting points of above compounds and unknown organic compounds (Kjeldahl method and electrically heated melting point apparatus).
4. Effect of impurities on the melting point mixed melting point of two unknown organic com-pounds.
5. Determination of boiling point of liquid compounds. (boiling point lower than and more than 100C by distillation and capillary method)
6. Chromatography

- Separation of a mixture of two amino acids by ascending and horizontal paper chromatography.
- Separation of a mixture of two sugars by ascending paper chromatography.
- Separation of a mixture of o-and p-nitrophenol or o-and p-aminophenol by thin layer chromatography (TLC).

Reference:

- Furniss, B.S., Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. Practical Org Chem, 5th Ed., Pearson (2012).
- Mann, F.G. & Saunders, B.C. Practical Organic Chemistry, Pearson Education (2009).

C- 4: PHYSICAL CHEMISTRY- II

Credits-6: (Theory-4, Practical-2)

Chemical thermodynamics (Unit-I)

Intensive and extensive variables; state and path functions; isolated, closed and open systems; zeroth law of thermodynamics. First law: Concept of heat, q, work, w, internal energy, U, and statement of first law; enthalpy, H, relation between heat capacities, calculations of q, w, U and H for reversible, irreversible and free expansion of gases (ideal and van der Waals) under isothermal and adiabatic conditions. Thermochemistry: Heats of reactions: standard states; enthalpy of formation of molecules and ions and enthalpy of combustion and its applications; calculation of bond energy, bond dissociation energy and resonance energy from thermochemical data, effect of temperature (Kirchhoff's equations) and pressure on enthalpy of reactions.

Second Law (Unit-II)

Concept of entropy; thermodynamic scale of temperature, statement of the second law of thermodynamics; molecular and statistical interpretation of entropy. Calculation of entropy change for reversible and irreversible processes. Third Law: Statement of third law, concept of residual entropy, calculation of absolute entropy of molecules. Free Energy Functions: Gibbs and Helmholtz energy; variation of S, G, A with T, V, P; Free energy change and spontaneity. Relation between Joule-Thomson coefficient and other thermodynamic parameters; inversion temperature; Gibbs-Helmholtz equation; Maxwell's relations; thermodynamic equation of state.

Systems of variable composition (Unit-III)

Partial molar quantities, dependence of thermodynamic parameters on composition; Gibbs Duhem equation, chemical potential of ideal mixtures, change in thermodynamic functions in mixing of ideal gases. Chemical equilibrium, Criteria of thermodynamic equilibrium, chemical equilibria in ideal gases, concept of fugacity. Thermodynamic derivation of relation between Gibbs free energy of reaction and reaction quotient (vant Hoff's reaction). Equilibrium constants and their quantitative dependence on temp, pressure and conc. Free energy of mixing and spontaneity; thermodynamic derivation of relations between the various equilibrium constants K_p; K_c & K_x: Le Chatelier principle (quantitative treatment) and its applications.

Solutions and Colligative Properties (Unit-IV)

Dilute solutions; lowering of vapour pressure, Raoults and Henrys Laws and their applications. 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.

Reference:

- Engel, T. & Reid, P. Physical Chemistry 3rd Ed., Prentice-Hall (2012).
- Assael, M. J.; Goodwin, A. R. H.; Stamatoudis, M.; Wakeham, W. A. & Will, S. Commonly Asked Questions in Thermodynamics. CRC Press: NY (2011).
- Peter, A. & Paula, J. de. Physical Chemistry 9th Ed., Oxford University Press (2011)
- Levine, I .N. Physical Chemistry 6th Ed., Tata Mc Graw Hill (2010).
- Metz, C.R. 2000 solved problems in chemistry, Schaum Series (2006).
- Castellan, G. W. Physical Chemistry 4th Ed., Narosa (2004).
- McQuarrie, D. A. & Simon, J. D. Molecular Thermodynamics Viva Books Pvt. Ltd.: New Delhi (2004).

PRACTICAL: C-4 LAB

THERMOCHEMISTRY

(a) Determination of heat capacity of a calorimeter for different volumes using change of enthalpy data of a known system (method of back calculation of heat capacity of calorimeter from known enthalpy of solution or enthalpy of neutralization).

(b) Determination of heat capacity of the calorimeter and enthalpy of neutralization of hydrochloric acid with sodium hydroxide.

(c) Calculation of the enthalpy of ionization of ethanoic acid.

(d) Determination of heat capacity of the calorimeter and integral enthalpy (endothermic and exothermic) solution of salts.

(e) Determination of basicity/proticity of a polyprotic acid by the thermochemical method in terms of the changes of temperatures observed in the graph of temperature versus time for different additions of a base. Also calculate the enthalpy of neutralization of the rst step.

(f) Determination of enthalpy of hydration of copper sulphate.

(g) Study of the solubility of benzoic acid in water and determination of AH.

Reference:

- Khosla, B. D.; Garg, V. C. & Gulati, A., Senior Practical Physical Chem, R. Chand & Co.: New Delhi (2011).
- Athawale, V. D. & Mathur, P. Experimental Physical Chemistry New Age International: New Delhi (2001).

SEMESTER-III

C – 5: INORGANIC CHEMISTRY- II

Credits-6: (Theory-4, Practical-2)

General Principles of Metallurgy (Unit-I)

Chief modes of occurrence of metals based on standard electrode potentials. Ellingham diagrams for reduction of metal oxides using carbon and carbon monoxide as reducing agent. Electrolytic Reduction, Hydrometallurgy. Methods of purification of metals: Electrolytic process, Parting process, van Arkel-de Boer process and Monds process, Zone refining.

Acids and Bases

Bronsted-Lowry concept of acid-base reactions, solvated proton, relative strength of acids, types of acid-base reactions, Lewis acid-base concept, Classification of Lewis acids, Hard and Soft Acids and Bases (HSAB) Application of HSAB principle.

Chemistry of s and p Block Elements-I (Unit-II)

Inert pair effect, Relative stability of different oxidation states, diagonal relationship and anomalous behaviour of first member of each group. Allotropy and catenation. Complex formation tendency of s and p block elements. Hydrides and their classification ionic, covalent and interstitial. Basic beryllium acetate and nitrate.

Chemistry of s and p Block Elements-II (Unit-III)

Study of the following compounds with emphasis on structure, bonding, preparation, properties and uses. Boric acid and borates, boron nitrides, borohydrides (diborane) carboranes and graphitic compounds, silanes. Oxides and oxoacids of nitrogen, Phosphorus and chlorine. Peroxo acids of sulphur, interhalogen compounds, polyhalide ions, pseudohalogens and basic properties of halogens.

Noble Gases(Unit- IV)

Occurrence and uses, rationalization of inertness of noble gases, Clathrates; preparation and proper-ties of XeF_2; XeF_4andXeF_6; Nature of bonding in noble gas compounds (Valence bond treatment and MO treatment for XeF_2). 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, and polysulphates.

Reference:

- Lee, J.D. Concise Inorganic Chemistry, ELBS, 1991.
- Douglas, B.E; Mc Daniel, D.H. & Alexander, J.J. Concepts & Models of Inorganic Chemistry 3rd Ed., John Wiley Sons, N.Y. 1994.
- Greenwood, N.N. & Earnshaw. Chemistry of the Elements, Butterworth-Heinemann. 1997.
- Cotton, F.A. & Wilkinson, G. Advanced Inorganic Chemistry, Wiley, VCH, 1999.
- Miessler, G. L. & Donald, A. Tarr. Inorganic Chemistry 4th Ed., Pearson, 2010.
- Shriver & Atkins, Inorganic Chemistry 5th Ed.

PRACTICAL: C-5 LAB

(A) Iodo / Iodimetric Titrations

(i) Estimation of Cu(II) and $K_2Cr_2O_7$ using sodium thiosulphate solution (Iodimetrically).

(ii) Estimation of available chlorine in bleaching powder iodometrically.

(B) Inorganic preparations

(i) Cuprous chloride, Cu_2Cl_2:
(ii) Preparation of manganese(III) phosphate, $MnPO_4:H_2O$:
(iii) Preparation of aluminium potassium sulphate $K_2SO_4:Al_2(SO_4)_2:24H_2O$ (Potash alum).

Reference:

Vogel, A.I. A Textbook of Quantitative Inorganic Analysis, ELBS. 1978

C-6: ORGANIC CHEMISTRY- II

Credits-6: (Theory-4, Practical-2)

Chemistry of Halogenated Hydrocarbons (Unit-I)

Alkyl halides: Methods of preparation, nucleophilic substitution reactions SN1, SN2 and SNi mechanisms with stereochemical aspects and effect of solvent etc.; nucleophilic substitution vs. elimination. Aryl halides: Preparation, including preparation from diazonium salts, nucleophilic aromatic substitution; SNAr, Benzyne mechanism. Relative reactivity of alkyl, allyl/benzyl, vinyl and aryl halides towards nucleophilic substitution reactions. Organometallic compounds of Mg and Li use in synthesis of organic compounds.

Alcohols, Phenols, Ethers and Epoxides(Unit-II)

Alcohols: preparation, properties and relative reactivity of 1°,2°,3° alcohols, Bouveault-Blanc Reduction; Preparation and properties of glycols: Oxidation by periodic acid and lead tetraacetate, Pinacol-Pinacolone rearrangement; Phenols: Preparation and properties; Acidity and factors effecting it, Ring substitution reactions, Reimer-Tiemann and Kolbes-Schmidt Reactions, Fries and Claisen rearrangements with mechanism; Ethers and Epoxides: Preparation and reactions with acids. Reactions of epoxides with alcohols, ammonia derivatives and $LiAlH_4$

Carbonyl Compounds (Unit-III)

Structure, reactivity and preparation: Nucleophilic additions, Nucleophilic addition-elimination reactions with ammonia derivatives with mechanism; Mechanisms of Aldol and Benzoin condensation, Knoevenagel condensation, Perkin, Cannizzaro and Wittig reaction, Beckmann rearrangements, haloform reaction and Baeyer Villiger oxidation, - substitution reactions, oxidations and reductions (Clemmensen, Wolf-Kishner, $LiAlH_4$, $NaBH_4$, MPV); Addition reactions of unsaturated carbonyl compounds: Michael addition. Active methylene compounds: Keto-enol tautomerism. Preparation and synthetic applications of diethyl malonate and ethyl acetoacetate.

Carboxylic Acids and their Derivatives (Unit-IV)

Preparation, physical properties and reactions of monocarboxylic acids: Typical reactions of dicarboxylic acids, hydroxy acids and unsaturated acids: succinic, lactic, malic, tartaric, citric, maleic and fumaric acids; Preparation and reactions of acid chlorides, anhydrides, esters and amides; Comparative study of nucleophilic sustitution at acyl group -Mechanism of acidic and alkaline hydrolysis of esters, Claisen

condensation, Dieckmann and Reformatsky reactions, Hofmann-bromamide degradation and Curtius rearrangement.

Sulphur containing compounds: Preparation and reactions of thiols, thioethers.

Reference:

- Morrison, R. T. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
- Graham Solomons, T.W. Organic Chemistry, John Wiley & Sons, Inc.

PRACTICAL: C-6 LAB

1. Functional group tests for alcohols, phenols, carbonyl and carboxylic acid group.
2. Organic preparations:

(i) Acetylation of one of the following compounds: amines (aniline, o-, m-, p-toluidines and o-, m-, p-anisidine) and phenols (-naphthol, vanillin, salicylic acid) by any one method:
   (a) Using conventional method.
   (b) Using green approach.

(ii) Benzolyation of one of the following amines (aniline, o-, m-, p- toluidines and o-, m-, p-anisidine) and one of the following phenols (-naphthol, resorcinol, p-cresol) by Schotten-Baumann reaction.

(iii) Bromination of any one of the following:
   (a) Acetanilide by conventional methods.
   (b) Acetanilide using green approach (Bromate-bromide method).

(iv) Nitration of any one of the following:
   (a) Acetanilide/nitrobenzene by conventional method.
   (b) Salicylic acid by green approach (using ceric ammonium nitrate).

The above derivatives should be prepared using 0.5-1gm. of the organic compound. The solid samples must be collected and may be used for recrystallization, melting point and TLC.

Reference:

- Mann, F.G. & Saunders, B.C. Practical Organic Chemistry, Pearson Education (2009).
- Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. Practical Org Chem, 5th Ed., Pearson (2012).
- Ahluwalia, V.K. & Aggarwal, R. Comprehensive Practical Organic Chemistry: Preparation and Quantitative Analysis, University Press (2000).
- Ahluwalia V.K. & Dhingra, S. Comprehensive Practical Org Chem: Qualitative Analysis, Univ Press (2000).

C-7: PHYSICAL CHEMISTRY- III

Credits-6: (Theory-4, Practical-2)

Phase Equilibria-I (Unit-I)

Concept of phases, components and degrees of freedom, derivation of Gibbs Phase Rule for nonreactive and reactive systems; Clausius-Clapeyron equation and its applications to solid-liquid, liquid-vapour and solid-vapour equilibria, phase diagram for one component systems, with applications (H_2O and sulphur system). Phase diagrams for systems of solid-liquid equilibria involving eutectic, congruent and incongruent melting points, solid solutions (Pb-Ag system).

Phase Equilibria (Unit-II)

Three component systems, water-chloroform-acetic acid system, triangular plots. Binary solutions: Gibbs-Duhem-Margules equation, its derivation and applications to fractional distillation of binary miscible liquids (ideal and non-ideal), azeotropes, partial miscibility of liquids, CST, miscible pairs. Nernst distribution law: its derivation and applications.

Chemical Kinetics (Unit-III)

Order and molecularity of a reaction, rate laws in terms of the advancement of a reaction, differential and integrated form of rate expressions up to second order reactions, experimental methods of the determination of orders, kinetics of complex reactions (integrated rate expressions up to first order only): (i) Opposing reactions (ii) parallel reactions and (iii) consecutive reactions and their differential rate equations (steady-state approximation in reaction mechanisms) (iv) chain reactions. Temperature dependence of reaction rates; Arrhenius equation; activation energy. Collision theory of reaction rates, qualitative treatment of the theory of absolute reaction rates.

Catalysis (Unit-IV)

Types of catalyst, specificity and selectivity, mechanisms of catalyzed reactions at solid surfaces; effect of particle size and efficiency of nanoparticles as catalysts. Enzyme catalysis, Michaelis-Menten mechanism, acid-base catalysis.

Surface chemistry: Physical adsorption, chemisorption, adsorption isotherms (Langmuir, Freundlich and Gibbs isotherms), nature of adsorbed state.

Reference:

- Peter Atkins & Julio De Paula, Physical Chemistry 9th Ed., Oxford University Press (2010). Castellan, G. W. Physical Chemistry, 4th Ed., Narosa (2004).
- McQuarrie, D. A. & Simon, J. D., Molecular Thermodynamics, Viva Books Pvt. Ltd.: New Delhi (2004).
- Engel, T. & Reid, P. Physical Chemistry 3rd Ed., Prentice-Hall (2012).
- Assael, M. J.; Goodwin, A. R. H.; Stamatoudis, M.; Wakeham, W. A. & Will, S. Commonly Asked Questions in Thermodynamics. CRC Press: NY (2011).
- Zundhal, S.S. Chemistry concepts and applications Cengage India (2011). Ball, D. W. Physical Chemistry Cengage India (2012).
- Mortimer, R. G. Physical Chemistry 3rd Ed., Elsevier: NOIDA, UP (2009). Levine, I. N. Physical Chemistry 6th Ed., Tata McGraw-Hill (2011).
- Metz, C. R. Physical Chemistry 2nd Ed., Tata McGraw-Hill (2009).

PRACTICAL: C- 7 LAB

I. Distribution of acetic/ benzoic acid between water and cyclohexane.

II. Study the equilibrium of at least one of the following reactions by the distribu-tion method:

III. Study the kinetics of the following reactions.

(1) Integrated rate method:

a. Acid hydrolysis of methyl acetate with hydrochloric acid.

b. Saponification of ethyl acetate.

(2) Compare the strengths of HCl and H_2SO_4 by studying kinetics of hydrolysis of methyl acetate.

Adsorption

Verify the Freundlich and Langmuir isotherms for adsorption of acetic acid on activated charcoal.

Reference:

- Khosla, B. D.; Garg, V. C. & Gulati, A. Senior Practical Phy Chemistry, R. Chand & Co.: New Delhi (2011).
- Garland, C. W.; Nibler, J. W. & Shoemaker, D. P. Experiments in Phy Chem 8th Ed.; McGraw-Hill: New York (2003).
- Halpern, A. M. & McBane, G. C. Experimental Phy Chem 3rd Ed.; W.H. Freeman & Co.: New York (2003).

SEMESTER- IV

C-8: INORGANIC CHEMISTRY-III

Credits-6: (Theory-4, Practical-2)

Coordination Chemistry (Unit-I)

Werners theory, Valence bond theory (inner and outer orbital complexes), electroneutrality principle and back bonding. Crystal field theory, measurement of CFSE weak and strong fields, pairing energies, factors affecting the magnitude of 10 Dq in octahedral vs. tetrahedral coordination, tetragonal distortions from octahedral geometry, Jahn-Teller theorem, square planar geometry. Qualitative aspect of ligand field and MO Theory. IUPAC nomenclature of coordination compounds, isomerism in coordination compounds. Stereochemistry of complexes with 4 and 6 coordination numbers. Chelate effect, Labile and inert complexes.

Transition Elements-I (Unit-II)

General group trends with special reference to electronic configuration, colour, variable valency, magnetic and catalytic properties, ability to form complexes. Stability of various oxidation states and e.m.f. (Latimer & Bsworth diagrams). Difference between the first, second and third transition series.

Transition Elements-II (Unit-III)

Chemistry of Ti, V, Cr Mn, Fe and Co in various oxidation states (excluding their metallurgy).

Lanthanoids and Actinoids (Unit-IV)

Electronic configuration, oxidation states, colour, spectral and magnetic properties, lanthanide contraction, separation of lanthanides (ion-exchange method only). General features of actinoids, separation of Np, Pm, Am from U.

Bioinorganic Chemistry: Metal ions present in biological systems, classification of elements according to their action in bi-ological system. Na/K-pump, carbonic anhydrase and carboxypeptidase. Excess and deficiency of some trace metals. Toxicity of metal ions (Hg, Pb, Cd and As), reasons for toxicity, Use of chelating agents in medicine. Iron & its application in bio-systems, Haemoglobin; Storage & transfer of iron.

Reference:

- Purcell, K.F & Kotz, J.C. Inorganic Chemistry W.B. Saunders Co, 1977. Huheey, J.E., Inorganic Chemistry, Prentice Hall, 1993.
- Lippard, S.J. & Berg, J.M. Principles of Bioinorganic Chemistry Panima Publishing Company 1994.
- Cotton, F.A. & Wilkinson, G, Advanced Inorganic Chemistry. Wiley-VCH, 1999.
- Basolo, F, and Pearson, R.C., Mechanisms of Inorganic Chemistry, John Wiley & Sons, NY, 1967. Greenwood, N.N. & Earnshaw A., Chemistry of the Elements, Butterworth-Heinemann, 1997.

PRACTICAL: C-8 LAB

Gravimetric Analysis:

- Estimation of nickel (II) using Dimethylglyoxime (DMG).
- Estimation of copper as CuSCN.
- Estimation of iron as Fe_2O_3 by precipitating iron as $Fe(OH)_3$:
- Estimation of Al(III) by precipitating with oxine and weighing as Al(oxine)3 (aluminium oxinate).

Chromatography of metal ions

Principles involved in chromatographic separations. Paper chromatographic separation of following metal ions:

i. Ni(II) and Co(II)

ii. Fe(III) and Al(III)

Reference: Vogel, A.I. A text book of Quantitative Analysis, ELBS 1986.

C-9: ORGANIC CHEMISTRY- III

Credits-6: (Theory-4, Practical-2)

Nitrogen Containing Functional Groups (Unit-I)

Preparation and important reactions of nitro compounds, nitriles. Amines: Effect of substituent and solvent on basicity; Preparation and properties: Gabriel phthalimide synthesis, Carbylamine reaction, Mannich reaction, Hoffmanns exhaustive methylation, Hofmann elimination reaction; Distinction between 1, 2 and 3 amines with Hinsberg reagent and nitrous acid.

Diazonium Salts (Unit-II)

Preparation and their synthetic applications. Polynuclear Hydrocarbons, Reactions of naphthalene and anthracene Structure, Preparation and structure elucidation and important derivatives of aphthalene and anthracene. Polynuclear hydrocarbons.

Heterocyclic Compounds (Unit-III)

Classification and nomenclature, Structure, aromaticity in 5-numbered and 6-membered rings containing one heteroatom; Synthesis, reactions and mechanism of substitution reactions of: Furan, Pyrrole (Paal-Knorr synthesis, Knorr pyrrole synthesis, Hantzsch synthesis), Thiophene, Pyridine (Hantzsch synthesis), Pyrimidine. Fischer indole synthesis and Madelung synthesis, structure of quinoline and isoquinoline. Derivatives of furan: Furfural and furoic acid (preparation only).

Alkaloids (Unit-IV)

Natural occurrence, General structural features, Isolation and their physiological action Hoffmanns exhaustive methylation, Emde's modification, Structure elucidation and synthesis of Hygrine and Nicotine. Medicinal importance of Nicotine, Hygrine, Quinine, Morphine, Cocaine, and Reserpine.

Terpenes Occurrence, classification, isoprene rule; Elucidation of stucture and synthesis of Citral, Neral and terpineol.

Reference:

- Acheson, R.M. Introduction to the Chemistry of Heterocyclic compounds, John Welly & Sons (1976).
- Graham Solomons, T.W. Organic Chemistry, John Wiley & Sons, Inc.
- Kalsi, P. S. Textbook of Organic Chemistry 1st Ed., New Age International (P) Ltd. Pub.
- Clayden, J.; Greeves, N.; Warren, S.; Wothers, P.; Organic Chemistry, Oxford University Press. Singh, J.; Ali, S.M. & Singh, J. Natural Product Chemistry, Prajati Parakashan (2010).
- Morrison, R. T. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
- Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Educa-tion).
- Finar, I. L. Organic Chemistry (Volume 2: Stereochemistry and the Chemistry of Natural Products), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).

PRACTICAL: C-9 LAB

1. Detection of extra elements (N, X, S).
2. Functional group test for nitro, amine and amide groups.
3. Qualitative analysis of unknown organic compounds containing simple functional groups (alcohols, carboxylic acids, phenols and carbonyl compounds).

Reference:

- Mann, F.G. & Saunders, B.C. Practical Organic Chemistry, Pearson Education (2009).
- Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. Practical Org Chem, 5th Ed., Pearson (2012).
- Ahluwalia, V.K. & Aggarwal, R. Comprehensive Practical Organic Chemistry: Preparation and Quantitative Analysis, University Press (2000).
- Ahluwalia, V.K. & Dhingra, S. Comprehensive Practical Org Chem: Qualitative Analysis, Univ Press (2000).

C-10: PHYSICAL CHEMISTRY- IV

Credits-6: (Theory-4, Practical-2)

Electrochemistry-I (Unit-I)

Quantitative aspects of Faradays 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 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, glass electrodes.

Electrochemistry-II (Unit-II)

Concentration cells with and without transference, liquid junction potential; determination of activity coefficients and transference numbers. Qualitative discussion of potentiometric titrations (acid-base, redox, precipitation). Electrical properties of atoms and molecules Basic ideas of electrostatics, Electrostatics of dielectric media. Clausius-Mosotti equation and Lorenz-Laurentz equation (no derivation), Dipole moment and molecular polarizabilities and their measurements. Diamagnetism, Paramagnetism, Magnetic Susceptibility and its Measurements.

Conductance-I (Unit-III)

Arrhenius theory of electrolytic dissociation. Conductivity, equivalent and molar conductivity and their variation with dilution for weak and strong electrolytes. Molar conductivity at infinite dilution. Kohlrausch law of independent migration of ions. Debye-Hckel-Onsager equation, Wien effect.

Conductance-II (Unit-IV)

Ionic velocities, mobilities and their determinations, transference numbers and their relation to ionic mobilities, determination of transference numbers using Hittorf and Moving Boundary methods. Applications of conductance measurement: (i) degree of dissociation of weak electrolytes, (ii) ionic product of water (iii) solubility and solubility product of sparingly soluble salts, (iv) conductometric titrations, and (v) hydrolysis constants of salts.

Reference:

- Rogers, D. W. Concise Physical Chemistry Wiley (2010).
- Silbey, R. J.; Alberty, R. A. & Bawendi, M. G. Physical Chemistry 4th Ed., John Wiley & Sons, Inc. (2005).
- Atkins, P.W & Paula, J.D. Physical Chemistry, 9th Ed., Oxford University Press (2011). Castellan, G. W. Physical Chemistry 4th Ed., Narosa (2004).
- Mortimer, R. G. Physical Chemistry 3rd Ed., Elsevier: NOIDA, UP (2009).
- Barrow, G. M., Physical Chemistry 5th Ed., Tata McGraw Hill: New Delhi (2006). Engel, T. & Reid, P. Physical Chemistry 3rd Ed., Prentice-Hall (2012).

PRACTICAL: C-10 LAB

Conductometry

- Determination of cell constant.
- Determination of equiv. conductance, degree of dissociation and dissociation constant of a weak acid.
- Perform the following conductometric titrations:
  i. Strong acid vs. strong base
  ii. Weak acid vs. strong base
  iii. Strong acid vs. weak base

Potentiometry

Perform the following potentiometric titrations:

i. Strong acid vs. strong base
ii. Weak acid vs. strong base
iii. Dibasic acid vs. strong base

Reference:

- Khosla, B. D.; Garg, V. C. & Gulati, A. Senior Practical Physical Chem, R. Chand & Co.: New Delhi (2011).
- Garland, C. W.; Nibler, J. W. & Shoemaker, D. P. Experiments in Phy Chem 8th Ed.; McGraw-Hill: New York (2003).
- Halpern, A. M. & McBane, G. C. Experimental Phy Chem 3rd Ed.; W.H. Freeman & Co.: New York (2003).

SEMESTER- V

C-11: ORGANIC CHEMISTRY- IV

Credits-6: (Theory-4, Practical-2)

Nucleic Acids (Unit-I)

Components of nucleic acids, Nucleosides and nucleotides; Structure, synthesis and reactions of: Adenine, Guanine, Cytosine, Uracil and Thymine; Structure of polynucleotides.

Enzymes: Introduction, classification and characteristics of enzymes. Salient features of active site of enzymes. Mechanism of enzyme action (taking trypsin as example), factors affecting enzyme action, coenzymes and cofactors and their role in biological reactions, specificity of enzyme action (including stereo specificity), enzyme inhibitors and their importance, phenomenon of inhibition (competitive, uncompetitive and non-competitive inhibition including allosteric inhibition).

Amino Acids, Peptides and Proteins (Unit-II)

Amino acids, peptides and their classification. -Amino acids - Synthesis, ionic properties and reactions. Zwitterions, pKa values, isoelectric point and electrophoresis. Study of peptides: determination of their primary structures-end group analysis, methods of peptide synthesis. Synthesis of peptides using N-protecting, C-protecting and C-activating groups -Solid-phase synthesis.

Lipids (Unit-III)

Introduction to oils and fats; common fatty acids present in oils and fats, Hydrogenation of fats and oils, Saponification value, acid value, iodine number. Reversion and rancidity.

Concept of Energy in Biosystems: Cells obtain energy by the oxidation of food stuff (organic molecules). Introduction to metabolism (catabolism and anabolism). Overview of catabolic pathways of fat and protein. Interrelationship in the metabolic pathways of protein, fat and carbohydrate. Caloric value of food, standard caloric content of food types.

Pharmaceutical Compounds: Structure and Importance (Unit-IV)

Classification, structure and therapeutic uses of antipyretics: Paracetamol (with synthesis), Analgesics: Ibuprofen (with synthesis), Antimalarials: Chloroquine (with synthesis). An elementary treatment of Antibiotics and detailed study of chloramphenicol, Medicinal values of curcumin (haldi), azadirachtin (neem), vitamin C and antacid (ranitidine).

Reference:

- Berg, J.M., Tymoczko, J.L. and Stryer, L. (2006) Biochemistry. VIth Edition. W.H. Freeman and Co.
- Nelson, D.L., Cox, M.M. and Lehninger, A.L. (2009) Principles of Biochem. IV Edition. W.H. Freeman & Co.
- Murray, R.K., Granner, D.K., Mayes, P.A. and Rodwell, V.W. (2009) Harpers Illustrated Biochemistry. XXVIII edition. Lange Medical Books/ McGraw-Hill.

PRACTICAL: C-11 LAB

1. Preparations of the following compounds:
   Aspirine, Phenacetin, Milk of magnesia, Aluminium hydroxide gel, Divol.
2. Saponification value of an oil or a fat.
3. Determination of Iodine number of an oil/ fat.

C-12: PHYSICAL CHEMISTRY- V

Credits-6: (Theory-4, Practical-2)

Quantum Chemistry (Unit-I)

Postulates of quantum mechanics, quantum mechanical operators, Schrodinger equation and its application to free particle and particle in one dimensional box (rigorous treatment), quantization of energy levels, zero-point energy and Heisenberg Uncertainty principle; wave functions, probability distribution functions, nodal properties. Extension to three dimensional boxes, separation of variables, degeneracy. Qualitative treatment of simple harmonic oscillator model of vibrational motion: Setting up of Schrodinger equation and discussion of solution and wave functions. Vibrational energy of diatomic molecules and zero-point energy.

Angular momentum: Commutation rules, quantization of square of total angular momentum and z-component. Rigid rotator model of rotation of diatomic molecule. Schrodinger equation, transformation to spherical polar coordinates. Separation of variables (Preliminary treatment). Qualitative treatment of hydrogen atom and hydrogen-like ions: setting up of Schrodinger equation in spherical polar coordinates, radial part, quantization of energy (only final energy expression). Average and most probable distances of electron from nucleus.

Chemical Bonding (Unit-II)

Chemical bonding: 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 (only wavefunctions, detailed solution not required) and their limitations. Qualitative description of LCAO-MO treatment of homonuclear and heteronuclear diatomic molecules (HF, LiH). Localised and non-localised molecular orbitals treatment of triatomic (BeH_2, H_2O) molecules. Qualitative MO theory and its application to AH_2 type molecules

Molecular Spectroscopy-I (Unit-III)

Interaction of electromagnetic radiation with molecules and various types of spectra; Born-Oppenheimer approximation. Rotational 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. Vibration-rotation spectroscopy: diatomic vibrating rotator, P, Q, R branches.

Raman spectroscopy: Qualitative treatment of Rotational Raman effect; Effect of nuclear spin, Vibrational Raman spectra, Stokes and anti-Stokes lines; their intensity difference, rule of mutual exclusion.

Molecular Spectroscopy-II (Unit-IV)

Electronic spectroscopy: Franck-Condon principle, electronic transitions, singlet and triplet states, fluorescence and phosphorescence, dissociation and predissociation.

Photochemistry

Characteristics of electromagnetic radiation, Lambert-Beers law and its limitations, physical significance of absorption coefficients. Laws, of photochemistry, quantum yield, examples of low and high quantum yields, photochemical equilibrium and the differential rate of photochemical reactions, photosensitised reactions, quenching. Role of photochemical reactions in biochemical processes, photostationary states, chemiluminescence.

Reference:

- Banwell, C. N. & McCash, E. M. Fundamentals of Molecular Spectroscopy 4th Ed. Tata McGraw- Hill: New Delhi (2006).
- Chandra, A. K. Introductory Quantum Chemistry Tata McGraw-Hill (2001).
- House, J. E. Fundamentals of Quantum Chemistry 2nd Ed. Elsevier: USA (2004). Lowe, J. P. & Peterson, K. Quantum Chemistry, Academic Press (2005).
- Kakkar, R. Atomic & Molecular Spectroscopy, Cambridge University Press (2015).

PRACTICAL: C-12 LAB

Colourimetry

1. Determine the concentration of HCl against 0.1 N NaOH spectrophotometrically.
2. To find the strength of given ferric ammonium sulfate solution by using EDTA spectrophotometrically.
3. To find out the strength of $CuSO_4$ solution by titrating with EDTA spectrophotometrically.
4. To determine the concentration of Cu(II) and Fe(III) solution photometrically by titrating with EDTA.

Reference:

- Khosla, B. D.; Garg, V. C. & Gulati, A., Senior Practical Physical Chemistry, R. Chand & Co.: New Delhi (2011).
- Garland, C. W.; Nibler, J. W. & Shoemaker, D. P. Experiments in Physical Chemistry 8th Ed.; McGraw-Hill: New York (2003).
- Halpern, A. M. & McBane, G. C. Experimental Physical Chemistry 3rd Ed.; W.H. Freeman & Co.: New York (2003).
- Experimental Physical Chemistry by J. N. Gurtu, R. Kapoor.

SEMESTER- VI

C-13: INORGANIC CHEMISTRY- IV

Credits-6: (Theory-4, Practical-2)

Organometallic Compounds-I (Unit-I)

Definition and classification of organometallic compounds on the basis of bond type. Concept of hapticity of organic ligands. Metal carbonyls: 18 electron rule, electron count of mononuclear, polynuclear and substituted metal carbonyls of 3d series. General methods of preparation (direct combination, reductive carbonylation, thermal and photochemical decomposition) of mono and binuclear carbonyls of 3d series. Structures of mononuclear and binuclear carbonyls of Cr, Mn, Fe, Co and Ni using VBT. - acceptor behaviour of CO (MO diagram of CO to be discussed), Synergic effect and use of IR data to explain extent of back bonding. Zeise's Salt: Preparation and structure, evidences of synergic effect and comparison of synergic effect with that in carbonyls.

Organometallic Compounds-II (Unit-II)

Metal Alkyls: Important structural features of methyl lithium (tetramer) and trialkyl aluminium (dimer), concept of multicentre bonding in these compounds. Role of triethylaluminium in polymerisation of ethene (Ziegler Natta Catalyst). Species present in ether solution of Grignard reagent and their structures. Ferrocene: Preparation and reactions (acetylation, alkylation, metallation, Mannich Condensation), structure and aromaticity, comparison of aromaticity and reactivity with that of benzene.

Theoretical Principles in Qualitative Analysis (H_2S Scheme) (Unit-III)

Basic principles involved in analysis of cations and anions and solubility products, common ion 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.

Catalysis by Organometallic Compounds

Study of the following industrial processes and their mechanism:

1. Alkene hydrogenation (Wilkinsons Catalyst).
2. Hydroformylation (Co salts).
3. Wacker Process.
4. Synthetic gasoline (Fischer Tropsch reaction).

Reaction Kinetics and Mechanism (Unit-IV)

Introduction to inorganic reaction mechanisms. Substitution reactions in square planar complexes, Trans-effect and its applications, theories of trans effect, Mechanism of nucleophilic substitution in square planar complexes. Thermodynamic and kinetic stability, Kinetics of octahedral substitution (classification of metal ions based on water exchange rate), General mechanism of substitution in octahedral complexes (D, I, Id, Ia).

Reference:

- Huheey, J. E.; Keiter, E.A. & Keiter, R.L. Inorganic Chemistry, Principles of Structure and Reactivity 4th Ed., Harper Collins 1993, Pearson,2006.
- Sharpe, A.G. Inorganic Chemistry, 4th Indian Reprint (Pearson Education) 2005.
- Douglas, B. E.; McDaniel, D.H. & Alexander, J.J. Concepts and Models in Inorganic Chemistry, 3rd Ed., John Wiley and Sons, NY, 1994.

- Greenwood, N.N. & Earnshaw, A. Chemistry of the Elements, Elsevier 2nd Ed, 1997 (Ziegler Natta Catalyst and Equilibria in Grignard Solution).
- Lee, J.D. Concise Inorganic Chemistry 5th Ed., John Wiley and sons 2008. Powell, P. Principles of Organometallic Chemistry, Chapman and Hall, 1988.
- Shriver, D.D. & P. Atkins, Inorganic Chemistry 2nd Ed., Oxford University Press, 1994.
- Basolo, F. & Person, R. Mechanisms of Inorganic Reactions: Study of Metal Complexes in Solution 2nd Ed., John Wiley & Sons Inc; NY.
- Purcell, K.F. & Kotz, J.C., Inorganic Chemistry, W.B. Saunders Co. 1977.
- Miessler, G. L. & Donald, A. Tarr, Inorganic Chemistry 4th Ed., Pearson, 2010.
- Collman, James P. et al. Principles and Applications of Organotransition Metal Chemistry. Mill Valley, CA: University Science Books, 1987.
- Crabtree, Robert H. The Organometallic Chem of the Transition Metals, New York, NY: John Wiley, 2000.
- Spessard, Gary O., & Gary L. Miessler. Organometallic Chem. Upper Saddle River, NJ: Prentice-Hall, 1996.
- Mehrotra R.C. and Singh, A. Organometallic Chemistry, New Age International Publishers, 2nd Edn, 2000.

PRACTICAL: C-13 LAB

Qualitative semimicro analysis of mixtures containing 3 anions and 3 cations. Emphasis should be given to the understanding of the chemistry of di erent reactions. The following radicals are suggested:

CO_3^{2} ; NO_2 ; S ; SO_3 ; $S_2O_3^{2}$; CH_3COO ; F ; Cl ; Br ; I ; NO_3 ; BO_3 ; $C_2O_4^{2}$; PO_4^{3} ; NH_4^{+}; K^{+}; $Pb^{+}{}_2$; $Cu^{+}{}_2$; $Cd^{+}{}_2$; $Bi^{+}{}_3$; Sn^{2+} ; Sb^{3+} ; Fe^{3+} ; Al^{3+}; ; Cr^{3+} ; Zn^{2+} ; Mn^{2+} ; Co^{2+} ; Ni^{2+}; Ba^{2+}; Sr^{2+}; Ca^{2+};

Mg^{2+} : Mixtures should preferably contain one interfering anion, or insoluble component ($BaSO_4$; $SrSO_4$; $PbSO_4$; CaF_2orAl_2O_3) or combination of anions e.g. CO_3^{2} and SO_3^{2} ; NO_2 and NO_3 ; Cl and Br ; Cl and I ; Br and I ; NO_3 and Br ; NO_3 and I : Spot tests should be done whenever possible.

Reference:

- Vogels Qualitative Inorganic Analysis, Revised by G. Svehla.
- Marr & Rockett Inorganic Preparations.

C-14: ORGANIC CHEMISTRY- V

Credits-6: (Theory-4, Practical-2)

Organic Spectroscopy-I (Unit-I)

UV-Visible Spectroscopy: Types of electronic transitions, λ_{max}, Chromophores and Auxochromes, Bathochromic and Hypsochromic shifts, Intensity of absorption; Application of Woodward rules for calculation of λ_{max} for the following systems: the unsaturated aldehydes: ketones, carboxylic acids and esters; Conjugated dienes: alicyclic, homoannular and heteroannular; Extended conjugated systems (aldehydes, ketones and dienes); distinction between cis and trans isomers.

IR Spectroscopy: Fundamental and non-fundamental molecular vibrations; IR absorption positions of O, N and S containing functional groups; Effect of H-bonding, conjugation, resonance and ring size on IR absorptions; Fingerprint region and its significance; application in functional group analysis.

Organic Spectroscopy-II (Unit-II)

NMR Spectroscopy: Basic principles of Proton Magnetic Resonance, chemical shift and factors influencing it; Spin-spin coupling and coupling constant; Anisotropic effects in alkene, alkyne, aldehydes and aromatics; Interpretation of NMR spectra of simple compounds. Mass Spectroscopy-Basic principle, Fragmentation pattern, Instrumentation, Determination of m/e ratio. Application of Mass Spectroscopy on CH_4, C_2H_6, n-butane and neo-pentane. Applications of IR, UV and NMR for identification of simple organic molecules.

Carbohydrates (Unit-III)

Occurrence, classification and their biological importance. Monosaccharides: Constitution and absolute configuration of glucose and fructose, epimers and anomers, mutarotation, determination of ring size of glucose and fructose, Haworth projections and conformational structures; Inter conversions of aldoses and ketoses; Killiani-Fischer synthesis and Ruff degradation; Disaccharides Structure elucidation of maltose. Polysaccharides Elementary treatment of starch, cellulose.

Dyes: Classification, colour and constitution; Mordant and Vat dyes; Chemistry of dyeing. Synthesis and applications of: Azo dyes Methyl orange and Congo red (mechanism of Diazo Coupling); Triphenyl methane dyes - Malachite Green, and crystal violet; Phthalein dyes Phenolphthalein and Fluorescein; Natural dyes Alizarin and Indigo; Edible dyes with examples.

Polymers (Unit-IV)

Introduction and classification including di-block, tri-block and amphiphilic polymers; Number average molecular weight, Weight average molecular weight, Degree of polymerization, Polydispersity Index. Polymerisation reactions -Addition and condensation -Mechanism of cationic, anionic and free radical addition polymerization; Metallocene-based Ziegler-Natta polymerisation of alkenes; Preparation and applications of plastics thermosetting (phenol-formaldehyde, Polyurethanes) and thermosoftening (PVC, polythene); Fabrics natural and synthetic (acrylic, polyamido, polyester); Rubbers natural and synthetic: Buna-S and Neoprene; Vulcanization; Polymer additives; Biodegradable and conducting polymers with examples.

Reference:

- Billmeyer, F. W. Textbook of Polymer Science, John Wiley & Sons, Inc.
- Gowariker, V. R.; Viswanathan, N. V. & Sreedhar, J. Polymer Science, New Age International (P) Ltd. Pub.
- Finar, I. L. Organic Chemistry (Volume 2: Stereochemistry and the Chemistry of Natural Prod-ucts), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).

- Kalsi, P. S. Textbook of Organic Chemistry 1st Ed., New Age International (P) Ltd. Pub.
- Morrison, R. T. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
- Graham Solomons, T.W. Organic Chemistry, John Wiley & Sons, Inc.
- Clayden, J.; Greeves, N.; Warren, S.; Wothers, P.; Organic Chemistry, Oxford University Press.
- Singh, J.; Ali, S.M. & Singh, J. Natural Product Chemistry, Pragati Prakashan (2010).
- Kemp, W. Organic Spectroscopy, Palgrave.

PRACTICAL: C-14 LAB.

1. Extraction of caffeine from tea leaves.
2. Preparation of sodium polyacrylate.
3. Preparation of urea formaldehyde.
4. Analysis of Carbohydrate: aldoses and ketoses, reducing and non-reducing sugars.
5. Qualitative analysis of unknown organic compounds containing mono-functional groups (carbohydrates, aryl halides, aromatic hydrocarbons, nitro compounds, amines and amides) and simple bifunctional groups, for e.g. salicylic acid, cinnamic acid, nitrophenols etc.

Reference:

- Vogel, A.I. Quantitative Organic Analysis, Part 3, Pearson (2012).
- Mann, F.G. & Saunders, B.C. Practical Organic Chemistry, Pearson Education (2009).
- Furniss, B.S., Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. Practical Org Chem, 5th Ed., Pearson (2012).
- Ahluwalia, V.K. & Aggarwal, R. Comprehensive Practical Organic Chemistry: Preparation and Quantitative Analysis, University Press (2000).
- Ahluwalia, V.K. & Dhingra, S. Comprehensive Practical Org Chem: Qualitative Analysis, Univ Press (2000).

DISCIPLINE SPECIFIC ELECTIVE (DSE)

DSE1:- INORGANIC MATERIALS OF INDUSTRIAL IMPORTANCE

Credits-6: (Theory-4, Practical-2)

Unit 1: Recapitulation of *s*- and *p*-Block Elements: Periodicity in *s*- and *p*-block elements with respect to electronic configuration, atomic and ionic size, ionization enthalpy, electronegativity (Pauling, Mulliken, and Alfred-Rochow scales). Allotropy in C, S, and P. Oxidation states with reference to elements in unusual and rare oxidation states like carbides and nitrides), inert pair effect, diagonal relationship and anomalous behaviour of first member of each group.

Unit 2: Silicate Industries

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. High technology 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 the setting process, quick setting cements.

Fertilizers: 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.

Unit 3: Surface Coatings: 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: 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: 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 (argon treatment, heat treatment, nitriding, carburizing). Composition and properties of different types of steels.

Unit 4: Catalysis: 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: Origin of explosive properties in organic compounds, preparation and explosive properties of lead azide, PETN, cyclonite (RDX). Introduction to rocket propellants.

Reference:

- E. Stocchi: *Industrial Chemistry*, Vol-I, Ellis Horwood Ltd. UK.
- R. M. Felder, R. W. Rousseau: *Elementary Principles of Chemical Processes*, Wiley Publishers, New Delhi.
- W. D. Kingery, H. K. Bowen, D. R. Uhlmann: *Introduction to Ceramics,* Wiley Publishers, New Delhi.
- J. A. Kent: Riegel's *Handbook of Industrial Chemistry*, CBS Publishers, New Delhi.
- P. C. Jain & M. Jain: *Engineering Chemistry,* Dhanpat Rai & Sons, Delhi.
- R. Gopalan, D. Venkappayya, S. Nagarajan: *Engineering Chemistry,* Vikas Publications, New Delhi.
- B. K. Sharma: *Engineering Chemistry*, Goel Publishing House, Meerut

PRACTICAL: DSE-1 LAB 20 Classes (2 hr duration)

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:

- E. Stocchi: *Industrial Chemistry*, Vol-I, Ellis Horwood Ltd. UK.
- R. M. Felder, R. W. Rousseau: *Elementary Principles of Chemical Processes*, Wiley Publishers, New Delhi
- W. D. Kingery, H. K. Bowen, D. R. Uhlmann: *Introduction to Ceramics,* Wiley Publishers, New Delhi.
- J. A. Kent: Riegel's *Handbook of Industrial Chemistry*, CBS Publishers, New Delhi.
- P. C. Jain, M. Jain: *Engineering Chemistry,* Dhanpat Rai & Sons, Delhi.
- R. Gopalan, D. Venkappayya, S. Nagarajan: *Engineering Chemistry,* Vikas Publications, New Delhi.
- Sharma, B.K. & Gaur, H. *Industrial Chemistry,* Goel Publishing House, Meerut (1996)

DISCIPLINE SPECIFIC ELECTIVE (DSE)

DSE-2: POLYMER CHEMISTRY

Credits-6: (Theory-4, Practical-2)

Introduction and history of polymeric materials: (Unit-I)

Different schemes of classification of polymers, Polymer nomenclature, Molecular forces and chemical bonding in polymers, Texture of Polymers.

Functionality and its importance: Criteria for synthetic polymer formation, classification of polymerization processes, Relationships between functionality, extent of reaction and degree of polymerization. Bi-functional systems, Polyfunctional systems.

Kinetics of Polymerization: (Unit-II)

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: Determination of crystalline melting point and degree of crystallinity, Morphology of crystalline polymers, Factors affecting crystalline melting point. Nature and structure of polymers-Structure property relationships.

Determination of molecular weight of polymers: (Unit-III)

(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 WLF equation, Factors affecting glass transition temperature (Tg).

Polymer Solution (Unit-IV)

Criteria for polymer solubility, Solubility parameter, Thermodynamics of polymer solutions, entropy, enthalpy, and free energy change of mixing of polymers solutions.

Properties of Polymers: (Physical, thermal & mechanical properties). Brief introduction to preparation, structure, prop-erties and application of the following polymers: polyolefins, polystyrene and styrene copolymers, poly(vinyl chloride) poly(vinyl acetate), polyacrylamide,fluoro polymers (Teflon), polyamides (nylon-6 and nylon 6,6). Phenol formaldehyde resins (Bakelite, Novalac), polyurethanes, silicone polymers (polysiloxane), Polycarbonates, Conducting Polymers, (polyacetylene, polyaniline).

Reference:

- Seymours Polymer Chemistry, Marcel Dekker
- G. Odian: Principles of Polymerization, John Wiley.
- F.W. Billmeyer: Text Book of Polymer Science, John Wiley. P. Ghosh: Polymer Science & Technology, Tata Mcgraw-Hill. R.W. Lenz: Organic Chemistry of Synthetic High Polymers.

PRACTICAL: DSE-2 LAB

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.

(a) Preparation of IPC.
(b) Purification of IPC.
(c) Interfacial polymerization.

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 wt. by end group analysis: Polyethylene glycol (PEG) (OH group).
4. 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

*at least 5 experiments to be carried out.

Reference:

- Malcohm P. Stevens, Polymer Chemistry: An Introduction, 3rd Ed.
- Harry R. Allcock, Frederick W. Lampe and James E. Mark, Contemporary Polymer Chemistry, 3rd ed. Prentice-Hall (2003).
- Fred W. Billmeyer, Textbook of Polymer Science, 3rd ed. Wiley-Interscience (1984). Joel R. Fried, Polymer Science and Technology, 2nd ed. Prentice-Hall (2003).
- Petr Munk and Tejraj M. Aminabhavi, Int. to Macromolecular Science, 2nd ed. John Wiley & Sons (2002).
- L.H. Sperling, Introduction to Physical Polymer Science, 4th ed. John Wiley & Sons (2005).

DSE-3: INDUSTRIAL CHEMICALS AND ENVIRONMENT

Credits-6: (Theory-4, Practical-2)

Industrial Gases and Inorganic Chemicals (Unit-I)

Industrial Gases: Large scale production, uses, storage and hazards in handling of the following gases: oxygen, nitrogen, argon, neon, helium, hydrogen, acetylene, carbon monoxide, chlorine, sulphur dioxide. Inorganic Chemicals: Manufacture, application and hazards in handling the following chemicals: hydrochloric acid, nitric acid, sulphuric acid, caustic soda, common salt, bleaching powder, sodium thiosulphate, hydrogen peroxide, potash alum, potassium dichromate and potassium permanganate.

Industrial Metallurgy: Preparation of metals (ferrous and nonferrous) and ultrapure metals for semiconductor technology.

Environment and its segments (Unit-II)

Ecosystems. Biogeochemical cycles of carbon, nitrogen and sulphur. Air Pollution: Major regions of atmosphere. Chemical and photochemical reactions in atmosphere. Air pollutants: types, sources, particle size and chemical nature; Photochemical smog: its constituents and photochemistry. Environmental effects of ozone. Major sources of air pollution. Pollution by SO_2; CO_2; CO; NO_x; and H_2S and control procedures. Effects of air pollution on living organisms and vegetation. Greenhouse effect and global warming, Ozone depletion by oxides of nitrogen, chlorofluorocarbons and halogens, removal of sulphur from coal.

Water Pollution (Unit-III):

Hydrological cycle, water resources, aquatic ecosystems, Sources and nature of water pollutants, Techniques for measuring water pollution, Impacts of water pollution on hydrological and ecosystems. Water purification methods. Effluent treatment plants (primary, secondary and tertiary treatment). Industrial effluents from the following industries and their treatment: electroplating, textile, tannery, dairy, petroleum and petrochemicals, fertilizer. Sludge disposal. Industrial waste management, incineration of waste. Water treatment and purification (reverse osmosis, ion exchange). Water quality parameters for waste water, industrial water and domestic water.

Energy & Environment (Unit-IV)

Sources of energy: Coal, petrol and natural gas. Nuclear fusion/fission, solar energy, hydrogen, geothermal, tidal and hydel. Nuclear Pollution: Disposal of nuclear waste, nuclear disaster and its management. **Biocatalysis:** Introduction to biocatalysis: Importance in green chemistry and chemical industry.

Reference:

- E. Stocchi: Industrial Chemistry, Vol-I, Ellis Horwood Ltd. UK.
- R.M. Felder, R.W. Rousseau: Elementary Principles of Chemical Processes, Wiley Publishers, New Delhi.
- Kent: Riegels Handbook of Industrial Chemistry, CBS Publishers, New Delhi.
- S. S. Dara: A Textbook of Engineering Chemistry, S. Chand & Company Ltd. New Delhi. De, Environmental Chemistry: New Age International Pvt., Ltd, New Delhi.
- S. M. Khopkar, Environmental Pollution Analysis: Wiley Eastern Ltd, New Delhi. S.E. Manahan, Environmental Chemistry, CRC Press (2005).
- G.T. Miller, Environmental Science 11th edition. Brooks/ Cole (2006).
- Mishra, Environmental Studies. Selective and Scienti c Books, New Delhi (2005).

PRACTICAL: DSE-3 LAB 20 Classes

1. Determination of dissolved oxygen in water.
2. Determination of Chemical Oxygen Demand (COD).
3. Determination of Biological Oxygen Demand (BOD).
4. Percentage of available chlorine in bleaching powder.
5. Measurement of chloride, sulphate and salinity of water samples by simple titration method ($AgNO_3$ and potassium chromate).
6. Estimation of total alkalinity of water samples (CO_3^{2} ; HCO_3) using double titration method.
7. Measurement of dissolved CO_2:
8. Study of some of the common bio-indicators of pollution.
9. Estimation of SPM in air samples.
10. Preparation of borax/ boric acid.

Reference:

- E. Stocchi: Industrial Chemistry, Vol-I, Ellis Horwood Ltd. UK.
- R.M. Felder, R.W. Rousseau: Elementary Principles of Chemical Processes, Wiley Publishers, New Delhi.
- Kent: Riegels Handbook of Industrial Chemistry, CBS Publishers, New Delhi.
- S. S. Dara: A Textbook of Engineering Chemistry, S. Chand & Company Ltd. New Delhi. De, Environmental Chemistry: New Age International Pvt., Ltd, New Delhi.
- S. M. Khopkar, Environmental Pollution Analysis: Wiley Eastern Ltd, New Delhi.

DSE: 4- Project & Seminar
(Credits: 06) (Compulsory)

Project: 80 marks, Seminar: 20 marks

GENERIC ELECTIVE (GE)

B.Sc. (Hons.) Students other than Chemistry Honours will opt two Chemistry GE Papers.

GE- 1: GENERAL CHEMISTRY-I

Credits-6: (Theory-4, Practical-2)

INORGANIC CHEMISTRY-1

Atomic Structure (Unit-I)

Review of: Bohrs theory and its limitations, dual behavior of matter and radiation, de-Broglie's relation, Heisenberg Uncertainty principle. Hydrogen atom spectra.

What is Quantum mechanics? Time independent Schrodinger equation and meaning of various terms in it. Significance of Schrodinger equation for hydrogen atom. Radial and angular parts of the hydogenic wave functions (atomic orbitals) and their variations for 1s, 2s, 2p, 3s, 3p and 3d orbitals (Only graphical representation). Significance of quantum numbers, orbital angular momentum and quantum numbers ml and ms. Shapes of s, p and d atomic orbitals, nodal planes. Discovery of spin, spin quantum number (s) and magnetic spin quantum number (ms). Rules for filling electrons in various orbitals, Electronic configurations of the atoms. Stability of half- filled and completely filled orbitals, concept of exchange energy. Relative energies of atomic orbitals, Anomalous electronic configurations.

Chemical Bonding and Molecular Structure (Unit-II)

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-Land equation for calculation of lattice energy, Born-Haber cycle and its applications, polarizing power and polarizability. Fajans 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 (N_2; O_2) and and heteronuclear diatomic molecules (CO, NO). Comparison of VB and MO approaches.

Organic Chemistry-1

Fundamentals of Organic Chemistry (Unit- III)

Physical Effects, Electronic Displacements: Inductive Effect, Electromeric Effect, Resonance and Hyper conjugation. Cleavage of Bonds: Homolysis and Heterolysis.Structure, shape and reactivity of organic molecules: Nucleophiles and electrophiles. Reactive Intermediates: Carbocations, Carbanions and free radicals. Strength of organic acids and bases: Comparative study with emphasis on factors affecting pK values. Aromaticity: Huckels rule.

Stereochemistry: Conformations with respect to ethane, butane and cyclohexane. Interconversion of Wedge Formula, Newmann, Sawhorse and Fischer representations. Concept of chirality (upto two carbon atoms). Configuration: Geometrical and Optical isomerism; Enantiomerism, Diastereomerism and Meso compounds). D and L; cis-trans nomenclature; CIP Rules: R/S (for one chiral carbon atoms) and E/Z Nomenclature (for up to

two C=C systems).

Aliphatic Hydrocarbons (Unit- IV)

Functional group approach for the following reactions (preparations & reactions) to be studied in context to their structure. Alkanes: (Upto 5 Carbons). Preparation: Catalytic hydrogenation, Wurtz reaction, Kolbes synthesis, from Grignard reagent. Reactions: Free radical Substitution: Halogenation.

Alkenes: (Upto 5 Carbons) Preparation: Elimination reactions: Dehydration of alkenes and dehydrohalogenation of alkyl halides (Saytzeff's rule); cis alkenes (Partial catalytic hydrogenation) and trans alkenes (Birch reduction). Reactions: cis-addition (alk. $KMnO_4$) and trans-addition (bromine), Addition of HX (Markownikoff's and anti-Markownikoff's addition), Hydration, Ozonolysis, Alkynes: (Upto 5 Carbons) Preparation: Acetylene from CaC_2 and conversion into higher alkynes; by de-halogenation of tetra halides and dehydrohalogenation of vicinal-dihalides.

Reactions: formation of metal acetylides, addition of bromine and alkaline $KMnO_4$, ozonolysis.

Reference:

- J. D. Lee: A new Concise Inorganic Chemistry, E L. B. S.
- F. A. Cotton & G. Wilkinson: Basic Inorganic Chemistry, John Wiley.
- Douglas, McDaniel and Alexader: Concepts and Models in Inorganic Chemistry, John Wiley. T. W. Graham Solomon: Organic Chemistry, John Wiley and Sons.
- E. L. Eliel: Stereochemistry of Carbon Compounds, Tata McGraw Hill. I. L. Finar: Organic Chemistry (Vol. I & II), E. L. B. S.
- R. T. Morrison & R. N. Boyd: Organic Chemistry, Prentice Hall.
- Arun Bahl and B. S. Bahl: Advanced Organic Chemistry, S. Chand.

PRACTICAL: GE-1 LAB

Section A: Inorganic Chemistry-Volumetric Analysis

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 Mohrs 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 $Na_2S_2O_3$:

Section B: Organic Chemistry

1. Detection of extra elements (N, S, Cl, Br, I) in organic compounds (containing upto two extra elements).
2. Separation of mixtures by Chromatography: Measure the Rf value in each case (combination of two compounds to be given).

(a) Identify and separate the components of a given mixture of 2 amino acids (glycine, aspartic acid, glutamic acid, tyrosine or any other amino acid) by paper chromatography.

(b) Identify and separate the sugars present in the given mixture by paper chromatography. Large

Reference Books:

- Vogels Qualitative Inorganic Analysis, A.I.
- Vogel, Prentice Hall, 7th Edition. Vogels Quantitative Chemical Analysis, A.I. Vogel, Prentice Hall, 6th Edition.
- Textbook of Practical Organic Chemistry, A.I. Vogel , Prentice Hall, 5th edition.
- Practical Organic Chemistry, F. G. Mann. & B. C. Saunders, Orient Longman, 1960.

GE- 2: GENERAL CHEMISTRY-II

Credits-6: (Theory-4, Practical-2)

Physical Chemistry-1

Chemical Energetics (Unit-I)

Review of thermodynamics and the Laws of Thermodynamics. Important principles and definitions of thermo chemistry. Concept of standard state and standard enthalpies of formations, integral and differential enthalpies of solution and dilution. Calculation of bond energy, bond dissociation energy and resonance energy from thermo chemical data. Variation of enthalpy of a reaction with temperature Kirchhoff's equation. Statement of Third Law of thermodynamics

Chemical Equilibrium: Free energy change in a chemical reaction. Thermodynamic derivation of the law of chemical equilibrium. Distinction between AG and AG°, Le Chateliers principle. Relationships between Kp, Kc and Kx for reactions involving ideal gases.

Ionic Equilibria (Unit- II)

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.

Organic Chemistry-2 (Unit- III)

Functional group approach for the following reactions (preparations & reactions) to be studied in context to their structure. Aromatic hydrocarbons: Preparation (in case of benzene): from phenol, by decarboxylation, from acetylene, from benzene sulphonic acid. Reactions: (in case of benzene): Electrophilic substitution: nitration, halogenation and sulphonation. Friedel-Crafts reaction (alkylation and acylation) (upto 4 carbons on benzene). Side chain oxidation of alkyl benzenes (up to 4 carbons on benzene).

Alkyl and Aryl Halides: Alkyl Halides (Up to 5 Carbons) Types of Nucleophilic Substitution (SN_1; SN_2 and SN_i) reactions. Preparation: from alkenes and alcohols.

Reactions: hydrolysis, nitrite & nitro formation, nitrile & isonitrile formation. Williamsons ether synthesis: Elimination vs substitution.

Aryl Halides Preparation: (Chloro, bromo and iodo-benzene case): from phenol, Sandmeyer & Gattermann reactions. Reactions (Chlorobenzene): Aromatic nucleophilic substitution (replacement by OH group) and effect of nitro substituent. Benzyne Mechanism: KNH_2=NH_3 (or $NaNH_2$=NH_3).

Alcohols, Phenols and Ethers (Upto 5 Carbons) (Unit- IV)

Alcohols: Preparation: Preparation of 1, 2 and 3 alcohols: using Grignard reagent, Ester hydrolysis, Reduction of aldehydes and ketones, carboxylic acid and esters.

Reactions: With sodium, HX (Lucas test), esterification, oxidation (with PCC, alk. $KMnO_4$, acidic dichromate, conc. HNO_3). Oppeneauer oxidation Diols: (Upto 6 Carbons) oxidation of diols. Pinacol-Pinacolone rearrangement.

Phenols: (Phenol case) Preparation: Cumene hydroperoxide method, from diazonium salts. Reactions: Electrophilic substitution: Nitration, halogenation and sulphonation. ReimerTiemann Reaction, Gattermann-Koch Reaction.

Ethers (aliphatic and aromatic): Cleavage of ethers with HI.

Aldehydes and ketones (aliphatic and aromatic): Formaldehye, acetaldehyde, acetone and benzalde-hyde Preparation: from acid chlorides and from nitriles.

Reactions Reaction with HCN, ROH, $NaHSO_3$, NH_2 G derivatives. Iodoform test. Aldol Condensation, Cannizzaros reaction, Benzoin condensation. Clemensen reduction and Wolf Kishner reduction.

Reference:

- T. W. Graham Solomons: Organic Chemistry, John Wiley and Sons.
- Peter Sykes: A Guide Book to Mechanism in Organic Chemistry, Orient Longman. I.L. Finar: Organic Chemistry (Vol. I & II), E. L. B. S.
- R. T. Morrison & R. N. Boyd: Organic Chemistry, Prentice Hall.
- Arun Bahl and B. S. Bahl: Advanced Organic Chemistry, S. Chand.
- G. M. Barrow: Physical Chemistry Tata McGraw-Hill (2007). G. W. Castellan: Physical Chemistry 4th Edn. Narosa (2004).
- H. Mahan: University Chemistry 3rd Ed. Narosa (1998).
- R. H. Petrucci: General Chemistry 5th Ed. Macmillan Publishing Co.: New York (1985).

PRACTICAL: GE-2 LAB

Section A: Physical Chemistry

Thermo chemistry

1. Determination of heat capacity of calorimeter for different volumes.
2. Determination of enthalpy of neutralization of hydrochloric acid with sodium hydroxide.
3. Determination of enthalpy of ionization of acetic acid.
4. Determination of integral enthalpy of solution of salts (KNO_3, NH_4Cl).
5. Determination of enthalpy of hydration of copper sulphate.
6. Study of the solubility of benzoic acid in water and determination of H. Ionic equilibria

pH measurements

a) Measurement of pH of different solutions like aerated drinks, fruit juices, shampoos and soaps (use dilute solutions of soaps and shampoos to prevent damage to the glass electrode) using pH-meter.

b) Preparation of buffer solutions:

(i) Sodium acetate-acetic acid.

(ii) Ammonium chloride-ammonium hydroxide.

Measurement of the pH of buffer solutions and comparison of the values with theoretical values.

Section B: Organic Chemistry

1. Purification of organic compounds by crystallization (from water and alcohol) and distillation.
2. Criteria of Purity: Determination of melting and boiling points.
3. Preparations: Mechanism of various reactions involved to be discussed. Recrystallisation, determination of melting point and calculation of quantitative yields to be done.

(a) Bromination of Phenol/Aniline.

(b) Benzoylation of amines/phenols.

(c) Oxime and 2,4 dinitrophenylhydrazone of aldehyde/ketone.

Reference:

- A. I. Vogel: Textbook of Practical Organic Chemistry, 5th edition, Prentice-Hall.
- F. G. Mann & B. C. Saunders, Practical Organic Chemistry, Orient Longman (1960). B.D. Khosla, Senior Practical Physical Chemistry, R. Chand & Co.

DEPARTMENT OF INFORMATION TECHNOLOGY(Hons.)

CBCS SYLLABUS

RAYAGADA AUTONOMOUS COLLEGE

RAYAGADA -765001, ODISHA.

ACADEMIC SESSION – 2018-2019

CHOICE BASED CREDIT SYSTEM (CBCS)

B.Sc. Information Technology (Hons.) Syllabus

1st Semester

Paper	Subjects	No. of Credits	Full Marks
Core – 1	Programming Fundamentals using C	**4**	**60+15=75**
Core – 1	C Programming Lab	**2**	**25**
Core – 2	Computer System Architecture	**4**	**60+15=75**
Core – 2	Computer System Architecture Lab	**2**	**25**
GE-1(Generic Elective)	Physics/NCC	**6**	
AECC-1(Ability Enhancement Compulsory Course)		**2**	

2nd Semester

Paper	Subjects	No. of Credits	Full Marks
Core – 3	Data Structures	**4**	**60+15=75**
Core – 3	Data Structure Lab	**2**	**25**
Core – 4	Data Communication and Networking	**4**	**60+15=75**
Core – 4	Data Communication and Networking Lab	**2**	**25**
GE-2(Generic Elective)	Mathematics	**6**	
AECC-2(Ability Enhan. Compulsory Course)		**2**	

3rd Semester

Paper	Subjects	No. of Credits	Full Marks
Core – 5	Object Oriented Programming in C++	**4**	**60+15=75**
Core – 5	C++ Programming Lab	**2**	**25**
Core – 6	Operating Systems	**4**	**60+15=75**
Core – 6	Operating Systems Lab	**2**	**25**
Core – 7	Internetworking	**4**	**60+15=75**
Core – 7	Internetworking Lab	**2**	**25**
GE-3(Generic Elective)	Mathematics	**6**	
SEC-1(Skill Enhancement Course)	Communicative English	**2**	

4th Semester

Paper	Subjects	No. Of Credits	Full Marks
Core – 8	E-Commerce	**4**	**60+15=75**
Core – 8	E-Commerce Lab	**2**	**25**
Core – 9	Software Engineering	**4**	**60+15=75**
Core – 9	Software Engineering Lab	**2**	**25**
Core – 10	Database Management Systems	**4**	**60+15=75**
Core – 10	Database Lab	**2**	**25**
GE-4(Generic Elective)	Physics/NCC	**6**	
SEC-2(Skill Enhancement Course)	Logical Thinking and Quantitative Aptitude	**2**	

5th Semester

Paper	Subjects	No. of Credits	Full Marks
Core – 11	Web Technology	**4**	**60+15=75**
Core – 11	Web Technology Lab	**2**	**25**
Core – 12	Java Programming	**4**	**60+15=75**
Core – 12	Java Programming Lab	**2**	**25**
DSE – 1(Discipline Specific Elective)	Computer Graphics	**4**	**60+15=75**
DSE –1(Discipline Specific Elective)	Computer Graphics Lab	**2**	**25**
DSE –2(Discipline Specific Elective)	Artificial Intelligence	**4**	**60+15=75**
DSE –2(Discipline Specific Elective)	Artificial Intelligence Lab	**2**	**25**

6th Semester

Paper	Subjects	No. of Credits	Full Marks
Core – 13	Programming in Visual Basic	**4**	**60+15=75**
Core – 13	Visual Basic lab	**2**	**25**
Core – 14	Data Warehousing and Data Mining	**4**	**60+15=75**
Core – 14	Data Warehousing and Data Mining Lab	**2**	**25**
DSE – 3 (Discipline Specific Elective)	Cloud Computing	**4**	**60+15=75**
DSE –3. (Discipline Specific Elective)	Cloud Computing Lab	**2**	**25**
DSE – 4 (Discipline Specific Elective) Any One	Software Development Project Work	**6**	**100**
	Total	**140**	

Note:

1. **There is no midterm Exam for the practical/Lab papers**
2. **When the AECC & SEC courses are practical in nature then there will be no Midterm exam and it will be of 50 marks, otherwise it will be distributed as End Sem (40 marks) + Midterm (10 marks).**

SEMESTER - I

Core – 1

Programming Fundamentals using C

Unit -1

Overview of Procedure oriented programming, Data types, Defining and Initializing Variables, Scope of Variables, Keywords, Casting of Data Types, Operators (Arithmetic, Relational, and Logical), main() function, Compiling and Executing a program, Using Comments in programs, Character I/O (getc, getchar, putc), printf(), scanf(), Basic Header Files (stdio.h, conio.h, math.h, string.h, etc).

Unit -2

Simple Expressions in C, Understanding precedence of Operators in Expressions, Conditional Statements (IF, IF… ELSE, Nested IF, Switch-Case), Iterative Statements(FOR, WHILE, and DO-WHILE), Use of BREAK and CONTINUE in Loops, Nested loops.

Unit -3

Use of functions, Call by Value, Call by Reference, Functions returning value, Void function, One Dimensional Arrays (Declaring an Array, Initializing an Array, Accessing individual elements in an Array, Manipulating array elements using loops), Use Various types of arrays (integer, float and character arrays / Strings), Two-dimensional Arrays, Working with Rows and Columns of a matrix.

Unit -4

Understanding use of structures, Declaring, initializing and using simple structures, Manipulating individual members of structures, Array of Structures, Understanding Pointer Variable, Simple use of Pointers, Pointer arithmetic, Differentiating between static and dynamic memory allocation, use of malloc and calloc functions, Simple file handling operations.

Books:

1. Programming in ANSI C - E. Balguruswamy, TMH
2. Let us C - Yaswant Kanitkar, BPB

Marks Distributions

Internal ----------15 Marks (1Hrs.)

Term End Examination ----------60 Marks (3 Hrs.)

Core - 1

C Programming Lab

1. Write a program to find the maximum among three numbers.
2. Write a program to find factorial of a number.
3. Write a program to print the Fibonacci series.
4. Write a program to print the prime numbers between 1 to n.
5. Write a program to check if it a Palindrome (e.g., madam).
6. Write a program to check if it is an Armstrong number. (An Armstrong number of three digits is an integer such that the sum of the cubes of its digits is equal to the number itself)
7. Write program to reverse the digits of an input number.
8. Write a program to find the sum of digits of a number.
9. Write a program to find the GCD and LCM of two numbers.
10. Write a program to perform different arithmetic operations using switch….case.
11. Write a program to count the number bits ―1‖ in a given binary number.
12. Write a program to find the factorial of a number using function.
13. Write a program to perform the arithmetic operations using function.
14. Write a program to find the largest element in an array.
15. Write a program to add two matrices.
16. Write a program to multiply two matrices.
17. Write a program to find the position of a given character in a string.
18. Write a program to count the number of times a character occurs in a string.
19. Write a program to create records of 10 students using structure.
20. Write a program to count the number of words, number of lines in a text file.

Marks Distributions

Experiments – 2 X 7.5 =15

Record - = 05

Viva-Voce- =05

Total=25

Core – 2

Computer System Architecture

Unit -1

Number systems – Decimal, Binary, Octal and Hexa-decimal number systems and their inter conversion, 1's & 2's complement, Binary Fixed- Point Representation, Arithmetic operations on Binary numbers, Overflow & underflow. Logic Gates, AND, OR, NOT gates and their Truth tables, NOR, NAND & XOR gates, Boolean Algebra – Basic Operations and Boolean Law's, Demorgan's theorem.

Unit -2

Sum of Product & Product of Sum, K-Map, Combinational & Sequential circuits, Half Adder & Full Adder, Adder & Subtractor, Multiplexer, De-multiplexer, Encoder, Decoder.

Unit -3

Flip-flops - RS, D, JK & T Flip-flops, Registers, Shift Registers, Counters.

Unit -4

Central Processing Unit: General register organisation, Stack organisation, Instruction Formats, Addressing modes, Memory: Main memory, Auxiliary memory, DMA- control signals for DMA transfers, Block diagram of DMA controller, DMA transfer in a microcomputer system.

Books:

1. Computer System Architecture - M. Mano, Pearson Education
2. Computer Organization, Fifth edition - Carl Hamacher, McGrawHill
3. Digital Design - M. M. Mano, Pearson Education Asia
4. Computer Fundamentals - B. Ram, New Age International Publishers

Marks Distributions

Internal ----------15 Marks (1Hrs.)

Term End Examination ----------60 Marks (3 Hrs.)

Core – 2

Computer System Architecture Lab

Topics to be covered in this lab are:

1. Introduction to different operating Systems such as Windows 7, Windows 8, UNIX and Linux etc.
2. Creation of folder and files in windows and LINUX
3. Discussion on doing copy and paste option in windows.
4. Using of CD Drive, Pen drive etc.
5. Use of Microsoft word, Microsoft Excel and Microsoft PowerPoint(Each software to be trained to the students)
6. Use of Internet and its uses
7. Learning of Assembly language programming(practical's to be done in Assembly language are as follows
    a. Program to print the digits 0, 1,2.....9.
    b. Program to check whether the number inputted is prime or not
    c. Program to find the no. of occurrences of character 'c' in the input string
    d. Program that prompts the user to enter an array of size 10 and display it.
    e. Program to check whether the input string is palindrome or not
    f. Program to Convert Decimal number to Hexadecimal number
8. Preparation of Presentation Slides on a particular topic

Marks Distributions

Experiments – 2 X 7.5 =15

Record - = 05

Viva-Voce- =05

SEMESTER - II

Core – 3

Data Structures

Unit -1

Primitive and non-primitive data types, Linear and non-linear data structures, Memory representation of Arrays (Single and Multi-dimensional Arrays), Representation of Stack, Queue, and Circular Queue, Insertion and deletion operations on these data structures, Applications of stack and Queue: Evaluation of recursive functions, Job Queues.

Unit -2

Limitations of Array representation, Linked List and its advantages, Representation of Singly, Doubly and Circularly linked Lists, Insertion and deletion operations on these data structures, Link list representation for Stack and Queue, Applications of linked list: Representation of polynomials, Sparse Matrix and its representation using Array and Linked list.

Unit -3

Introduction to Tree as a data structure, Binary Tree: Definition, related terminologies, Memory representation of Binary tree using array and linked list, Operations such as Inorder, Preorder, and Post order Traversals (recursive algorithms only), Binary Search Tree, Threaded Binary Tree (Representation only),Concept of Height-Balanced Tree.

Unit -4

Searching and Sorting techniques: Linear Search, Binary Search, Comparison of Linear and Binary Search, Selection Sort, Bubble sort, Insertion Sort, Comparison of Sorting techniques. Merging of arrays.

Books:

1. Data Structures, Schaume‘s Outlines, By Lipschutz TMH Publications
2. Data Structures, By Ellis Horowitz, SartajSahani, Galgotia Publications
3. Data Structures using C & C++ By Aaron M. Tenenbaum, YedidyahLangsam PHI

Marks Distributions

Internal ----------15 Marks (1Hrs.)

Term End Examination ----------60 Marks (3 Hrs.)

Core – 3

Data Structure Lab

1. Write a program in C to search for an item in an array and display its position using Linear search.
2. Write a program in C to search for an item in an array and display its position using Binary search.
3. Write a program in C to arrange a set of numbers in ascending order of values using Selection sort technique.
4. Write a program in C to arrange a set of numbers in ascending order of values using Bubble sort technique.
5. Write a program in C to perform Insertion and Deletion operations in a Stack represented as an array.
6. Write a program in C to perform Insertion and Deletion operations in a Queue data structure represented as an array.
7. Write a program in C to perform Insertion and Deletion operations in a Circular Queue represented as an array.
8. Write a program in C to perform Insertion and Deletion operations in a Stack represented as a linked list.
9. Write a program in C to perform Insertion and Deletion operations in a Queue data structure represented as a linked list.
10. Write a program in C to merge two sorted arrays.

Marks Distributions

Experiments – 2 X 7.5 =15

Record - = 05

Viva-Voce- =05

Core – 4

Data Communication and Networking

Unit - 1

Overview of Data Communications and Networking: Introduction, Network Models

Physical Layer: Signals, Digital Transmission, Analog Transmission, Multiplexing, Transmission Media, Circuit Switching and Telephone Network.

Unit - 2

Data Link Layer: Error Detection and Correction, Data Link Control and Protocol, Point to Point Access: PPP, Multiple Access, Local Area Networks: Ethernet, Wireless LANs, Backbone Networks, Virtual LANs, Cellular Telephone and Satellite Networks, Virtual Circuit Switching.

Unit - 3

Network Layer: Host-to-Host Delivery: Internetworking, Addressing and Routing, Network Layer

Protocols: ARP, IPv4, ICMP, and IPv6, Routing, Unicast and Multicast Routing

Unit - 4

Transport Layer: Process-to-Process Delivery: UDP and TCP, Congestion Control.

Application Layer: Client-Server Model, Socket Interface, Domain Name System (DNS), Electronic Mail (SMTP), and File Transfer (FTP), HTTP and WWW.

Books:

1. Data Communications and Networking - B A Forouzan, TMH.
2. Computer Networks - A S Tanenbaum, PHI
3. Data and Computer Communications - W Stallings, PHI

Marks Distributions

Internal ----------15 Marks (1Hrs.)

Term End Examination ----------60 Marks (3 Hrs.)

Core – 4

Data Communication and Networking Lab

1. Simulate Cyclic Redundancy Check (CRC) error detection algorithm for noisy channel
2. Simulate and implement stop and wait protocol for noisy channel.
3. Simulate and implement go back n sliding window protocol.
4. Simulate and implement selective repeat sliding window protocol.
5. Simulate and implement distance vector routing algorithm
6. Simulate and implement Dijkstra algorithm for shortest path routing.

Marks Distributions

Experiments – 2 X 7.5 =15

Record - = 05

Viva-Voce- =05

SEMESTER - III

Core – 5

Object Oriented Programming in C++

Unit -1

Object Oriented Programming concept, Procedural vs OOP programming, OOP terminology and features, Tokens, Character set, Keywords, Data-types, Constants and variables, expressions, Standard Library and header files. Operator and Expressions: Arithmetic Operator, Increment/Decrement Operator, Relational Operator, Logical Operator and conditional operators, library functions, Logical Expressions.

Unit - 2

Control statements, IF, IF …ELSE, Nested IF, Switch….Case, Looping statements, While, Do-while,

For statements, nested loops. Classes and Objects: Need for Classes, Declaration of Classes, referencing class Members, Data members and member Functions, Inline Functions, Creation of objects.

Unit-3

Use of access specifiers, Public and Private, Function Overloading, use of Constructors and Destructors, Types of constructors: default, parameterized, and copy constructors, Operator overloading, Friend function, Arrays of objects.

Unit - 4

Concept of Inheritance, Types of inheritance: Single level, multi-level, multiple, hybrid, Use of protected access specifier, Function overriding, Exception handling, Simple file handling.

Books:

1. Object Oriented Programming with C++ -E. Balaguruswamy, TMH
2. Let us C++ -YashavantKanetkar, BPB
3. Object Oriented Programming with C++ -Sourav Sahay, Oxford University Press
4. The C++ Programming Language - Bjarne Stroustrup, Addison-Wesley

Marks Distributions

Internal ----------15 Marks (1Hrs.)

Term End Examination ----------60 Marks (3 Hrs.)

Core – 5

C++ Programming Lab

1. Define a class called STUDENT with the data members Roll No., Name, Marks secured in five subjects. Write member functions to do the following:

    i. Read data

    ii. Find the total mark and division

    iii. Display Roll No., Name, Total mark, and Division

2. Define a class called SHAPE with appropriate data members. Find the area of different geometrical shapes using function overloading.

3. Define a class called ACCOUNT with the data members Account no. Customer name, Amount and initialize with suitable constructor. Write member functions to do the following:

    i. Deposit amount

    ii. Withdraw amount

    iii. Check balance

4. Using operator overloading add two given Lengths expressed as Feet and Inch.

5. Using operator overloading add two given TIMEs expressed as Hour : Minute : Second.

6. Concatenate two strings by overloading the ‗+' operator.

7. Define a class called PLAYER with the data members Player ID, player name, highest runs scored, batting average, and number of wickets taken. Create 10 player instances (using array of objects) and initialize them with parameterized constructors. Write a member function to display the details of a player on inputting the player ID.

8. Define a class called PERSON with the data members Name, DOB, PAN #. Inherit two classes from it (i) CUSTOMER with A/C no. & Amount and (ii) EMPLOYEE with Organization, Designation & Salary. Write suitable member functions to do the following:

    i. Input data for both base as well as derived class objects

    ii. Display customer details along with name, DOB and PAN #
    iii. Display employee details along with name, DOB and PAN #

9. Define a class called STACK and implement the PUSH and POP operations on it.
10. Define a class called QUEUE and implement the Insertion and Deletion operations on it.

Marks Distributions

Experiments – 2 X 7.5 =15

Record - = 05

Viva-Voce- =05

Total=25

Core – 6

Operating Systems

Unit -1

Introduction, Basic OS functions, resource abstraction, types of operating systems–Batch, Multi programming, Time sharing, and Real time systems; operating systems for personal computers, Operating System Organization, Processor and user modes, kernels, system calls and system programs.

Unit -2

Process Management, Process State Transition diagram, Non-pre-emptive and pre-emptive scheduling algorithms: FCFS, Shortest Job First, Round Robin, Priority Scheduling, Concurrent processes, concept of critical section, semaphores, Concept of Deadlock, Condition for deadlock. Concept of deadlock prevention, detection and recovery.

Unit -3

Memory Management, Physical and virtual address space, memory allocation strategies: fixed and variable partitions, Paging, Segmentation, Demand paging, virtual memory, Page replacement techniques (FIFO, LRU and Optimal).

Unit -4

File and I/O Management, Directory structures:Single level, multi-level, and tree structured directory, Concept of file, file operations, file allocation methods, Disk scheduling techniques(FCFS, Shortest Seek Time First, and Scan), File Protection and Security Policy, File Authentication andAccess control.

Books:

1. Operating Systems Concepts -A. Silberschatz and P.B. Galvin, John Wiley
2. Operating Systems - A Concept based Approach – D M Dhamdhere, TMH
3. Modern Operating Systems - A.S. Tanenbaum, Pearson Education
4. Operating Systems - Concepts and design- M. Milenkovic, Tata McGraw Hill

Marks Distributions

Internal ----------15 Marks (1Hrs.)

Term End Examination ----------60 Marks (3 Hrs.)

Core – 6

Operating Systems Lab

1. Write program to implement FCFS scheduling algorithm.
2. Write program to implement Round Robin scheduling algorithm.
3. Write program to implement SJF scheduling algorithm.
4. Write program to implement non-preemptive priority based scheduling algorithm.
5. Write program to implement preemptive priority based scheduling algorithm.
6. Write program to implement SRJF scheduling algorithm.
7. Write program to calculate sum of n numbers using *thread* library.
8. Write a program to implement first-fit, best-fit and worst-fit allocation strategies.
9. WRITE A PROGRAM to report behaviour of Linux kernel including kernel version, CPU type and model. (CPU information)
10. WRITE A PROGRAM to report behaviour of Linux kernel including information on configured memory, amount of free and used memory. (memory information)
11. WRITE A PROGRAM to print file details including owner access permissions, file access time, where file name is given as argument.
12. WRITE A PROGRAM to copy files using system calls.

Marks Distributions

Experiments – 2 X 7.5 =15

Record - = 05

Viva-Voce- =05

Total=25

Core – 7

Internetworking

Unit - 1

An Overview on Internet, Internet services, Internet protocols and standardization, Review of Network technologies, TCP/IP Internetworking Concepts, Architectural model, Application level interconnection, Network level interconnection, Properties of the Internet, Interconnection through IP Gateways or routers, Internet and Intranet

Unit - 2

Internet Address, Universal identifiers, Three primary classes of IP addresses, Classless IP address, Network and Broadcast addresses, Mapping internet addresses to physical addresses (ARP), ARP protocol format, Transport Gateways and subnet addressing, Multicast addressing.

Internet Protocol, Connectionless delivery system, Internet Datagram, Table driven IP routing, Bootstrap protocol (BOOTP)

Unit - 3

Routing, The origin of Gateway routing tables, Automatic route propagation, Vector distance (Bellman-Ford) routing, Gateway to Gateway Protocol (GGP), Exterior Gateway Protocol (EGP), Interior Gateway Protocol, Routing Information Protocol (RIP)

Unit - 4

Enterprise Networking, Broadband, High speed dedicated WAN services and switched WAN services, ISDN, BISDN and ATM services, Virtual private network concepts, DNS, DHCP Servers, FTP, TELNET, E-Mail, Firewall, Activities of Firewall, Configuration of firewall

Books:

1. Internetworking with TCP / IP - Douglas E .Comer, PE.
2. TCP/IP protocol suite - Forouzan Behrouz A, TMH.
3. Computer Networks – Andrew S. Tanenbaum, PHI.
4. Data and Computer Communication - William Stallings, PHI.

Marks Distributions

Internal ----------15 Marks (1Hrs.)

Term End Examination ----------60 Marks (3 Hrs.)

Core – 7

Internetworking Lab

1. TCP/IP Internetworking.
2. Interconnection through IP Gateways or routers.
3. IP Addressing.
4. Internet and Intranet.
5. E-Mail Firewall, Activities of Firewall and Configuration of firewall.

Marks Distributions

Experiments – 2 X 7.5 =15

Record - = 05

Viva-Voce- =05

Total=25

SEMESTER - IV

Core – 8

E-Commerce

Unit - 1

Introduction to E-Commerce, Definition, Scope of E-Commerce, E-Commerce and Trade Cycle, Electronic Markets, Electronic Data Interchange and Internet Commerce. E-Commerce business models, B2B, B2C, C2C, Electronic Markets, Electronic Data Interchange (EDI), Technology, Standards, Communications, Implementations, Agreements, Security, EDI and Business, Inter-Organizational E-commerce.

Unit - 2

Electronic Payment system (EPS): Over view of EPS, smart card, credit card and debit card based EPS, financial instrument. Home banking, On-line banking

E-business, Internet bookshops, Software supplies and support, Electronic Newspapers, Internet Banking, Virtual Auctions, Online Share Dealing

Unit - 3

Legal issues, Paper Document vs. Electronic document, Authentication of Electronic document,

Laws, Legal issues for Internet Commerce, Copyright, Jurisdiction issues, Service provider liability,

Enforceable online contract. Security threats, transaction security Security Solutions, Symmetric and Asymmetric Cryptosystems, and Digital Signature, Protocols for secure messaging, Secure Electronic Transaction (SET) Protocol

Unit - 4

Mobile Commerce: Introduction to mobile commerce, Mobile computing applications, WAP technology, mobile information devices, client- server network

Books:

1. E-Commerce-Strategy, Technologies & Applications - David Whitley, TMH
2. E-Commerce- The cutting edge of business - Kamlesh K. Bajaj, TMH
3. E-Commerce - Ritendra Goel, New Age International

Marks Distributions

Internal ----------15 Marks (1Hrs.)

Term End Examination ----------60 Marks (3 Hrs.)

Core – 8

E-Commerce Lab

1. Steps to set and change computer name.
2. Steps to set and change work group name.
3. Steps to include web-site in your favourite.
4. Steps to un-hide pop-up block.
5. Steps to show default workgroup name.
6. Steps to set default gateways.
7. Steps to identify IP address.
8. Steps to set URL as home page.
9. Steps to set IP address and subnet mask.
10. Steps to view network connection.
11. Steps to change font size of web content.
12. Steps to view the coding of web page.
13. Steps to enable/disable firewall.
14. Steps to turn on and turn off automatic updates.
15. Steps to create e-mail account.
16. Steps to send e-mail.
17. Steps to add name in address book.

Marks Distributions

Experiments – 2 X 7.5 =15

Record - = 05

Viva-Voce- =05

Total=25

Core – 9

Software Engineering

Unit -1

The Evolving Role of Software, Software Characteristics, Software Engineering Approach, Software Process Framework, Framework and Umbrella Activities, Process Models, Capability Maturity Model Integration (CMMI).

Unit -2

Software Requirement Analysis: Requirement Analysis and Modelling Techniques, Flow Oriented Components of SRS, Need for SRS, Software Project Management :Project Estimation, Project Scheduling, Software Risks: Risk Management, Risk Identification, Risk Projection and Risk Refinement, RMMM.

Unit -3

Software Quality: Software Quality Assurance, Metrics for Process and Projects, Software Design: Design Concepts, Software Architecture, Data Design at the Architectural Level and Component Level, Mapping of Data Flow into Software Architecture.

Unit -4

Software Testing: Strategic Approach to Software Testing, Test case generation, Validation Testing, System Testing, Black-Box Testing, White-Box Testing, Path Testing.

Books:

1. Fundamentals of Software Engineering - Rajiv Mall
2. Software Engineering: A Practitioner‘s Approach - R.S. Pressman

Marks Distributions

Internal ----------15 Marks (1Hrs.)

Term End Examination ----------60 Marks (3 Hrs.)

Core – 9

Software Engineering Lab

S. No	Practical Title
1.	• Problem Statement, • Process Model
2.	Requirement Analysis: • Creating a Data Flow • Data Dictionary, Use Cases
3.	Project Management: • Computing FP • Effort • Schedule, Risk Table, Timeline chart
4.	Design Engineering: • Architectural Design • Data Design, Component Level Design
5.	Testing: • Basis Path Testing

Marks Distributions

Experiments – 2 X 7.5 =15

Record - = 05

Viva-Voce- =05

Total=25

Core – 10

Database Management Systems

Unit -1

Concept of Database and DBMS, Characteristics of database approach, Role of DBMS, Data models

(Relational, Hierarchical, network and Object-oriented), Layered architecture of DBMS, Data independence.

Unit -2

Entity Relationship(ER) Modeling, Entity types, relationships, constraints. Relational data model, relational constraints, Mapping ER models to relational database, Relational algebra, SQLqueries.

Unit -3

Database design, Data dependencies (functional transitive, and multi-valued), Normalforms(INF, 2NF, and 3NF), Database transactions: Transaction Processing, ACID properties, concurrency control.

Unit -4

File Structure and Indexing, overview of File organizations (Sequential, Indexed, and Direct Access files), Indexing (Primary index, secondary index, clustering index), Concept of B and B+ trees.

Books:

1. Database Systems Concepts - A. Silberschatz, H. F. Korth, S. Sudarshan (McGraw Hill)
2. Fundamentals of Database Systems - Elmsari and Navathe (Addision Wesley)
3. Database Management Systems – Rajiv Chopra, S Chand

Marks Distributions

Internal ----------15 Marks (1Hrs.)

Term End Examination ----------60 Marks (3 Hrs.)

Core – 10

Database Lab

Create tables as indicated against each question and write SQL statements to answer the given queries:

1. Student (roll_no, name, department, marks), Attendance (roll_no, department, attendance)
    a) Create the table with above schema
    b) Display the details of the students
    c) Display the details of the student with attendance less than 20
    d) Find the average mark of student having attendance less than 20
    e) Find the average mark.
    f) Display the details of the students whose name starts with _s‘
    g) Display details of the student with mark greater than 70
    h) Display the details of the students whose name starts with _s‘ or _c‘
    i) Find subject wise average mark
    j) Display details of the students whose age is between 20 and 23

2. Course (roll_no, subject, mark) Attendance (roll_no, name, attendance)
    a) Create the table with above schema
    b) Find the Roll no. of the student securing the highest mark in a given subject
    c) Display the roll_no, marks of student who have taken the subject ―IT‖
    d) Display the average marks of the students who have attendance less than 25
    e) Find average mark for each subject
    f) Find lowest marks in each subject
    g) Find the Roll no.s of the students securing highest mark in each subject
    h) Find the student names with highest and lowest attendance
    i) Display the subjects taken by the students whose attendance more than 30
    j) Display the attendance details of the students whose mark less than 200

3. Employee (Emp_Id, Name, Address, Salary) Leave(Emp_Id,Leave_Taken)
    a) Create the table with above schema

b) Count the number of employee with salary greater than 5000

c) Find average salary of the employee who have taken more than 15 leaves

d) Find average salary of all the employees

e) Display the details of the employee with highest salary

f) Display the leave details of the employee whose name starts with _R‘

g) Display the details of the employee whose salary less than 3000

h) Count the number of employee belongs to ―Education‖ department

i) Display the details of the employee whose salary is between 10000 and 20000

j) Find average salary of the employees belong to ―Revenue‖ department

Marks Distributions

Experiments – 2 X 7.5 =15

Record - = 05

Viva-Voce- =05

Total=25

SEMESTER - V

Core – 11

Web Technology

Unit - 1

Developing Static Web Pages, types and issues, tiers; WWW-Basic concepts, web client and web server, http protocol, universal resource locator (url), HTML- different tags, sections, image & pictures, listings, tables, frame, frameset, forms

Unit - 2

Developing Dynamic Web Pages, need for dynamic web pages; an overview of DHTML, cascading style sheet (css), comparative studies of different technologies of dynamic page creation. Active Web Pages, Need for active web pages; Java applet life cycle

Unit - 3

Java Script, Data types, variables, operators, conditional statements, array object, date object, string object.Java Servlet, Servlet environment and role, HTML support, Servlet API, The servlet life cycle, Cookies and Sessions.

Unit - 4

JSP architecture, JSP servers, JSP tags, understanding the layout in JSP, Declaring variables, methods in JSP, inserting java expression in JSP, processing request from user and generating dynamic response for the user, inserting applets and java beans into JSP, using include and forward action, comparing JSP and CGI program, comparing JSP and ASP program; Creating ODBC data source name, introduction to JDBC.

Books:

1. Web Technologies - Godbole A. S. & Kahate A., TMH
2. Web Technology & Design - Xavier C., New Age Publication
3. Java Server Programming, J2EE edition, WROX publishers

Marks Distributions

Internal ----------15 Marks (1Hrs.)

Term End Examination ----------60 Marks (3 Hrs.)

Core – 11

Web Technology Lab

Creation of web programme using HTML, XML , DHTML and JAVA SCRIPT.

Marks Distributions

Experiments – 2 X 7.5 =15

Record - = 05

Viva-Voce- =05

Total=25

Core – 12

Java Programming

Unit -1

Java Architecture and Features, Difference betweenC++ and Java, Compiling and Executing a Java Program, Variables, Constants, Keywords, DataTypes, Operators, Expressions, Executing Basic Java Programs, Conditional and looping statements.

Unit -2

Java Methods, Definition, Scope, Passing and Returning Arguments, Type Conversion and TypeChecking, Built-in Java Class Methods, Using Arrays(1-D and 2-D),Java Strings: Java String class, Creating and Using String Objects,Manipulating Strings.

Unit -3

Defining and Using Classes in Java, Controlling Access to Class Members, Constructors, Method Overloading, Class Variables and Methods, Objectsas parameters, final keyword.

Unit -4

Inheritance (Single Level and Multilevel), Method Overriding, Interfaces and Packages, Extending interfaces and packages,Introduction to Applets, Writing Java Applets, Event Handling in Java.

Books:

1. Programming with Java - E. Balaguruswamy, 4th Edition, McGraw Hill
2. Programming in Java - Sachin Malhotra and Saurabh Choudhury, Oxford University Press
3. Programming with JAVA -John R. Hubbard, Schaum's Series, McGraw Hill

Marks Distributions

Internal ----------15 Marks (1Hrs.)

Term End Examination ----------60 Marks (3 Hrs.)

Core – 12

Java Programming Lab

1. Write a Java Program to define a class called Student (Name, Roll No, Course, Marks in five papers). Find division of the student.
2. Write a Java Program to define a class, describe its constructor, overload the Constructor and instantiate its object.
3. Write a Java Program to define a class, define instance methods and overload them and use them for dynamic method invocation.
4. Write a Java Program to demonstrate use of sub class.
5. Write a Java Program to demonstrate use of nested class.
6. Write a Java Program to implement array of objects.
7. Write a Java program to practice using String class and its methods.
8. Write a Java Program to implement inheritance and demonstrate use of method overriding.
9. Write a program to demonstrate use of implementing interfaces.
10. Write a program using Applet to display a message in the Applet.

Marks Distributions

Experiments – 2 X 7.5 =15

Record - = 05

Viva-Voce- =05

Total=25

Discipline Specific Electives

DSE – 1

Computer Graphics

Unit -1

Definition, Application, Pixel, Frame Buffer, Raster and Random Scan display, Display devicesCRT, Color CRT Monitors, Scan Conversion of line- DDA algorithm of line drawing, Scan conversion of circle- Bresenham‘s circle generating algorithm, Polygon Filling-Scan line polygon filling algorithm.

Unit -2

2-D transformation, Translation, Rotation, Scaling, Homogeneous Coordinates, 3-D transformation, Translation, Rotation Scaling, Reflection, Shear.

Unit -3

Window to view port transformation, clipping, line clipping, Cohen –Sutherland line clipping, Polygon clipping, Sutherland and Gary Hodgman polygon clipping algorithm.

Unit -4

Hidden Surface removal—Depth comparison, Z-Buffer Algorithm, Back-Face Removal, The Painter‘s Algorithm, Scan-Line Algorithm, Subdivision Algorithm.

Books:

1. Computer Graphics – Donald Hearn and M. Pauline Baker (Pearson)
2. Computer Graphics - Zhigang Xiang, Roy A. Plastock (McGraw-Hill, India)
3. Computer Graphics – Er. Rajiv Chopra, (S. Chand Publication)
4. Principles of Interactive Computer Graphics − W.M. Newmen, R F Sproull (McGraw Hill)

Marks Distributions

Internal ----------15 Marks (1Hrs.)

Term End Examination ----------60 Marks (3 Hrs.)

DSE – 1

Computer Graphics Lab

1. Write a program to implement Bresenham's line drawing algorithm.
2. Write a program to implement mid-point circle drawing algorithm.
3. Write a program to clip a line using Cohen and Sutherland line clipping algorithm.
4. Write a program to clip a polygon using Sutherland Hodgeman algorithm.
5. Write a program to fill a polygon using Scan line fill algorithm.
6. Write a program to apply various 2D transformations on a 2D object (use homogenous coordinates).
7. Write a program to apply various 3D transformations on a 3D object and then apply parallel and perspective projection on it.
8. Write a program to draw Hermite/Bezier curve.

Marks Distributions

Experiments – 2 X 7.5 =15

Record - = 05

Viva-Voce- =05

Total=25

DSE – 2

Artificial Intelligence

Unit -1

Definition of AI, Characteristics of AI problems, AI problem solving approaches, State space search, problem reduction, search techniques, Breadth first and Depth first techniques, Heuristic search techniques, Hill climbing, Best first search.

Unit -2

Knowledge representation in AI, propositional logic, Semantic nets, Frames, and Scripts.
Handling uncertainty in AI problems, Probabilistic reasoning, Bayesian Belief networks

Unit -3

Concept of Learning, types of learning, Artificial Neural networks, ANN structures, Feed forward networks, Back propagation network, Applications of ANN.

Unit -4

Natural language processing, levels of knowledge used in language understanding, parsing, top-down and bottom-up parsing, transition networks

Expert systems, ES architecture, need for ES, steps for developing an expert system.

Books:

1. Artificial Intelligence: A Practical Approach – Rajiv Chopra, S. Chand publications
2. Introduction to Artificial Intelligence and Expert Systems – D W Patterson, PHI

Marks Distributions

Internal ----------15 Marks (1Hrs.)

Term End Examination ----------60 Marks (3 Hrs.)

DSE – 2

Artificial Intelligence Lab

1. Write a prolog program to calculate the sum of two numbers.
2. Write a prolog program to find the maximum of two numbers.
3. Write a prolog program to calculate the factorial of a given number.
4. Write a prolog program to calculate the nth Fibonacci number.
5. Write a prolog program, insert_nth(item, n, into_list, result) that asserts that result is the list into_list with item inserted as the n'th element into every list at all levels.
6. Write a Prolog program to remove the Nth item from a list.
7. Write a Prolog program, remove-nth(Before, After) that asserts the After list is the Before list with the removal of every n'th item from every list at all levels.
8. Write a Prolog program to implement append for two lists.
9. Write a Prolog program to implement palindrome(List).
10. Write a Prolog program to implement max(X,Y,Max) so that Max is the greater of two numbers X and Y.
11. Write a Prolog program to implement maxlist(List,Max) so that Max is the greatest number in the list of numbers List.
12. Write a Prolog program to implement sumlist(List,Sum) so that Sum is the sum of a given list of numbers List.
13. Write a Prolog program to implement two predicates evenlength(List) and oddlength(List) so that they are true if their argument is a list of even or odd length respectively.
14. Write a Prolog program to implement reverse(List,ReversedList) that reverses lists.
15. Write a Prolog program to implement maxlist(List,Max) so that Max is the greatest number in the list of numbers List using cut predicate.
16. Write a Prolog program to implement GCD of two numbers.
17. Write a prolog program that implements Semantic Networks/Frame Structures.

Marks Distributions

Experiments – 2 X 7.5 =15

Record - = 05

Viva-Voce- =05

Total=25

SEMESTER - VI

Core – 13

Programming in Visual Basic

Unit - 1

GUI Environment: Introduction to graphical user interface (GUI), programming language (procedural, object oriented, even driven), The GUI environment, compiling, debugging and running the programs. Controls: Introduction to controls text boxes, frames, check boxes, option buttons, images, setting boarders and styles, the shape control, the line control, working with multiple controls.

Unit - 2

Operations: Data types, constants, named & intrinsic, declaring variables, scope of variables, VAL function, arithmetic operations, formatting data. Decision Making: If statement, comparing strings, compound conditions (and, or, not), nested if statements, case structure, using if statements with option buttons & check boxes, displaying message in message box, testing whether input is valid or not.

Unit - 3

Modular programming: Menus, sub-procedures and sub-functions defining / creating and modifying a menu, using common dialog box, creating a new sub-procedure, passing variables to procedures, passing argument by value or by reference, writing a function/ procedure. Forms handling.

Unit - 4

Iteration handling: Do/ loops, for/ next loops, using msgbox function, using string function, Arrays and Grouped data control: Arrays-1-dimension arrays, initializing an array using for each, user-defined data types, accessing information with user-defined data types, using list boxes with array, Database connectivity.

Books:

1. Programming in Visual Basic 6.0 – Julia Case Bradley, Anita C. Millispangh, TMH

Marks Distributions

Internal ----------15 Marks (1Hrs.)

Term End Examination ----------60 Marks (3 Hrs.)

Core – 13

Visual Basic Lab

1. To implement a Visual Basic program to calculate the simple interest and compound interest.
2. To implement a Visual Basic program to generate Fibonacci series.
3. To implement a Visual Basic program to create a scientific calculator using control arrays.
4. To implement a Visual Basic program to perform string operations based on the user choice.
5. To implement a Visual Basic program to perform matrix operations.
6. To implement a Visual Basic program to prepare salary calculation of employees.
7. To create a Visual Basic application with MDI features and text editing capabilities.
8. To create a Visual Basic application to compute discounts for different product and print the net price.
9. To implement a Visual Basic program to design a calendar.
10. To implement a Visual Basic program to create a student mark sheet.

Marks Distributions

Experiments – 2 X 7.5 =15

Record - = 05

Viva-Voce- =05

Total=25

Core – 14

Data Warehousing and Data Mining

Unit -1

Concept of a Data warehouse, features of data warehousing: subject oriented, integrated, time variant, and non-volatile, multi-dimensional data model, data cubes, OLAP operations: roll-up, drill-down, slice and dice, Architecture of data warehouse.

Unit -2

Concept of Data mining, data mining techniques, process of knowledge discovery in databases, mining frequent patterns, market basket analysis, Association rule mining, Interestingness measures.

Unit -3

Classification and prediction, classification techniques, decision tree, rule-based classification, k-Nearest neighbor classifier, Bayesian classification, linear regression.

Unit -4

Cluster analysis, clustering techniques, k-Means and k-Medoids methods, Introduction to Hierarchical and Density-Based methods, Outliers. Applications of data mining in finance, business, social networks, and web mining

Books:

1. Data Mining: Concepts and Techniques - J Han and M Kamber, Elsevier
2. Data Mining Techniques - Arun K Pujari, University Press

Marks Distributions

Internal ----------15 Marks (1Hrs.)

Term End Examination ----------60 Marks (3 Hrs.)

Core – 14

Data Warehousing and Data Mining Lab

1. Build Data Warehouse and Explore WEKA.
2. Perform data pre-processing tasks and Demonstrate performing association rule mining on data sets.
3. Demonstrate performing classification on data sets.
4. Demonstrate performing clustering on data sets.
5. Demonstrate performing Regression on data sets.

Marks Distributions

Experiments – 2 X 7.5 =15

Record - = 05

Viva-Voce- =05

Total=25

Discipline Specific Electives

DSE – 3

Cloud Computing

Unit -1

Recent trends in Computing: Grid Computing, Cluster Computing, Distributed Computing, Utility Computing, Cloud Computing, Cloud service providers, Benefits and limitations of Cloud Computing

Unit -2

Cloud Computing Architecture, Comparison with traditional computing architecture (client/server), Services provided at various levels, Service Models- Infrastructure as a Service(IaaS), Platform as a Service(PaaS), Software asa Service(SaaS), How Cloud Computing Works, Deployment Models- Public cloud, Private cloud, Hybrid cloud, Community cloud.

Unit -3

Service Management in Cloud Computing, Service Level Agreements(SLAs), Billing & Accounting, Comparing Scaling Hardware: Traditional vs. Cloud, Economics of scaling. Examples of cloud systems like Google App Engine, Microsoft Azure, AmazonEC2.

Unit -4

Cloud Security, Infrastructure Security, Network level security, Host level security, Application level security, Data security and Storage- Data privacy and security Issues, Jurisdictional issues raised by Data location, Authentication in cloud computing

Books:

1. Cloud Computing – U S Pandey and K Choudhary, S Chand
2. Cloud Computing: Principles and Paradigms - Rajkumar Buyya, James Broberg, Andrzej M. Goscinski, Wiley

Marks Distributions

Internal ----------15 Marks (1Hrs.)

Term End Examination ----------60 Marks (3 Hrs.)

DSE – 3

Cloud Computing Lab

1. Create virtual machines that access different programs on same platform.
2. Create virtual machines that access different programs on different platforms .
3. Working on tools used in cloud computing online-
a) Storage
b) Sharing of data
c) manage your calendar, to-do lists,
d) a document editing tool
4. Exploring Google cloud
5. Exploring microsoft cloud
6. Exploring amazon cloud

Marks Distributions

Experiments – 2 X 7.5 =15

Record - = 05

Viva-Voce- =05

Total=25

DSE – 4

Software Development Project Work

[FULL MARK 80 + 20 VIVA-VOCE]

A student has to undertake a software development project work under the guidance of a teacher during the 6^{th} semester. After completion of the project, t he student has to submit a project report which will be evaluated by an External Examiner.

B.Sc.(Honours)-Mathematics Syllabus

(Choice Based Credit System)

2018-2021

2018-2019:- 1st year

2019-2020:- 2nd Year

2020-2021:- 3rd Year

COURSE STRUCTURE

B.Sc.(Honours)-Mathematics

- **Core Courses:6 credit each, Max. Marks:100**
- **Ability Enhancement Compulsory Courses (AECC):2 credit each, Max. Marks:50**
- **Skill Enhancement Courses (SEC):2 credit each, Max. Marks:50**
- **Discipline Specific Elective (DSE):6 credit each, Max. Marks:100**
- **Generic Electives (GE):6 credit each, Max. Marks:100**
- **For papers with practical component:** Theory: 75(Mid-Sem:15+End Sem: 60)Marks, Practical(End Sem):25 Marks.
- **For papers with no practical/practical component:** Theory 100(Mid-Sem.:20+End Sem.:80) Marks
- **For papers with 50 Marks:** Mid-Sem.:10 Marks+End Sem.:40 Marks.

Core Courses (C)	**Ability Enhancement Compulsory Courses (AECC)**	**Skill Enhancement Courses (SEC)**	**Discipline Specific Elective (DSE)**	**Generic Electives (GE)**
Semester-1				
C-I Calculus-I(p) C-II Algebra-I	AECC-1			GE-I(Calculus and Ordinary Differential Equations)for Physic's Hons
Semester-II				
C-III: Real Analysis (Analysis-I) C-IV: Differential Equations(P)	AECC-II			GE-II(Calculus and Ordinary Differential Equations)for Chemistry Hons
Semester-III				
C-V: Theory of Real Functions (Analysis-II) C-VI: Group Theory (Algebra-II) C-VII: Partial Differential Equations and Systems of Ordinary Differential Equations (P)		**S**EC-I		GE-III(Linear Algebra and Advanced Algebra) For Chemistry Hons
Semester-IV				
C-VIII: Numerical Methods(P) C-IX: Riemann Integration and Series of Functions (Analysis-III) C-X: Ring Theory and Linear Algebra-I (Algebra-III)		**SEC-II** Quantitative & Logical thinking		GE-IV(Linear Algebra and Advanced Algebra) For Physics Hons

Semester-V				
C-XI: Multivariate Calculus (Calculus-II) C-XII: Probability and Statistics			DSE-I: Programming in C++)(P) DSE-II: Boolean Algebra and Automata Theory	
Semester-VI				
C-XIII: Metric Spaces andComplex Analysis (Analysis-IV) C-XIV: Linear Programming			DSE-III: Theory of Equations DSE-IV: Mathematical Modelling.	

CORE COURSES
B.Sc. (Honours)-Mathematics

Semester-I

CORE-I

Calculus-I

(Total Marks: 100)

Part-I (Marks: 75)
(Theory: 60 Marks+Mid-Sem: 15 Marks)

(The question paper consists 2 sections i.e A and B. section A contains 4 compulsory questions of 3 marks ,one from each unit. Section B contains, one question from each unit consisting of two parts a,b or c,d having equal marks.)

Unit-I 12+3 marks

Hyperbolic functions,Higher order derivatives, Leibniz rule and its applications to problems of the type e^{ax} sin (bx+c); e^{ax} cos (bx+c); $e^{m \sin^{-1} x}$; $(\tan^{-1} x)^2$, L'Hospital's rule.Asymptotes, Curvature. (Curve tracing in Standard curves as Astroid, Cissoid,Hypocycloid, Limacon, Cycloid, Descrates Folium etc ,for practical)

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Unit-II 12 +3marks

Reduction formulae, derivations and illustrations of reduction formula of the type $\int sin^n x\, dx$, $\int cos^n x\, dx$, $\int tan^n x\, dx$, $\int cot^n x\, dx$, $\int sec^n x\, dx$, $\int cosec^n x\, dx$, $\int sin^n x\, cos^n x\, dx$. Arc length i.e rectification and area (Cartesian form, Polar form and Parametric form).

Unit-III 12+3 marks

Techniques of sketching conics, refletion properties of conics, rotation of axes and second degree equations, Classification into conics using the discriminant, polar equations of conics. Sphere.

Unit-IV 12+3 marks

Introduction to vector functions, operations with vector-valued functions, limits and continuity of vector functions, differentiation and integration of vector functions, tangent and normal components of acceleration.

Part-II(Practical, Marks:25)

(viva – 5 marks, Record – 5 marks, Experiment – 15 marks)

List of Practical's (Using any software)
Practical/Lab work to be performed on a Computer

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1. Tracing of conics in Cartesian co-ordinates (ex- Astroid, Cissoids, Cartenary.).
2. Tracing of conics in Polar co- ordinates(Lemniscates of Bernoulli, $r = a\, sin2\theta, r^2 = a^2 cos2\theta$)
3. Sketching parametric curves (cycloid,$x = a(t + sint), y = a(1 + cost)$)
4. Plotting of$e^x, 2^x, \frac{1}{2x+1}$.
5. Matrix operation (addition, multiplication, inverse, transpose).

Books Recommended

1. Topics in Calculus By R.K. Panda & P.K.Satpathy. S.G.Publications, Puri

Ch-1(Excluding 1.13,1.14), Ch- 2.1 to 2.13, Ch-5.

2. Calculus I by dhirendra Kumar Dalai, Kalyani Publication-Chapter 1(upto1.3),2,6,8,13,14.

Books for Reference:

1. M.J. Strauss, G.L. Bradley and K. J. Smith, Calculus, 3rd Ed., Dorling Kindersley (India) P. Ltd.(Pearson Education), Delhi, 2007: Chapters:4(4.3,4.4,4.5 & 4.7), 9(9.4), 10(10.1-10.4)

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2. H. Anton, I. Bivens and S. Davis, Calculus, 7th Ed., John Wiley and Sons (Asia) P. Ltd., Singapore,2002: Chapters: 6, (6.2-6.5),7(7.8), 8(8.2-8.3, Pages:532-538), 11(11.1), 13(13.5)

3. Analytical Geometry of Quadratic Surfaces, B.P. Acharya and D.C. Sahu, Kalyani Publishers, New Delhi, Ludhiana.

4. G.B. Thomas and R.L. Finney, Calculus, 9th Ed., Pearson Education, Delhi, 2005:

5. R. Courant and F. John, Introduction to Calculus and Analysis (Volumes I & II), Springer-Verlag,New York, Inc., 1989

6. Shanti Narayan and P.K. Mittal-Analytical Solid Geometry, S. Chand & Company Pvt. Ltd., New Delhi.

Semester-I
CORE-II

Algebra-I

Total Marks:100
Theory:80 Marks+Mid-Sem:20 Marks

(The question paper consists 2 sections i.e A and B. section A contains 4 compulsory questions of 4 marks ,one from each unit. Section B contains, one question from each unit consisting of two parts a,b or c,d having equal marks.)

Unit-I 16+4 Marks

Polar representation of complex numbers, n-th roots of unity, De Moivers theorem for rational indices and its applications.

Unit-II 16+4 Marks

Equivalence relations, Functions, Composition of functions, Invertible functions, One to one correspondence and cardinality of a set, Well-ordering property of positive integers, Division algorithm, Divisibility and Euclidean algorithm, Congruence relation between integers, Principles of Mathematical Induction, statement of Fundamental Theorem of Arithmetic, Euler's φ function.

Unit-III 16+4 marks

Vector spaces, subspaces, algebra of subspaces, quotient spaces, linear combination of vectors, linear span, linear dependence and independence.Dimension and basis for vector spaces,

Unit-IV 16+4 Marks

Linear transformations, null space, range and kernel of a linear map, rank and nullity of a linear transformation, Inverse of a linear transformation.

Books Recommended:

1. Higher Engineering Mathematics by B.S. Grewal, 38th edition:- chap-19 (19.1,19.2,19.4,19.5,19.6,19.13,19.14)
2. Topics in algebra by S. Padhy, Lokanath Sahu. Kalyani Publishers Ch 1.6-1.11, Ch 2.1-2.1.2, 2.1.5, 2.1.6, Lemma 2.1.1. Ch-5 , ch-6 (upto 6.4).

3. An introduction to Linear Algebra By V. Krishnamurthy, V.P.Mainra, J.L.Arora Affiliated East-west press Pvt Ltd, New Delhi:- Ch 4.1.1, 4.1.2, 4.1.4 to 4.1.5, 4.2.2, 4.3.1, 4.4.3.

Books for Reference:

1. L.V. Ahlfors, Complex Analysis, McGraw-Hill (International Student Edn.)
2. Titu Andreescu and Dorin Andrica, Complex Numbers from A to Z, Birkhauser, 2006: Chapter:2
3. Edgar G. Goodaire and Michael M. Parmenter, Discrete Mathematics with Graph Theory, 3rd Ed., Pearson Education (Singapore) P. Ltd., Indian Reprint, 2005: Chapters:2(2.4), 3,4(4.1-4.1.6,4.2-4.2.11, 4.4(4.1-4.4.8),4.3-4.3.9, 5(5.1-5.1.4).

Semester-II
CORE-III
Real Analysis (Analysis-I)

Total Marks:100
Theory:80 Marks+Mid-Sem:20 Marks
5 Lectures, 1 Tutorial (per week per student)

(The question paper consists 2 sections i.e A and B. section A contains 4 compulsory questions of 4 marks ,one from each unit. Section B contains, one question from each unit consisting of two parts a,b or c,d having equal marks.)

Unit-I 16 +4Marks

Review of Algebraic and Order structure Properties of R; Neighborhood of a point in R; Idea of countable sets, uncountable sets and uncountability of R: Bounded above sets, Bounded below sets, Bounded Sets, Unbounded sets, Suprema and Infima.(Except Dedekind) absolute value and properties.

Unit-II 16+4 Marks

The Completeness Property of R; The Archimedean Property, Density of Rational (and Irrational) numbers in R, Intervals. Limit points of a set, Isolated points, Illustrations of Bolzano-Weierstrasstheorem for sets.

Unit-III 16+4 marks

Sequences, Bounded sequence, Convergent sequence, Limit of a sequence. Limit Theorems, Monotone Sequences, Monotone Convergence Theorem. Subsequences, Divergence Criteria, Monotone Subsequence Theorem (statement only), Bolzano Weierstrass Theorem for Sequences. Cauchy sequence, Cauchys Convergence Criterion.

Unit-IV 16+4 Marks

Infinite series, convergence and divergence of infinite series, Cauchy Criterion, Tests for convergence: Comparison test, Limit for Comparison test, Ratio Test, Raabe's Test. Cauchys n-th root test, Alternating series, Leibniz test, Absolute and Conditional convergence.

Book Recommended:

1. S.C. Mallik and S. Arora-Mathematical Analysis, New Age International Publications ch-1(excluding 4.3, 4.4),ch-2(upto 3.2, 4), ch-3 (excluding art 3, art7), ch-4 (excluding art 7,8,9,10.3 to 10.5,11).

Books for References:

1. R.G. Bartle and D. R. Sherbert, Introduction to Real Analysis, 3rd Ed., John Wiley and Sons(Asia) Pvt. Ltd., Singapore, 2002
2. G. Das and S. Pattanayak, Fundamentals of Mathematics Analysis, TMH Pub-lishing Co., Chapters: 2(2.1 to 2.4, 2.5 to 2.7), 3(3.1-3.5), 4(4.1 to 4.7, 4.10, 4.11,4.12, 4.13).

Semester-II
CORE-IV

Differential Equations (Total Marks:100)

Part-I (Marks:75)
Theory: 60 Marks+Mid-Sem:15 Marks
04 Lectures (per week per student)

(The question paper consists 2 sections i.e A and B. section A contains 4 compulsory questions of 3 marks ,one from each unit. Section B contains, one question from each unit consisting of two parts a,b or c,d having equal marks.)

Unit-I 12+3 marks

Differential equations and mathematical models. First order and 1st degree ODE (variables separable, homogeneous,reducible to homogenous, exact, and linear). Equations of 1st order but of higher degree.(for practical Applications of 1st order differential equations (Growth, Decay , Oxygen debt, Economics Models).

Unit-II 12 +3marks

Higher order linear equations (homogeneous and non-homogeneous) with constant coefficients,

Unit-III 12 +3marks

Second order equations with variable coefficients, variation of parameters, (Wronskion)method of undetermined coefficients, equations reducible to linear equations with constant coefficients, Euler's equation. Applications of second order differential equations, Legendre equation.

Unit-IV 12+3 marks

Power series solutions of second order differential equations. Legendre, Bessel's series solutions. (excluding polynomials and Bessel's functions),Laplace transforms and its applications to solutions of differential equations, convolution theorem.

Part-II(Practical: Marks:25)

(viva – 5 marks, Record – 5 marks, Experiment – 15 marks)

List of Practical's (Using any Software)

Practical/Lab work to be performed on a Computer.

1. Growth model (exponential case only).Doubling time period.
2. Decay model (exponential case only). Half life time
3. Oxygen debt model.
4. Economic model.
5. Vibration problems.(Undamped SHM)
6. Malthusian law of population Growth.

Book Recommended:

1. J. Sinha Roy and S. Padhy, A Course of Ordinary and Partial Differential Equations, Kalyani Publishers, New Delhi. Chapters: 2 (2.1 to 2.7, 2.8(a), 2.8(f), 2.8(h)), 3(excluding 3.6, 3.8), 4(4.1 to 4.7), 5(upto 5.2), 7(7.1 to 7.4)excluding polynomial, 9(9.1, 9.2, 9.3, 9.4, 9.5, 9.10, 9.11, 9.12, 9.13).

Books for References:

1. Martin Braun, Differential Equations and their Applications, Springer International.
2. M.D. Raisinghania-Advanced Differential Equations, S. Chand & Company Ltd., New Delhi.
3. G. Dennis Zill-A First Course in Differential Equations with Modelling Applications.

Semester-III
Core-V
Theory of Real Functions (Analysis-II)

Total Marks:100
Theory: 80 Marks+Mid-Sem:20 Marks
5 Lectures, 1 Tutorial (per week per student)

(The question paper consists 2 sections i.e A and B. section A contains 4 compulsory questions of 4 marks ,one from each unit. Section B contains, one question from each unit consisting of two parts a,b or c,d having equal marks.)

Unit-I 16+4 Marks

Limits of functions ($\epsilon - \delta$ approach), sequential criterion for limits, divergence criteria. Limit theorems, one sided limits. Infinite limits and limits at infinity. Continuous functions, sequential criterion for continuity and discontinuity.

Unit-II 16+4 Marks

Algebra of continuous functions. Continuous functions on an interval, intermediate value theorem, location of roots theorem, preservation of intervals theorem. Uniform continuity, uniform continuity theorem.

Unit-III 16+4 marks

Derivability at a point, Increasing, decreasing, Relative extrema, interior extremum theorem. Rolles theorem, Mean value theorem, Cauchy's mean value theorem, intermediate value property of derivatives. Applications of mean value theorem to inequalities. Taylor's theorem to inequalities

Unit-IV 16+4 Marks

Maclaurins theorem and problems, Taylor's theorem with Lagrange's form of remainder, Taylors theorem with Cauchys form of remainder, Application of Taylors theorem to convex functions, relative extrema. Taylors series and Maclaurins series expansions of exponential and trigonometric functions,ln(1 + x); 1/(ax + b) and $(1 + x)^n$:

Book Recommended:

1. S.C. Mallik and S. Arora-Mathematical Analysis, New Age International Publications ch-5, ch-6 (excluding art 4), ch-7 (excluding art 2)

Books for References:

1. . G. Das and S. Pattanayak, Fundamentals of Mathematics Analysis, TMH Pub-lishing Co., Chapters:6(6.1-6.8), 7(7.1-7.4),
2. R. Bartle and D.R. Sherbet, Introduction to Real Analysis, John Wiley and Sons, 2003.
3. K.A. Ross, Elementary Analysis: The Theory of Calculus, Springer, 2004.
4. A. Mattuck, Introduction to Analysis, Prentice Hall, 1999.
5. S.R. Ghorpade and B.V. Limaye, A Course in Calculus and Real Analysis, Springer, 2006.

Semester-III
Core-VI
Group Theory (Algebra-II)

Total Marks: 100
Theory: 80 Marks+Mid-Sem:20 Marks
5 Lectures, 1 Tutorial (per week per student)

(The question paper consists 2 sections i.e A and B. section A contains 4 compulsory questions of 4 marks ,one from each unit. Section B contains, one question from each unit consisting of two parts a,b or c,d having equal marks.)

Unit-I 16+4 Marks

Symmetries of a square, dihedral groups, definition and examples of groups including permutation groups and quaternion groups (illustration through matrices), elementary properties of groups. Subgroups and examples of subgroups, centralizer, normalizer, center of a group, product of two subgroups.

Unit-II 16+4 Marks

Properties of Cyclic groups, Classification of Subgroups of Cyclic groups of Group A, cycle notation properties of Permutations, Even and Odd Permutations, Alternating Group of Degree *n*. Properties of cosets, Lagrange's Theorem and Consequences, including fermat's little theorem. An application of cosets to permutation groups.

Unit-III 16+4 Marks

External direct product of a finite number of groups, normal subgroups, factor groups, cauchys theorem for finite abelian groups.

Unit-IV 16+4 Marks

Group Homomorphisms, Properties of Homomorphisms, Isomorphisms: Definition and examples Cayleys Theorem, Properties of isomorphisms, first, second and third Isomorphism theorems

Book Recommended:

1. Joseph A. Gallian, Contemporary Abstract Algebra(4th Edn.), Narosa Publishing House, New Delhi.

Chapters: I, II,III,IV,V,VI(up to Theorem 6.2 only), VII, VIII, IX, XC

Books for References:

1. John B. Fraleigh, A First Course in Abstract Algebra, 7th Ed., Pearson, 2002.
2. M. Artin, Abstract Algebra, 2nd Ed., Pearson, 2011.
3. Joseph J. Rotman, An Introduction to the Theory of Groups, 4th Ed., Springer Verlag, 1995.
4. I.N. Herstein, Topics in Algebra, Wiley Eastern Limited, India, 1975.

Semester-III
Core-VII

Partial Diff. Equations and Systems of Ordinary Diff. Equations

(Total Marks:100)

Part-I (Marks: 75)
Theory: 60 Marks+Mid-Sem: 15 Marks
04 Lectures (per week per student)

(The question paper consists 2 sections i.e A and B. section A contains 4 compulsory questions of 3 marks ,one from each unit. Section B contains, one question from each unit consisting of two parts a,b or c,d having equal marks.)

Unit-I 12+3 Marks

Homogeneous linear systems with constant coefficients (Two Equations in two unknown functions). Simultaneous linear 1st order equations in three variables, methods of solution, Pfaffian differential equations, methods of solutions of Pfaffian differential equations in three variables.

Unit-II 12+3 Marks

Formation of 1st order partial differential equations, Linear and non-linear partial differential equations of 1st order, special types of 1st-order equations, Solutions of partial differential equations of 1st order satisfying given conditions.

Unit-III 12+3 Marks

Linear partial differential equations with constant coefficients, Equations reducible to linear partial differential equations with constant coefficients. Separation of variables,

Unit-IV 12+3 Marks

Solution of Laplace equation by separation of variables, solution of wave equation by method of separation of variables.Solution of Partial differential equation of 2nd order with variable co-efficients type-I,Type-II, Type-III, Monge's method Rr+Ss+Tt=V .

Part-II(Practical: Marks:25)

List of Practical's (Using any Software)
Practical/Lab work to be performed on a Computer.

1. To find the general solution of the non-homogeneous system of the form:
$$\frac{dx}{dt} = a_1x + b_1y + f_1(t), \qquad \frac{dy}{dt} = a_2x + b_2y + f_2(t)$$
with given conditions.
2. Solutions of wave equations $\frac{\partial^2 u}{\partial t^2} - c^2 \frac{\partial^2 u}{\partial x^2} = 0$ for the following associated conditions:
   a. $u(x,0) = \phi(x), u_t(x,0) = \psi(x), x \epsilon R, t > 0.$
   b. $u(x,0) = \phi(x), u_t(x,0) = \psi(x), u_x(0,t) = 0, x \epsilon (0,\infty), t > 0.$
   c. $u(x,0) = \phi(x), u_t(x,0) = \psi(x), u(0,t) = 0, x \epsilon (0,\infty), t > 0.$

d. $u(x,0) = \phi(x), u_t(x,0) = \psi(x), u(0,t) = 0, u(1,t) = 0,\ 0 < x < l, t > 0.$

3. Solutions of Heat equation $\frac{\partial u}{\partial t} - k^2 \frac{\partial^2 u}{\partial x^2} = 0$ for the following associated conditions
   a. $u(x,0) = \phi(x), u(0,t) = a, u(l,t) = b, 0 < x < l, t > 0.$
   b. $u(x,0) = \phi(x), x \in R, 0 < t < T.$
   c. $u(x,0) = \phi(x), u(0,t) = a, x \in (0,\infty),\ t \geq 0.$

Book Recommended:

1. J.Sinha Roy and S. Padhy, A Course on Ordinary and Partial Defferential Equations, KalyaniPublishers, New Delhi, Ludhiana, 2012:-Chapters:11 (excluding method iv, 11.3 Natani's method),Ch-15.5, Ch-16.1.1
1. Mathematics for 2nd yr degree students by Dr. P.K.Mittal, S.chand & co.Ltd, New delhi Ch-9, ch-10 (excluding 10.4), ch-11 (excluding 11.8 to 11.10), ch-12 (excluding 12.2,12.3)
2. A text Book of Differential Equations by N.M.Kapoor, Pitamber Publishing Co (Pvt)Ltd Chapter-12(12.1 to 12.5)

Books for References:

1. Tyn Myint-U and Lokenath Debnath, Linear Partial Di_erential Equations for Scientists and Engineers, 4th edition, Springer, Indian reprint, 2006.
2. S.L. Ross, Di_erential equations, 3rd Ed., John Wiley and Sons, India, 2004.

Semester-IV
Core-VIII

Numerical Methods

(Total Marks:100)

Part-I(Marks:75)
Theory:60 Marks+Mid-Sem:15 Marks
04 Lectures (per week per student)

(The question paper consists 2 sections i.e A and B. section A contains 4 compulsory questions of 3 marks ,one from each unit. Section B contains, one question from each unit consisting of two parts a,b or c,d having equal marks.)

Unit-1 12+3 Marks

Algorithms, Convergence, Errors: Relative, Absolute, Round off, Truncation. Transcendental and Polynomial equations: Bisection method, Newton's Raphson method, Secant method.

Unit-II 12+3 Marks

System of linear algebraic equations: Gaussian Elimination and Gauss Jordan methods. Gauss Jacobi method, Gauss Seidel method.

Unit-III 12+3 Marks

Interpolation: Lagrange and Newton's methods. Error bounds. Finite difference operators. Gregory forward and backward difference interpolation.

Unit-IV 12+3 Marks

Numerical Integration: Trapezoidal rule, Simpsons $1/3^{rd}$ rule, Simpsons 3/8th rule.Ordinary Differential Equations: Euler method, Picard's method, Runge-Kutta methods of orders two and four.

Part-II(Practical: Marks:25)

List of Practicals (Using any Software)
Practical/Lab work to be performed on a Computer

1. Enter 100 integers into an array and sort them in an ascending order.and desending order.
2. Bisection Method.
3. Newton Raphson Method..
4. Gauss-Siedel Method.
5. Lagrange Interpolation or Newton Interpolation.
6. Simpsons rule.
7. Roots of Quadratic Equation.

Note: For any of the CAS (Computer aided software) Data types-simple data types, oating data types,character data types, arithmetic operators and operator precedence, variables and constant declarations,expressions, input/output, relational operators, logical operators and logical

expressions, control state-ments and loop statements, Arrays should be introduced to the students.

Book Recommended:

1. Introductory Numerical Analysis by dr. N Datta & R.N.Jena, Sreedhar Prakashan, Kolkotta:- Ch -I(except theorems), Ch-II (upto 2.15), Ch-III (3.7 to 3.14), Ch-IV (4.3 to 4.6), Ch-V (upto 5.3, 5.7), Ch-VI (6.1 to 6.3)

Books for reference:

1. B.P. Acharya and R.N. Das, A Course on Numerical Analysis, Kalyani Publishers, New Delhi, Ludhiana. Chapters: I, 2(2.1 to 2.4, 2.6, 2.8, 2.9), 3(3.1 to 3.4, 3.6 to 3.8, 3.10), 4(4.1, 4.2), 5(5.1, 5.2, 5.3), 6(6.1, 6.2, 6.3, 6.10, 6.11), 7(7.1, 7.2, 7.3, 7.4 &7.7).
2. Brian Bradie, A Friendly Introduction to Numerical Analysis, Pearson Education, India, 2007.

Semester-IV
Core-IX

Riemann Integration and Series of Functions (Analysis-III)

Total Marks:100

Theory:80 Marks+Mid-Sem:20 Marks
5 Lectures, 1 Tutorial (per week per student)

(The question paper consists 2 sections i.e A and B. section A contains 4 compulsory questions of 4 marks ,one from each unit. Section B contains, one question from each unit consisting of two parts a,b or c,d having equal marks.)

Unit-I 16+4 marks

Riemann integration; inequalities of upper and lower sums; Riemann conditions of integrability. Riemannsum and definition of Riemann integral through Riemann sums; equivalence of two definitions; Riemann integrability of monotone and continuous functions, Properties of the Riemann integral; definition andintegrability of piecewise continuous and monotone functions.Intermediate Value theorem for Integrals;Fundamental theorems of Calculus.

Unit-II 16+4 marks

Improper integrals; Convergence of Beta and Gamma functions.

Unit-III 16+4 marks

Pointwise and uniform convergence of sequence of functions. Theorems on continuity, derivability andintegrability of the limit function of a sequence of functions. Series of functions; Theorems on thecontinuity and derivability of the sum function of a series of functions; Cauchy criterion for uniformconvergence and Weierstrass M-Test.

Unit-IV 16+4 marks

Limit superior and Limit inferior. Power series, radius of convergence; Abels Theorem; Weierstrass Approximation Theorem.

Book Recommended:

1. S.C. Mallik and S. Arora-Mathematical Analysis, New Age International Ltd., New Delhi. ch-9 (upto 10.2), ch-11(upto 4.4 and Problems of poisson's integral and Dirichlet's integral) , Ch-12 (upto 3.2, upto theorem 4).
2. Engineering Mathematics by Erwin Kreyszig :- Ch-14(14.1, 14.2).

Books for References:

1. K.A. Ross, Elementary Analysis, The Theory of Calculus, Undergraduate Texts in Mathematics,Springer (SIE), Indian reprint, 2004.
2. R.G. Bartle D.R. Sherbert, Introduction to Real Analysis, 3rd Ed., John Wiley and Sons (Asia)Pvt. Ltd., Singapore, 2002.
3. G. Das and S. Pattanayak-Fundamentals of Mathematics Analysis, TMH Publishing Co., Chapters:8, 9.10

Semester-IV
Core-X

Ring Theory and Linear Algebra-I(Analysis-III)

Total Marks:100

Theory:80 Marks+Mid-Sem:20 Marks
5 Lectures, 1 Tutorial (per week per student)

(The question paper consists 2 sections i.e A and B. section A contains 4 compulsory questions of 4 marks ,one from each unit. Section B contains, one question from each unit consisting of two parts a,b or c,d having equal marks.)

Unit-I 16+4 Marks

Definition and examples of rings,some special classes of rings, Def^{n} of Field, properties of rings, sub rings, integral domains and fields, characteristic of a ring. Ideal, ideal generated by a subset of a ring, factor rings, operations on ideals.

Unit-II 16+4 marks

Ring homomorphism's, properties of ring homomorphism's, Isomorphism theorem.

Unit-III 16+4 Marks

Matrix associated with a linear map. Rank and Nullity of a Matrix, transpose of a matrix, Elementary Row operations, matrix inversion.

Unit-IV 16+4 Marks

Determinant Minors and rank of a matrix, Product of determinants, Eigen values, Eigen Vectors and Characteristic Equation of a matrix.

Book Recommended:

1. Joseph A. Gallian, Contemporary Abstract Algebra(4th Edn.), Narosa Publishing House, NewDelhi. Chapters:12, 13, 14, 15.

2. V. Krishnamurthy, V. P. Mainra, J. L. Arora-An introduction to Linear Algebra, Affiliated East-West Press Pvt. Ltd., New Delhi, Chapters: 5(5.1, 5.2, 5.5, 5.6, 5.7, 5.9), 6(6.1, 6.2, 6.5, 6.6, 6.8).

Books for Reference:

1. Mathematics for degree students(1st year) by Dr. P.K.Mittal by S.Chand & Co. Ltd-Chap-14, Chap-15

2. Stephen H. Friedberg, Arnold J. Insel, Lawrence E. Spence, Linear Algebra, 4th Ed., Prentice-Hall of India Pvt. Ltd., New Delhi, 2004. Chapters: 1 (1.2-1.6), 2(2.1-2.5).
3. I.N. Herstein-Topics in Algebra, Wiley Eastern Pvt. Ltd.

Semester-V
CORE-XI
Multivariate Calculus (Calculus-II)

Total Marks:100

Theory:80 Marks+Mid-Sem:20 Marks
5 Lectures, 1 Tutorial (per week per student)

(The question paper consists 2 sections i.e A and B. section A contains 4 compulsory questions of 4 marks ,one from each unit. Section B contains, one question from each unit consisting of two parts a,b or c,d having equal marks.)

Unit-I 16+4 Marks

Functions of several variables, limit and continuity of functions of two variables Partial differentiation, Derivative of composite functions, change of variables. Chain rule for one and two independent parameters.

Unit-II 16+4 marks

Taylor's theorem, Maclaurin's theorem for two variables.Extrema of functions of two variables, method of Lagrange multipliers.

Unit-III 16+4 marks

Double integration over rectangular region, double integration over non-rectangular region, Double integrals in polar co-ordinates,line integral, Change of variables in double integrals. Change of order of integration, Green's theorem (without proof)

Unit-IV 16+4 marks

Definition of vector field, divergence and curl,Length of curve, Mass and Work. surface integrals, integrals over parametrically defined surfaces. Stokes theorem, Gauss Divergence theorem.(without proof of theorems). Volume by triple integral.

Books Recommended:

1. S.C. Mallik and S. Arora-Mathematical Analysis, New Age International Ltd., New Delhi. Ch-15 (upto3.1, 5, 5.1, 7.2, 8, 9, 10 to 10.2), ch-16 (2, 3, 3.2), Ch-17 (upto 1.4, 2.8, 3.4, 4,5) Ch-18 (1.3, 2.2, 3.1, 5, 7.7)
2. Advanced Integral Calculus by J.K.Gayal, K. P. Gupta, Pragati Prakasan, Meerut. Chapter-3
3. Topics in calculus by R.K.Panda &P.K.Satapathy :- Chap-6 (6.15 to 6.17)

Books for Reference:

1. M.J. Strauss, G.L. Bradley and K. J. Smith, Calculus, 3rd Ed., Dorling Kindersley (India) Pvt. Ltd.(Pearson Education), Delhi, 2007. Chapters: 11(11.1(Pages: 541-543), 11.2-11.6, 11.7(Pages:598-605), 11.8(Pages:610-614)), 12 (12.1, -12.3, 12.4(Pages:652-660), 12.5, 12.6), 13 (13.2, 13.3,13.4(Pages:712-716), 13.5(Pages:723-726; 729-730), 13.6 (Pages:733-737), 13.7(Pages:742-745))

Semester-V
CORE-XII

Probability & Statistics

Total Marks:100
Theory:80 Marks+Mid-Sem:20 Marks
5 Lectures, 1 Tutorial (per week per student)

(The question paper consists 2 sections i.e A and B. section A contains 4 compulsory questions of 4 marks ,one from each unit. Section B contains, one question from each unit consisting of two parts a,b or c,d having equal marks.)

Unit-I 16+4 Marks

Sample Space, Probability axioms, real random variables (discrete & continuous), Probability measure, Conditioning and independence, Basic properties, Baye's theorem, Independent events.

Unit-II 16+4 Marks

Random variables, Probability function, Distribution function, density function, Mathematical expectation, moments, Probability Generating Function, Mean and Variance.

Unit-III 16+4 Marks

Discrete Distribution, Uniform, Binomial, Poisson, Continuous distribution, uniform, normal Distribution.

Unit-IV 16+4 Marks

Chebyshev's inequality, Weak Law of large numbers, Bernoulli's theorem, Expectation of function of two variables, Expectation & Variance.

Books Recommended:

1. Elements of Probability Theory by D. Pratihari, S.P.Mohanty:-
   Ch-3, Ch-4 (upto 4.3.5, 4.10 upto Example 20), Ch-5 (upto 5.4.1, 5.4.3, 5.5, 5.6), Ch-6 (upto 6.2.1, 6.3), Ch-8 (upto 8.5), Ch-9 (upto 9.2.3, 9.2.5, 9.2.6), Ch-10 (10.4.1).

Semester-VI
CORE-XIII
Metric Spaces and Complex Analysis (Analysis-IV)

Total Marks:100

Theory:80 Marks+Mid-Sem:20 Marks
5 Lectures, 1 Tutorial (per week per student)

. (The question paper consists 2 sections i.e A and B. section A contains 4 compulsory questions of 4 marks ,one from each unit. Section B contains, one question from each unit consisting of two parts a,b or c,d having equal marks.))

Unit-I 16+4 Marks

Metric spaces: definition and examples. Spheres, diameter of a non empty set, bounded metric space, open sets, closed sets, open and closed spheres, derived set and theorems..

Unit-II 16+4 Marks

Properties of complex numbers, regions in the complex plane, functions of complex variable, mappings. Derivatives, differentiation formulas, Cauchy-Riemann equations, sufficient conditions for differentiability. Analytical function, examples of analytical functions.

Unit-III 16+4 Marks

Complex integration, cauchy's theorem. Contours, Contour integrals and its examples, upper bounds for moduli of contour integrals. Cauchy- Goursat theorem, Cauchy integral formula.

Unit-IV 16+4 Marks

Convergence of sequences and series, Taylor series and its examples. Laurent series and its examples, absolute and uniform convergence of power series.Calculus of Residues (unit circle method and upper half of large semicircle method).

Books Recommended:

1. S.C. Mallik and S. Arora-Mathematical Analysis, New Age International Ltd., New Delhi:- Ch- 19(upto 2.5 closed sets upto theorem 4.(excluding Euclidean metric space, Hilbert space, subspaces etc.)
2. Engineering mathematics by B.S.Grewell, 40^{th} edition :- Ch 20 (excluding 20.7-20.11, 20.15 (1), (2), (3), (4)), integration around a small semi-circle, rectangular contours, indenting contours having pole on real line).

Books for Reference:

1. P.K. Jain and K. Ahmad, Metric Spaces, Narosa Publishing House, New Delhi. Chapters: 2(1-9),3(1-4), 4(1-4), 6(1-2), 7(1 only).
2. James Ward Brown and Ruel V. Churchill, Complex Variables and Applications, 8th Ed., McGrawHill International Edition, 2009. Chapters: 1(11 only), 2(12,13), 2(15-22, 24, 25), 3(29, 30, 34)4(37-41, 43-46, 50-53), 5(55-60, 62,63,66).

Books for References:

Semester-VI
CORE-XIV

Linear Programming

Total Marks:100

Theory:80 Marks+Mid-Sem:20 Marks
5 Lectures, 1 Tutorial (per week per student)

(The question paper consists 2 sections i.e A and B. section A contains 4 compulsory questions of 4 marks ,one from each unit. Section B contains, one question from each unit consisting of two parts a,b or c,d having equal marks.)

Unit-I 16+4 Marks

Basic of Operations research, Scope, Phase, Models of Operation Research. Classification of models, Linear Programming, Formulation of LP problems, Sensitivity Analysis, Graphical Method.

Unit-II 16+4 marks

Simplex Method Introduction, Definition, Simplex Algorithm.

Unit-III 16+4 Marks

Artificial Variables Technique, Charne's Big M Method, Duality in Linear Programming.

Unit-IV 16+4 Marks

Transportation Problem Introduction Mathematical Formulation, Optimal solution, North West Corner Rule, Least Cost Or Matrix Minima Method.Transhipment and Assignment Problems, Game theory.

Recommended Book.

1. Operations Research with C Programming by S.KalaVathy, Vikas Publishing House Pvt Ltd. Noida , New Delhi: Ch-1, Ch-2 (upto 2.3 Excluding 2.3.1, 2.3.2), Ch-3, Ch-4, Ch-5 (upto 5.2), Ch-6, Ch-8 (upto 8.4.2), Ch-9 (upto9.6), Ch-19 (upto 19.4)

Books for Reference:

1. Mokhtar S. Bazaraa, John J. Jarvis and Hanif D. Sherali, Linear Programming and Network Flows,2nd Ed., John Wiley and Sons, India, 2004. Chapters:3(3.2-3.3, 3.5-3.8), 4(4.1-4.4), 6(6.1-6.3).
2. F.S. Hillier and G.J. Lieberman, Introduction to Operations Research, 9th Ed., Tata McGraw Hill,Singapore, 2009. Chapter:14
3. Hamdy A. Taha, Operations Research, An Introduction, 8th Ed., PrenticeHall India, 2006. Chap-ter:5(5.1, 5.3, 5.4).

DISCIPLINE SPECIFIC ELECTIVE(DSE)

SEMESTER-V
DSE-I

Programming In C++ (Compulsory)

Part-I(Marks:75)
(Theory:60 Marks+Mid-Sem:15 Marks
04 Lectures (per week per student)

(The question paper consists 2 sections i.e A and B. section A contains 4 compulsory questions of 3 marks ,one from each unit. Section B contains, one question from each unit consisting of two parts a,b or c,d having equal marks.)

Unit-I **12+3 Marks**

Introduction To Structured Programming: Data Types- Simple Data Types, Oating Data Types, Character Data Types, String Data Types.

Unit-II 12+3 Marks

Arithmetic Operators and Operators Precedence, Variables and Constant Declarations, Expressions, Input Using The Extraction Operator >>and Cin, Output Using The Insertion Operator << and Cout.

Unit-III 12+3 Marks

Preprocessor Directives, Increment(++) And Decrement({) Operations, CreatingA C++ Program, Input/ Output, Relational Operators, Logical Operators and Logical Expressions.

Unit-IV 12+3 Marks

If And If-Else Statement, Switch and Break Statements. for, While andDo-While Loops and Continue Statement, Nested Control Statement, Value Returning Functions, Value Versus Reference Parameters, Local and Global Variables, One Dimensional Array, Two Dimensional Array, Pointer Data and Pointer Variables.

Book Recommended:- 1. D. S. Malik: C++ Programming Language, Edition-2009, Course Technology, Cengage Learning,India Edition. Chapters: 2(Pages:37-95), 3(Pages:96-129), 4(Pages:134-178), 5(Pages:181-236),6, 7(Pages:287-304), 9 (Pages: 357-390), 14(Pages:594-600).

Books For References:- 1. E. Balaguruswami: Object Oriented Programming with C++, _Fth Edition, Tata Mcgraw HillEducation Pvt. Ltd.

2. R. JohnsonbaughAnd M. Kalin-Applications Programming In Ansi C, Pearson Education.
3. S. B. LippmanAnd J. Lajoie, C++ Primer, 3rd Ed., Addison Wesley, 2000.
4. BjarneStroustrup , The C++ Programming Language, 3rd Ed., AddisonWelsley.

Part-II(Practical, Marks:25)
List OfPracticals (Using Any Software)
Practical/Lab Work To Be Performed On A Computer.
Record =5 Marks; Viva-Voce=5 Marks ; Experiment=15 Marks

1. Calculate the Sum of the series :-$\frac{1}{1}+\frac{1}{2}+\frac{1}{3}\ldots.+\frac{1}{N}$for any Positive Integer N:

2. Calculate the Factorial of any Natural Number.

3. Write a program that prompts the user to input a positive integer. it should then output a message Indicating whether the number is a Prime Number.
4. Write a Program that Prompts the user to input the Value of A; B and C involved in the equation $ax^2+ bx+ c= 0$ and outputs the type of the Roots of the equation. Also the Program should outputs all the Roots of the Equation.
5. Write a Program that Generates Random Integer Between 0 and 99: given that first Two Fibonacci Numbers are 0 and 1; Generate all Fibonacci Numbers Less than or equal to Generated Number.
6. Write a Program that uses Whileloops to perform the following steps:
A. Prompt the user to input Two Integers : First Num and Second Num (first Num Shoul be Less than Second Num).
B. Output all Odd and Even Numbers Between First Num and Second Num.
C. Output the Sum of all Even Numbers Between first Num and Second Num.
D. Output the Sum of the Square of the Odd Numbers Firs Num and Second Num.
7. Enter 100 Integers Into An Array And Short Them In An Ascending/ Descending Order And Print The Largest/ Smallest Integers.
8. Enter 10 Integers Into An Array And Then Search For A Particular Integer In The Array.
9. Multiplication/ Addition of Two Matrices using two dimensional arrays.

SEMESTER-V
DSE-II

Boolean Algebra and Automata Theory

Total Marks:100

Theory:80 Marks+Mid-Sem:20 Marks
5 Lectures, 1 Tutorial (per week per student)

(The question paper consists 2 sections i.e A and B. section A contains 4 compulsory questions of 4 marks ,one from each unit. Section B contains, one question from each unit consisting of two parts a,b or c,d having equal marks.)

Unit-I 16+4 Marks

Introduction: Alphabets, strings, and languages. Finite Automata and Regular Languages: deterministic and non-deterministic finite automata, regular expressions, regular languages andtheir relationship with finite automata, pumping lemma and closure properties of regular languages.

Unit-II 16+4 Marks

Context Free Grammars and Pushdown Automata: Context free grammars (CFG), parse trees,ambiguities in grammars and languages, pushdown automaton (PDA) and the language acceptedby PDA, deterministic PDA, Non- deterministic PDA, properties of context free languages;normal forms, pumping lemma, closure properties, decision properties

Unit-III 16+4 Marks

Turing Machines: Turing machine as a model of computation, programming with a Turingmachine, variants of Turing machine and their equivalence.

Unit-IV 16+4 Marks

Undecidability: Recursively enumerable and recursive languages, undecidable problems aboutTuring machines: halting problem, Post Correspondence Problem, and undecidability problemsAbout CFGs.

Books Recommended:-

1. **J. E. Hopcroft, R. Motwani and J. D. Ullman*, Introduction to Automata Theory, Languages,and Computations,2nd Ed., Addison-Wesley,2001:- Ch-1(upto 5), Ch-2(upto2.1.3,2.2,2.3.1-2.3.5), Ch-3(3.1,3.2), Ch-4(4.1,4.2), Ch-5(5.1,5.2.1,5.2.2,5.4.1,5.4.2), Ch-6(6.1,6.2,6.4), Cp-7(7.1,7.2,7.3,7.4) Ch-8(8.2,8.3,8.4),Ch-9(9.1,9.2,9.3,9.4,9.5.2)***

SEMESTER-VI

DSE-III

Theory of Equations

Total Marks:100
Theory:80 Marks+Mid-Sem:20 Marks
5 Lectures, 1 Tutorial (per week per student.

(The question paper consists 2 sections i.e A and B. section A contains 4 compulsory questions of 4 marks ,one from each unit. Section B contains, one question from each unit consisting of two parts a,b or c,d having equal marks.)

Unit-I 16+4 Marks

General Properties of Polynomials and equations, Relations between roots and Co-efficient of equations.

Unit-II 16+4 Marks

Symmetric functions of roots, Application of Symmetric function of the roots, Transformation of equations, Newton's theorem on sums of powers of roots.

Unit-III 16+4 Marks

Limits of the roots of equations, Sturms theorem, Newton's method to find Superior limits of positive and negative roots.

Unit-IV 16+4 Marks

Algebraic solutions of cubic equation by Cardon's method, solution of Biquadratic equation by Descarte's, Ferrari's method.Descarte's rule of sign for positive roots & negative roots, repeated roots solution of reciprocal equations.

Books Recommended:

1. A Text Book of Algebra by Ravinder kumar and siri krishanwasan, pitamber publishing co.(pvt) ltd :- Ch-3
2. Higher Algebra by A. Kurosh, Moscow Mir Publications:- Art 39, 40.

SEMESTER-VI

DSE-IV
Mathematical Modelling

Total Marks: 100
Theory: 80 Marks+Mid-Sem:20 Marks
5 Lectures, 1 Tutorial (per week per student)

(The question paper consists 2 sections i.e A and B. section A contains 4 compulsory questions of 4 marks ,one from each unit. Section B contains, one question from each unit consisting of two parts a,b or c,d having equal marks.)

Unit-I 16+4 Marks

Mathematical Modelling through differential equations1st order, linear growth and decay models, non-linear growth and decay models, compartment models, Growth of scientists, Mathematical Modelling (Effect of Immigration and Emigration on population size), Newton's law of Cooling, Fick's Law of Diffusion, Change of Price Commodity, Spread of Technological Innovations and infections Diseases, Orthogonal Trajectories. SHM.

Unit-II 16 +4Marks

Mathematical Modelling in Dynamics through ordinary Differential equation of 1^{st} order, Motion under gravity in a resisting medium, Motion of a rocket, Mathematical Modelling in population dynamics, competition model, Diffusion of Glucose or medicine in the Blood stream.

Unit-III 16+4 Marks

Mathematical Modelling of Epidemics through system of ordinary differential equation of 1^{st} order (A simple Epidemic model, SIS model, SIS with constant number of carriers), Richardson's model for arms races, Lanchester's combat model.Mathematical Modelling in Economics based on systems of ordinary differential equations of first order (Domar macro model, Domar first debt model, second debt model, Allen's speculative model)

Unit-IV 16+4 Marks

Motion of projectiles, Mathematical Modelling of Rectilinear motion, Electric circuits.Mathematical Modelling of Planetary motions, Components of velocity and Acceleration Vectors along Radial and Transverse Directions, Motion Under a central forces, Motion under the inverse square law, Kepler's Laws of planetary motion, Circular Motion & satellites, Circular motion of satellites, Catenary, A curve of pursuit.

Books Recommended:

1. J.N. Kapur-Mathematical Modelling, Ch-2(Exculding 2.4.3), ch- 3(excluding 3.1.3, 3.1.4, 3.2.5, 3.2.6, 3.3, 3.4.5- 3.4.8), Ch-4 (Excluding 4.2.4, 4.3.3)

SEMESTER -IV

Skill Enhancement Course (SEC-II)
(bachelor of Arts/Science/Commerce)
(Credit: 2, Total Marks: 50)

Quantitative & Logical Thinking

Total Marks:50
Internal Examination: 10 marks
End semester Examination : 1 mark question from section A(answer any 20 out of 25): 20X1=20
2 mark question from section B(answer any 10 out of 15): 10X2=20

Section-A

Unit-1 10X1

Whole numbers, integers, Rational and irrational numbers, fractions, square roots and Cube roots, surds and indices, problems on numbers, Divisibility, steps of long division method for finding square roots, Basic concepts, different formulae of percentage, profit and loss, discount, simple interest, ratio and proportion, mixture, time and work, pipes and cisterns, basic concept of time, distance and speed.

Unit-II **10X1**

Concepts of angles, different polygons like triangles, rectangle, square, right angled triangle, Pythagorean theorem, perimeter and area of triangles, rectangles, circles, Raw and Grouped data, Bar graphs, Pie charts, Mean, Median, Mode, Events and Sample space, Probability.

Section - B

Unit-III 5 X 2

Analogy basing on kinds of relationships, simple analogy, pattern and series of numbers, letters, figures, coding-decoding of numbers, letters, symbols, blood relations.

Unit-IV 5 X 2

Logical statements – Two premise argument, more than two premise argument using connectives, Venn diagrams, Mirror images, problems on Cubes and Dices.

Books Recommended:

Quantitative and Logical Thinking, Odisha State Higher Education Council, Bhubaneswar.

Electives Generic /Interdisciplinary

SEMESTER-I(for physic's Hons students)

GE-I: Calculus and Ordinary Differential Equations

Total Marks:100

Theory:80 Marks+Mid-Sem:20 Marks

5 Lectures, 1 Tutorial (per week per student

(The question paper consists 2 sections i.e A and B. section A contains 4 compulsory questions of 4 marks ,one from each unit. Section B contains, one question from each unit consisting of two parts a,b or c,d having equal marks.)

Unit-I 16 +4marks

Curvature, Asymptotes, Rectification, Quardrature,(length of the plane curves), Volume of solids of revolution.

Unit-II 16+4 Marks

Sphere, Cones and Cylinders.

Unit-III 16+4 marks

Explicit and Implicit functions, Limit and Continuity of functions of several variables, Partial derivatives, Partial derivatives of higher orders, Homogeneous functions, Change of variables, Taylors theorem and Maclaurins theorem for functions of two variables. Maxima and Minima of functions of two variables.

Unit-IV 16+4 marks

Ordinary Differential Equations of 1st order and 1st degree (Variables separable, homogenous, exact and linear). Reducible to homogeneous equation. Equations of 1st order but higher degree.Second order linear equations with constant coeffcients, homogeneous forms, Second order equations with variable coeffcients, Variation of parameters.

Books Recommended:

1. Topics in Calculus by R.K.Panda & P.K.Satpathy, S.G.Publications:- Chap 1(upto1.10), Ch-2 (up to, 2.15.
2. Analytical Solid Geometry by Shanti Narayan:-Ch- 6.11 to 6.6, Ch-7.1 to 7.14, 7.42, 7.6 to 7.82.
3. Mathematical Analysis by S.C.Mallick:- Chap 15(1.1 to 3, 5, 5.1, 7, 8, 9, 10 to 10.2,)
4. J. Sinharoy and S. Padhy-A Course of Ordinary and Partial Differential Equations, Kalyani Publishers. Chapters: 2(2.1 to 2.7 (i)), 3(up to 3.5, 3.7), 4(4.2, 4.4, 4.5 to 4.7), 5(upto 5.2)

Books for References:

1. Shantinarayan-Text Book of Calculus, Part-II, S. Chand and Co., Chapter-8 (Art. 24, 25, 26)
2. Shantinarayan-Text Book of Calculus, Part-III, S. Chand and Co., Chapter-1 (Art 1,2), 3, 4(Art.10 to 12 omitting Simpsons Rule), 5(Art-13) and 6(Art-15).

3. B.P. Acharya and D.C. Sahu-Analytical Geometry of Quadratic Surfaces, Kalyani Publishers, New Delhi, Ludhiana.
4. Santosh K. Sengar-Advanced Calculus, Chapters: 2, 4, 5, 6, 7, 11, 12, 13.

5. Shanti Narayan and P.K. Mittal-Analytical Solid Geometry, S. Chand & Company Pvt. Ltd., New Delhi.
6. David V. Weider-Advanced Calculus, Dover Publications.
7. Martin Braun-Differential Equations and their Applications-Martin Braun, Springer International.
8. M.D. Raisinghania-Advanced Differential Equations, S. Chand & Company Ltd., New Delhi.27
9. G. Dennis Zill-A First Course in Differential Equations with Modelling Applications, Cengage Learning India Pvt. Ltd.

SEMESTER-II(for chemistry &I.T Hons students)

GE-II: Calculus and Ordinary Differential Equations

Total Marks:100
Theory:80 Marks+Mid-Sem:20 Marks
5 Lectures, 1 Tutorial (per week per student

(The question paper consists 2 sections i.e A and B. section A contains 4 compulsory questions of 4 marks ,one from each unit. Section B contains, one question from each unit consisting of two parts a,b or c,d having equal marks.)

Unit-I 16+4 marks

Curvature, Asymptotes, Rectification, Quardrature,(length of the plane curves), Volume of solids of revolution.

Unit-II 16+4 Marks

Sphere, Cones and Cylinders.

Unit-III 16+4 marks

Explicit and Implicit functions, Limit and Continuity of functions of several variables, Partial derivatives, Partial derivatives of higher orders, Homogeneous functions, Change of variables, Taylors theorem and Maclaurins theorem for functions of two variables. Maxima and Minima of functions of two variables.

Unit-IV 16+4 marks

Ordinary Differential Equations of 1st order and 1st degree (Variables separable, homogenous, exact and linear). Reducible to homogeneous equation. Equations of 1st order but higher degree.Second order linear equations with constant coeffcients, homogeneous forms, Second order equations with variable coeffcients, Variation of parameters.

Books Recommended:

1. Topics in Calculus by R.K.Panda & P.K.Satpathy, S.G.Publications:- Chap 1(upto1.10), Ch-2 (up to, 2.15.
2. Analytical Solid Geometry by Shanti Narayan:-Ch- 6.11 to 6.6, Ch-7.1 to 7.14, 7.42, 7.6 to 7.82.
3. Mathematical Analysis by S.C.Mallick:- Chap 15(1.1 to 3, 5, 5.1, 7, 8, 9, 10 to 10.2,).
4. J. Sinharoy and S. Padhy-A Course of Ordinary and Partial Differential Equations, Kalyani Publishers. Chapters: 2(2.1 to 2.7 (i)), 3(up to 3.5, 3.7), 4(4.2, 4.4, 4.5 to 4.7), 5(upto 5.2)

Books for References:

1. Shantinarayan-Text Book of Calculus, Part-II, S. Chand and Co., Chapter-8 (Art. 24, 25, 26)
2. Shantinarayan-Text Book of Calculus, Part-III, S. Chand and Co., Chapter-1 (Art 1,2), 3, 4(Art.10 to 12 omitting Simpsons Rule), 5(Art-13) and 6(Art-15).

3. B.P. Acharya and D.C. Sahu-Analytical Geometry of Quadratic Surfaces, Kalyani Publishers, New Delhi, Ludhiana.
4. Santosh K. Sengar-Advanced Calculus, Chapters: 2, 4, 5, 6, 7, 11, 12, 13.

5. Shanti Narayan and P.K. Mittal-Analytical Solid Geometry, S. Chand & Company Pvt. Ltd., New Delhi.
6. David V. Weider-Advanced Calculus, Dover Publications.
7. Martin Braun-Differential Equations and their Applications-Martin Braun, Springer International.
8. M.D. Raisinghania-Advanced Differential Equations, S. Chand & Company Ltd., New Delhi.27
9. G. Dennis Zill-A First Course in Differential Equations with Modelling Applications, Cengage Learning India Pvt. Ltd.

SEMESTER-III(for Chemistry& I.T Hons students)

GE-III: Linear Algebra and Advanced Algebra

Total Marks:100
Theory:80 Marks+Mid-Sem:20 Marks
5 Lectures, 1 Tutorial (per week per student

(The question paper consists 2 sections i.e A and B. section A contains 4 compulsory questions of 4 marks ,one from each unit. Section B contains, one question from each unit consisting of two parts a,b or c,d having equal marks.)

Unit-I 16+4 marks

Vector space, Subspace, Span of a set, Linear dependence and Independence, Dimensions and Basis. Linear transformations, Range, Kernel, Rank, Nullity.Matrices and linear maps, Rank and Nullity of a matrix, Transpose of a matrix, Types of matrices. Elementary row operations, Matrix inversion using row operations, Rank of matrices.

Unit-II 16 +4marks

Group Theory: Definition and examples, Subgroups, permutation groups, cyclic groups, lagranges theorem. A counting principle.

Unit-III 16+4 marks

Lagranges Interpolation, Newtons Gregory Forword Interpolation, Simpson's 1/3 rule, Trapezoidal Rule.

Unit-IV 16+4 marks

Scalar & vector point function, Velocity, Acceleration, tangent plane, normal, Divergence, Gradient, Curl.

Books Recommended:

1. Topics in Algebra by S.Padhy, L. Sahoo by Kalyani Pub.:- Ch-3 (upto 3.6), ch-5, Ch-6 (upto6.3)
2. . V. Krishnamurthy, V. P. Mainra, J. L. Arora-An introduction to Linear Algebra, Affiliated East-West Press Pvt. Ltd., New Delhi, Chapters: 5(5.1,5.5,5.6,5.7,5.9), 6(6.1, 6.2, 6.5).
3. Introductory Numerical Analysis By Dutta and Jena , Sreedhar Prakashan:- Ch-2 (upto 2.14, Ch-3 (3.10 to 3.14)
4. Topics in Calculus by Panda & Satapathy, S.G. Pub. :- Ch-6 (excluding 6.13, 6.14)

Books for Reference

1. I.H. Seth-Abstract Algebra, Prentice Hall of India Pvt. Ltd., New Delhi.
2. I.N. Herstein-Topics in Algebra, Wiley Eastern Pvt. Ltd.

SEMESTER-IV(for Physic's Hons students)

GE-IV: Linear Algebra and Advanced Algebra

Total Marks:100
Theory:80 Marks+Mid-Sem:20 Marks
5 Lectures, 1 Tutorial (per week per student

(The question paper consists 2 sections i.e A and B. section A contains 4 compulsory questions of 4 marks ,one from each unit. Section B contains, one question from each unit consisting of two parts a,b or c,d having equal marks.)

Unit-I 16+4 marks

Vector space, Subspace, Span of a set, Linear dependence and Independence, Dimensions and Basis. Linear transformations, Range, Kernel, Rank, Nullity.Matrices and linear maps, Rank and Nullity of a matrix, Transpose of a matrix, Types of matrices. Elementary row operations, Matrix inversion using row operations,Rank of matrices.

Unit-II 16+4 marks

Group Theory: Definition and examples, Subgroups, permutation groups, cyclic groups, lagranges theorem. A counting principle.

Unit-III 16+4 marks

Lagranges Interpolation, Newtons Gregory Forword Interpolation, Simpson's 1/3 rule, Trapezoidal Rule.

Unit-IV 16+4 marks

Scalar & vector point function, Velocity, Acceleration, tangent plane, normal, Divergence, Gradient, Curl.

Books Recommended:

1. Topics in Algebra by S.Padhy, L. Sahoo by Kalyani Pub.:- Ch-3 (upto 3.6), ch-5, Ch-6 (upto6.3)
2. . V. Krishnamurthy, V. P. Mainra, J. L. Arora-An introduction to Linear Algebra, Affiliated East-West Press Pvt. Ltd., New Delhi, Chapters: 5(5.1,5.5,5.6,5.7,5.9), 6(6.1, 6.2, 6.5).
3. Introductory Numerical Analysis By Dutta and Jena , Sreedhar Prakashan:- Ch-2 (upto 2.14, Ch-3 (3.10 to 3.14)
4. Topics in Calculus by Panda & Satapathy, S.G. Pub. :- Ch-6 (excluding 6.13, 6.14)

Books for Reference

1. I.H. Seth-Abstract Algebra, Prentice Hall of India Pvt. Ltd., New Delhi.
2. I.N. Herstein-Topics in Algebra, Wiley Eastern Pvt. Ltd.

B.SC. PHYSICS HONOURS SYLLABUS UNDER CHOICE BASED CREDIT SYSTEM DEPARTMENT OF PHYSICS RAYAGADA AUTONOMOUS COLLEGE

1ST SEMESTER & 2ND SEMESTER-2018-19

3RD SEMESTER & 4TH SEMESTER-2019-20

5TH SEMESTER & 6TH SEMESTER-2020-21

Course Structure (Physics-Major)

Course	*Credits	
	Theory+ Practical	Theory + Tutorial
I. Core Course		
(14 Papers)	14X4= 56	14X5=70
Core Course Practical / Tutorial*		
(14 Papers)	14X2=28	14X1=14
II. Elective Course		
(8 Papers)		
A.1. Discipline Specific Elective	4X4=16	4X5=20
(4 Papers)		
A.2. Discipline Specific Elective		
Practical/Tutorial*	4 X 2=8	4X1=4
(4 Papers)		
B.1. Generic Elective/		
Interdisciplinary	4X4=16	4X5=20
(4 Papers)		
B.2. Generic Elective		
Practical/ Tutorial*	4 X 2=8	4X1=4
(4 Papers)		
Optional Dissertation or project work in place of one Discipline Specific		
E**lective paper (6 credits) in 6th Semester**		
III. Ability Enhancement Courses		
1. **Ability Enhancement Compulsory**		
(2 Papers of 2 credit each)	2 X 2=4	2 X 2=4
Environmental Science		
English/MIL Communication		
2. **Ability Enhancement Elective** (Skill Based)		
(Minimum 2)	2 X 2=4	2 X 2=4
(2 Papers of 2 credit each)		
Total credit	**140**	**140**

Mark Distribution

Core Course:	14x100=1400
DSE:	4x100=400
GE-I:	2x100=200
GE-II:	2x100=200
Ability Enhancement (Compulsory):	2x50=100
Ability Enhancement (Elective, Skill Based):	2x50=100

Total Mark=2400, **Total no of Papers=26**

Subjects with Practical:

Theory-75 Marks, Practical-**25** Marks
Mid Semester Theory-**15** Marks, End Semester Theory-**60** Marks
There is no Practical Exam. in Mid Semester.

Subjects without Practical: 100 Marks
Mid Semester-**20** Marks, End Semester-**80** Marks

QUESTION PATTERN IN END-SEMESTER

All the papers shall have 4 units. The question paper will have two sections. Section "A" shall have 20% of marks and number of objective questions of four marks each. There shall be no choice in section "A". Section "B" shall have 80% of marks. Students have to answer four long questions, one from each unit.

The duration of examination for 100 marks is 3 hours and for 50 marks it is 2 hours.

	CORE COURESE 14	**Ability Enhancement Compulsory Course (AECC)(2)**	**Ability Enhancement Elective Course (AEEC) (2) (Skill Based)**	**Elective: Discipline Specific DSE (4)**	**Elective: Generic (GE) (4)**
I	Mathematical Physics-I (4+2)	English/Odia/Telugu/Hindi			GE-1
	Mechanics (4 +2)				
II	Electricity& Magnetism(4+2)	Environmental Science			GE-2
	Waves and Optics (4 + 2)				
III	Mathematical Physics–II (4 +2)		SEC -1 **Communicative English**		GE-3
	Thermal Physics (4 + 2)				
	Digital Systems and Applications (4 + 2)				
IV	Mathematical Physics–III (4+2)		SEC -2 ***Quantitative Aptitude and Logical Thinking***		GE-4
	Elements of Modern Physics (4+2)				
	Analog Systems & Applications (4+2)				
V	Quantum Mechanics and Applications (4+ 2)			DSE-1 Classical Dynamics (Compulsory)	
	Solid State Physics (4 + 2)			DSE-2 Nuclear and Particle Physics (Compulsory)	
VI	Electromagnetic Theory (4+2)			DSE-3 Computational Physics/ Nano Materials and Applications/ Biophysics	
	Statistical Mechanics (4 + 2)			DSE-4 Physics of the Earth	

Core Papers (C): (Credit:06 each, 04 Theory and 02 Practical)
1. Mathematical Physics-I (4 + 2)
2. Mechanics (4 + 2)
3. Electricity and Magnetism (4 + 2)
4. Waves and Optics (4 + 2)
5. Mathematical Physics–II (4 + 2)
6. Thermal Physics (4 + 2)
7. Digital Systems and Applications (4 + 2)
8. Mathematical Physics III (4 + 2)
9. Elements of Modern Physics (4 + 2)
10. Analog Systems and Applications (4 + 2)
11. Quantum Mechanics and Applications (4 + 2)
12. Solid State Physics (4 + 2)
13. Electromagnetic Theory (4 + 2)
14. Statistical Mechanics (4 + 2)

Discipline Specific Elective Papers: (Credit: 06 each) (4 papers) DSE 1 - 4
1. Classical Dynamics (5) + Tutorials (1)
2. Nuclear and Particle Physics (5) + Tutorials (1)
3. Biophysics (5) + Tutorials (1)
4. Physics of Earth(5) + Tutorial (1)

Generic Elective/Interdisciplinary(4 papers-Two papers from two disciplines)- GE 1& GE 4
1. Mathematics (5) + Tut (1) **(Compulsory)**
2. Chemistry Th. (4) + Lab (2)

Skill Enhancement Courses (2 papers)
(Credit: 02 each)- SEC 1 to SEC 2
1. Communicative English **(Compulsory)**
2. Quantitative Aptitude and Logical Thinking

Generic Elective Papers (GE) (Physics) (any two) for other
Departments/Disciplines: (Credit: 06 each)
1. Mechanics (4) + Lab (2)
2. Electricity and Magnetism (4) + Lab (2)

CORE COURSE (HONOURS IN PHYSICS)

Semester I

PHYSICS-C I: MATHEMATICAL PHYSICS-I
(Credits: Theory-04, Practicals-02)

The emphasis of course is on applications in solving problems of interest to physicists.
The students are to be examined entirely on the basis of problems, seen and unseen.

UNIT-I

Vector Calculus:

Recapitulation of vectors: Properties of vectors under rotations. Scalar product and its invariance under rotations. Vector product, Scalar triple product and their interpretation in terms of area and volume respectively. Scalar and Vector fields.

Vector Differentiation: 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, Gradient, divergence, curl and Laplacian in spherical and cylindrical coordinates.

UNIT-II

Calculus:

Calculus of functions of more than one variable: Partial derivatives, exact and inexact differentials. Integrating factor, with simple illustration. Calculus of variation, Eule equation, Constrained Maximization using Lagrange Multipliers.

Dirac Delta function and its properties:

Definition of Dirac delta function. Representation as limit of a Gaussian function and rectangular function. Properties of Dirac delta function.

UNIT-III

Orthogonal Curvilinear Coordinates:

Orthogonal Curvilinear Coordinates. Derivation of Gradient, Divergence, Curl and Laplacian in Cartesian, Spherical and Cylindrical Coordinate Systems. Comparison of velocity and acceleration in cylindrical and spherical coordinate system.

UNIT-IV

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).

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
- Advanced Engineering Mathematics, Erwin Kreyszig, 2008, Wiley India.
- Essential Mathematical Methods, K.F.Riley & M.P.Hobson, 2011, Cambridge Univ.Press

 Mathematical Physics and Special Relativity--M. Das, P.K. Jena and B.K. Dash (Srikrishna Prakashan) 2nd Edition 2009
 Mathematical Physics--H. K. Dass, Dr. Rama Verma (S. Chand Higher Academics)
 6th Edition 2011.
 Mathematical Physics–C. Harper, (Prentice Hall India) 2006.
 Mathematical Physics-Goswami (Cengage Learning) 2014
 Mathematical Method for Physical Sciences-- M. L. Boas (Wiley India) 2006

PHYSICS LAB- C I LAB:

The aim of this Lab is not just to teach computer programming and numerical analysis but to emphasize its role in solving problems in Physics.

 Highlights the use of computational methods to solve physical problems
 The course will consist of lectures (both theory and practical) in the Lab
 Evaluation done not on the programming but on the basis of formulating the problem
 Aim at teaching students to construct the computational problem to be solved
 Students can use any one operating system Linux or Microsoft Windows

Topics	**Description with Applications**
Introduction and Overview	Computer architecture and organization, memory and Input/output devices.
Basics of scientific computing	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.
Errors and error Analysis	Truncation and round off errors, Absolute and relative errors, Floating point computations.
Review of C & C++ Programming fundamentals	Introduction to Programming, constants, variables and data types, operators and Expressions, I/O statements, scanf and printf, c in and c out, Manipulators for data formatting, Control statements (decision making and looping statements) (*If---statement. If---else Statement. Nested if Structure. Else---if Statement. Ternary Operator. Goto Statement. Switch Statement. Unconditional and Conditional Looping. While Loop. Do-While Loop. FOR Loop. Break and Continue Statements. Nested Loops),* Arrays (*1D & 2D*) and strings, user defined functions, Structures and Unions, Idea of classes and objects
Programs:	Sum & average of a list of numbers, largest of a given list of numbers and its location in the list, sorting of numbers in ascending descending order, Binary search
Random number generation	Area of circle, area of square, volume of sphere, value of π.

Solution of Algebraic and Transcendental equations by Bisection, Newton Raphson and Secant methods	Solution of linear and quadratic equation, solvingType equation here. A=tan α; $I=I_0\left(\frac{\sin\alpha}{\alpha}\right)^2$ in optics
Interpolation by Newton Gregory Forward and Backward difference formula, Error estimation of linear interpolation	Evaluation of trigonometric functions e.g. *sin θ, cos θ, tan θ, etc.*
Numerical differentiation (Forward and Backward difference formula) and Integration (Trapezoidal and Simpson rules), Monte Carlo method	Given Position with equidistant time data to calculate velocity and acceleration and vice versa. Find the area of B-H Hysteresis loop
Solution of Ordinary Differential Equations (ODE) First order Differential equation Euler, modified Euler and Runge-Kutta (RK) second and fourth order methods	First order differential equation • Radioactive decay • Current in RC, LC circuits with DC source • Newton's law of cooling • Classical equations of motion Attempt following problems using RK 4 order method: • Solve the coupled differential equations $dx/dt=y+x-x^3/3$; $dy/dx = -x$ for four initial conditions $x(0) = 0$, $y(0) = -1, -2, -3, -4$. Plot x vs y for each of the four initial conditions on the same screen for $0 \le t \le 15$ The differential equation describing the motion of a pendulum is $\frac{\partial^2\upsilon}{\partial t^2} = -\sin\upsilon$ The pendulum is released from rest at an angular displacement α, i. e. $\upsilon(0) = \alpha \;\&\; \upsilon' = 0$. Solve the equation for α = 0.1, 0.5 and 1.0 and plot as a function of time in the range $0 \le t \le 8\pi$. Also plot the analytic solution valid for small $\upsilon, \sin\upsilon = \upsilon$

Referred Books:

- Introduction to Numerical Analysis, S.S. Sastry, 5th Edn. , 2012, PHI Learning Pvt. Ltd.
- Schaum's Outline of Programming with C++. J. Hubbard, 2000, McGraw---Hill Pub.
- Numerical Recipes in C: The Art of Scientific Computing, W.H. Pressetal, 3rd Edn. 2007, Cambridge University Press.
- A first course in Numerical Methods, U.M. Ascher & C. Greif, 2012, PHI Learning.
- Elementary Numerical Analysis, K.E. Atkinson, 3rd Edn. , 2 0 0 7 , 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.

PHYSICS-C II: MECHANICS
(Credits: Theory-04, Practicals-02)

UNIT-I

Rotational Dynamics: Centre of Mass and Laboratory frames. Angular momentum of a particle and system of particles. Torque. Principle of conservation of angular momentum. Rotation about a fixed axis. Moment of Inertia. Perpendicular and parallel axes theorem, Calculation of moment of inertia for rectangular, cylindrical and spherical bodies. Kinetic energy of rotation. Motion involving both translation and rotation.

Non-Inertial Systems: Non-inertial frames and fictitious forces. Uniformly rotating frame. Laws of Physics in rotating coordinate systems. Centrifugal force. Coriolis force and its applications.

UNIT-II

Elasticity: Relation between Elastic constants. Twisting torque on a Cylinder or Wire.

Fluid Motion: Kinematics of Moving Fluids: Poiseuille's Equation for Flow of a Liquid through a Capillary Tube.

UNIT-III

Gravitation and Central Force Motion: Law of gravitation. Gravitational potential energy. Inertial and gravitational mass. Potential and field due to spherical shell and solid sphere.

Motion of a particle under a central force field. Two-body problem and its reduction to one-body problem and its solution. The energy equation and energy diagram. Kepler's Laws. Satellite in circular orbit and applications. Geosynchronous orbits. Weightlessness. Basic idea of global positioning system (GPS). Physiological effects on astronauts.

UNIT-IV

Oscillations: 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.

Special Theory of Relativity: 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, frequency and wave number. Relativistic addition of velocities. Variation of mass with velocity. Massless Particles. Mass-energy Equivalence. Relativistic Doppler effect. Relativistic Kinematics. Transformation of Energy and Momentum. Energy-Momentum Four Vector.

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
- Introduction to Special Relativity, R. Resnick, 2005, John Wiley and Sons.
- University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole.

Additional Books for Reference

- Mechanics, DS. Mathur, S. Chand and Company Limited, 2000
- University Physics. F.W Sears, M.W Zemansky, H.D Young 13/e, 1986, Addison Wesley

 Physics for scientists and Engineers with Modern Phys., J.W. Jewett, R.A.Serway, 2010, Cengage Learning

 Theoretical Mechanics, M.R. Spiegel, 2006, Tata McGraw Hill.

 Mechanics- J. C. Slater and N. H. Frank (McGraw-Hill)

PHYSICS LAB-C II LAB

1. To study the random error in observations.

2. To determine the height of a building using a Sextant.

3. To study the Motion of Spring and calculate (a) Spring constant, (b) **g** and (c) Modulus of rigidity.

4. To determine the Moment of Inertia of a Flywheel.

5. To determine **g** and velocity for a freely falling body using Digital Timing Technique

6. To determine Coefficient of Viscosity of water by Capillary Flow Method (Poiseuille's method).

7. To determine the Young's Modulus of a Wire by Optical Lever Method.

8. To determine the Modulus of Rigidity of a Wire by Maxwell's needle.

9. To determine the elastic Constants of a wire by Searle's method.

10. To determine the value of g using Bar Pendulum.

11. To determine the value of g using Kater's Pendulum

Reference Books

 Advanced Practical Physics for students, B. L. Flint and H.T. Worsnop, 1971, AsiaPublishing 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

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Semester II

PHYSICS-C III: ELECTRICITY AND MAGNETISM
(Credits: Theory-04, Practicals-02)

UNIT-I

Electric Field and Electric Potential

Electric field: Electric field lines. Electric flux. Gauss' Law with applications to charge distributions with spherical, cylindrical and planar symmetry.

Conservative nature of Electrostatic Field. Electrostatic Potential. Laplace's and Poisson equations. The Uniqueness Theorem. Potential and Electric Field of a dipole. Force and Torque on a dipole.

Electrostatic energy of system of charges. Electrostatic energy of a charged sphere. Conductors in an electrostatic Field. Surface charge and force on a conductor.

Capacitance: Capacitance of a system of charged conductors. Parallel-plate capacitor. Capacitance of an isolated conductor. Method of Images and its application to: (1) Plane Infinite Sheet and (2) Sphere.

UNIT-II

Magnetic Field: Magnetic force between current elements and definition of Magnetic Field **B**. Biot-Savart's Law and its simple applications: straight wire and circular loop. Current Loop as a Magnetic Dipole and its Dipole Moment (Analogy with Electric Dipole). Ampere's Circuital Law and its application to (1) Solenoid and (2) Toroid. Properties of **B**: curl and divergence. Vector Potential. Magnetic Force on (1) point charge (2) current carrying wire (3) between current elements. Torque on a current loop in a uniform Magnetic Field. Ballistic Galvanometer**:** Torque on a current Loop. Ballistic Galvanometer: Current and Charge Sensitivity. Electromagnetic damping. Logarithmic damping. CDR

UNIT-III

Dielectric Properties of Matter: Electric Field in matter. Polarization, Polarization Charges. Electrical Susceptibility and Dielectric Constant. Capacitor (parallel plate, spherical, cylindrical) filled with dielectric. Displacement vector **D**. Relations between **E**, **P** and **D**. Gauss' Law in dielectrics. .

Magnetic Properties of Matter: Magnetization vector (**M).** Magnetic Intensity (**H).** Magnetic Susceptibility and permeability. Relation between **B, H, M**. Ferromagnetism. B-H curve and hysteresis.

UNIT-IV

Electromagnetic Induction: Faraday's Law. Lenz's Law. Self Inductance and Mutual Inductance. Reciprocity Theorem. Energy stored in a Magnetic Field.

Electrical Circuits: 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.

Network theorems: 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:

- Electricity, Magnetism & Electromagnetic Theory, S. Mahajan and Choudhury, 2012, Tata McGraw
- Electricity and Magnetism, Edward M. Purcell, 1986 McGraw-Hill Education
- Introduction to Electrodynamics, D.J. Griffiths, 3rd Edn., 1998, Benjamin Cummings.
- 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.
- Electricity and Magnetism, J.H.Fewkes & J.Yarwood. Vol. I, 1991, Oxford Univ. Press.

PHYSICS LAB-C III LAB

1. Use a Multimeter for measuring (a) Resistances, (b) AC and DC Voltages, (c) DC Current, (d) Capacitances, and (e) Checking electrical fuses.

2. To study the characteristics of a series RC Circuit.

3. To determine an unknown Low Resistance using Potentiometer.

4. To determine an unknown Low Resistance using Carey Foster's Bridge.

5. To compare capacitances using De'Sauty's bridge.

6. Measurement of field strength B and its variation in a solenoid (determine dB/dx)

7. To verify the Thevenin and Norton theorems.

8. To verify the Superposition, and Maximum power transfer theorems.

9. To determine self inductance of a coil by Anderson's bridge.

10. 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.

11. To study the response curve of a parallel LCR circuit and determine its (a) Antiresonant frequency and (b) Quality factor Q.

12. Measurement of charge and current sensitivity and CDR of Ballistic Galvanometer

13. Determine a high resistance by leakage method using Ballistic Galvanometer.

14. To determine self-inductance of a coil by Rayleigh's method.

15. To determine the mutual inductance of two coils by Absolute method.

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.

PHYSICS-C IV: WAVES AND OPTICS
(Credits: Theory-04, Practicals-02)

UNIT-I

Geometrical optics: Fermat's principle, reflection and refraction at plane interface, Matrix formulation of geometrical Optics. Idea of dispersion. Application to thick lense, Ramsden and Huygens eyepiece.

Wave Motion: Plane and Spherical Waves. Longitudinal and Transverse Waves. Plane Progressive (Travelling) Waves. Wave Equation. Particle and Wave Velocities. Differential Equation. Pressure of a Longitudinal Wave. Energy Transport. Intensity of Wave. Water Waves: Ripple and Gravity Waves.

UNIT-II

Superposition of two perpendicular Harmonic Oscillations: Graphical and Analytical Methods. Lissajous Figures (1:1 and 1:2) and their uses.

Wave Optics: Electromagnetic nature of light. Definition and properties of wave front. Huygens Principle.Reflection and refraction from Hygen's principle.

Interference: Division of amplitude and wavefront. Young's double slit experiment. Lloyd's Mirror and Fresnel's Biprism.

UNIT-III

Interference: 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.

Interferometer: 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. Fabry-Perot interferometer.

UNIT-IV

Fraunhofer diffraction: Single slit. Circular aperture, Resolving Power of a telescope. Double slit. Multiple slits. Diffraction grating. Resolving power of grating.

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.

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
- 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.
- Optics- Brijlal & Subramaniam- (S. Chand Publication) 2014.
- Geometrical and Physical Optics– R.S. Longhurst, Orient Blackswan, 01-Jan-1986
- Vibrations and Waves-- A. P. French, (CBS) Indian print 2003
- Optics, E. Hecht (PearsonIndia)

PHYSICS LAB- C IV LAB

1. To determine the frequency of an electric tuning fork by Melde's experiment and verify λ^2 –T law.

2. To investigate the motion of coupled oscillators.

3. To study Lissajous Figures.

4. Familiarization with: Schuster`s focusing; determination of angle of prism.

5. To determine refractive index of the Material of a prism using sodium source.

6. To determine the dispersive power and Cauchy constants of the material of a prism using mercury source.

7. To determine the wavelength of sodium source using Michelson's interferometer.

8. To determine wavelength of sodium light using Fresnel Biprism.

9. To determine wavelength of sodium light using Newton's Rings.

10. To determine the thickness of a thin paper by measuring the width of the interference fringes produced by a wedge-shaped Film.

11. To determine wavelength of (1) Na source and (2) spectral lines of Hg source using plane diffraction grating.

12. 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
- 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

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Semester III

PHYSICS-C V: MATHEMATICAL PHYSICS-II
(Credits: Theory-04, Practicals-02)

The emphasis of the course is on applications in solving problems of interest to physicists. Students are to be examined on the basis of problems, seen and unseen.

UNIT-I

Fourier Series: 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.

UNIT-II

Some Special Integrals: Beta and Gamma Functions and Relation between them. Expression of Integrals in terms of Gamma Functions. Error Function (Probability Integral).

Theory of Errors: Systematic and Random Errors. Propagation of Errors. Normal Law of Errors. Standard and Probable Error.

UNIT-III

Frobenius Method and Special Functions: Singular Points of Second Order Linear Differential Equations and their importance, Frobenius method and its applications to differential equations: Legendre & Hermite Differential Equations. Properties of Legendre & Hermite Polynomials:
Rodrigues Formula, Generating Function, Orthogonality. Simple recurrence relations. Expansion of function in a series of Legendre Polynomials.

UNIT-IV

Partial Differential Equations: Solutions to partial differential equations, using separation of variables: Laplace's Equation in problems of rectangular, cylindrical and spherical symmetry. Conducting and dielectric sphere in an external uniform electric field. Wave equation and its solution for vibrational modes of a stretched string.

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.
- Mathematical methods for Scientists & Engineers, D.A. McQuarrie, 2003, Viva Books
- Mathematical Physics and Special Relativity--M. Das, P.K. Jena and B.K. Dash (Srikrishna Prakashan) 2nd Edition 2009
- Mathematical Physics--H. K. Dass, Dr. Rama Verma (S. Chand Higher Academics) 6th Edition 2011.
- Mathematical Physics–C. Harper, (Prentice Hall India) 2006.
- Mathematical Physics-Goswami (CENGAGE Learning) 2014
- Mathematical Method for Physical Sciences-- M. L. Boas (Wiley India) 2006
- Mathematics for Physicists, P. Dennery and A. Krzywicki Dover)

PHYSICS LAB-C V LAB

The aim of this Lab is to use the computational methods to solve physical problems. Course will consist of lectures (both theory and practical) in the Lab. Evaluation done not on the programming but on the basis of formulating the problem.

Topics	**Description with Applications**
Introduction to Numerical computation software Scilab	Introduction to Scilab, Advantages and disadvantages, Scilab environment, Command window, Figure window, Edit window, Variables and arrays, Initialising variables in Scilab, Multidimensional arrays, Subarray, Special values, Displaying output data, data file, Scalar and array operations, Hierarchy of operations, Built in Scilab functions, Introduction to plotting, 2D and 3D plotting (2), Branching Statements and program design, Relational & logical operators, the while loop, for loop, details of loop operations, break & continue statements, nested loops, logical arrays and vectorization (2) User defined functions, Introduction to Scilab functions, Variable passing in Scilab, optional arguments, preserving data between calls to a function, Complex and Character data, string function, Multidimensional arrays (2) an introduction to Scilab file processing, file opening and closing, Binary I/o functions, comparing binary and formatted functions, Numerical methods and developing the skills of writing a program (2).
Curve fitting, Least square fit, Goodness of fit, standard deviation	Ohms law to calculate R, Hooke's law to calculate spring constant
Solution of Linear system of equations by Gauss elimination method and Gauss Seidal method. Diagonalization of matrices, Inverse of a matrix, Eigen vectors, eigen values problems	Solution of mesh equations of electric circuits (3 meshes) Solution of coupled spring mass systems (3 masses)
Solution of ODE First order Differential equation Euler, modified Euler and Runge-Kutta second order methods Second order differential equation. Fixed difference method	First order differential equation • Radioactive decay • Current in RC, LC circuits with DC source • Newton's law of cooling • Classical equations of motion Second order Differential Equation • Harmonic oscillator (no friction) • Damped Harmonic oscillator • Over damped • Critical damped • Oscillatory

Partial differential equations	• Forced Harmonic oscillator • Transient and • Steady state solution • Apply above to LCR circuits also • Solve $x^2 \frac{d^2y}{dx^2} - 4x(1+x)\frac{dy}{dx} + 2(1+x)y = x^3$ With boundary condition at x=1, y= ½ e^2, $\frac{dy}{dx} = -\frac{3}{2}e^2 - \frac{1}{2}$ In the range 1≤x≤3. Plot y and $\frac{dy}{dx}$ against x in the given range on the graph. Partial differential equations: • Wave equation • Heat equation • Poisson equation • Laplace equation
Using Scicos / xcos	• Generating square wave, sine wave, saw tooth wave • Solution to harmonic oscillator • Study of beat phenomenon • Phase space plots

Reference Books:

- Mathematical Methods for Physics and Engineers, K.F Riley, M.P. Hobson and S. J.20 Bence, 3rd ed., 2006, Cambridge University Press
- Complex Variables, A.S. Fokas &M.J. Ablowitz, 8th Ed., 2011, Cambridge Univ. Press
- First course in complex analysis with applications, D.G. Zill and P.D. Shanahan, 1940, Jones & Bartlett
- Simulation of ODE/PDE Models with MATLAB®, OCTAVE and SCILAB: Scientific and Engineering Applications: A.V. Wouwer, P. Saucez, C.V. Fernández. 2014 Springer
- Scilab by example: M. Affouf 2012, ISBN: 978-1479203444
- Scilab (A free software to Matlab): H.Ramchandran, A.S.Nair. 2011 S.Chand & Company
- Scilab Image Processing: Lambert M. Surhone. 2010 Betascript Publishing

PHYSICS-C VI: THERMAL PHYSICS
(Credits: Theory-04, Practicals-02)

(*Include related problems for each topic*)

UNIT-I

Introduction to Thermodynamics

Recapitulation of Zeroth and First law of thermodynamics:

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. Carnot's Theorem. Applications of Second Law of Thermodynamics: Thermodynamic Scale of Temperature and its Equivalence to Perfect Gas Scale.

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 Principle of Increase of Entropy. Temperature–Entropy diagrams for Carnot's Cycle. Third Law of Thermodynamics. Unattainability of Absolute Zero.

UNIT-II

Thermodynamic Potentials: Extensive and Intensive Thermodynamic Variables. 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. First and second order Phase Transitions with examples, Clausius Clapeyron Equation and Ehrenfest equations

UNIT-III

Maxwell's Thermodynamic Relations: 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. Magnetic Work, Cooling due to adiabatic demagnetization,

UNIT-IV

Kinetic Theory of Gases

Distribution of Velocities: Maxwell-Boltzmann Law of Distribution of Velocities in an Ideal Gas and its Experimental Verification. Stern's Experiment. Mean, RMS and Most Probable Speeds. Degrees of Freedom. Law of Equipartition of Energy (No proof required). Specific heats of Gases.

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.

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-Waaal Gases, Temperature inversion, Joule –Thomson Cooling.

Reference Books:

- Heat and Thermodynamics, M.W. Zemansky, Richard Dittman, 1981, McGraw-Hill.
- A Treatise on Heat, Meghnad Saha, and B.N.Srivastava, 1958, Indian Press
- 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
- Heat and Thermal Physics-Brijlal & Subramaiam (S.Chand Publication) 2014
- Thermal Physics- C. Kittel and H. Kroemer (McMillan Education India) 2010

PHYSICS LAB- C VI LAB

1. To determine Mechanical Equivalent of Heat, J, by Callender and Barne's constant flow method.

2. To determine the Coefficient of Thermal Conductivity of Cu by Searle's Apparatus.

3. To determine the Coefficient of Thermal Conductivity of Cu by Angstrom's Method.

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).

6. To study the variation of Thermo-Emf of a Thermocouple with Difference of Temperature of its Two Junctions.

7. To calibrate a thermocouple to measure temperature in a specified Range using

(1) Null Method, (2) Direct measurement using Op-Amp difference amplifier

and to determine Neutral Temperature.

8. To determine J by Caloriemeter.

9*.To determine the Thermal conductivity of Rubber

10*. To determine the specific heat of a liquid by Newton's law of cooling.

11*. To determine the apparent expansion of a liquid by using a Weight thermometer.

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.

PHYSICS-C VII: DIGITAL SYSTEMS AND APPLICATIONS
(Credits: Theory-04, Practicals-02)

UNIT-I

Integrated Circuits (Qualitative treatment only): 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.

Digital Circuits: 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.

Boolean algebra: 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.

UNIT-II

Introduction to CRO: Block Diagram of CRO. Electron Gun, Deflection System and Time Base. Deflection Sensitivity. Applications of CRO: (1) Study of Waveform, (2) Measurement of Voltage, Current, Frequency, and Phase Difference.

Data processing circuits: Basic idea of Multiplexers, De-multiplexers, Decoders, Encoders.

Arithmetic Circuits: Binary Addition. Binary Subtraction using 2's Complement. Half and Full Adders. Half & Full Subtractors, 4-bit binary Adder/Subtractor.

Timers: IC 555: block diagram and applications: Astable multivibrator and Monostable multivibrator.

UNIT-III

Introduction to Computer Organization: Input/Output Devices. Data storage (idea of RAM and ROM). Computer memory. Memory organization & addressing. Memory Interfacing. Memory Map

UNIT-IV

Shift registers: Serial-in-Serial-out, Serial-in-Parallel-out, Parallel-in-Serial-out and Parallel-in-Parallel-out Shift Registers (only up to 4 bits).

Counters(4 bits): Ring Counter. Asynchronous counters, Decade Counter. Synchronous Counter.

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 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.
- Microprocessor Architecture Programming & applications with 8085, 2002, R.S. Goankar, Prentice Hall.
- Concept of Electronics: D.C.Tayal (Himalay Publication) 2011
- Electronics-V. K. Meheta (S. Chand Publication)2013
- The Art of Electronics, P. Horowitz and W. Hill, CUP

PHYSICS PRACTICAL-C VII LAB

1. To measure (a) Voltage, and (b) Time period of a periodic waveform using CRO.
2. To test a Diode and Transistor using a Multimeter.
3. To design a switch (NOT gate) using a transistor.
4. To verify and design AND, OR, NOT and XOR gates using NAND gates.
5. To design a combinational logic system for a specified Truth Table.
6. To convert a Boolean expression into logic circuit and design it using logic gate ICs.
7. To minimize a given logic circuit.
8. Half Adder, Full Adder and 4-bit binary Adder.
9. Half Subtractor, Full Subtractor, Adder-Subtractor using Full Adder I.C.
10. To build Flip-Flop (RS, Clocked RS, D-type and JK) circuits using NAND gates.
11. To build JK Master-slave flip-flop using Flip-Flop ICs
12. To build a 4-bit Counter using D-type/JK Flip-Flop ICs and study timing diagram.
13. To make a 4-bit Shift Register (serial and parallel) using D-type/JK Flip-Flop ICs.
14. To design an astable multivibrator of given specifications using 555 Timer.
15. To design a monostable multivibrator of given specifications 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.
• Microprocessor Architecture Programming and applications with 8085, R.S. Goankar, 2002, Prentice Hall.
• Microprocessor 8085:Architecture, Programming and interfacing, A. Wadhwa, 2010, PHI Learning.

Semester IV

PHYSICS-VIII: MATHEMATICAL PHYSICS-III
(Credits: Theory-04, Practicals-02)

The emphasis of the course is on applications in solving problems of interest to physicists. Students are to be examined on the basis of problems, seen and unseen.

UNIT-I

Complex Analysis: Definition of a function, continuity of a function, Differentiability of function, Analytic function, Cauchy-Riemann equation, Laplace differential equation, Cauchy-Riemann equation in polar coordinates, conjugate function and their constructions, Integration of analytic function, Riemann's definition of integration, Cauchy's theorem(original), Cauchy's theorem general form, Cauchy's integral formula, Derivation of analytic function, Higher order derivatives of analytic functions, Cauchy's inequality, Taylor's series, Laurent series.

UNIT-II

Calculus of Residue: Singularities of complex function, The point at infinity, residue at pole, calculation of residues, cauchy's residue theorem, evaluation of definite integral such as a) integration round an unir circle b) integration round an infinite circle c0 Jordan inequality, Jordan Lemmad d) integration round indented semicircle e) integration along double circle, branch point, branch cuts.

UNIT-III

Integrals Transforms:

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.

UNIT-IV

Laplace Transforms: Laplace Transform (LT) of Elementary functions. Properties of LTs: Change of Scale Theorem, Shifting Theorem. LTs of Derivatives and Integrals of Functions, Derivatives and Integrals of LTs. LT of Unit Step function, Dirac Delta function, Periodic Functions. Convolution Theorem. Inverse LT.

Application of Laplace Transforms to Differential Equations: Damped Harmonic Oscillator, Simple Electrical Circuits.

Reference Books:

• Mathematical Methods for Physics and Engineers, K.F Riley, M.P. Hobson and S. J. Bence, 3rd ed., 2006, Cambridge University Press

• Mathematical Methods for Physicists: Arfken, Weber, 2005, Harris, Elsevier.

• Advanced Engineering Mathematics, E. Kreyszig (New Age Publication) 2011.

• 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 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.

• Mathematical Physics--H. K. Dass, Dr. Rama Verma (S. Chand Higher Academics) 6th Edition 2011.

•Mathematical Physics –C. Harper, (Prentice Hall India) 2006.
•Mathematical Physics-Goswami (Cengage Learning) 2014
•Mathematical Method for Physical Sciences -- M. L. Boas (Wiley India) 2006
•Introduction to the theory of functions of a complex variable- E.T.Copson (Oxford) Univ. Press, 1970

PHYSICS PRACTICAL-C VIII LAB

Scilab based simulations experiments based on Mathematical Physics problems like

1. Solve differential equations:

$dy/dx = e^{-x}$ with $y = 0$ for $x = 0$

$dy/dx + e^{-x}y = x^2$

$d^2y/dt^2 + 2\ dy/dt = -y$

$d^2y/dt^2 + e^{-t}dy/dt = -y$

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* σ*=1,0.1, 0.01 and show it tends to 5*

3. Fourier Series:

Program to sum $\sum_{n=1}^{\infty}(0.2)^n$

Evaluate the Fourier coefficients of a given periodic function (square wave)

4. Frobenius method and Special functions:

$$\int_{-1}^{1} p_n(\mu)\,p_m(\mu)\,d\mu = \delta n, m$$

Plot $P_n(x)$, $J_v(x)$

Show recursion relation

5. Calculation of error for each data point of observations recorded in experiments done in previous semesters (choose any two).

6. Calculation of least square fitting manually without giving weightage to error. Confirmation of least square fitting of data through computer program.

7. Evaluation of trigonometric functions e.g. *sin θ,* Given Bessel's function at N points find its value at an intermediate point. Complex analysis: Integrate $1/(x^2+2)$ numerically and check with computer integration.

8. Integral transform: FFT of e^{-x2}

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. Fernández. 2014 Springer ISBN: 978-3319067896
• Scilab by example: M. Affouf, 2012. ISBN: 978-1479203444
• Scilab (A free software to Matlab): H.Ramchandran, A.S.Nair. 2011 S.Chand & Company
• Scilab Image Processing: Lambert M. Surhone. 2010 Betascript Publishing

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PHYSICS-C IX: ELEMENTS OF MODERN PHYSICS
(Credits: Theory-04, Practicals-02)

UNIT-I

Atomic Spectra and Models

Inadequacy of classical physics, Brief Review of Black body Radiation , Photoelectric effect, Compton effect,. Atomic spectra, Line spectra of hydrogen atom, Ritz Rydberg combination principle. Alpha Particle Scattering, Rutherford Scattering Formula, Rutherford Model of atom and its limitations, Bohr's model of H atom, explanation of atomic spectra, correction for finite mass of the nucleus, Bohr correspondence principle, limitations of Bohr model, discrete energy exchange by atom, Frank Hertz Expt. Sommerfeld's Modification of Bohr's Theory.

UNIT-II

Wave Particle Duality

Dual nature of radiation, wave nature of particles. de Broglie hypothesis, Experimental confirmation of matter wave, Davisson Germer Experiment, velocity of de Broglie wave, wave particle duality, Complementarity. Superposition of two waves, phase velocity and group velocity , wave packets ,Gaussian Wave Packet , spatial distribution of wave packet, Localization of wave packet in time.

Time development of a wave Packet ; Heisenberg Uncertainty Principle ,Illustration of the Principle through thought Experiments of Gamma ray microscope and electron diffraction through a slit. Estimation of ground state energy of harmonic oscillator and hydrogen atom, non existence of electron in the nucleus. Uncertainty and Complementarities.

UNIT-III

Nuclear Physics

Size and structure of atomic nucleus and its relation with atomic weight; Imposibility of an electron in the nucleus as a consequence of uncertainity principle, Nature of nuclear force, NZ graph, Liquid Drop model: semi-empirical mass formula and binding energy, Nuclear Shell Model and magic numbers.

UNIT-IV

Radioactivity: stability of the nucleus; Law of radioactive decay; Mean life and half-life; Gamow's theory of Alpha decay; Beta decay(qualitative idea only)- 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.

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).

Reference Books:

• Concepts of Modern Physics, Arthur Beiser, 2002, McGraw-Hill.
• Introduction to Modern Physics, Rich Meyer, Kennard, Coop, 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.
• Quantum Mechanics: Theory & Applications, A.K.Ghatak & S.Lokanathan, 2004, Macmillan
• Modern Physics – Bernstein, Fishbane and Gasiorowicz (Pearson India) 2010
• Quantum Physics of Atoms, Molecules, Solids, Nuclei and Particles -- R. Eisberg (Wiley India) 2012

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.
• Six Ideas that Shaped Physics: Particle Behave like Waves, T.A.Moore, 2003, McGraw Hill
•Modern Physics-Serway (CENGAGE Learnings) 2014
•Modern Physics ---Murugesan and Sivaprasad –(S. Chand Higher Academics)
•Physics of Atoms and Molecules – Bransden (Pearson India) 2003

PHYSICS PRACTICAL-C IX LAB

1. Measurement of Planck's constant using black body radiation and photo-detector

2. Photo-electric effect: photo current versus intensity and wavelength of light; maximum energy of photo-electrons versus frequency of light

3. To determine work function of material of filament of directly heated vacuumdiode.

4. To determine the Planck's constant using LEDs of at least 4 different colours.

5. To determine the wavelength of H-alpha emission line of Hydrogen atom.

6. To determine the ionization potential of mercury.

7. To determine the absorption lines in the rotational spectrum of Iodine vapour.

8. To determine the value of e/m by (a) Magnetic focusing or (b) Bar magnet.

9. To setup the Millikan oil drop apparatus and determine the charge of an electron.

10. To show the tunneling effect in tunnel diode using I-V characteristics.

11. To determine the wavelength of laser source using diffraction of single slit.

12. To determine the wavelength of laser source using diffraction of double slits.

13. To determine (1) wavelength and (2) angular spread of He-Ne laser using plane diffraction grating

14*. To determine Young's modulus by bending of beam

15*. To determine Young's modulus by vibration of a single light cantilever.

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

PHYSICS-C X: ANALOG SYSTEMS AND APPLICATIONS
(Credits: Theory-04, Practicals-02)

UNIT-I

Semiconductor Diodes: 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.

Two-terminal Devices and their Applications: (1) Rectifier Diode: Half-wave Rectifiers. Centre-tapped and Bridge Full-wave Rectifiers, Calculation of Ripple Factor and Rectification Efficiency, (2) Zener Diode and Voltage Regulation. Principle and structure of (1) LEDs, (2) Photodiode, (3) Solar Cell.

UNIT-II

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.

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.

UNIT-III

Coupled Amplifier: RC-coupled amplifier and its frequency response.

Feedback in Amplifiers: Effects of Positive and Negative Feedback on Input Impedance, Output Impedance, Gain, Stability, Distortion and Noise.

Sinusoidal Oscillators: Barkhausen's Criterion for self-sustained oscillations. RC Phase shift oscillator, determination of Frequency. Hartley & Colpitts oscillators.

UNIT-IV

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.

Applications of Op-Amps: (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.

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
• 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
• Electronic Devices, 7/e Thomas L. Floyd, 2008, Pearson India
•Concept of Electronics: D.C.Tayal (Himalay Publication) 2011
•Electronic devices :Circuits and Applications :W.D. Stanley Prentice Hall
•.Electronics- V. K. Meheta (S. Chand Publication)2013
•.Electronic Circuits :L.Schilling and Velove: 3rd Ed Mc Graw Hill
• Electronics–Raskhit & Chattopadhyay (New age International Publication)2011

•Electricity and Electronic-D.C.Tayal (Himalaya Pub.)2011
•Electronic devices and circuits –R.L. Boylstad (Pearson India) 2009

PHYSICS PRACTICAL-C X LAB

1. To study V-I characteristics of PN junction diode, and Light emitting diode.
2. To study the V-I characteristics of a Zener diode and its use as voltage regulator.
3. Study of V-I & power curves of solar cells, and find maximum power point & efficiency.
4. To study the characteristics of a Bipolar Junction Transistor in CE configuration.
5. To study the various biasing configurations of BJT for normal class A operation.
6. To design a CE transistor amplifier of a given gain (mid-gain) using voltage divider bias.
7. To study the frequency response of voltage gain of a RC-coupled transistor amplifier.
8. To design a Wien bridge oscillator for given frequency using an op-amp.
9. To design a phase shift oscillator of given specifications using BJT.
10. To study the Colpitt`s oscillator.
11. To design a digital to analog converter (DAC) of given specifications.
12. To study the analog to digital convertor (ADC) IC.
13. To design an inverting amplifier using Op-amp (741,351) for dc voltage of given gain
14. To design inverting amplifier using Op-amp (741,351) and study its frequency response
15. To design non-inverting amplifier using Op-amp (741,351) & study its frequency response
16. To study the zero-crossing detector and comparator
17. To add two dc voltages using Op-amp in inverting and non-inverting mode
18. To design a precision Differential amplifier of given I/O specification using Op-amp.
19. To investigate the use of an op-amp as an Integrator.
20. To investigate the use of an op-amp as a Differentiator.
21. To design a circuit to simulate the solution of a $1_{st}/2_{nd}$ order differential equation.

22*. To determine M & H by deflection & oscillation magnetometer.

23*. To calibrate a meter bridge.

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

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Semester V

PHYSICS-C XI: QUANTUM MECHANICS AND APPLICATIONS
(Credits: Theory-04, Practicals-02)

UNIT-I

Schrodinger equation & the operators: Time dependent Schrodinger equation and dynamical evolution of a quantum state; Properties of Wave Function. Interpretation of Wave Function Probability and probability current densities in three dimensions; Conditions for Physical Acceptability of Wave Functions. Normalization. Linearity and Superposition Principles. Hermitian operator, Eigen values and Eigen functions. Position, momentum and Energy operators; commutator of position and momentum operators; Expectation values of position and momentum. Wave Function of a Free Particle.

Time independent Schrodinger equation-Hamiltonian, stationary states and energy eigen values; expansion of an arbitrary wave function as a linear combination of energy eigen functions; General solution of the time dependent Schrodinger equation in terms of linear combinations of stationary states; Application to spread of Gaussian wave-packet for a free particle in one dimension; wave packets, Fourier transforms and momentum space wave function; Position-momentum uncertainty principle.

UNIT-II

General discussion of bound states in an arbitrary potential- continuity of wave function, boundary condition and emergence of discrete energy levels; application to one-dimensional problem-square well potential.

UNIT-III

Quantum mechanics of simple harmonic oscillator-energy levels and energy eigen functions ground state, zero point energy & uncertainty principle

One dimensional infinitely rigid box- energy eigen values and eigen functions, normalization;

Quantum dot as example; Quantum mechanical scattering and tunnelling in one dimension-across a step potential & rectangular potential barrier.

UNIT-IV

Atoms in Electric & Magnetic Fields: Electron angular momentum. Space quantization. Electron Spin and Spin Angular Momentum. Larmor's Theorem. Spin Magnetic Moment. Stern-Gerlach Experiment. Zeeman Effect: Electron Magnetic Moment and Magnetic Energy, Gyromagnetic Ratio and Bohr Magneton.

Atoms in External Magnetic Fields:- Normal and Anomalous Zeeman Effect. Paschen Back and Stark Effect (Qualitative Discussion only).

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.
• 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
• Quantum Physics----S. Gasiorowicz (Wiley India) 2013
•.Quantum Mechanics -J.L. Powell and B. Craseman (Narosa) 1988
• Introduction to Quantum Mechanics- M.Das, P.K.Jena,(SriKrishna Prakashan)

• Basic Quantum Mechanics –A.Ghatak (Mc Millan India) 2012
•.Introduction to Quantum Mechanics – R. Dicke and J. Wittke
• Quantum Mechanics- Eugen Merzbacher, 2004, John Wiley and Sons, Inc.
• Introduction to Quantum Mechanics, D.J. Griffith, 2nd Ed. 2005, Pearson Education
• Quantum Mechanics, Walter Greiner, 4th Edn., 2001, Springer
•Quantum Mechanics - F. Mandl (CBS) 2013
•Cohen-Tannoudji, B Diu and F Laloë, Quantum Mechanics (2 vols) Wiley-VCH 1977

PHYSICS PRACTICAL-C XI LAB

Use C/C++/Scilab for solving the following problems based on Quantum Mechanics like

1. Solve the s-wave Schrodinger equation for the ground state and the first excited state of the hydrogen atom:

$$\frac{d^2y}{dr^2} = A(r)u(r), A(r) = \frac{2m}{h^2}\left[V(r) - E\right] \text{ where V(r)= } -\frac{e^2}{r}$$

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 $(eVÅ)^{1/2}$, ħc = 1973 (eVÅ) and m = $0.511x10^6$ eV/c^2.

2. Solve the s-wave radial Schrodinger equation for an atom:

$$\frac{d^2y}{dr^2} = A(r)u(r), A(r) = \frac{2m}{h^2}\left[V(r) - E\right]$$

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

$$V(r)= -\frac{e^2}{r}e^{-r/a}$$

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 $(eVÅ)^{1/2}$, m = $0.511x10^6$ eV/c2, and a = 3 Å, 5 Å, 7 Å. In these units ħc = 1973 (eVÅ). The ground state energy is expected to be above -12 eV in all three cases.

3. Solve the s-wave radial Schrodinger equation for a particle of mass m:

$$\frac{d^2y}{dr^2} = A(r)u(r), A(r) = \frac{2m}{h^2}\left[V(r) - E\right]$$

For the anharmonic oscillator potential

$V(r) = ½ kr^2 + 1/3 br^3$

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 MeV/c^2, k = 100 MeV fm^{-2}, b = 0, 10, 30 MeV fm-3In these units, cħ = 197.3 MeV fm. The ground state energy I 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:

$$\frac{d^2y}{dr^2} = A(r)u(r), A(r) = \frac{2m}{h^2}\left[V(r) - E\right]$$

Where μ is the reduced mass of the two-atom system for the Morse potential

V(r)= $D\left(e^{-2\alpha r'}-e^{\alpha r'}\right), r' = \frac{r-r_0}{r}$

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 = 940x10^6eV/C^2, D = 0.755501 eV, α = 1.44, r_o = 0.131349 Å

Laboratory based experiments:

5. Study of Electron spin resonance- determine magnetic field as a function of the resonance frequency
6. Study of Zeeman effect: with external magnetic field; Hyperfine splitting
7. To show the tunneling effect in tunnel diode using I-V characteristics.
8. Quantum efficiency of CCDs

Reference Books:

• Schaum's outline of Programming with C++. J.Hubbard, 2000,McGraw-- ‑ Hill Publication
• Numerical Recipes in C: The Art of Scientific Computing, W.H. Pressetal., 3rd Edn., 2007, Cambridge University Press.
• 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. Fernández.2014 Springer.
• Scilab (A Free Software to Matlab): H. Ramchandran, A.S. Nair. 2011 S. Chand & Co.
• Scilab Image Processing: L.M.Surhone.2010 Betascript Publishing ISBN:978-6133459274

PHYSICS-C XII: SOLID STATE PHYSICS
(Credits: Theory-04, Practicals-02)

UNIT-I

Crystal Structure: Solids: Amorphous and Crystalline Materials. Lattice Translation Vectors. Lattice with a Basis – Central and Non-Central Elements. Unit Cell. Miller Indices. Types of Lattices, Reciprocal Lattice. Brillouin Zones. Diffraction of X-rays by Crystals. Bragg's Law. Atomic and Geometrical Factor.

Elementary Lattice Dynamics: 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

UNIT-II

Magnetic Properties of Matter: Dia-, Para-, Ferri- and Ferromagnetic Materials. Classical Langevin Theory of dia–and Paramagnetic Domains. Curie's law, Weiss's Theory of Ferromagnetism and Ferromagnetic Domains. Discussion of B-H Curve. Hysteresis and Energy Loss.

UNIT-III

Dielectric Properties of Materials: Polarization. Local Electric Field at an Atom. Depolarization Field. Electric Susceptibility. Polarizability. Clausius Mosotti Equation. Classical Theory of Electric Polarizability.

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.

UNIT-IV

Elementary band theory: Kronig Penny model. Band Gap. Conductor, Semiconductor (P and N type) and insulator. Conductivity of Semiconductor, mobility, Hall Effect. Measurement of conductivity (04 probe method) & Hall coefficient.

Superconductivity: 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, 2nd Edition, 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, H. Ibach and H. Luth, 2009, Springer
• Elementary Solid State Physics, 1/e M. Ali Omar, 1999, Pearson India
• Solid State Physics, M.A. Wahab, 2011, Narosa Publications
• Solid State Physics – S. O. Pillai (New Age Publication)
•Solid State Physics- R.K.Puri &V.K. Babbar (S.Chand Publication)2013
•Lasers and Non linear Optics –B.B.Laud-Wiley Eastern.
•LASERS: Fundamentals and Applications – Thyagarajan and Ghatak (McMillanIndia) 2012

PHYSICS PRACTICAL-C XII LAB

1. Measurement of susceptibility of paramagnetic solution (Quinck`s Tube Method)
2. To measure the Magnetic susceptibility of Solids.
3. To determine the Coupling Coefficient of a Piezoelectric crystal.
4. To measure the Dielectric Constant of a dielectric Materials with frequency
5. To determine the complex dielectric constant and plasma frequency of metal using Surface Plasmon resonance (SPR)
6. To determine the refractive index of a dielectric layer using SPR
7. To study the PE Hysteresis loop of a Ferroelectric Crystal.
8. To draw the BH curve of Fe using Solenoid & determine energy loss from Hysteresis.
9. To measure the resistivity of a semiconductor (Ge) with temperature by four-probe method (room temperature to 150 oC) and to determine its band gap.
10. To determine the Hall coefficient of a semiconductor sample.
11*. To determine the resistance of electrolytic solution by Kohlarch's bridge.
12* To determine Ballistic constant by discharge method.
13*. To determine the resistance of a galvanometer by Kelvin's method
14*. To determine self inductance of a coil by Anderson bridge.

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.

Semester VI

PHYSICS-C XIII: ELECTROMAGNETIC THEORY
(Credits: Theory-04, Practicals-02)

UNIT-I

Maxwell Equations: Maxwell's equations. Displacement Current. 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.

UNIT-II

EM Wave Propagation in Unbounded Media: Plane EM waves through vacuum and isotropic dielectric medium, transverse nature of plane EM waves, refractive index and dielectric constant, wave impedance.

Plane EM waves through vacuum, refractive index, Propagation through conducting media, relaxation time, skin depth. Electrical conductivity of ionized gases, plasma frequency, refractive index, skin depth, application to propagation through ionosphere

UNIT-III.

EM Wave in Bounded Media: 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)

Optical Fibres:- Numerical Aperture. Step and Graded Indices (Definitions Only). Single and Multiple Mode Fibres (Concept and Definition Only).

UNIT-IV

Polarization of Electromagnetic Waves: Description of Linear, Circular and Elliptical Polarization. Propagation of E.M. Waves in Anisotropic Media. Symmetric Nature of Dielectric Tensor. Fresnel's Formula. Uniaxial and Biaxial Crystals. Light Propagation in Uniaxial Crystal. Double Refraction. Polarization by Double Refraction. Nicol Prism. Ordinary & extraordinary refractive indices. Production & detection of Plane, Circularly and Elliptically Polarized Light. Phase Retardation Plates: Quarter-Wave and Half-Wave Plates. Babinet Compensator and its Uses. Analysis of Polarized Light.

Rotatory Polarization: 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 polarimeter.

Reference Books:

• Introduction to Electrodynamics, D.J. Griffiths, 3rd Ed., 1998, Benjamin Cummings.
• 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
• Electromagnetic Field Theory for Engineers & Physicists, G. Lehner, 2010, Springer
• Electricity and Magnetism ---D C Tayal (Himalaya Publication)2014
• Introduction to Electrodynamics-A.Z.Capri & P.V.Panat (Alpha Science) 2002
• Optics E.Hecht, (Pearson India)

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-A. Murthy (S. Chand Publication)2014
• Classical Electrodynamics, J. D. Jackson (Wiley India)

PHYSICS PRACTICAL-C XIII LAB

1. To verify the law of Malus for plane polarized light.

2. To determine the specific rotation of sugar solution using Polarimeter.

3. To analyze elliptically polarized Light by using a Babinet's compensator.

4. To study dependence of radiation on angle for a simple Dipole antenna.

5. To determine the wavelength and velocity of ultrasonic waves in a liquid (Kerosene Oil, Xylene, etc.) by studying the diffraction through ultrasonic grating.

6. To study the reflection, refraction of microwaves

7. To study Polarization and double slit interference in microwaves.

8. To determine the refractive index of liquid by total internal reflection using Wollaston's air-film.

9. To determine the refractive Index of (1) glass and (2) a liquid by total internal reflection using a Gaussian eyepiece.

10. To study the polarization of light by reflection and determine the polarizing angle for air-glass interface.

11. To verify the Stefan`s law of radiation and to determine Stefan's constant.

12. To determine the Boltzmann constant using V-I characteristics of PN junction diode.

13*. To determine the resolving power of a telescope.

14*. To calibrate a milliammeter.

15*. To determine the resonant frequency of a L-C-R circuit by using an Oscilloscope.

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

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PHYSICS-C XIV: STATISTICAL MECHANICS
(Credits: Theory-04, Practicals-02)

UNIT-I

Classical Statistics: Macrostate & Microstate, Elementary Concept of Ensemble, Microcanonical, Canonical and grand canonical ensemble. Phase Space, Entropy and Thermodynamic Probability, Maxwell-Boltzmann Distribution Law, Partition Function,

Thermodynamic Functions of an Ideal Gas, Classical Entropy Expression, Gibbs Paradox, Sackur Tetrode equation, Law of Equipartition of Energy (with proof) – Applications to Specific Heat and its Limitations, Thermodynamic Functions of a Two-Energy Levels System, Negative Temperature.

UNIT-II

Radiation: Properties of Thermal Radiation. Blackbody Radiation. Pure temperature dependence. Kirchhoff's law. Stefan-Boltzmann law: Thermodynamic proof. Radiation Pressure.

UNIT-III

Wien's Displacement law. Wien's Distribution Law. Saha's Ionization Formula.

Rayleigh-Jean's Law. Ultraviolet Catastrophe. 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.

UNIT-IV

Quantum Statistics: Identical particles, macrostates and micro states. Fermions and Bosons, Bose Einstein distribution function and Fermi-Dirac Distribution function. Bose-Einstein Condensation, Bose deviation from Planck's law, Effect of temperature on F-D distribution function, degenarate Fermigas, Density of States, Fermi energy.

Reference Books:

• Statistical Mechanics-R.K.Pathria & Paul D. Beale (Academic Press) 3rd Edition (2011)
• 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.
• An introduction to Equilibrium Statistical Mechanics: Palash Das (I.K.International Publication) 2012
•Statistical Physics -- F. Mandl (CBS) 2012
•Statistical Physics of Particles-M. Kardar (CUP 2007)

PHYSICS PRACTICAL-C XIV LAB

Use C/C++/Scilab for solving the problems based on Statistical Mechanics like

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 Wein's Law and Raleigh-Jeans Law at high temperature (room temperature) and low temperature.

4. Plot Specific Heat of Solids by comparing (a) Dulong-Petit law, (b) Einstein distribution function, (c) Debye distribution function for high temperature (room temperature) and low temperature and compare them for these two cases

5. Plot Maxwell-Boltzmann distribution function versus temperature.

6. Plot Fermi-Dirac distribution function versus temperature.

7. Plot Bose-Einstein distribution function versus temperature.

Reference Books:

• Elementary Numerical Analysis, K.E.Atkinson, 3 r d Edn. 2007, Wiley India Edition

• Statistical Mechanics, R.K. Pathria, Butterworth Heinemann: 2nd Ed., 1996, Oxford University Press.

• 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

• 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

PHYSICS-DSE (Discipline Specific Elective): (4 papers)
DSE-1 to DSE-4 (6 Credits each)
CLASSICAL DYNAMICS
DSE-1
(Credits: Theory-05, Tutorial-01)
SEMESTER-V

The emphasis of the course is on applications in solving problems of interest to physicists. Students are to be examined on the basis of problems, seen and unseen.

UNIT-I

Classical Mechanics of Point Particles: Generalised coordinates and velocities. Hamilton's Principle, Lagrangian and Euler-Lagrange equations. Applications to simple systems such as coupled oscillators.

UNIT-II

Canonical momenta & Hamiltonian. Hamilton's equations of motion.

Applications: Hamiltonian for a harmonic oscillator, particle in a central force field. Motion of charged particles in external electric and magnetic fields.

UNIT-III

Special Theory of Relativity: Postulates of Special Theory of Relativity. Lorentz Transformations. Minkowski space. The invariant interval, light cone and world lines. Space-time diagrams. Time-dilation, length contraction & twin paradox.

UNIT-IV

Four-vectors: space-like, time-like & light-like. Four-velocity and acceleration. Metric and alternating tensors. Four-momentum and energy-momentum relation. Doppler effect from a four vector perspective. Concept of four-force. Conservation of four-momentum. Relativistic kinematics. Application to two-body decay of an unstable particle.

Reference Books:

• Classical Mechanics, H.Goldstein, C.P. Poole, J.L. Safko, 3rd Edn. 2002,Pearson Education.
• Mechanics, L. D. Landau and E. M. Lifshitz, 1976, Pergamon.
• Classical Mechanics: An introduction, Dieter Strauch, 2009, Springer.
• Solved Problems in classical Mechanics, O.L. Delange and J. Pierrus, 2010, Oxford Press
•Classical Mechanics-J. C.Upadhyay (Himalaya Publication) 2014
•Classical Dynamics of Particles and Systems – S. T. Thornton (Cengage Learning) 2012
•Introduction to Classical Mechanics-R. K. Takwale, S.Puranik-(Tata Mc Graw Hill)
• Classical Mechanics-M. Das, P.K.Jena, M. Bhuyan, R.N.Mishra (Srikrishna Prakashan)

PHYSICS-DSE: 2
Nuclear and Particle Physics
(Credits: Theory-05, Tutorials-01)
SEMESTER-V

UNIT-I

General Properties of Nuclei: 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.

Nuclear Models: Liquid drop model approach, semi empirical mass formula and significance of its various terms, condition of nuclear stability, two nucleon separation energies, evidence for nuclear shell structure, nuclear magic numbers, basic assumption of shell model,

UNIT-II

Radioactivity decay:(a) Alpha decay: basics of α-decay processes, theory of α- emission, Gamow factor, Geiger Nuttall law. (b) β-decay: energy kinematics for β-decay, positron emission, electron capture, neutrino hypothesis. (c) Elementary idea of Gamma decay.

Nuclear Reactions: Types of Reactions, Conservation Laws, kinematics of reactions, Q-value,

UNIT-III

Detector for Nuclear Radiations: 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.

Particle Accelerators: Van-de Graaff generator (Tandem accelerator), Linear accelerator, Cyclotron, Synchrotrons.

UNIT-IV

Particle physics: Particle interactions; basic features, types of particles and its families. Symmetries and Conservation Laws: energy and momentum, angular momentum, parity, baryon number, Lepton number, Isospin, Strangeness and charm. Elementary ideas of quarks and gluons.

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 High Energy Physics, D.H. Perkins, Cambridge Univ. Press
• Introduction to Elementary Particles, D. Griffith, John Wiley & Sons
• Basic ideas and concepts in Nuclear Physics - An Introductory Approach by K. Heyde (IOP-Institute of Physics Publishing, 2004).
• Theoretical Nuclear Physics, J.M. Blatt & V.F.Weisskopf (Dover Pub.Inc., 1991)
• Atomic and Nuclear Physics -A. B. Gupta, Dipak Ghosh. (Books and Allied Publishers)
• Physics of Atoms and Molecules – Bransden (Pearson India) 2003
•. Subatomic Physics - Henley and Gracia (World Scientific) 2012
•Introduction to Nuclear and Particle Physics-A.Das and T.Ferbel (World Scientific)
•Radiation detection and measurement, G.F. Knoll (John Wiley & Sons, 2000).

PHYSICS-DSE: 3
BIO-PHYSICS
(CREDITS: THEORY-05, TUTORIALS-01)
SEMESTER-VI

UNIT-I

Building Blocks & Structure of Living State: Atoms and ions, molecules essential forblife, what is life. **Living state interactions:** Forces and molecular bonds, electric &bthermal interactions, electric dipoles, casimir interactions, domains of physics in biology.

UNIT-II

Heat Transfer in biomaterials: Heat Transfer Mechanism, The Heat equation, Joule heating of tissue. **Living State Thermodynamics:** Thermodynamic equilibrium, fIrst law of thermodynamics and conservation of energy. Entropy and second law of thermodynamics, Physics of many particle systems, Two state systems, continuous energy distribution, Composite systems, Casimir contribution of free energy, Protein folding and unfolding.

Open systems and chemical thermodynamics: Enthalpy, Gibbs Free Energy and chemical potential, activation energy and rate constants, enzymatic reactions, ATP hydrolysis & synthesis, Entropy of mixing, The grand canonical ensemble, Hemoglobin.

UNIT-III

Diffusion and transport Maxwell-Boltzmann statistics, Fick's law of diffusion, sedimentation of Cell Cultures, diffusion in a centrifuge, diffusion in an electric field, Lateral diffusion in membranes, Navier stokes equation, low Reynold's Number Transport, Active and passive membrane transport.

UNIT-IV

Fluids: Laminar and turbulent fluid flow, Bernoulli's equation, equation of continuity, venture effect, Fluid dynamics of circulatory systems, capillary action.

Bioenergetics and Molecular motors: Kinesins, Dyneins, and microtubule dynamics, Brownian motion, ATP synthesis in Mitochondria, Photosynthesis in Chloroplasts, Light absorption in biomolecules, vibrational spectra of bio-biomolecules.

Reference Books:

• Introductory Biophysics, J. Claycomb, JQP Tran, Jones & Bartelett Publishers
• Aspects of Biophysics, Hughe S W, John Willy and Sons.
• Essentials of Biophysics by P Narayanan, New Age International
• Molecular Biophysics- P.K.Banarjee (S. Chand Publication) 2014.
•. Essentials of Biophysics : P. Narayanan, (New Age International, New Delhi) 2005 .
•. Biophysics: An introduction : Rodney Cotterill, John Wiley and Sons Ltd,2002.
•.Biophysics- Dr.G.R.Chatwal (Himalaya Pub.)2011

PHYSICS-DSE: 4
PHYSICS OF EARTH
(CREDITS: THEORY-05, TUTORIALS-01)
SEMESTER-VI

UNIT-I

(a) Origin of universe, creation of elements and earth. A Holistic understanding of our dynamic planet through Astronomy, Geology, Meteorology and Oceanography. Introduction to various branches of Earth Sciences.

(b) General characteristics and origin of the Universe. The Milky Way galaxy,solar system, Earth's orbit and spin, the Moon's orbit and spin. The terrestrial and Jovian planets. Meteorites & Asteroids. Earth in the Solar system, origin, size, shape, mass, density, rotational and revolution parameters and its age.

(c) Energy and particle fluxes incident on the Earth.

(d) The Cosmic Microwave Background.

UNIT-II- Structure:

(a) The Solid Earth: Mass, dimensions, shape and topography, internal structure,magnetic field, geothermal energy. How do we learn about Earth's interior?

(b) The Hydrosphere: The oceans, their extent, depth, volume, chemical composition. River systems.

(c) The Atmosphere: variation of temperature, density and composition with altitude, clouds.

(d) The Cryosphere: Polar caps and ice sheets. Mountain glaciers.

(e) The Biosphere: Plants and animals. Chemical composition, mass. Marine and land organisms.

UNIT-III-Dynamical Processes:

(a) The Solid Earth: Origin of the magnetic field. Source of geothermal energy. Convection in Earth's core and production of its magnetic field. Mechanical layering of the Earth. Introduction to geophysical methods of earth investigations. Concept of plate tectonics; sea-floor spreading and continental drift. Geodynamic elements of Earth: Mid Oceanic Ridges, trenches,transform faults and island arcs. Origin of oceans, continents, mountains and rift valleys. Earthquake and earthquake belts. Volcanoes: types products and distribution.

(b) The Hydrosphere: Ocean circulations. Oceanic current system and effect of coriolis forces. Concepts of eustasy, tend – air-sea interaction; wave erosion and beach processes. Tides. Tsunamis.

(c) The Atmosphere: Atmospheric circulation. Weather and climatic changes.Earth's heat budget. Cyclones.

Climate:

i. Earth's temperature and greenhouse effect.

ii. Paleoclimate and recent climate changes.

iii. The Indian monsoon system.

(d) Biosphere: Water cycle, Carbon cycle, Nitrogen cycle, Phosphorous cycle.The role of cycles in maintaining a steady state.

UNIT-IV -Evolution:

Nature of stratigraphic records, Standard stratigraphic time scale and introduction to the concept of time in geological studies. Introduction to geochronological methods in their application in geological studies. History of development in concepts of uniformitarianism, catastrophism and neptunism. Law of superposition and faunal succession. Introduction to the geology and geomorphology of Indian subcontinent.

1. Time line of major geological and biological events.
2. Origin of life on Earth.

3. Role of the biosphere in shaping the environment.
4. Future of evolution of the Earth and solar system: Death of the Earth.

Disturbing the Earth – Contemporary dilemmas

(a) Human population growth.
(b) Atmosphere: Green house gas emissions, climate change, air pollution.
(c) Hydrosphere: Fresh water depletion.
(d) Geosphere: Chemical effluents, nuclear waste.
(e) Biosphere: Biodiversity loss. Deforestation. Robustness and fragility of ecosystems.

Reference Books:

- Planetary Surface Processes, H. Jay Melosh, Cambridge University Press, 2011.
- Consider a Spherical Cow: A course in environmental problem solving, John Harte. University Science Books
- Holme's Principles of Physical Geology. 1992. Chapman & Hall.
- Emiliani, C, 1992. Planet Earth, Cosmology, Geology and the Evolution of Life and Environment. Cambridge University Press.

GENERIC ELECTIVE PAPERS (GE) -(ANY TWO) FOR OTHERDEPARTMENTS/DISCIPLINES: (CREDIT: 06 EACH)
GE: 1-SEMESTER-I
MECHANICS
(Credits: Theory-04, Practicals-02)

UNIT-I

Vectors: Vector algebra. Scalar and vector products. Derivatives of a vector with respect to a parameter.

Ordinary Differential Equations: 1st order homogeneous differential equations. 2nd order homogeneous differential equations with constant coefficients

Laws of Motion: Frames of reference. Newton's Laws of motion. Dynamics of a system of particles. Centre of Mass.

Momentum and Energy: Conservation of momentum. Work and energy. Conservation of energy. Motion of rockets.

UNIT-II

Gravitation: Newton's Law of Gravitation. Motion of a particle in a central force field (motion is in a plane, angular momentum is conserved, areal velocity is constant). Kepler's Laws (statement only). Satellite in circular orbit and applications. Geosynchronous orbits. Basic idea of global positioning system (GPS). Weightlessness. Physiological effects on astronauts.

Rotational Motion: Angular velocity and angular momentum. Torque. Conservation of angular momentum.

UNIT-III

Oscillations: Simple harmonic motion. Differential equation of SHM and its solutions. Kinetic and Potential Energy, Total Energy and their time averages. Damped oscillations.

Elasticity: 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 - Work done in stretching and work done in twisting a wire - Twisting couple on a cylinder - Determination of Rigidity modulus by static torsion - Torsional pendulum-Determination of Rigidity modulus and moment of inertia - q, η and σ by Searles method.

UNIT-IV

Special Theory of Relativity: Constancy of speed of light. Postulates of Special Theory of Relativity. Length contraction. Time dilation. Relativistic addition of velocities.

Note: *Students are not familiar with vector calculus. Hence all examples involve differentiation either in one dimension or with respect to the radial coordinate .*

Reference Books:

• University Physics. F.W. Sears, M.W. Zemansky and H.D. Young, 13/e, 1986. Addison-Wesley
• Mechanics Berkeley Physics, Vol..1: Charles Kittel, et. al. 2007, Tata McGraw-Hill.
• Physics – Resnick, Halliday & Walker 9/e, 2010, Wiley
• University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole.
• Properties of Matter - D.S. Mathur (S.Chand publication) 2013
• Mechanics- D.C.Tayal (Himalaya Publication) 2013
• Classical Dynamics of Particles and Systems –S. T. Thornton (Cengage Learning) 2012
• Analytical Mechanics-Fowles (Cengage Learnings) 2014
•Classical Mechanics-M.Das,P.K.Jena, M.Bhuyan and R.N.Mishra (Srikrishna Publication)

PHYSICS LAB: GE LAB: MECHANICS

1. Measurements of length (or diameter) using vernier caliper, screw gauge and travelling microscope.

2. To determine the Height of a Building using a Sextant.

3. To determine the Moment of Inertia of a Flywheel.

4. To determine the Young's Modulus of a Wire by Optical Lever Method.

5. To determine the Modulus of Rigidity of a Wire by Maxwell's needle.

6. To determine the Elastic Constants of a Wire by Searle's method.

7. To determine g by Bar Pendulum.

8. To determine g by Kater's Pendulum.

9. To study the Motion of a Spring and calculate (a) Spring Constant, (b) g.

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, Indu Prakash and Ramakrishna, 11th Edition, 2011, Kitab Mahal, New Delhi.

GE: IV SEMESTER-IV
ELECTRICITY , MAGNETISM AND EMT
(Credits: Theory-04, Practicals-02)

UNIT-I

Vector Analysis: Scalar and Vector product, gradient, divergence, Curl and their significance, Vector Integration, Line, surface and volume integrals of Vector fields, Gauss-divergence theorem and Stoke's theorem of vectors (statement only).

UNIT-II

Electrostatics: Electrostatic Field, electric flux, Gauss's theorem of electrostatics. Applications of Gauss theorem- Electric field due to point charge, infinite line of charge, uniformly charged spherical shell and solid sphere, plane charged sheet, charged conductor. Electric potential as line integral of electric field, potential due to a point charge, electric dipole, uniformly charged spherical shell and solid sphere. Calculation of electric field from potential.

Capacitance : Capacitance of an isolated spherical conductor. Parallel plate, spherical and cylindrical condenser. Energy per unit volume in electrostatic field. Dielectric medium, Polarisation, Displacement vector. Gauss's theorem in dielectrics. Parallel plate capacitor completely filled with dielectric.

UNIT-III

Magnetism: Magnetostatics: Biot-Savart's law and its applications- straight conductor, circular coil, solenoid carrying current. Divergence and curl of magnetic field. Magnetic vector potential. Ampere's circuital law. Magnetic properties of materials: Magnetic intensity, magnetic induction, permeability, magnetic susceptibility. Brief introduction of dia-, para-and ferromagnetic materials.

Electromagnetic Induction: 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.

UNIT-IV

Maxwell`s equations and Electromagnetic wave propagation: 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.

Reference Books:

• Electricity and Magnetism, Edward M. Purcell, 1986, McGraw-Hill Education
• Electricity & 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.
• D.J.Griffiths, Introduction to Electrodynamics, 3rd Edn, 1998, Benjamin Cummings.
•Electricity and Magnetism- K.K Tewari (S. Chand Higher Academics)2013

GE LAB: ELECTRICITY, MAGNETISM AND EMT

1. To use a Multimeter for measuring (a) Resistances, (b) AC and DC Voltages, (c) DC Current, and (d) checking electrical fuses.

2. Ballistic Galvanometer:

(i) Measurement of charge and current sensitivity

(ii) Measurement of CDR

(iii) Determine a high resistance by Leakage Method

(iv) To determine Self Inductance of a Coil by Rayleigh's Method.

3. To compare capacitances using De'Sauty's bridge.

4. Measurement of field strength B and its variation in a Solenoid (Determine dB/dx)

5. To study the Characteristics of a Series RC Circuit.

6. To study a series LCR circuit LCR circuit and determine its (a) Resonant frequency, (b) Quality factor

7. To study a parallel LCR circuit and determine its (a) Anti-resonant frequency and

(b) Quality factor Q

8. To determine a Low Resistance by Carey Foster's Bridge.

9. To verify the Thevenin and Norton theorems

10. To verify the Superposition, and Maximum Power Transfer Theorems

Reference Books

• Advanced Practical Physics for students, B.L.Flint & 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

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RAYAGADA AUTONOMOUS COLLEGE

Syllabus for B.Sc. (CORE) Zoology

Under Choice Based Credit System (CBCS)

2018-2021

DEPARTMENT OF ZOOLOGY

RAYAGADA

Syllabus for +3 (Hons.) ZOOLOGY, Choice Based Credit System

SEMESTER	COURSE OPTED	COURSE NAME	Credits	Marks
SEMESTER- I	Ability EnhancementCompulsory Course-I	English communications	2	50
	Core course-I(Theory)	Biology of Non-Chordata-I Protista to Pseudo coelomates	4	75
	Core Course-I(Practical)		2	25
	Core course-II (Theory)	Principles and Ethics of Ecology	4	75
	Core course-II (Practical)		2	25
	Generic Elective -1(Theory)	Animal Diversity	4	75
	Generic Elective -1 (Practical)		2	25
SEMESTER-II	Ability Enhancement Compulsory Course-II	Environmental Science	2	50
	Core course-III(Theory)	Biology of Non-Chordata-II Coelomate Nonchordates	4	75
	Core course-III (Practical)		2	25
	Core course-IV(Theory)	Physiology: Life sustaining systems	4	75
	Core course-IV (Practical)		2	25
SEMESTER - III	Core course-V(Theory)	Biology Of Chordata	4	75
	Core course-V(Practical)		2	25
	Core course-VI (Theory)	Physiology:Controlling And Coordinating System	4	75
	Core course-VI (Practical)		2	25
	Core course-VII (Theory)	Comparative Anatomy Of Vertebrates	4	75
	Core course-VII (Practical)		2	25
	Skill Enhencement Course-I	Communicative English	2	50

Syllabus for +3 (Hons.) ZOOLOGY, Choice Based Credit System

SEMESTER	COURSE OPTED	COURSE NAME	Credits	Marks
SEMESTER - IV	Core course-VIII (Theory Core course-VIII (Practical)	Biochemistry Of Metabolic Processes	4 2	75 25
	Core course-IX (Theory) Core course-IX (Practical)	Cell Biology	4 2	75 25
	Core Course- X (Theory) Core Course- X (Practical)	Principles Of Genetics	4 2	75 25
	Generic Elective-4 (Theory) Generic Elective-4(Practical)	Environment And Public Health	4 2	75 25
	Skill Enhencement Course-II	Quantitative and Logical Thinking	2	50
SEMESTER-V	Core-XI (Theory) Core course-XI (Practical)	Developmental Biology	4 2	75 25
	Core-XII (Theory) Core course-XII (Practical)	Molecular Biology	4 2	75 25
	Discipline Specific Elective - 1(Theory) Discipline Specific Elective - 1(Practical)	Animal Behaviour	4 2	75 25
	Discpline Specific Elective – 2(Theory) Discpline Specific Elective – 2(Practical)	Animal Biotechnology	4 2	75 25

Syllabus for +3 (Hons.) ZOOLOGY, Choice Based Credit System

SEMESTER	COURSE OPTED	COURSE NAME	Credits	Marks
SEMESTER -VI	Core course-XIII (Theory)	Immunology	4	75
	Core course-XIII (Practical)		2	25
	Core course-XIV (Theory)	Evolutionary Biology	4	75
	Core course-XIV (Practical)		2	25
	Discipline Specific Elective – 3(Theory)	Microbiology	4	75
	Discipline Specific Elective – 3(Practical)		2	25
	Discipline Specific Elective – 4and DSE Practical	Project and Seminar	6	100

CBCS MARKS&TIME DISTRIBUTION PATTERN

1. In Core or Generic or other courses, Papers carrying the full marks of 100, holding 15 Marks for MidSem., 60 Marks in Semester examination and 25 Marks in Practical examination.

2. In Skill Enhanced Compulsory Courses, papers carrying the full Marks of 50, holding 10 Marks for MidSem, 40 marks in Semester examination.

3. In the Papers of full marks 100, the Semester examination will be of 60 full marks for 03 hours duration.

4. In the papers of full Marks 50, the Semester examination will be of full marks 40 for 02 hours duration.

5. In term end Semester Examination- Section A carries objective questions with 4 marks each for the 20 % of the full marks meant for the term end examinations in a paper. Section B comprises of 4 long questions from 4 different units in a paper each carrying equal marks.

CORE COURSE: ZOOLOGY
PaperI
Biology of Non-Chordata-I Protista to Pseudo coelomates
(CREDITS: THEORY-4, PRACTICALS-2)
THEORY

Unit 1: Phylum Protozoa, Parazoa and Metazoa
General characteristics and classification upto classes; Life cycle, pathogenicity and prophylaxis of *Plasmodium vivax, Trypanosoma gambiense*and *Entamoeba histolytica;* Locomotion and reproduction in Protozoa, origin of Metazoa.

Unit 2: Phylum Porifera and Ctenophora
General characteristics and classification upto classes; Canal system in sponges; General characteristics and evolutionary significance of Ctenophora

Unit 3: Phylum Cnidaria
General characteristics and classification upto classes; Metagenesis in *Obelia*; Polymorphism in Cnidaria; Corals and coral reefs.

Unit 4: Phylum Helminthes
General characteristics and classification upto classes; Life cycle, pathogenicity and prophylaxis of *Fasciola hepatica* and *Ascaris lumbricoides;* Parasitic adaptations.

Note: Classification to befollowedfrom"BarnesRD (1982)InvertebrateZoology. 5thEdition."

PRACTICALS

PhylumProtozoa

1. Morphology of *Paramecium,* Binary fission and Conjugation in *Paramecium.*
2. Life stages of *Plasmodium vivax, Trypanosmagambiense*and *Entamoeba histolytica* (Slides/Micro-photographs).
3. Examination of pond waterfor protists.

PhylumPorifera
4. Study of *Sycon*(including T.S. and L.S.) *Hyalonema,* and *Euplectella.*
5. Temporary mounts of spicules, gemmules and spongin fibres.

PhylumCnidaria

6. Studyof*Obelia,Physalia,Millepora,Aurelia,*Ephyralarva,*Tubipora,Corallium, Alcyonium, Gorgonia*and *Metridium*(includingT.S.andL.S.).

PhylumCtenophora

7. Anyonespecimen/slide.

PhylumHelminthes

8. Study of adult *Fasciolahepatica*, *Taeniasolium*and their life stages (Slides/ microphotographs).Studyof adult*Ascarislumbricoides,Wuchereriabancrofti*andtheirlifestages(Slides/ microphotographs).

Note: Classification to be followed from"BarnesRD (1982)InvertebrateZoology. 5thEdition."

SUGGESTED READINGS

1. AroraMP (2006) Non-Chordata-I. 1st edition. HimalayaPublishing House,New Delhi.
2. AroraMP (2008)Non-Chordata-II.1st edition. HimalayaPublishingHouse,New Delhi.
3. Barnes RD(1982)InvertebrateZoology.6th Edition. Holt SaundersInternational Edition.
4. BarnesRSK,CalowP,OlivePJW,GoldingDW& SpicerJI(2002)TheInvertebrates:A NewSynthesis. 3rd Edition. Blackwell Science,USA.
5. Barrington EJW(1979)Invertebrate Structure andFunctions. 2nd Edition.ELBS and Nelson.
6. BoradaleLAand Potts EA (1961)Invertebrates:AManual fortheuseofStudents. Asia PublishingHome.
7. JordanELandVermaPS(1963)InvertebrateZoology.RevisedEdition.S.Chand,New Delhi.
8. MohantyPK(2000)Illustrated DictionaryofBiology. Kalyani Publishers,Ludhiana.
9. Kotpal R.L Modern Text Book of Zoology, Invertebrates. RastogiPublication,Meerut.
10. Singh.H.S. &Rastogi.P., Parasitology,RastogiPublication,Meerut.

CORE COURSE: ZOOLOGY
PaperII
Principles and Ethics of Ecology
(CREDITS: THEORY-4, PRACTICALS-2)
THEORY

Unit 1: Introduction to Ecology
Relevance of studying ecology; History of ecology; Autecology and synecology; Levels of organization; Laws of limiting factors; Detailed study of temperature and lights physical factors.

Unit 2: Population
Unitary and modular populations; Unique and group attributes of population: Density, natality, mortality, lifetables, fecundity tables, survivorship curves, age ratio, sex ratio, dispersal and dispersion; Exponential and logistic growth, equation and patterns, rand K strategies, Population regulation-density-dependent and independent factors; Population interactions, Gause's Principle with laboratory and field examples

Unit3: Community
Community characteristics: dominance, diversity, species richness, abundance, stratification; Ecotone and edge effect; Ecosystem development (succession)with example and Theories pertaining to climax community.

Unit 4: Ecosystem
Types of ecosystem; Food chain, Detritus and grazing food chains, Linear and Y-shaped food chains; Food web; Energy flow through the ecosystem; Ecological pyramids and
Ecologicalefficiencies;Nutrientandbiogeochemicalcycle,NitrogencycleandSulphur cycle.

PRACTICALS

1. Studyoflifetables andplottingof survivorship curves ofdifferent types from the hypothetical/real dataprovided.
2. Determinationofpopulationdensityinanatural/hypotheticalcommunitybyquadrate method and calculation ofShannon-Weinerdiversityindexfor thesamecommunity.

3. Study of an aquatic ecosystem: fauna and flora Measurement of area, temperature,turbidity/penetrationoflight,determinationofpH,andDissolvedOxygen content(Winkler's method), Chemical OxygenDemandand freeCO2.

SUGGESTED READINGS

1. ColinvauxPA(1993)*Ecology*.IIEdition. JohnWileyand Sons,Inc., USA.
2. Dash MC(1993)Fundamentals of Ecology. McGraw Hill Book Company,New Delhi.
3. JoshiNandJoshiPC(2012)EcologyandEnvironment.1st Edition.HimalayaPublishing House, NewDelhi.
4. MohantyPK(2000)Illustrated DictionaryofBiology. Kalyani Publishers,Ludhiana.
5. Odum EP (2008)*Fundamentals of Ecology*.Indian Edition. Brooks/Cole.
6. Ricklefs, R.E., (2000). *Ecology*. 5thEdition. Chiron Press.
7. RobertLeo Smith EcologyandfieldbiologyHarperand Row.
8. SinghJS, Gupta SR and Singh SP (2014) Ecology, Environmental Science and Conservation. S. Chand, New Delhi.
9. Sharma P.D (2011): Ecology and Environment. RastogiPublication,Meerut.

CORE COURSE: ZOOLOGY
Paper III
Biology of Non-Chordata-II Coelomate Nonchordates
(CREDITS: THEORY-4, PRACTICALS-2)
THEORY

Unit 1: Phylum Annelida
General characteristics and classification upto classes; Evolution of Coelom; Metamerism and Excretion in Annelida.

Unit 2: Phylum Arthropoda and Onychophora
General characteristics and classification upto classes; Vision in Arthropoda; Respiration in Arthropoda, Larval forms in Crustacea, General characteristics and affinities of *Peripatus.*

Unit 3: Phylum Mollusca
General characteristics and classification upto classes; Respiration in Mollusca; Torsion in Gastropoda, Evolutionary significance of trochophorelarva.

Unit 4:PhylumEchinodermata
Generalcharacteristicsandclassificationuptoclasses;Water-vascularsystemin Asteroidea;LarvalformsinEchinodermataandits Evolutionarysignificance

Note: Classification tobefollowed from "Barnes, R.D. (1982). *InvertebrateZoology*, 5thEdition, Holt SaundersInternational Edition."

PRACTICAL

PhylumAnnelida
1. Studyof*Aphrodite,Nereis,Heteronereis,Sabella, Terebella,Serpula,Chaetopterus, Pheretimaand Hirudinaria.*
2. T.S. through pharynx, gizzard,and typhlosolarintestineofearthworm.
3. T.S. through cropof leech.

PhylumArthropoda

4. Study of *Limulus, Palamnaeus, Palaemon, Daphnia, Balanus, Sacculina, Cancer, Eupagurus, Scolopendra, Julus,* termite, louse, honeybee, silk moth, waspand dragon fly.

PhylumOnychophora

5. Anyonespecimen/slide.

PhylumMollusca

6. Study of *Chiton, Dentalium, Pila, Doris, Helix, Unio, Ostrea, Mytilus, Loligo, Sepia,Octopus*and *Nautilus* and *Cypraea*(cowrie).

Phylum Echinodermata

7. Study of Echinoderm larvae
8. Study of Pentaceros, Asterias, Ophiura, Clypeaster, Echinus, Echinocardium, Cucumaria and Antedon

Note: Classification tobe followed from "Barnes, R.D. (1982). *InvertebrateZoology,* 5thEdition, Holt SaundersInternational Edition".

SUGGESTED READINGS

1. AroraMP (2006)Non-Chordata-I. 1stedition. HimalayaPublishingHouse, New Delhi.
2. AroraMP (2008)Non-Chordata-II.1stedition.HimalayaPublishing House, New Delhi.
3. Barnes RD(1982)InvertebrateZoology. 6thEdition. Holt SaundersInternational Edition.
4. BarnesRSK,CalowP,OlivePJW,GoldingDW&SpicerJI(2002)TheInvertebrates:A NewSynthesis. 3rdEdition. Blackwell Science,USA.
5. Barrington EJW(1979)*Invertebrate Structure and Functions*. 2ndEdition.ELBSand Nelson.
6. BoradaleLAand Potts EA (1961)*Invertebrates:A Manual for theuseof Students*. Asia PublishingHome.
7. Jordan ELandVermaPS(1963)InvertebrateZoology.RevisedEdition.S.Chand,New Delhi.
8. MohantyPK(2000)Illustrated DictionaryofBiology. Kalyani Publishers,Ludhiana.
9. Kotpal R.L Modern Text Book of Zoology, Invertebrates. RastogiPublication,Meerut.

CORE COURSE: ZOOLOGY
Paper IV
PHYSIOLOGY:LIFE SUSTAINING SYSTEMS
(CREDITS: THEORY-4, PRACTICALS-2)
THEORY

Unit 1:DigestiveSystem
Structuralorganization,histologyandfunctionsofgastrointestinaltractanditsassociated glands;Mechanicaland chemical digestionoffood;Absorptionsofcarbohydrates,lipids, proteins,water,mineralsandvitamins;Roleofgastrointestinalhormonesonthesecretion and control of enzymes ofgastrointestinal tract.

Unit 2: Respiratory System
Mechanismofrespiration,Pulmonaryventilation; Respiratoryvolumeandcapacity; Transport ofoxygenintheblood;Oxygen-hemoglobin andmyoglobin,dissociationcurveandthefactorsinfluencingit;Carbonmonoxide poisoning;Carbondioxidetransportintheblood;bufferingactionofbloodand haemoglobinand Control of respiration.

Unit 3:Excretory System
Structureofkidneyanditshistologicaldetails;Renalbloodsupply;Mechanismofurine formation and its regulation and Regulation ofacid-basebalance.

Unit 4:Circulatory System
Componentsofbloodand theirfunctions;Haemopoiesis; Haemostasisand Coagulation ofblood,Structureofheart,Cardiaccycle, Bloodpressureanditsregulation, Electrocardiogram

PRACTICAL

1. Enumeration of red blood cells usinghaemocytometer.
2. Estimation of haemoglobin usingSahli'shaemoglobinometer.
3. Preparation ofhaeminand haemochromogencrystals.
4. Recordingof blood pressureusingaSphygmomanometer.

5.
Examinationofsectionsofmammalianoesophagus,stomach,duodenum,ileum,rectum liver, trachea, lungand kidney.

SUGGESTED READINGS

1. AreyLB (1974)HumanHistology. 4th Edition.W.B. Saunders, USA.

2. ChatterjeeCC (2008)Human Physiology.Vol.IandII. MedicalAllied Agency, Kolkata.

3. GuytonAC andHall JE(2006) Textbook of Medical Physiology. 9th Edition. W.B. Saunders Company, Philadelphia.

4. MohantyPK(2000)Illustrated DictionaryofBiology. Kalyani Publishers,Ludhiana.

5. TortoraGJand Derrickson B(2012) Principles ofAnatomy&Physiology.13th Edition JohnWileyand sons, USA.

6. Victor PE (2008)diFiore'sAtlas of Histologywith Functional Correlations. 12th Edition. Lippincott W. &Wilkins, USA.

7. Goyal K.A. &Shastri K.V. Animal Physiology, RastogiPublication.Meerut.

CORE COURSE: ZOOLOGY
Paper V
BIOLOGY OFCHORDATA
(CREDITS: THEORY-4, PRACTICALS-2)

THEORY

Unit 1: Protochordata and Cyclostomata

General characters of Hemichordata, Urochordata and Cephalochordata; Retrogressive metamorphosis in Urochordata; General characters and classification of cyclostomes upto class; Structural peculiarities and affinities of *Petromyzon* and *Myxine*.

Unit 2: Pisces and Amphibia

General characters of Chondrichthyes and Osteichthyes and classification upto order; Migration; Osmoregulation in fishes; Scales in fishes; Origin of *Tetrapoda* (Evolution of terrestrial ectotherms); General characters and classification up to order and Parental care in Amphibians.

Unit 3: Reptilia and Aves

General characters and classification upto order; Affinities of *Sphenodon*; Poison apparatus and Biting mechanism in snakes; General characters and classificationuptoorder;Flightadaptations; *Archaeopteryx*-a connectinglink and Migration in birds.

Unit 4:Mammals

Generalcharactersandclassificationuptoorder;Affinitiesof PrototheriaandMetatheria;Dentitioninmammals;Adaptiveradiationwithreferencetol ocomotoryappendages.

PRACTICAL

1. Protochordata

1. *Balanoglossus, Herdmania, Branchiostoma*and Colonial Urochordata.
2. Sections of*Balanoglossus*through proboscis andbranchiogenitalregions.
3. Sections of*Amphioxus* through pharyngeal, intestinal and caudal regions.
4. Permanent slide ofspicules of*Herdmania*.

2.Agnatha

5. Petromyzon and *Myxine.*

3. Fishes

6. *Sphyrna, Pristis, Trygon, Torpedo, Chimaera, Notopterus, Mystus, Heteropneustes, Hippocampus, Exocoetus, Echeneis, Anguilla, Tetrodon,Diodon, Anabas* and Flat fish.

4.Amphibia

7. Ichthyophis/Ureotyphlus, Necturus, Duttaphrynus, Polypedates, Hyla, Alytes and *Salamandra.*

5. Reptiles

*8. Chelone, Trionyx, Hemidactylus, Varanus, Uromastix, Chamaeleon, Draco, Ophiosaurus, Bungarus, Vipera, Naja, Hydrophis, Zamenis*and *Crocodylus.*

9. KeyforIdentificationofpoisonous and non-poisonous snakes.

6. Aves

10. Studyofsixcommon birds from different orders.

11. Types of beaksand claws.

12. Types offeathers.

7. Mammalia

13.Sorex, Bat (Insectivorous and Frugivorous), *Funambulus, Loris, Herpestes*and *Hemiechenis.*

SUGGESTED READINGS

1. Agarwal VK (2011)Zoology for degree students. S. Chand, New Delhi.

2. Arora MP (2006) Chordata-1. 1st Edition. Himalaya Publishing House, New Delhi.

3. Hall BK and HallgrimssonB(2008)*Strickberger's Evolution*. 4th Edition. Jones and Bartlett Publishers Inc.,USA.

4. Jordan EL and Verma PS(1963) Chordate Zoology. Revised Edition. S. Chand, New Delhi.

5. Mohanty PK (2000) Illustrated Dictionary of Biology. Kalyani Publishers, Ludhiana.

6. Young JZ(2004) *The Life of Vertebrates*. 3rd Edition. Oxford University Press, USA.

7. Kotpal R.L. (2015) Modern Text Book of Zoology, Vertebrates, Rastogi Publication, Meerut.

CORE COURSE: ZOOLOGY
Paper VI
PHYSIOLOGY:CONTROLLING AND COORDINATING SYSTEM
(CREDITS: THEORY-4, PRACTICALS-2)

THEORY

Unit 1: Tissues and Glands, Bone and cartilage

Structure, location, function and classification of Epithelial tissue, Connective tissue, Muscular tissue, Nervous tissue; Types of glands and their functions; Structure and types of bones and cartilages; Ossification, bone growth and resorption.

Unit 2: Nervous System

Structureofneuron,restingmembranepotential;Originofactionpotentialandits propagationacrossthemyelinatedandunmyelinatednervefibers;typesofsynapsis, Synaptictransmission;Neuromuscularjunction;Reflexactionanditstypes,Reflexarc and Physiologyof hearingandvision.

Unit 3: Muscle

Histology ofdifferenttypesofmuscle;Ultrastructureofskeletalmuscle;Molecularand chemicalbasisofmusclecontraction;Characteristicsofmuscletwitch;MotorUnit, summation and tetanus.

Unit 4:EndocrineSystem

FunctionalHistologyofendocrine glands-pineal,pituitary,thyroid,parathyroid,thymus, pancreas,adrenals;Hormonessecretedbythemandtheirmechanismofaction;Classificat ionofhormones;Regulationoftheirsecretion;Modeofhormone action Hypothalamus(neuroendocrinegland),

PRACTICALS

1. Demonstrationoftheunconditionedreflexaction(Deeptendonreflexsuchaskneejerk reflex).
2. Preparation oftemporarymounts: Squamousepithelium, Striatedmusclefibresandnerve cells.
3. Examinationofsectionsofmammalianskin,Cartilage,Bone,Spinalcord,Nervecell, Pituitary, Pancreas, Testis, Ovary, Adrenal, Thyroid and Parathyroid.

SUGGESTED BOOKS

1. AreyLB (1974)HumanHistology. 4th Edition.W.B. Saunders, USA.

2. ChatterjeeCC (2008)Human Physiology.Vol.IandII. MedicalAllied Agency, Kolkata.

3. GuytonAC andHall JE(2006) Textbook of Medical Physiology. 9th Edition. W.B. Saunders Company, Philadelphia.

4. MohantyPK(2000)Illustrated DictionaryofBiology. Kalyani Publishers,Ludhiana.

5. TortoraGJand DerricksonB(2012) Principles ofAnatomy&Physiology.13th Edition JohnWileyand sons, USA.

6. Victor PE (2008)diFiore'sAtlas of Histologywith Functional Correlations. 12th Edition. Lippincott W. and Wilkins, USA.

7. Goyal K.A. &Shastri K.V. Animal Physiology, RastogiPublication.Meerut.

8. Pocock G.&Rechards C. The Human Body, Oxford University Press,U.K.

CORE COURSE: ZOOLOGY
Paper VII
COMPARATIVE ANATOMY OF VERTEBRATES
(CREDITS: THEORY-4, PRACTICALS-2)

THEORY

Unit 1: Integumentary System and Skeletal System
Structure, functions and derivatives of integument; Axial and appendicular skeletons; Jaw suspensorium in vertebrates.

Unit 2: Digestive and Respiratory System
Alimentary canal and associated glands; Skin, gills, lungs and airsacsandAccessory respiratoryorgansin fishes.

Unit 3:Circulatory Systemand Urinogenital System
General plan ofcirculation; Evolution of heartandaortic arches. Succession ofkidney; Evolution of urinogenitalducts and Types of mammalian uteri.

Unit 4:Nervous SystemandSenseOrgans
Comparativeaccountofbrain;Autonomicnervoussystem;SpinalNerves;Spinalcord; CranialnervesinMammals;Classificationofreceptors;visual receptors,chemo- receptorsand mechanoreceptors.

PRACTICAL

1. Studyof placoid,cycloidand ctenoid scales through permanent slides/photographs.
2. Disarticulated skeleton of Frog, *Varanus*,Fowl and Rabbit.
3. Carapace and plastron ofturtleor tortoise.
4. Mammalian skulls(Oneherbivorous and one carnivorous animal).

SUGGESTED READINGS

1. Hilderbrand Mand Gaslow GE. Analysis of Vertebrate Structure. John Wileyand Sons., USA.
2. KardongKV(2005) Vertebrates'Comparative Anatomy,Function and Evolution. 4thEdition. McGraw-Hill Higher Education, New York.
3. Kent GC and CarrRK (2000)Comparative Anatomyof theVertebrates. 9th Edition. The McGraw-Hill Companies, New York.
4. MohantyPK(2000)Illustrated DictionaryofBiology. Kalyani Publishers,Ludhiana.
5. Weichert CK and William Presch (1970) Elements of Chordate Anatomy.TataMcGraw Hill, New York.

CORE COURSE: ZOOLOGY
Paper VIII
BIOCHEMISTRY OF METABOLIC PROCESSES
(CREDITS: THEORY-4, PRACTICALS-2)

THEORY

Unit 1: Carbohydrate Metabolism

Glycolysis; Citric acid cycle; pentosephosphate pathway; Gluconeogenesis; Shuttle systems (Malate-aspartate shuttle, Glycerol3-phosphateshuttle); Glycogenolysis; Glycogenesis.

Unit 2: Lipid Metabolism

β-oxidation of saturated fatty acids with even and odd number of carbon atoms; Biosynthesis of palmitic acid and Ketogenesis and its regulation.

Unit 3: Protein Metabolism

Catabolism of amino acids: Transamination, Deamination; Urea cycle; Fate of C-skeleton of Glucogenic and Ketogenic amino acids.

Unit 4: Enzymes and Oxidative Phosphorylation

Kinetics and Mechanism of action of enzymes; Inhibition of enzyme action; Allosteric enzymes; Oxidative phosphorylation in mitochondria; Respiratory chain, ATP synthase, Inhibitors and Uncouplers.

PRACTICALS

1. Identification of unknown carbohydrates in given solutions (Starch, Sucrose, Lactose, Galactose, Glucose, Fructose).
2. Colour tests of functional groups in protein solutions.
3. Action of salivary amylase under optimum conditions.
4. Effect of pH on the action of salivary amylase.
5. Effect of temperature on the action of salivary amylase.
6. Estimation of total protein in given solutions by Lowry's method.

SUGGESTED READINGS

1. Berg JM, Tymoczko JL and StryerL(2007)Biochemistry. 6thEdition, W.H. Freeman and Co., New York.
2. Cox MM and Nelson DL(2008)Lehninger Principles of Biochemistry. 5th Edition. W.H. Freeman and Co.,NewYork.

3. Devesena T (2014) Enzymology.2nd Edition. Oxford University Press, UK.
4. HamesBD and HooperNM (2000)Instant Notesin Biochemistry. 2ndEdition. BIOS ScientificPublishersLtd., U.K.
5. MohantyPK(2000)Illustrated DictionaryofBiology. Kalyani Publishers,Ludhiana.
6. MurrayRK,BenderDA,Botham KM, KennellyPJ,RodwellVWand WellPA(2009) Harper'sIllustratedBiochemistry. 28thEdition.International Edition. TheMcGraw-Hill CompaniesInc.,New York.
7. Trudy Mckee, & James Mckee5thEdition,Biochemistry, Oxford University Press,U.K.
8. Gupta S.N., A Text Book of Bio-Chemistry, RastogiPublication,Meerut.

CORE COURSE: ZOOLOGY
Paper IX
CELL BIOLOGY
(CREDITS: THEORY-4, PRACTICALS-2)

THEORY

Unit 1: Cells and Plasma Membrane

Prokaryotic and Eukaryotic cells; Mycoplasma; Virus, Viroids, Virions and Prions; Various models of plasma membrane; Transport across membranes; Cell junctions: Occluding junctions (Tight junctions), Anchoring junctions(desmosomes), Communicating junctions (gap junctions) and Plasmodesmata.

Unit 2: Endomembrane System, Mitochondria and Peroxisomes

The Endoplasmic Reticulum; Golgi apparatus; Mechanism of vesicular transport; Lysosomes; Structure and function of mitochondria: Chemi-osmotic hypothesis; Semi-autonomous nature of mitochondria; Endosymbiotic hypothesis and Peroxisomes.

Unit3: Cell Cycle and Cell Signaling

Cell cycle and its Regulation of cell cycle; Signaling molecules and their receptors.

Unit4: Apoptosis and Cancer

Extrinsic (Death Receptor) Pathway and Intrinsic(Mitochondrial)Pathway; Growth and development of tumors and Metastasis.

PRACTICAL

1. Gram's staining technique for visualization of prokaryotic cells.
2. Study various stages of mitosis from permanent slides.
3. Study various stages of meiosis from permanent slides.
4. Study the presence of Barr body in human female blood cells/cheek cells. (Preparation of permanent slides).
5. Cytochemical demonstration (Preparation of permanent slides).

i. DNA by Feulgen reaction.
ii. Mucopolysaccharides by PAS reaction.
iii. ProteinsbyMercuro-bromophenol blue.
iv. DNAand RNAbyMethylGreenPyronin.

(In practical examination, 05 marks should be of permanent slide submission; one markeachfor DNA,PAS, Proteins, MGPandBarrbody slide.)

SUGGESTED READINGS

1. Becker WM, KleinsmithLJ,Hardin JandBertoni G P (2009)TheWorld ofthe Cell. 7th Edition. Pearson Benjamin CummingsPublishing,San Francisco.

2. BruceAlbert, BrayDennis,Levis Julian, RaffMartin, Roberts Keith and Watson James (2008)MolecularBiologyof theCell. 5th Edition.Garland publishingInc.,New York.

3. CooperGM and Hausman RE (2009)TheCell: AMolecularApproach. 5th Edition. ASM Press, Washington D.C.

4. DeRobertis EDP and DeRobertis EMF(2006)Cell and MolecularBiology. 8th Edition. Lippincott Williams andWilkins,Philadelphia.

5. Karp G(2010)Cell and Molecular Biology: Concepts and Experiments. 6th Edition.John Wileyand Sons.Inc.,USA.

6. MohantyPK(2000)Illustrated DictionaryofBiology. Kalyani Publishers,Ludhiana.

7. Debasena.T. Cell Biology,Oxford University Press,U.K.

8. Gupta.P.K., Cell & Molecular Biology, RastogiPublication,Meerut.

CORE COURSE: ZOOLOGY
Paper X
PRINCIPLES OF GENETICS
(CREDITS: THEORY-4, PRACTICALS-2)

THEORY

Unit 1: Mendelian Genetics and its Extension

Principles of inheritance; Incomplete dominance and co-dominance; Multiple alleles, Lethal alleles; Epistasis; Pleiotropy; Sex-linked inheritance.

Unit 2: Linkage, Crossing Over and Chromosomal Mapping

Linkage and crossing over; Cytological basis of crossing over; Molecular mechanisms of crossing over; Recombination frequency as a measure of linkage intensity; Two factor and three factor crosses; Interference and coincidence and Somatic cell hybridization.

Unit 3: Mutations

Gene mutations; Chromosomal mutations: Deletion, duplication, inversion, translocation;Aneuploidyandpolyploidy;Inducedversusspontaneousmutations; Backwardandforwardmutations;Suppressormutations;Molecularbasisofmutationsin relationtoUVlightandchemicalmutagens;Detectionofmutations:CLBmethod, attached *X*methodand DNA repair mechanisms.

Unit 4:Sex DeterminationandQuantitativeGenetics

Chromosomalmechanismsofsexdetermination;Sex-linked,sex-influencedandsex limited characters; Polygenic inheritance and Transgressivevariation.

PRACTICAL

1.TostudytheMendelianlawsandgeneinteractionsandtheirverificationbyChisquarean alyses usingseeds/beads/*Drosophila*.

2. Identification ofvariousmutants of *Drosophila*.

3. Tocalculate allelic frequenciesbyHardy-WeinbergLaw.

4. Linkagemaps based on datafrom crosses of*Drosophila*.

5. Studyof human karyotype(normal andabnormal).

6. Pedigree analysis of somehuman inherited traits.

7. Preparation ofpolytenechromosomes from larvaof*Chironomous*/*Drosophila*.

8. To studyMutagenicityin*Salmonella/E. coli*byAmes test.

SUGGESTED READINGS

1. Gardner EJ, SimmonsMJ,Snustad DP (2008)Principles of Genetics. 8th Edition. Wiley India.

2. Griffiths AJF, WesslerSR,Lewontin RC and Carroll SB.Introduction toGenetic Analysis. 9th Edition. W.H. Freeman and Co.,New York.

3. KlugWS, CummingsMR, Spencer CA and Palladino MA (2012)Concepts of Genetics.10th Edition. Pearson Edsucation,Inc., USA.

4. MohantyPK(2000)Illustrated DictionaryofBiology.Kalyani Publishers,Ludhiana.

5. Russell PJ(2009) Genetics-A MolecularApproach. 3rd Edition. BenjaminCummings, USA.

6. Snustad DP and Simmons MJ(2012)Principles of Genetics. 6th Edition.John Wileyand SonsInc., USA.

7. VermaPS and AgarwalVK(2010) Genetics. 9th Edition. S. Chand, New Delhi.

CORE COURSE: ZOOLOGY
Paper XI
DEVELOPMENTALBIOLOGY
(CREDITS: THEORY-4, PRACTICALS-2)

THEORY

Unit 1: Early Embryonic Development

Gametogenesis (Spermatogenesis, Oogenesis);Typesofeggs;Eggmembranes; Fertilization:Changesingametes,monospermyandpolyspermy;Planesandpatternsof cleavage;earlydevelopmentoffrogandchickuptogastrulation;Fatemaps;embryonic induction andorganizers.

Unit 2:LateEmbryonicDevelopment

Fateofgermlayers;Extra-embryonicmembranesinbirds;Implantationofembryoin humansand Placenta(Structure, types andfunctions of placenta).

Unit 3:PostEmbryonicDevelopment

Metamorphosis:Changes,hormonalregulationsinamphibians;Regeneration:Modesof regeneration(epimorphosis,morphallaxisandcompensatoryregeneration);Ageing: Concepts and models.

Unit 4:Implications ofDevelopmental Biology

Teratogenesis:Teratogenicagentsandtheireffectsonembryonicdevelopment;*invitro* Fertilization;Stem cell cultureandAmniocentesis.

PRACTICAL

1. Studyofwholemountsandsectionsofdevelopmentalstagesoffrogthroughpermanent slides:Cleavagestages,blastula,gastrula,neurula,tail-budstage,tadpole(externaland internal gill stages).
2. Studyofwholemountsofdevelopmentalstagesofchickthroughpermanent slides:Primitivestreak(13and18hours)21,24,28,33,36,48,72and96hoursof incubation(HamiltonandHamburger stages).
3. Studyofdevelopmentalstages(abovementioned)byraisingchickembryointhe laboratory.
4. Studyof thedevelopmental stages and lifecycleof*Drosophila* from stock culture.
5. Studyof differenttypes ofplacenta.
6. Project report on*Drosophila* culture/chick embryo development.

SUGGESTED READINGS

1. BalinskyBIandFabianBC (1981)AnIntroduction to Embryology.5th Edition. International ThompsonComputerPress.

2. Gilbert SF(2010)Developmental Biology. 9th Edition. SinauerAssociates,Inc.,USA.

3. Kalthoff(2008) Analysis of Biological Development. 2nd Edition. McGraw-Hill, New York.

4. MohantyPK(2000)Illustrated DictionaryofBiology. Kalyani Publishers,Ludhiana.

5. WolpertL, BeddingtonR,Jessell T, LawrenceP,MeyerowitzEand Smith J(2002) Principles of Development. 1st Edition, Oxford UniversityPress,NewYork.

6. Sastry K.V & Shukla Vinita, Developmental Biology, RastogiPublication,Meerut.

CORE COURSE: ZOOLOGY
Paper XII
MOLECULAR BIOLOGY
(CREDITS: THEORY-4, PRACTICALS-2)

THEORY

Unit 1:Nucleic Acids andDNA Replication

SalientfeaturesofDNAdoublehelix;WatsonandCrickmodelofDNA;DNA denaturationandrenaturation;DNAtopology-linkingnumberandDNAtopo-isomerases;StructureofRNA,tRNAandDNAandRNAassociated proteins;DNAReplicationinprokaryotesandeukaryotes;MechanismofDNA replication

Unit 2: Transcriptionand Translation

RNApolymeraseandtranscriptionUnit;Mechanismoftranscriptioninprokaryotesand Eukaryotes;SynthesisofrRNAandmRNA; Transcriptionfactorsandregulationof transcription.Genetic code,Wobble Hypothesis;Processofprotein synthesisinprokaryotes and Eukaryotes

Unit 3:Post Transcriptional Modifications andProcessing ofEukaryoticRNA

StructureofglobinmRNA;Splitgenes: concept ofintronsandexons,splicing mechanism, alternativesplicing, exon shuffling,and RNA editing,

Unit 4: GeneRegulationandRegulatory RNAs

Transcriptionregulationinprokaryotes:Principlesoftranscriptionalregulationwith examplesfrom*lac*operonand*trp*operon;Transcriptionregulationineukaryotes: Activators,repressors,enhancers,silencerselements;Genesilencing,Geneticimprintin g; Ribo-switches, RNAinterference, miRNAandsiRNA.

PRACTICAL

1. StudyofDNAreplicationusingPhotographsorslidesandspecialcases,e.g.,Polyteny usingpermanent slides of polytene chromosomes.
2. Preparation ofliquid culturemedium (LB)andraise cultureof*E. coli*.
3. Estimation of the growthkinetics of*E.coli* byturbiditymethod.

4. Preparation of solid culture medium (LB) and growth of *E. coli* byspreading and streaking.

5. Demonstrationofantibioticsensitivity/resistanceof*E.coli*toantibioticpressureand interpretation of results.

6. Quantitative estimation of salmon sperm/calf thymus DNA using colorimeter(Diphenylamine reagent) orspectrophotometer(A260 measurement).

7. Quantitativeestimation of RNA usingOrcinol reaction.

SUGGESTED READINGS

1. Becker WM, KleinsmithLJ,Hardin JandBertoni GP (2009)TheWorld ofthe Cell. 7th Edition. Pearson Benjamin CummingsPublishing,San Francisco.

2. BruceAlberts, AlexanderJohnson,Julian Lewis,Martin Raff, Keith Roberts, Peter Walter(2008)MolecularBiologyof theCell, 4th Edition. Garland publishingInc.,New York.

3. CooperGM and Hausman RE (2007)TheCell: AMolecularApproach**.** 4th Edition, ASM Press, USA.

4. DeRobertis EDP and DeRobertis EMF(2006)Cell and MolecularBiology. 8th Edition. Lippincott Williams andWilkins,Philadelphia.

5. Karp G(2010)Cell and Molecular Biology: Concepts and Experiments. 6th Edition.John Wileyand Sons.Inc., USA.

6. MohantyPK(2000)Illustrated DictionaryofBiology. KalyaniPublishers,Ludhiana.

7. Craig N. & Cohen-fix.O., Molecular Biology, Oxford UniversityPress,U.K.

8. Pal.J.K. &Ghaskadbi S.S., Fundamentals of MolecularBiology,Oxford University,U.K.

CORE COURSE: ZOOLOGY
Paper XIII
IMMUNOLOGY
(CREDITS: THEORY-4, PRACTICALS-2)

THEORY

Unit 1:ImmuneSystemand Immunity
Innateimmunity,Adaptiveimmunity. Cellmediatedandhumoral responses, Cells and Organs of the Immune system

Unit 2:Antigens
Antigenicity andimmunogenicity,Immunogens,Adjuvantsandhaptens,Factors influencingimmunogenicity, Band T-Cell epitopes.

Unit 3: Immunoglobulins
Antibody structure and function, antibody isotypes, Applications Monoclonalantibodies.

Unit4:Hypersensitivity
Type-I hypersensitivity- allergens, mast cell degranulation, mediators of type-I reaction, Type-II-antibody mediated cytotoxic, Type-III and Type IV hypersensitivity.

PRACTICAL

1. Demonstration of lymphoid organs.
2. Ouchterlony's doubleimmuno-diffusion method.
3. Determination of ABOblood group.
4.Preparationofsinglecellsuspensionofsplenocytesfromchickspleen,cellcountingand viabilitytest.
5. ELISA/ dot Elisa (usingkit).
6. Principles, experimental set up andapplications of immuno-electrophoresis,RIA,F.

SUGGESTED READINGS

1. Abbas KA andLechtmanHA(2003) Cellular andMolecularImmunology.5th Edition. Saunders Publication, Philadelphia.

2. David M, Jonathan B, David RBandIvan R (2006)Immunology. 7th Edition. Elsevier Publication,USA.

3. Kindt TJ, GoldsbyRA,OsborneBAand KubyJ(2006)Immunology.6thEdition. W.H. Freeman and Company,New York.

4. MohantyPK(2000)Illustrated DictionaryofBiology. Kalyani Publishers,Ludhiana.

5. Khanna R. Immunology,OxfordUniversity,U.K.

6. Lal.S.S& Kumar Sanjeev, Immunology,RastogiPublication,Meerut.

CORE COURSE: ZOOLOGY
Paper XIV
EVOLUTIONARY BIOLOGY
(CREDITS: THEORY-4, PRACTICALS-2)

THEORY

Unit 1: History of Life, theories of Evolution and Extinction

Chemogeny, Biogeny, RNA World, Major Events in History of Life; Lamarckism; Darwinism; Neo-Darwinism; Background of extinction, Mass extinction (Causes, Names of five major extinctions, K-T extinction in detail) and Role of extinction in evolution.

Unit 2: Evidences of Evolution

Fossils and its types; Dating of fossils, Phylogeny of horse and human; Molecular evidences (Globin gene families as an example) and Molecular clock concept.

Unit 3: Processes of Evolutionary Change

Organic variations; Isolating mechanisms; Natural selection (Industrial melanism, Pesticide/Antibiotic resistance); Types of natural selection (Directional, Stabilizing, Disruptive), Sexual Selection and Artificial selection.

Unit 4: Principles of population genetics

Concept of gene pool, Gene frequencies–equilibrium frequency (Hardy-Weinberg equilibrium), Shift in gene frequencywithoutselection–Geneticdrift,Mutationpressure and Geneflow and Shiftsin gene frequencies with selection, species concept

PRACTICAL

1. Studyoffossil evidencesfrom plaster cast models and pictures.
2. Studyof homologyandanalogyfrom suitable specimens/ pictures.
3. Demonstration of changingallele frequencieswith and without selection.
4. Construction of cladogram based on morphological characteristics.
5. Construction ofphylogenetictreewith bioinformatics tools (Clustal X and Phylip).
6. Interpretation ofphylogenetictrees.

SUGGESTED READINGS

1. Barton NH,Briggs DEG,EisenJA, Goldstein DBand Patel NH(2007)Evolution. Cold SpringHarbourLaboratoryPress.
2. Campbell NAand ReeceJB(2011)Biology. 9thEdition. Pearson EducationInc., New York.
3. Douglas JF(1997) EvolutionaryBiology. SinauerAssociates, USA.
4. Hall BKand Hallgrimsson B(2008)Evolution. 4th Edition.Jones and Bartlett Publishers, USA.
5. MohantyPK(2000)Illustrated DictionaryofBiology.Kalyani Publishers,Ludhiana.
6. Pevsner J(2009) BioinformaticsandFunctional Genomics. 2nd Edition. Wiley-Blackwell, USA.
7. RidleyM (2004) Evolution. 3rd Edition. Blackwell Publishing, USA.
8. Tomar B.S & Singh S.P. Evolutionary Biology,RastogiPublication,Meerut.

DISCIPLINE SPECIFIC ELECTIVE-I
ANIMAL BEHAVIOUR
(CREDITS: THEORY-4, PRACTICALS-2)

THEORY

Unit 1: Introduction andMechanisms ofBehaviour

OriginandhistoryofEthology;BriefprofilesofKarlvonFrisch,IvanPavlov,Konrad Lorenz,NikoTinbergen;Proximateandultimatebehavior;Objectiveofbehaviour, Behaviourasabasisofevolution;Behaviourasadisciplineofscience;Innatebehaviour, Instinct, Stimulus filtering, Sign stimuli andCodebreakers.

Unit 2:Patterns of Behaviour

Reflexes: Typesofreflexes,reflexpath,characteristicsofreflexes(latency,after discharge, summation, fatigue, inhibition) and itscomparison with complexbehavior.

Orientation: Primaryandsecondaryorientation;kinesis-orthokinesis,klinokinesis; taxistropotaxisand klinotaxisand menotaxis (lightcompass orientation) and mnemotaxis.

Learning:Associativelearning,classicalandoperantconditioning,Habituationand Imprinting.

Unit 3: Social Behaviour

Insects'society;Honeybee:Societyorganization,polyethism,foraging,rounddance, waggledance,Experimentstoprove distanceanddirectioncomponentofdance,learning abilityinhoneybee,formationofnewhive/queen;Reciprocalaltruism,Hamilton'srule and inclusivefitness withsuitable examples.

Unit 4:Sexual Behaviour

Asymmetryofsex,Sexualdimorphism,Matechoice,Intra-sexualselection(male rivalry),Inter-sexualselection(femalechoice),Infanticide,Consequencesofmatechoice forfemalefitness,Sexual conflict formaleversusfemaleparentalcareandCourtship behaviour in threespinestickleback.

PRACTICAL

1. Tostudydifferenttypesofanimal behavior suchashabituation,sociallife,courtship behavior ininsects,andparentalcarefromshortvideos/moviesandprepareashort report.
2. To studynests and nestinghabits of thebirds andsocial insects.
3. To studythe behaviouralresponses ofwoodlicetodrycondition.

4. To studybehaviouralresponses ofwood licein response to humid condition.
5. To studygeotaxis behaviour inearthworm.
6. To studythephototaxisbehaviour in insect larvae.
7. Visit to Forest/ Wild life Sanctuary/Biodiversity Park/Zoological Park to study behaviouralactivities of animals and prepareashort report.

SUGGESTED READINGS

1. David McF. Animal Behaviour. Pitman PublishingLimited,London, UK.
2. John A(2001)Animal Behaviour. 7th Edition.SinauerAssociateInc., USA.
3. ManningA and Dawkins MS. AnIntroduction toAnimal Behaviour. Cambridge UniversityPress, USA.
4. MohantyPK(2000)Illustrated DictionaryofBiology. Kalyani Publishers,Ludhiana.
5. Paul WS andJohn A (2013)ExploringAnimal Behaviour. 6th Edition.SinauerAssociate Inc., Massachusetts, USA.
6. Mathur R. Animal Behaviour, RastogiPublication,Meerut.

DISCIPLINE SPECIFIC ELECTIVE II
ANIMAL BIOTECHNOLOGY
(CREDITS: THEORY-4, PRACTICALS-2)

THEORY

Unit 1: Concept and scope of Biotechnology, Cloning vectors (Types and characteristics), Restriction enzymes: Nomenclature, detailed study of Type-II.

Unit 2: Transformation techniques: Calcium chloride method and electroporation, Construction of genomic and cDNA libraries and screening, Blotting techniques, DNA sequencing, Polymerase Chain Reaction, DNA finger printing and DNA microarray

Unit3: Production of cloned and transgenic animals: Nuclear transplantation, retroviral method, DNA microinjection, Applications of Transgenic animals: production of pharmaceuticals, knock out mice, donor organs, production of transgenic plants: Agrobacterium mediated transformation, Application of Transgenic plants: insect and herbicide resistant plants.

Unit4: Animal cell culture, Expression of cloned genes, molecular diagnosis of genetic diseases (Cystic fibrosis/Sickle cell anemia), Recombinant DNA in medicine: insulin/growth hormone, Gene therapy.

PRACTICAL

1. Genomic DNA isolation from E. Coli.
2. Plasmid DNA isolation.
3. Restriction digestion
4. Construction of circular and linear restriction map
5. Calculation of transformation efficiency from the data provided
6. To study the following technique through photographs Southern Blotting NothernBlotting DNA sequencing PCR DNA fingerprinting
7. Project report on animal cell culture.

SUGGESTED READINGS

1. Brown, T. A. Molecular Biology, LabfaxII: Gene cloning and DNA Analysis, II Edition

2. Glick, B. R. and Pasternak, JJ, Molecular Biotechnology-Principles and Application of Recombinant DNA, IV Edition

3. Griffiths, AJF etal. (2009): An Introduction to Genetic Analysis, IX Edition

4. Snustad, DP and Simmons MJ, Principles of Genetics, V Edition

5. Watson JD, Myers RM, Caudy A and Witkowski JK (2007): Recombinant DNA-Genes and Genomes-A short Course, III Edition

6. Beauchamp TI and Childress JF (2008): Principles of Biomedical Ethics, VI Edition.

DISCIPLINE SPECIFIC ELECTIVE III
MICROBIOLOGY
(CREDITS: THEORY-4, PRACTICALS-2)

THEORY

Unit 1: Historyof Microbiology; Microbial World– Characterization, Classification and identification ofmicrobes.

Unit 2: Prokaryotes: General morphologyandclassification ofbacteria, theircharactersand economicimportance; Gram-positive and Gram-negativebacteria.Eukaryotes: General morphologyof Protista and Fungi– classification and economic importance.

Unit3: Viruses:structure,genome,replicationcycle;Epidemiologyofinfectiousdisease swith referenceofhumanhosts–Bacterial(Tuberculosis),Viral(Hepatitis),Protozoan (Amoebiasis) and Fungal(anyone)disease.

Unit4: Microbeinteractions – ImmuneResponses-Antibioticsandotherchemotherapeutic agents; Appliedmicrobiologyinthefields of food, agriculture, industryand environment.

PRACTICAL

1. Cleaningofglasswares, sterilization principleandmethods-moistheat-dryheatand filtration methods.
2.Mediapreparation:Liquidmedia,Solidmedia,Agarslants,Agarplates.Basal,enriched , selectivemediapreparation-quality control ofmedia,growthsupportingproperties, sterilitycheck of media.
3. Pureculturetechniques:Streak plate, pourplateand decimal dilution.
4. Culturalcharacteristicsofmicroorganisms:Growthondifferentmedia,growth characteristics and description and demonstration ofpigment production.
5. Stainingtechniques:Smearpreparation,simplestaining,Gram'sstaining,Acidfast stainingand stainingformetachromaticgranules.
6. Morphologyof microorganisms.
7. Antibioticsensitivitytesting: Discdiffusion test- Qualitycontrol with standard strains
8. Physiology characteristics:IMViCtest,H2S,Oxidase,catalase,ureasetest,Carbohydrate fermentation,Maintenanceofpureculture,Paraffinmethod,Stabcultureand maintenanceof mold culture.

SUGGESTED READINGS

1. Ahsan Jand Sinha SP(2010)A Hand book on EconomicZoology. S Chand, NewDelhi.

2. AroraDRandAroraB(2001)MedicalParasitology.2nd Edition.CBSPublicationsand Distributers.

3. AtwalAS(1993)AgriculturalPestsofIndiaandSouthEastAsia.KalyaniPublishers, Ludhiana.

4. DubeyRCand MaheshwariDK(2013)ATextbookofMicrobiology.S.Chand,New Delhi.

5. Dunham RA(2004) Aquaculture and Fisheries Biotechnology Genetic Approaches. CABIpublications.

6. PelczarMJ,ChanECSandKriegNR(1993)Microbiology.5th Edition,TataMcGraw Hill PublishingCo.Ltd.

7. Pradhan, S (1983)InsectPests of Crops. National Book Trust ofIndia, New Delhi.

8. Shrma P.D. Microbiology, RastogiPublication,Meerut.

DISCIPLINE SPECIFIC ELECTIVE IV

PROJECT AND SEMINAR

CREDITS: 6

FULL MARK-100

GENERIC ELECTIVE -I
ANIMAL DIVERSITY
(THEORY-4, PRACTICALS-2)
THEORY

Unit 1:
General characters of Protozoa; Life cycle of plasmodium
General characters & canal system in Porifera
General characters of Cnidarians & Polymorphism in hydrozoa
General characters of Helminthes**;**Life cycle of *Taeniasolium*
General characters ofNemathelminthes ; Parasitic adaptation

Unit 2:
General characters &MetamerisminAnnelida ;
General characters of Arthropoda ; Social life in insects
General characters of Mollusca ; Pearl formation
General characters of Echinoderms ; Water vascular system in Starfish

Unit 3:
Salient features of Protochordates
Osmoregulation , Migration of Fishes
General characters of Amphibians ; Adaptation of Amphibians for terrestrial life Parental care in Amphibia

Unit 4:
Origin of Reptiles ; Terrestrial adaptations in Reptiles
Origin of Birds ; Flight adaptation in birds
Early evolution of Mammals ; Primates ; Dentition in Mammal

PRACTICALS

1.Study of following specimens :

Non chordates :*Euglena,Noctiluca,Paramecium,Sycon,Physalia,Tubipora,Metridium,Taenia,Ascaris, Nereis,Aphrodite,Leech,Peripatus,Limulus,*Hermit crab*,Daphnia,*Millipede,Centipede, *Beetle,Chiton,Dentalium,Octopus, Asterias,Antedon*

Chordates
:*Balanoglossus,Amphioxus,Petromyzon,Pristis,Hippocampus,Labeo,Ichthyophis,Salamander,Rhacophorus,Draco,Uromastix,Naja,Viper,Model of Archaeopteryx,* Crow,Duck,Owl,Squirrel,Bat

2. Study of permanent slides :
C.S of Sycon, Sea anemone,Ascaris T.S of Earthworm passing through pharynx,gizzard,typhlosolar region of intestine Bipinnaria&Pluteus larva

3. **Temporary mount** of Septal & Pharyngeal nephridia of Earthworm Placoid, cycloid,ctenoid scales

4. **Dissection** of Digestive & Nervous system of Prawn,Cockroach. Urinogenital system of Rat, Calotes.

SUGGESTED BOOKS

1. Barnes,R.D.(1992). Invertebrate Zoology. Saunders college Pub. USA.
2. Ruppert, Fox & Barnes (2006) Invertebrate Zoology.A functional Evolutionary Approach 7th Edition, Thomson Books/Cole
3. Campbell & Reece (2005). Biology,Pearson Education, (Singapore) Pvt. Ltd.
4. Kardong,K.V.(2002). Vertebrates Comparative Anatomy, Function and Evolution. Tata McGraw Hill Publishing Company, New Delhi.
5. Raven, P.H. and Johnson, G.B., (2004). Biology, 6th edition, Tata McGraw Hill Publications.New Delhi.
6. Arora MP (2006) Non-Chordata-I&II,1st edition. Himalaya Publishing House, New Delhi.
7. Arora MP (2006) Chordata- I.1st edition. Himalaya Publishing House, New Delhi.
8. Jordan EL andVerma PS (1963) Invertebrate Zoology. Revised Edition, S.Chand, New Delhi.
9. Jordan EL and Verma PS (1963) Chordate Zoology. Revised Edition, S.Chand, New Delhi.
10. Agarwal VK (2011) Zoology for Degree students. S.Chand, New Delhi.
11. Kotpal R.L Modern Text Book of Zoology, Invertebrates. RastogiPublication,Meerut.
12. Kotpal R.L. (2015) Modern Text Book of Zoology, Vertebrates, RastogiPublication,Meerut.

GENERIC ELECTIVE -4

4^{TH} SEMESTER

ENVIRONMENT AND PUBLIC HEALTH

(THEORY-4, PRACTICALS-2)

THEORY MARK-100

Unit 1: Introduction

Sources of environmental hazards, hazard identification and accounting, fate of toxic and persistent substances in the environment, dose response evalution, exposure assessment.

Unit 2: Climate change

Greenhouse gases and global warming, Acid rain, Ozone layer destruction, Effect of climate change on public health.

Unit 3: Pollution

Air, Water, Noise pollution; sources and effects, pollution control

Unit 4: Pollution oriented diseases

Sources of waste, types and characteristics, sewage disposal and its management, solid waste disposal, causes, symptoms and control of Tuberculosis, Asthma, Cholera, Minamata disease, Typhoid.

PRACTICALS

To determine -P^H, Cl^-, SO_4^{--}, NO_3^-in soil and water sample from different location.