MASTER OF SCIENCE IN

BOTANY

(SEMESTER PATTERN)

CHOICE BASED CREDIT SYSTEM SYLLABUS

TWO-YEAR FULL TIME PROGRAMME

COURSES OF STUDIES

(2023 -2024)

Buxi Jagabandhu Bidyadhar Autonomous College

Bhubaneswar - 751014

Accredited at the 'A' Level by

National Assessment and Accreditation Council (NAAC)

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Preamble

The M. Sc. Botany course will be effective from the academic year 2023 –2024. It has been prepared keeping in view the unique requirements of M. Sc. Botany students and CSIR NET syllabus. The emphasis is to provide students the latest information along with due weightage to the concepts of classical botany so that they are able to understand and appreciate the current interdisciplinary approaches particularly in the field of research and innovation in the plant sciences and its role in societal development. Todays' plant science is a mixture of the traditional components with the modern aspects of biochemistry, molecular biology and biotechnology. Over the years, plant science (Botany) has shown enormous gain in information and applications owing to tremendous inputs from research in all its aspects. Thus the course content also lists new practical exercises so the students gets a hands on experience of the latest techniques that are currently in use. The four semester M. Sc. syllabus is a balanced, carefully-crafted course structure taking care of different aspects of plant science, namely plant diversity, cytogenetic, physiology, biochemistry, molecular biology, biotechnology, developmental biology, anatomy, taxonomy, ecology, economic botany and the impact of environment on the growth and development of plants. All these aspects have been given due weightage over the four semesters having special emphasis on some aspects in the last semester. Students should be encouraged to opt for one allied elective paper from other Life Sciences like Zoology and Biotechnology courses to increase interdisciplinary approaches of understanding and application. The course will also inspire students to pursue higher studies in botany, for becoming an entrepreneur and enable students to get employed in plant based industries. On the whole, the curriculum is a source of lot of information and is supported by rich resource materials. On behalf of Department of Botany, this new syllabus will cater the fundamental requirements for the students being employed in different sectors to serve the world as a whole.

M.Sc. PROGRAMME IN BOTANY

(SEMESTER SYSTEM)

To be effective from the session 2023-2024

Outlines of M.Sc. (Botany) Syllabus

Semester-I			
Core Papers:	**Core Papers Name**	**Mark**	**Credit**
Paper-C-101	Diversity of Life	100	04
Paper-C-102	Diversity of Vascular Plants	100	04
Paper-C-103	Cell & Molecular Biology of Plants	100	04
Paper-C-104	Plant Biochemistry	100	04
Paper-C-105	Practical pertaining to Theory Papers C-101, C- 102, C -103 and C-104	100	04
	TOTAL	500	20
Semester-II			
Paper-C-201	Cytogenetics, Plant Breeding & Biostatistics	100	04
Paper-C-202	Biotechnology & Genetic Engineering of Plants	100	04
Paper-C-203	Plant Physiology	100	04
Paper-C-204	Plant Taxonomy, Ecology & Evolution	100	04
Paper-C-205	Practical Pertaining to Theory Papers C-201, C-202, C-203 and C-204	100	04
	TOTAL	500	20
Semester-III			
Paper-C-301	Plant Development, Reproduction and Economic Botany	100	04
Paper-C-302	Conservation Biology	100	04
Paper-C-303	Plant physiology and Developmental biology	100	04
Paper-EC-304 (Elective A)	Plants & Environment	100	04
Paper-C-305	Practical Pertaining to Theory Papers C-301, C-302, C-303 and EC-304	100	04
	TOTAL	500	20
Semester-IV			
Paper-C-401	Biochemistry and Molecular Biology - I	100	04
Paper-C-402	Biochemistry and Molecular Biology -II	100	04
Paper- EC-403 (Elective B)	Biosystematics	100	04
Paper-C-404	Seminar -50 Practical - 50	100	04
Paper-C-405	Project/ Dissertation	100	04
	TOTAL	**500**	**20**
	GRAND TOTAL	**2000**	**80**

SEMESTER – I

PAPER- C-101
DIVERSITY OF LIFE

100 Marks/ 4 Credits

Course Objectives:

The paper aims to enhance the knowledge of students on diversity of microorganisms and lower plants, their classification, structure, life cycle and their significance.

UNIT- I

History and development of microbiology, Bergey's manual for classification of microbes, isolation, culture and maintenance of microorganisms, Microbial growth, Roles of microbes in agriculture and industry, Factors influencing growth of microbes.

UNIT- II

Structure and reproduction of Eubacteria, Cyanobacteria, Archaea, Actinomycetes, Mycoplasma, Rickettsiae, Spirochaetes, Virus, Viroids, Prions, Biofertilizers: cyanobacteria, *Rhizobium*, PSB, Mycorrhizae and *Azotobacter*. Plant diseases caused by viruses, bacteria, mycoplasma.

UNIT- III

Algae in diversified habitats (terrestrial, freshwater and marine), classification based on pigment, food reserve and flagella, thallus organization, reproduction. Life cycles in algae. Salient features of Chlorophyta, Bacillariophyta, Dinophyta, Phaeophyta and Rhodophyta, algal bloom and toxins, algae as food, seaweed cultivation.

UNIT- IV

Classification of fungi, structure and reproduction of Phycomycetes, Ascomycetes, Basidiomycetes and Deuteromycetes. Degeneration of sex in fungi, nutrition in fungi, heterothallism, heterokaryosis. Host- parasite relationship, fungal toxins and their mode of action.

UNIT- V

Origin, evolution and classification of Bryophytes, Ecological significance of bryophytes, structure and reproduction of Anthocerotales, Marchantiales, Jungermanniales, Sphagnales, and Polytrichales, Progressive sterilization of sporogenous tissues, evolution of gametophytes in bryophytes.

Course Outcomes:

The course will impart theoretical knowledge on diversity of microorganisms, their life forms, economic importance and various plant diseases caused by them. Students will learn the basics of microbial techniques like isolation, culture and preservation of bacteria, algae and fungi. Students will learn about origin, evolution and reproductive strategies of bryophytes.

SEMESTER – I

PAPER-C-102
DIVERSITY OF VASCULAR PLANTS

100 Marks/ 4 Credits

Course Objectives:

The paper aims to understand the evolutionary diversification, morphology, reproduction of extinct and present day vascular plants. students will also be exposured to paleobotany and palynology.

UNIT- I

Origin, evolution and classification of pteridophytes, General account of Psilophytales, fossil lycophytes, Sphenophytes, fossil ferns. Stellar evolution; Origin of heterospery, Heterospory and seed habit.

UNIT- II

Structure, reproduction and evolution of Psilopsida, Lycopsida, Sphenopsida and Pteropsida, soral evolution, origin, morphology and evolutionary significance of sporocarp.

UNIT-III

Evolution and classification of Gymnosperms, General account of Pteridospermales, Cycadeoidales, Pentoxyllales, fossil Ginkgoales, Cordaitales and fossil Coniferales.

UNIT-IV

Structure and reproduction of Cycadales, Ginkgoales, Coniferales, Ephedrales, Welwitscilales, and Gnetales. Complexities and gametophytes in gymnosperm, Evolution of female gametophytes; variation in the structure of pollen grains of Angiospermis.

UNIT- V

Paleobotany, Geological time scale, Basic concepts of continental drift, Fossilization process, Types of fossil, Dating of fossil, Fundamentals and applications of paleobotany Palynology: Spore and pollen morphology, polarity, symmetry, ornamentation

Course Outcomes:

Students will learn about evolution of gametophytes, sporophytes and conducting tissues of fossil and living pteridophyte as well as gymnosperm. Students will have knowledge on basics of paleobotany and palynology along with their applications.

SEMESTER – I

PAPER-C-103
CELL & MOLECULAR BIOLOGY OF PLANTS

100 Marks/ 4 Credits

Course Objectives:

The objective of the present course content is to provide a foundation and background of cellular structure, cell organelles in relation to their functions and regulatory mechanisms.

UNIT-I

Cell Wall: Structure & functions; biogenesis; growth. *Plasma membrane*: Structure, models, electrical properties of membrane & functions; sites for ATPases, ion carriers, channels and pumps; receptors *Plasmodesmata:* Structure; role in movement of molecules & macromolecules; comparison with gap junctions.

UNIT-II

Chloroplast: Structure, genome organization, gene expression, RNA editing, nucleochloroplastic interaction. *Mitochondria*: Structure, genome organization, Biogenesis. *Other cellular organelles*: Structure & functions of microbodies, golgi apparatus, Lysosomes, endoplasmic reticulum.

UNIT-III

Nucleus: Structure, nuclear pores, nucleosome organization, DNA structure, A, B & Z forms, eplication, damage & repair. *Transcription*: Plant promoters & transcription factors, splicing, m-RNA transport, Nucleolus, t-RNA, micro-RNA.

UNIT-IV

Ribosomes: Structure, site of protein synthesis, mechanism of translation initiation, elongation & termination. Stability of proteins, Conformation of proteins (Ramachandran plot, secondary structure, domains, motif and folds). *Protein sorting*: Targeting of proteins to organelles, mechanism of sorting and regulation of target transport.

UNIT-V

Cell shape & motility: The cytoskeleton, organization & role of microtubules and microfilaments, motor movements, implications in flagellar & other movements. *Cell cycle and apoptosis*: Control mechanisms, role of cyclins & cyclin dependent kinases, retinoblastoma & E2F proteins, cytokinesis & cell plate formation, mechanism of programmed cell death.

Course Learning Outcomes:

The students will be learning about the structure and function of cell wall and plasma membrane, cell organelles such as chloroplast, mitochondria and others. Students will have knowledge on nuclear organization, DNA structure, replication and repair, transcription, translation and protein sorting. Understanding about regulatory mechanism of cell cycle and apoptosis of the students will be enhanced.

SEMESTER – I

PAPER-C-104
PLANT BIOCHEMISTRY

100 Marks/ 4 Credits

Course Objectives:

The course aims to educate student on basic principles biophysics, fundamentals of biochemistry, structure and properties of various bio-molecules such as carbohydrates, proteins, lipids and enzymes.

UNIT-I

Principles of Biophysical Chemistry: Reaction kinetics: equilibrium and law of mass action, concept of reaction rates. Thermodynamics: Concept and Laws of thermodynamics, biological applications; *Fundamentals of Biochemistry:* Proteolysis of water and hydrogen ion concentration, pH, Buffers;Solution and Colligative properties; *Stabilizing interactions*: Vanderwaals, Electrostatic, Hydrogen bonding and Hydrophobic interactions; *Metabolism and bioenergetics:* Generation and utilization of ATP, coupled reaction, group transfer, biological energy transducers.

UNIT-II

Carbohydrate: Structure, Physical & chemical properties, Biological activity of monosaccharide, oligosaccharide and polysaccharide

UNIT-III

Proteins: Amino acid Classification, structure and properties, Proteins : Primary, Secondary, tertiary and quaternary structure, determination of amino acid sequence, Protein folding.

UNIT-IV

Lipids: Classification, Structure, Physical and chemical properties of essential non essential fatty acids, triglycerides, phospholipids, wax. *Secondary metabolites:* Importance of secondary metabolites, biosynthesis of terpenes, phenols and nitrogenous compounds and their roles.

UNIT-V

Enzymes: Nomenclature and Classification of enzymes, Enzyme kinetics: Michaelis-Menten equation and Briggs-Haldane modification; Determination of Km, Competitive, non-competitive and un-competitive inhibition of enzymes, Determination of inhibition constant. Mechanism of action of Chymotrypsin and Ribonuclease, Regulation of enzyme activity (covalent modification, feedback regulation and allosteric control)

Course Outcomes:

Students will be learning about concepts of reaction kinetics, thermodynamics and their biological applications, fundamentals of biochemistry including metabolism and bioenergetics. Students will gain knowledge on structure and properties of carbohydrate, proteins, lipids and secondary metabolites. Students will learn the basics of enzyme kinetics and regulation of enzyme activity.

SEMESTER – I

PAPER-C-105
PRACTICALS PERTAINING TO THEORY PAPERS C-101, C-102, C-103 and C-104

100 Marks/ 4 Credits

Course Objectives:

Aim of the course is to impart knowledge on practical aspect of structure of microorganisms, lower plants and vascular plants. Practical skills on analysis of cell cycle, isolation and analysis bio-molecules along with understanding of their biochemistry will be given.

Semester-I (Diversity of Life, Diversity of Vascular Plants, Cell & Molecular Biology of Plants, Plant Physiology & Biochemistry)

Course Learning Outcomes:

Students will gain practical knowledge on microscopic examination microorganisms like bacteria, fungi, and algae. Students will be learning about gametophytic and sporophytic structures of bryophytes, pteridophytes and gymnosperm. Students will be able to isolate and quantify bio-molecule like DNA, RNA, protein, carbohydrate and lipids. Students will be able to identify different stages of cell cycle.

Reference books

- Smith G M Crptogamic Botany Vol I Algae and Fungi Mc Graw Hill Publ.
- Smith G M Crptogamic Botany Vol II Bryophytes and Pteridophytes Mc Graw Hill Publ.
- Kumar, H. D. (1988). Introductory Phycology. East-West Press, New Delhi.
- Maloy, S. R., Cronan, J. E. Jr. and Freifielder, D. (2008). Microbial Genetics, 2nd Ed. Norosa, New Delhi.
- Mehrotra, R. S. and Aneja, R. S. (1998). An Introduction to Mycology, New Age International, NewDelhi.
- Prescott, L. M., Harley, J. P. and Klen, D. A. (1999). Microbiology, 4th Ed. WCB- McGra-Hill, New Delhi.

- Alexopoulus, C. J., Mims, C. W. and Blackwel, M. (1996). Introductory Mycology, John Wiley, New York.
- Pandey. D.C. A Text Book on Algae (simple Photosynthetic Plants)
- Vashista, B. R. (1995) Botany for Degree students, Vol I & II Chand & Co, New Delhi.
- Sharma, O.P. (1990). Text book of Algae. Tata McGraw Hill Publishing Co., Ltd., New Delhi.
- Mehrothra, R.S. Plant Pathology -Tata McGraw Hill Publishing Co. New Delhi .
- Rangaswami,G.& A.Mahadevan. (1994) Diseases of Crop plants in India (4th Ed) Prentice Hall of India (P) Ltd. New Delhi.1998.
- Vashishtha series for Algae. Fungi Bryophyta Pteridophyta and Gymnosperms S Chand Publ.
- Sharma, O.P. Text book of Fungi-Tata McGraw Hill Publishing Co. New Delhi.
- Srivastava, J.P. Introduction to Fungi. Central Book Dept. Allahabad, India.
- Dubey. H.C. (1990) An introduction of fungi. 2nd Edition. Vikas Publishers. ISBN PB: 9788125914334.
- Parihar, N. S. (1991). Biology and Morphology of Pteridophytes. Central Book Depot, Allahabad.
- Bhatnagar, S. P. and Moitra, A. (1996). Gymnosperms. New Age International, New Delhi.
- Maloy, S. R., Cronan, J. E. Jr. and Freifielder, D. (2008). Microbial Genetics, 2nd Ed. Norosa, New Delhi.
- Chamberlin, C. J. (1935). Gymnosperms: Structure and Evolution. Dover Publications, New York.
- Cooper G. M. (1997). The Cell: A molecular approach. ASM Press, Washington, D. C., USA.
- Buchachnanan, B. B., Grissem, W. and Jones, R. L. J., (2000). Biochemistry and molecular biology of plants. American Society of plant physiologists, Rockville, USA
- Malacinski, G. M and Feidfelder, D (1998). Essentials of Molecular Biology, 3rd Ed. Jones and Bartel, London.
- Lewine, B. (2004) Gene VIII, Person-Prentice Hall, London.
- Devlin, R. N. and Witham, F. H. (1983). Plant Physiology. CBS Publishers, Delhi.
- Salisbury, F. B. and Ross, C. W. (1992). Plant Physiology, 4th Edition Wadsworth Publication California, USA.
- Noggle, G.R. and Fritz G.J. (1983) Introductory Plant Physiology. 2nd edition, 2010
- Boyer, R. (2004). Modern Experimental Biochemistry, 3rd Ed. Pearson Educational Publication, Singapore.
- Taiz, L. and E. Zeiger. 2002. Plant Physiology. 3rd Edition. Sinauer Associates, Inc., Sunderland, MA. 690 pp.
- David Freifielder (1995). Molecular cell biology - 2nd Edition, Narosa publishing House.
- Karp, G. Cell and Molecular Biology: Concepts and Experiments, 2000. John Wiley and Sons, New York.
- Benjamin Lewin, Genes VIII, 2004, Pearson Prentice Hall, New Jersey.

- Harvey Lodish, Arnold Berk, Paul Matsudaira, Chris A. Kaiser, Monty Krieger, Matthew P. Scott, S. Lawrence Zipursky, James Darnell. 2004. Molecular Cell Biology, Fifth Edition, W. H. Freeman and Company, New York.
- Sawhney , R Singh Introductory Practical Biochemistry Narosa Publishing House Pvt Ltd
- Rangaswamy, D (1988) Disease of crop plants in India, Prentice Hall India, Ltd New Delhi.
- Asada, Y, Bbushnell, NR Ouchi. S, and vance, P (1982) Plant infection. The physiology and Biochemical basis, Springer Verlag, Berlin Nee York.
- Kosuge, T and Nester, EN (1984) Plant microbe interaction – molecular and genetic perspectives, MacMillan, New York.

SEMESTER – II

PAPER-C-201
CYTOGENETICS, PLANT BREEDING & BIOSTATISTICS

100 Marks/ 4 Credits

Course Objectives:

The paper will deal with chromatin organization, structural and numerical alternation in chromosomes, genetics of prokaryotes and eukaryotic organelles, molecular cytogenetics and regulation of gene expression. Students will be taught about basics of statistical analysis and its application in biological studies.

UNIT- I

Chromatin organization: Chromosome structure, and Models, nucleolus, Euchromatin and heterochromatin, Chromosome banding, telocentric chromosome, isochromosome and B chromosome, Cell cycle, Molecular basis of cell division, Initiation of Meiosis Karyotype and its significance. *Genetic recombination and mapping*: Molecular basis of recombination, Role of Rec A and Rec BCD, physical mapping of genes on chromosomes, sex determination in plants.

UNIT- II

Structural and numerical alteration in chromosomes: Spontaneous and induced mutations, Physical and chemical mutagens, Chromosomal aberrations, Meiotic behaviour of deletion, duplication, inversion and translocation, Molecular basis of gene mutation, Euploids and aneuploids-classification, origin, induction, cytological features and genetic analysis, Role of polyploidy in evolution and practical significance in crop improvement. *Plant Breeding*: Method of plant breeding – introduction & selection (Pedigree, back cross, mass selection, bulk method), male sterility and heterosis breeding, mutation breeding.

UNIT- III

Genetics and Prokaryotes and Eukaryotic Oragnelles: Genetic transformation, transduction and conjugation in bacteria, Gene mapping in bacteria, Genetic recombination in bacteriophages and mapping of phage genome, Genetics of mitochondria and chloroplasts, Cytoplasmic male sterility, Transposable genetic elements.

UNIT- IV

Molecular cytogenetics: Nuclear DNA content, C-value paradox, nucleic acid denaturation and renaturation, *Cot* curve and its significance, introns and RNA splicing, Genetic code, Regulation of gene expression in prokaryotes and eukaryotes, Restriction mapping, RFLP, RAPD, AFLP, *in situ* hybridization, Flow cytometry.

UNIT- V

Statistical Methods: Sampling methods, Sampling distribution, parametric and non-parametric statistics, measures of central tendency and dispersion, mean, mode & median, Mean deviations coefficient of variance (CV).Standard deviations, Standard error of mean, probability distribution (normal, binominal and poison), confidence intervals, regression and correlation, tests of significance (t-test, and X^2 test), analysis of variance.

Course Learning Outcomes:

Students will learn about genetic recombination and mapping techniques, karyotype analysis, chromosomal aberrations, DNA damage and repair mechanism. Students will gain knowledge on plant breeding techniques for crop improvement. Students will have basic knowledge on regulation of gene expression, molecular markers and their application. Students will learn about sampling techniques, testing of hypothesis, correlation and regression.

SEMESTER – II

PAPER – C- 202
BIOTECHNOLOGY & GENETIC ENGINEERING OF PLANTS

100 Marks/ 4 Credits

Course Objectives:

The paper will deal plant cell, tissue & organ culture, somatic hybridization and cybridization, recombinant DNA technology and genetic engineering of plants. Students will be taught about various instruments and techniques used in biological experiments.

UNIT- I

Plant cell, tissue & organ culture: History, scope and concept of cellular differentiations, totipotency, Fundamental aspects of morphogenesis: organogenesis and somatic embryogenesis, Clonal propagation, Artificial seeds. Androgenesis and production of haploids, Callus and cell suspension culture, Productionof somaclonal variants, production of secondary metabolites in cultures, Cryopreservation.

UNIT- II

Somatic hybridization and cybridization: Factors affecting protoplast isolation, culture and plant regeneration, Protoplast fusion-chemical fusion & electrofusion mechanism & techniques, Selection of heterokaryotic fusion products, biochemical selection and physical selection (micromanipulation, flow cytometric characterization and cell sorting), Analysis of hybrids, Somatic hybrids and cybrids for crop improvement.

UNIT- III

Recombinant DNA technology: Gene cloning-principles, Cloning vectors-plasmids, phages, cosmids & phagemids; Artificial chromosomes, Polymerase Chain Reaction-principles, types and applications, RT- PCR; Genomic and c DNA libraries; Construction of recombinant DNA molecules and their mobilization into bacteria; Analysis of recombinant clones, DNA sequencing.

UNIT- IV

Genetic Engineering of plants: Methods for gene transfer to plants, *Agrobacterium* mediated and direct gene delivery, Gene tagging, detection of foreign gene and gene products; Southern blotting, Northern blotting and Western blotting; Chloroplast transformation, Gene targeting, Transgenic plants for crop improvement, possible ecological risks and ethical concerns.

UNIT-V

Biological methods: UV/Visible Spectrophotometry, Atomic Absorption Spectrophotometry fluorescence spectroscopy, NMR & ESR Spectroscopy, Mass Spectrometry, Electrophoresis, ELISA, Electron Microscopy–Scanning and transmission, Image processing, Chromatography. Centrifugation techniques, pH Electrode. Northern, Southern and Western Hybridization.

Course Outcomes:

Students will learn about clonal propagation, production of haploids, somaclonal variants, development of somatic hybrids and cybrids for crop improvement. Students will gain knowledge on recombinant DNA technology and *Agrobacterium* mediated gene transfer for development of transgenic plants. Students will learn techniques like electrophoresis, blotting techniques, spectroscopy, chromatograph, ELISA etc.

SEMESTER – II

PAPER-C-203
PLANT PHYSIOLOGY

100 Marks/ 4 Credits

Course Objectives:

The course aims to educate students on concepts of membrane transport, translocation of water and solutes, photosynthesis, respiration, lipid and nitrogen metabolism, sensory photobiology, plant growth regulators and mechanism of flowering.

UNIT- I

Membrane transport and translocation of water and solutes: Uptake, transport and translocation of water, ion, solutes and macromolecules by membrane transport through xylem and phloem; transpiration and stomatal movement, mechanism of loading and unloading of photoassimilates.

UNIT- II

Photosynthesis: Photosynthetic pigments and light harvesting complexes, mechanism of electron transport, photoprotective mechanisms; CO_2 fixation: C_3, C_4 and CAM pathways, Photorespiration.

UNIT- III

Respiration and lipid metabolism: Glycolysis, TCA cycle, electron transport and ATP synthesis, alternate oxidase system, structure and functions of lipids, fatty acid biosynthesis, structure and function of carbohydrates.

UNIT- IV

Nitrogen metabolism: Biological nitrogen fixation, mechanism of nitrate uptake and reduction, nitrate and ammonium assimilation, amino acid biosynthesis.

Sensory Photobiology: Pigments as photoreceptors, structure, function and mechanisms of action of phytochromes, cryptochromes and phototropins, photoperiodism

Stress Physiology: Responses of plants to biotic (pathogen and insects) and abiotic (water temperature and salt) stresses. Metal toxicity, oxidative stress.

UNIT- V

Flowering and Senescence: Mechanism of flowering, Vernalization, biological clocks. Molecular mechanism of senescence and aging in plants. *Plant Growth regulators:* Biosynthesis, storage,

breakdown and transport of plant hormones; Mechanism of action, physiological effects and applications of plant growth regulators. Growth movement, measurement and indices.

Course Outcomes:

Students will learn about mechanism of membrane transport, transport through xylem and phloem, mechanism of photosynthesis, respiration and nitrogen metabolism. Students will gain knowledge on stress physiology, photoreceptors, flowering and senescence in plants.

SEMESTER – II

PAPER-C-204
PLANT TAXONOMY, ECOLOGY & EVOLUTION

100 Marks/ 4 Credits

Course Objectives:

The course aims to add to the understanding of the students about the nomenclature, classification and diversity of flowering plants. Students will be taught about ecosystem, population and community ecology. Students will be exposed to concepts of evolution and population genetics.

UNIT- I

Nomenclature : The species concept, delimitation of taxa and attribution of ranks, salient features of ICBN, the relevance of taxonomy to conservation, herbarium and floras, herbarium methodology, important herbaria of the world. Phenetic and phylogenetic systems of classification, relative merits and demerits of major system of classification, cladistics in taxonomy, Molecular taxonomy.

UNIT- II

Taxonomic evidence: Morphology, palyonology, anatomy, embryology, cytology and Phytochemistry. *Range of floral structures*: Ranales, Rosales, Asterales, Scitaminae and Orchidales

UNIT- III

Physical and biotic environment, Biotic and abiotic interactions, concept of habitat and niche, niche width and overlap, fundamentals and realized niche, resource partitioning and character displacement, Population characteristic, population growth curves, population regulation, life history strategies (r and k selections), concept of metapopulation- Demes, Dispersal. Interdemic extinctions, age structure populations.

UNIT- IV

Community ecology: nature, structure and its attributes, levels of species diversity and its measurement. Edges and Ecotones, ecological succession: types, mechanism, changes involved in succession, climax concept. *Ecosystem Ecology:* Structure, function, energy flow, mineral cycling (C, N, P), Primary Production and decomposition, structure and functions of Indian ecosystems: terrestrial (forest and grassland) and aquatic (fresh water, marine and estuarine).

UNIT- V

Evolution: Lamark and Darwin concept of variation, adaptation and natural selection, evolution of prokaryotes, origin and evolution of eukaryotes, origin and development of major group of organisms in geological time scale, molecular evolution. *Population genetics*: Populations, Gene pool, Gene frequency; Hardy-Weinberg Law; Adaptive radiation; Isolating mechanisms; Speciation; Allopatricity and Sympatricity; Convergent evolution; Sexual selection;Co-evolution.

Course Outcomes:

Students will learn about ICBN and rules for plant nomenclature, merits and demerits of major system of classification, Taxonomic evidence and range of floral structures of different orders. Students will gain knowledge on habitat, population characteristics, structure and attributes of community, ecological succession, structure and function of ecosystem. Students will learn about theories of evolution and maintenance of gene frequency in population.

SEMESTER – II

PAPER-C-205
PRACTICALS PERTAINING TO THEORY PAPERS C-201, C-202, C-203 and C-204

100 Marks/ 4 Credits

Course Objectives:

Aim of the course is to impart knowledge on practical aspect of karyotype chromosomal aberrations, micropropagation, electrophoresis, spectrophotometry, identification of plants and community analysis.

Semester-II (Cytogenetics, Plant Breeding & Biostatistics, Biotechnology & Genetic Engineering of Plants, Plant Physiology, Plant Taxonomy, Ecology & Evolution)

Course Outcomes:

Students will gain hand-on training on the identification of chromosomal aberrations, karyotyping, photosynthetic pigment isolation and quantification, aseptic techniques in clonal propagation, taxonomic identification of flowering plants, chromatographic techniques for separation of compounds and quantitative analysis of plant communities in various ecosystems.

Reference Books

- Glick, B. R. and Pasternak (2003). Molecular Biotechnology: Principles and Applications of Recombinant DNA. ASM Press, Washington, D. C., USA.
- Kyte, L. and Kleyn, J. (1996). Plants From Test Tube to: an Introduction to Micropropagation, 3 Ed. Timber press, Port land, USA.
- Pollard, W. J. and Walker (1990). Plant Cell and Tissue Culture Vol VI. Humana press Clifton, USA.
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- Sharma O.P. (2009). Plant Taxonomy, 2nd Edition Tata McGraw Hill Publisher
- Sambamurty, A. V. S. S. (2005). Taxonomy of Angiosperms. I. K. International Pvt.Ltd., New Delhi.
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- Lawrence G.H. (1951) Taxonomy of Vascular Plants. 1st edition. Prentice Hall College Div Publishers, ISBN-13: 978-0023681905, 823 pp.
- Sharma, P.D. (1991)..Ecology and Environment. 10th ed. 2005. Rastogi Publications, ISBN, 8171339050, 9788171339051. 640 pp.
- M.C. Dash. (2004) Fundamentals of Ecology. 4th Edition Mc Graw Hill Education publishers. 504pp.

- Gomez, K. A. and Gomez, A. A. ((1984). Statistical Procedures for Agricultural Research, 2nd Ed. John Weley, New York.
- Kormondy, E. J. (1996). Concepts of Ecology, Prentice-Hall India, New Delhi.
- Odum, E. P. (1971). Fundamentals of Ecology, Saundas, Philadelphia, USA.
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- Smith, R. L. (1996). Ecology and Field Biology. Harper Collins, New York.
- Subrahmanyam, N. S. and Sambamurty, A. V. S. S. (2000). Ecology. Narosa, New Delhi.
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- Negi, S. S. (1993). Biodeiversity and its Conseravation in India. Indus Publishing Company, New Delhi.
- Simmonds, N. W. (1979). Evolution of Crop Plants. Longman, New York.
- Bewley, J.D. and Black, M. (1994). Seed: physiology of Development and Germination. Plenum, New York.
- Bhojwani, S.S. and Bhatnagar, S. P. (2008). The Embryology of Angiosperms. Vikas Publishing House, New Delhi.
- Raghavan, V (1997). Molecular Embryology of Flowering Plant. Cambridge University Press, Cambridge.
- Raghavan, V. (1999). Developmental Biology of Flowering Plants. Springer-Verlag, New York.
- K. Wilson and Walker J. Practical Biochemistry- Principles and Techniques. 5th Edn. Tata Mc. Graw Hill Publishers.
- P. Maheshwari (1950). Introduction to the Embryology and Angiosperms. Mc Graw Hill NY.

SEMESTER – III

PAPER-C-301

PLANT DEVELOPMENT AND REPRODUCTION, ECONOMIC BOTANY

100 Marks/ 4 Credits

Course Objectives:

Aim of the course is to educate students regarding differentiation of meristematic tissues, developmental biology, reproductive biology and economic botany of the flowering plants.

UNIT- I

Differentiation and Development: Difference between animal and plant cell development with unique features in plant cell development, use of mutants in seedling development; Molecular analysis of shoot apical meristem; root apical meristem & leaf growth, transition to flowering, vascular tissue differentiation of root, shoot & leaf, Floral development & homoeotic mutants in *Arabidopsis* & *Antirrhinum.*

UNIT- II

Developmental Biology: Molecular and cytological analysis of endosperm & fruit development, fruit ripening and its manipulation; polyembryony, apomixes, seed germination; seed dormancy,

bud dormancy, types & programmed cell death in life cycle of plants, metabolic changes associated with senescence and its regulation. Influence of hormones & environmental factors on senescence.

UNIT- III

Male gametophyte: Structure of anthers, microsporogenesis, role of tapetum, pollen development, male sterility, male nuclei dimorphism and hybrid seed production, pollen germination, pollen tube growth and guidance, pollen storage, pollen allergy, pollen embryos.

UNIT- IV

Female gametophyte: Ovule development, megasporogenesis, organization of the embryo sac, structure of the embryo sac cells, floral characteristics, pollination mechanisms and vectors, breeding systems, structure of pistil. *Developmental Embryology:* pollen-stigma interactions, sporophytic and gametophytic self incompatibility (cytological, biochemical and molecular aspects), double fertilization, *in vitro* fertilization.

UNIT- V

Economic Botany: Origin and domestication of cultivated plants, world centres of diversity of domesticated plants, plant introduction and secondary centre origin, evolution and uses of food, forage, fodder, fibre and oil-yielding crops. Uses of medicinal and aromatic plants, Important firewood and timber yielding plants and nonwood forest products, plants used as avenue trees for shade, pollution control and aesthetics.

Course Outcomes:

Students will learn about plant cell development, differentiation of apical meristems & vascular tissues, flower development and its genetic regulation. Students will gain knowledge on development of fruit, senescence and its regulation, development of male and female gametophyte, pollen-stigma interactions and double fertilization. Students will learn about centre of origin of plants and various economic uses of domesticated and wild plants.

SEMESTER – III

PAPER-C-302
CONSERVATION BIOLOGY

100 Marks/ 4 Credits

Course Objectives:

Aim of the course is to educate students regarding biodiversity, resource conservation, biodiversity conservation strategies, intellectual property rights (IPR) and their protection.

UNIT- I

Concepts and concerns of biodiversity, biodiversity status, monitoring and documentation, major drivers of biodiversity changes, plant introduction, Invasion and its impact on biodiversity, biodiversity mapping

UNIT- II

Resource conservation: Survey and regeneration of bioresources, endemism and hot spots, endangered plants, red data book, convention of biological diversity. Principles of conservation, extinction, environmental status of plants based on IUCN, Salient features of Biodiversity Act and rules. Strategies for resources conservation and management strategies.

UNIT- III

In situ conservation: International efforts and Indian initiatives; protected areas in India – Sanctuaries, national parks, biosphere reserves, wetlands and mangroves for conservation of wild biodiversity.

UNIT- IV:

Ex situ conservation: Principles and practices; botanical gardens, field gene banks, seed banks, cryobanks, general account of the activities of Botanical Survey of India (BSI), National Bureau of Plant Genetic Resources (NBPGR). ICAR, CSIR, DBT and ICRISAT.

UNIT- V

Intellectual Property Rights and their Protection: Sovereign Rights, copyrights, trademarks, trade secrets, patents, geographical indications, etc; Protection of plant variety and farmers right act; Indian patent act and amendments, patent filing; Patenting of biological materials.

Course Outcomes:

Students will learn about importance of biodiversity and drivers of biodiversity change, convention of biological diversity, IUCN categories of plants, Biodiversity Act and rules, Strategies for resources conservation and management, *in situ and ex situcoservation.* Students will gain knowledge on various types of IPR and their protection strategies.

SEMESTER – III

PAPER-C-303
PLANT PHYSIOLOGY AND DEVELOPMENTAL BIOLOGY

100 Marks/ 4 Credits

Course Objectives:

Aim of the course is to educate students of allied subjects regarding fundamental of plant physiology and development.

UNIT- I

Photosynthesis: Photosynthetic pigments and light harvesting complexes, mechanism of electron transport, photoprotective mechanisms; CO2 fixation: C_3, C_4 and CAM pathways, Photorespiration.

UNIT- II

Sensory Photobiology: Pigments as photoreceptors, structure, function and mechanisms of action of phytochromes, cryptochromes and phototropins, photoperiodism *Flowering and Senescence:* Mechanism of flowering, Vernalization, biological clocks. Molecular mechanism of senescence and aging in plants.

UNIT- III

Plant Growth regulators: Biosynthesis, storage, breakdown and transport of plant hormones; Mechanism of action, physiological effects and applications of plant growth regulators. Growth movement, measurement and indices.

UNIT- IV

Male gametophyte: Structure of anthers, microsporogenesis, role of tapetum, pollen development, pollen germination, pollen tube growth and guidance, pollen storage, pollen allergy.

UNIT- V

Female gametophyte: Ovule development, megasporogenesis, organization of the embryo sac, structure of the embryo sac cells, structure of pistil, *Developmental Embryology:* pollen-stigma interactions, sporophytic and gametophytic self incompatibility, double fertilization, *in vitro* fertilization.

Course Outcomes:

Students will learn about physiology of photosynthesis, flowering and senescence, mechanism of action of plant growth regulators, development of male and female gametophyte and the process of fertilization.

SEMESTER – III

Free Elective:

PAPER- EC -304
PLANTS AND ENVIRONMENT

100 Marks/ 4 Credits

Course Objectives:

Aim of the course is to educate students regarding environment and the plants, plants for environmental protection, phytoremediation and phytomining, environmental pollution bioenergy and aerobiology.

UNIT- I

Environment and the plants: concept of environment and its components: atmosphere, hydrosphere, lithosphere and biosphere, physical and chemical environment. *Biogeography:* Major terrestrial Biomes (Vegetation types of the world and India), theory of Iceland Biogeography, Biogeographical zones of India.

UNIT- II

Plants for environmental protection: salt tolerant plants (Mangroves) and their role for environmental protection, nature and characteristics of mangroves and their distribution in India (Sundarban and Bhitarkanika), deforestation and afforestation, social forestry, agroforestry, waste land and mine reclamation.

UNIT- III

Phytoremediation and Phytomining: concept and definition of Phytoremediation and Phytomining, methods of phytoremediation: phytoextraction, rhizofiltration, phytodetoxification, phytovolatilization, role of hyperaccumulators, biomining and bioleaching.

UNIT- IV

Environmental pollution: Environmental pollution (Water, air and soil), urban air quality, green house effects, GHG emission and climatic changes, remote sensing and its application in plants and environment, Agro-meteorology. *Plants and pollution control:* Bioindicators of water and air pollution: Algae and lichens as indicator plants, role of lichens on phytoair monitoring, insecticidal plants, plants as natural pesticides.

UNIT- V

Bioenergy and aerobiology: concept of biomass and bioenergy, energy plantation, petro plants, bioethanol and methane production, energy from solar and wind sources, rain water harvesting technology.

Aerobiology: importance and scope of aerobiology, aerobiology and crop diseases, aerobiology and pollen allergy.

Course Outcomes:

Students will learn about components of environment, biogeography and biogeographical zones of India, mangroves and their role for environmental protection, phytoremediation and phytomining, methods. Students will gain knowledge on pollution of water, air and soil, remote sensing and its application in plants and environment, plants and pollution control, biomass and bioenergy, aerobiology and pollen allergy.

SEMESTER – III

PAPER-C-305
PRACTICALS PERTAINING TO THEORY PAPERS C-301, C-302. C-303 AND EC-304

100 Marks/ 4 Credits

Course Objectives:

Aim of the course is to impart knowledge on advanced practical relating to plant embryology, tissue culture, microbiology, molecular biology and biochemistry.

Course Outcomes:

Students will gain hand on training on Microtome, germination of pollen grains, isolation and Purification DNA, PCR , electrophoresis, commet assay, antimicrobial assay Quantification of protein, carbohydrate, chlorophyll, proline, sugar etc., phytochemical analysis by TLC/ HPTLC, micropropagation and synthetic seed preparation.

Semester-III (Plant Development, Reproduction and Economic Botany,* Conservation Biology, *Plant Physiology and Developmental Biology, Plants and Environment)

Reference books

- Krishnamurthy, K.V. 2004. An advanced textbook on Biodiversity Principles and Practice. Oxford and IBH Publishing Co. Pvt. Ltd.
- Das, R. C., Baral. J. K., Sahu, N. C. and Misra, M. K. (1998). The Environmental Divide: The Dilemma of Developing Countries. A. P. H. Publication, New Delhi.
- Heywood, V. H. and Watson, R. T. (1995). Global Biodiversity Assessment. Cambridge University Press, UK.
- Hill, M. K. (1997). Understanding Environmental Pollution. Cambridge University Press, UK.
- Mason, C. F. (1991). Biology of Freshwater Pollution. Longman, New York.
- K.V. Krishnamurthy An Advanced Textbook on Biodiversity Principles and Practice, Oxford & IBH Publishing Co. Pvt. Ltd.
- Gomez, K. A. and Gomez, A. A. ((1984). Statistical Procedures for Agricultural Research, 2nd Ed. John Weley, New York.
- Misra, B. N. and Misra, M. K. (1998). Introductory Practical Biostatistics, Naya prokash, kolkata

SEMESTER – IV

CORE ELECTIVE PAPER

A student has to select Paper-C-401 & C-402 (Biochemistry and Molecular Biology)

PAPER-C- 401
BIOCHEMISTRY AND MOLECULAR BIOLOGY-I

100 Marks/ 4 Credits

Course Objectives:

The course aims to educate student about various bio-molecules such as amino acid, proteins, enzymes, carbohydrate and lipid metabolism and basics of immunology.

UNIT- I

Amino acids: Classification, structure and properties, Proteins: Primary, Secondary, tertiary and quaternary structure, determination of amino acid sequence, Protein folding.

UNIT- II

Enzymology: extraction, assay and purification of enzymes; Enzyme kinetics: Michaelis-Menten equation and Briggs-Haldane modification; Determination of Km, Competitive, non-competitive and un-competitive inhibition of enzymes, Determination of inhibition constant. Mechanism of action of Chymotrypsin and Ribonuclease, Regulation of enzyme activity (covalent modification, feedback regulation and allosteric control), Industrial and clinical application of enzymes.

UNIT- III

Carbohydrate Metabolism: Regulation of Calvin cycle, HSK pathway, CAM pathway, Glycolysis, TCA cycle and oxidative pentose phosphate pathway, electron transport chain (Chloroplast and Mitochondrial), photophosphorylation and oxidative phosphorylation, Hydrolysis and biosynthesis of starch and sucrose.

UNIT- IV

Lipid Metabolism: Biosynthesis and hydrolysis of triacylglycerols, structural lipids of membranes, fatty acids; Oxidation of fatty acids; Gluconeogenesis. Cell signaling and signal transduction.

UNIT- V

Intellectual property Rights (IPR) and its protection: IPR forms of protection of Intellectual Property, Patenting of biological material, plant variety rights and protection. Farmer's and plant breeders rights, Terminator Seed Technology.

Course Outcomes:

Students will be learning about protein conformation, enzyme kinetics, regulation of enzyme activity, regulation of carbohydrate metabolism, oxidation of fatty acids, cell signaling and signal transduction. Students will gain knowledge on immunoglobulins, mechanism of immune response, vaccines and immunological techniques.

SEMESTER – IV

PAPER-C-402
BIOCHEMISTRY AND MOLECULAR BIOLOGY-II

100 Marks/ 4 Credits

Course Objectives:

The course aims to educate student on DNA replication, transcription, translation, gene regulation, genetic marker, antisense and ribozyme technology.

UNIT- I

DNA replication, Transcription: Enzymes and necessary protein in DNA replication, DNA damage, repair and recombination, Prokaryotic and eukaryotic transcription mechanisms, posttranscriptional modification of RNA, Nuclear export of m-RNA.

UNIT- II

Translation: Prokaryotic and eukaryotic translation, Regulation and posttranslational modification of proteins, protein import into nucleus, chloroplast, mitochondria and peroxisomes. Aminoacylation of tRNA, tRNA-identity, aminoacyl tRNA synthetase, and translational proof-reading, translational inhibitors.

UNIT- III

Gene Regulation: Regulation of gene expression in prokaryotes and eukaryotes (lac-operon, trp-operon, ara-operon, attenuation and anti-termination).

UNIT- IV

Genetic Marker: t-DNA and transposon tagging, targeted gene replacement, augmentation, gene knockout, vector engineering, gene correction and editing, molecular makers in genome analysis, (RFLP, RAPD and AFLP, ISSR and SSR and SNP).

UNIT- V

Antisense and Ribozyme technology: Molecular mechanism of antisense molecules, inhibition of splicing, polyadenylation and translation, disruption of RNA structure and capping. Biochemistry of ribozyme (hammer-head, hairpin and other ribozymes), designing of ribozymes. Applications of antisense and ribozyme technologies.

Course Outcomes:

Students will be learning about DNA replication, DNA damage, repair and recombination, Prokaryotic and eukaryotic translation, regulation of gene expression in prokaryotes and eukaryotes, gene correction and editing, molecular makers in genome analysis, designing of ribozymes, applications of antisense and ribozyme technologies.

SEMESTER – IV

PAPER- EC- 403
BIOSYSTEMATICS

100 Marks/ 4 Credits

Course Objectives:

The course aims to educate student on plant systematic, International Code of Botanical Nomenclature (ICBN), plant identification, herbarium and evolutionary trends in some plant orders.

UNIT- I

Systematics: scope and components, criteria of classification of flowering plants, types of classification, critical evaluation of Bentham & Hooker's system of classification and its application in herbarium methodology, comparative accounts of classificatory systems - Bentham Hooker, Hutchinson, Cronquist, Takhtajan, Dahlgren, Thorne and APG.

UNIT- II

Development of International Code of Botanical Nomenclature (ICBN), frame work of ICBN, nomenclature of taxa according to their ranks, typification, effective and valid publication, choice, retention and rejection of names and epithets, principle of priority and its limitations, names of hybrids, orthography of names and epithets.

UNIT- III

Plant identification, methods of plant identification - Botanical keys for identification of angiospermic plants, types of botanical keys and methods of preparation, limitation of botanical key, use of computers for identification, taxonomic literature: flora, monograph, manuals, journal and indices.

UNIT- IV

Herbarium concept, historical development, function and management, role of herbarium in plant identification, herbarium methodology, important herbaria of the world with special reference to Central National Herbarium, Indian botanical gardens and famous botanical gardens of the world.

UNIT- V

Evolutionary trends in Ranales, Rosales, Umbellales, Asterales, Lamiales, Microspermae and Scitaminae.

Course Outcomes:

Students will be learning about microbial nutrient metabolism, biofertilizers, nutritional types of microbes, nitrogen fixation, bio-reactors, downstream processing and microbes as food, microbe-microbe, plant microbe and animal-microbe interaction.

SEMESTER – IV

PAPER- C- 404
SEMINAR PRESENTATION AND PRACTICAL

(Seminar – 50, Practical - 50)

100 Marks (4 Credits)

Course Objectives:

The objective of the course is to enable to students for public speaking and presentation of a scientific topic.

PRACTICAL PERTAINING TO THEORY PAPERS C-401, C-402 AND EC-403
Semester-IV (Biochemistry and Molecular Biology and Biosystematics.

Course Outcomes:

Students will acquire the skill of public speaking, content development for presentation and discussion with audience.

SEMESTER – IV

PAPER- C- 405
DISSERTATION

200 Marks (4 Credits)

Course Objectives:

The course aims to develop the skill of experimental design, critical thinking and scientific writing. Semester-IV (Biochemistry and Molecular Biology, Biotechnology and Plant Genetic Manipulations, Cytogenetics and Cell Biology, Environmental Biotechnology, Microbial Technology, *Biosystematics).*

Course Outcomes:

Students will learn how to design experiments, think critically and write dissertation. The course will be a preliminary training to do research.

BIOCHEMISTRY AND MOLECULAR BIOLOGY

Reference Books

- Nelson, D.L., Cox M.M. (2008) Lehninger Principles of Biochemistry, 5th edn. Macmillan Publisher. 1158 pp.
- Zubay G.L. (1983) Biochemistry, 4th edition, 1999. Addison-Wesley publishers, 1268pp.
- Voet, D. and Voet, JG. (2004) Biochemistry. 3rd edition John Wiley and Sons publisher; New York. 1616 pp. ISBN: 978-0471193500.
- Stryer L. (2002). Biochemistry, 5th Revised edition, W.H.Freeman & Co publisher, 1050 pp. ISBN: 978-0716746843.
- Palmer, T. and Bonner, P.L. (2007). Enzymes: Biochemistry, Biotechnology, Clinical Chemistry, 2nd edn, Woodhead Publishing, ISBN: 9781904275275, 432 pp.
- Goodwin T. W. and Mercer E. I. (1990). Introduction to Plant Biochemistry, Second Edition, Pergamon Publisher, 660 pp.
- Lea PJ and Leagood RC (1999) Plant Biochemistry and Molecular Biology. Wiley, San Diego.
- David Freifielder (1995). Molecular cell biology - 2nd Edition, Narosa publishing House.
- Karp, G. Cell and Molecular Biology: Concepts and Experiments, 2000. John Wiley and Sons, New York.
- Benjamin Lewin, Genes VIII, 2004, Pearson Prentice Hall, New Jersey.
- Harvey Lodish, Arnold Berk, Paul Matsudaira, Chris A. Kaiser, Monty Krieger, Matthew P. Scott, S. Lawrence Zipursky, James Darnell. 2004. Molecular Cell Biology, Fifth Edition, W. H. Freeman and Company, New York.
- Buchanan, B. B., Grissem, W. and Jones, R. L. (2000). Biochemistry and molecular biology of plants. American Society of plant physiologists, Rockville, USA
- Trevor Palmer (1991) Understanding enzymes. 3rd edition. E. Horwood publisher, ISBN: 9780139282508, 399 pp.
- Mathews, C. K., Van Holde, K. E. and Ahern, K. G. (2000). Biochemistry, Addison-Wesley Publishing Company, San Francisco, USA.
- Goodwin, T. W. and Mercer, E. I. (1985). Introduction to Plant Biochemistry, 2nd ed. Pergamon, Oxford.
- Richard A. Goldsby, Thomas J. Kindt & Barbara A. Osborne. Kuby Immunology (4th Ed.). W. H. Freeman and Company

- Sawhney , R Singh Introductory Practical Biochemistry Narosa Publishing House Pvt Ltd
- Sadasivam S and Manickam A 1996. Biochemical methods. 2nd edn. New Age International, ISBN: 9788122409765. 256 pages

BIOSYSTEMATICS

Reference Books

- Conway, G. and Barbier, E. (1994). Plants, Genes and Agriculture. Jones and Bartlett, Boston, USA.
- Heywood, V. H. and Wyse Jackson, P. S. (1991). Tropical Botanical Gardens, Their role in Conservation and Development. Academic press, San Diego, USA.
- Takhtajan, A. L. (1997). Diversity and Classification of Flowering Plants. Columbia University Press, New York.
- Woodland, D. W. (1991). Contemporary Plant Systematics. Prentice-Hall, New Jersey, USA.
- Heywood, V. H. and Moore, D. M. (1984). Current Concepts in Plant Taxonomy. Academic press, London.
- Solbrig, O. T. (1970). Principles and Methods Plant Biosystematics. MacMillan, London.
- Stace, C. A. (1989). Plant taxonomy and Biosystematics. Edward Arnold, London.
- Davis, P. H. and Heywood, V. H. (1973). Principles of Angiosperms Taxonomy. Robert E. Kreiger, New York.
- Henry A N An Aid to the International Code of Botanical Nomenclature.

MASTER OF SCIENCE IN

CHEMISTRY

(SEMESTER PATTERN)

CHOICE BASED CREDIT SYSTEM SYLLABUS

TWO-YEAR FULL TIME PROGRAMME

COURSES OF STUDIES

(2023 -2024)

Buxi Jagabandhu Bidyadhar Autonomous College

Bhubaneswar - 751014

Accredited at the 'A' Level by

National Assessment and Accreditation Council (NAAC)

Telephone/Fax : 0674-2436971, Website : www.bjbcollege.ac.in

Distribution of courses in Semester Pattern under Choice based credit System for M. Sc. (Chemistry) Programme effective from 2023-24

Semester	Paper code	Paper Name	Marks		Full Marks	Credits
			Mid Semester	End Semester		
I	**C-101**	Inorganic Chemistry-I	30	70	100	6
	C-102	Organic Chemistry-I	30	70	100	6
	C-103	Physical Chemistry-I	30	70	100	6
	C-104	Spectroscopy-I	30	70	100	6
	C-105	Inorganic Chemistry Practical		100	100	6
II	**C-201**	Inorganic Chemistry-II	30	70	100	6
	C-202	Organic Chemistry-II	30	70	100	6
	C-203	Physical Chemistry-II	30	70	100	6
	C-204	Spectroscopy-II	30	70	100	6
	C-205	Organic Chemistry Practical		100	100	6
III	**C-301**	Bioinorganic & Supramolecular Chemistry	30	70	100	6
	C-302	Pericyclic Reaction & Photochemistry	30	70	100	6
	C-303	Polymer Chemistry	30	70	100	6
	EC-304	Elective-A	30	70	100	6
	C-305	Physical Chemistry Practical		100	100	6
IV	**C-401**	Organic Synthesis	30	70	100	6
	C-402	Analytical Chemistry	30	70	100	6
	EC403	Elective-B	30	70	100	6
	C-404	Seminar and Practical (Analytical Chemistry)	50 (seminar)	50 (Practical)	100	6
	C-405	Dissertation		100	100	6
Total		20 Papers			2000	120

The Department offers the following elective papers. Students can opt one paper from each elective (EC – Elective core)

	Elective-A (EC-304)		**Elective-B (EC-403)**
1.	Environmental Chemistry	1.	Solid State Chemistry
2.	Applications of Spectroscopy	2.	Bioorganic Chemistry
3.	Materials Chemistry	3.	Computer for Chemists

PROGRAMME OUTCOMES (POs):

On completion of the programme (M.Sc. Chemistry) the students will be able to:

- To acquire conceptual knowledge and a comprehensive understanding of the fundamental aspects of all branches of chemistry
- Visualize and gain practical knowledge on multidisciplinary aspects related to current research in the fields of Chemical sciences.
- Acquire knowledge about good laboratory practices, practical skills, hands-on training on basic equipment to get motivation for innovation, design of methods, and techniques to carry out research.
- Communicate effectively, present and publish scientific ideas in the Native and English languages.
- To train the students to accept the challenges in Chemistry and to become responsible citizens in society.

PROGRAMME SPECIFIC OUTCOMES (PSOs):

On completion of the specific programme the student will be able to:

- Acquire in-depth functional knowledge of the fundamental principles and contemporary practices of chemistry
- Utilize skills in problem-solving, critical thinking, and analytical reasoning in chemistry.
- Acquire skills to design, execute, and document laboratory experiments at a level suitable to succeed at an entry-level position in research, academia, or the chemical industry.
- Develop a creative scientific mind to communicate effectively in public forums (orally or in writing)
- Acquire confidence to face competitive examinations at the national level and also to enhance job opportunities in Chemical, pharmaceutical, and other chemistry-based industries; R&D institutions

SEMESTER - I

C-101

INORGANIC CHEMISTRY-I

Marks- **100** (**6** Credit)
Mid Sem: **30** marks
End Sem: **70** marks

Objective:

(i) To understand the concepts of bonding and stereochemistry of main group elements,

(ii) To learn about the formation and stability of metal complexes and their determination and

(iii) Mechanistic aspects of different types of reaction of metal complexes in solution,

(iv) To impart knowledge on preparative methods, structure and bonding of metal-p complexes and cultures.

Course Outcome :

At the end of the course the student will

(i) Acquire the knowledge and have the ability to describe the bonding and stereochemistry of different inorganic compounds and ions.

(ii) Be able to understand the concept of stability constant, its determination and application in different fields.

(iii) Understand the reactions and mechanism of different types of reactions in coordination compounds and their applications in practical fields.

(iv) Understand the synthesis, structure and bonding of metal carbonyls, metal nitrosyls, dioxygen, dinitrogen complexes as well as metal clusters.

UNIT-I

Stereochemistry and bonding in main group compounds:

VSEPR, Bent rule and energetics of hybridization, Walsh diagrams (tri-and penta-atomic molecules), $d\pi$-$p\pi$ bonds, some simple reactions of covalently bonded molecules. Wade's rule, Styx number, carboranes, isolobal analogy, Lipscomb topology, applications of boron compounds.

UNIT- II

Metal-Ligand Equilibria in Solution

Stepwise and overall formation constants and their interrelation, trends in stepwise constants, factors affecting the stability of metal complexes with reference to nature of metal ion and ligand, chelate effect and its thermodynamic origin, determination of binary formation constants by pH-metry, spectrophotometry, Job's method of continuous variation.

UNIT- III

Reactivity of metal complexes

Energy profile of a reaction, reactivity of metal complexes, inert and labile complexes, kinetic applications of valence bond and crystal field theories,

Reaction Mechanism of Transition Metal Complexes-I

Kinetics of octahedral substitution. Acid hydrolysis, factors affecting acid hydrolysis, base

hydrolysis, conjugate base mechanism, direct and indirect evidences in favour of conjugate mechanism, anation reactions, Reactions without metal ligand bond cleavage.

UNIT- IV

Reaction Mechanism of Transition Metal Complexes-II

Substitution reactions and mechanism in square planar complexes. The trans effect. Electron transfer reactions: Mechanism of one electron transfer reactions, outer sphere type reactions, cross-reactions and Marcus-Hush theory, Inner sphere type reactions.

UNIT-V

Metal π-Complexes

Metal Carbonyls, Structure and bonding, Vibrational spectra of metal carbonyls for bonding and structural elucidation, important reactions of metal carbonyls. Preparation, bonding, structure and important reactions of transition metal nitrosyls, dinitrogen and dioxygen complexes, ligating behaviour of tertiary phosphines.

Metal Clusters : metalloboranes and metallocarboranes. Metal carbonyl and halide clusters, compounds with metal-metal multiple bonds.

Books and references:

1. Advanced Inorganic Chemistry: A Comprehensive Text: F.A. Cotton and G. Wilkinson, John Wiley
2. Inorganic chemistry, J.E. Huheey, E.A. Keiter, R.L. Keiter, O.K. Medhi, 4 th edition, Pearson education, (2006)
3. Advanced Inorganic Chemistry: F.A. Cotton, M. Bochmann, C.A. Murrilo, G. Wilkinson, 6th Edition, Wiley India(2007)
4. Fundamental concepts of inorganic chemistry, Vol. 2,4,5, 6; Asim K. Das, CBS publisher, 2nd edition(2013)
5. Comprehensive Co-ordination Chemistry eds: G. Wilkinson,R.D.Gillards and J. A. Mc Cleverty, Pergamon (2003)
6. Inorganic Chemistry; K.F. Purcell & J. C. Kotz, Cengage Learning, Indian Ed.(2010)

SEMESTER - I

C-102

ORGANIC CHEMISTRY-I

Marks- **100** (**6** Credit)
Mid Sem: **30** marks
End Sem: **70** marks

Objective:

To understand the molecular details in greater depth on the following topics: aromaticity, stereochemistry, and substitution reactions in aliphatic compounds.

Course Outcome:

Upon completion of this course students will be able to:

(i) Understand the fundamental aspects of aromaticity, nonaromaticity and antiaromaticity,

(ii) Feel the structural details of organic compounds and the origin of optical activity of the chiral molecules,

(iii) Understand the origin of stereoselectivity as far as asymmetric catalysis is concern, and the basic mechanism of substitution reactions in aliphatic compounds.

UNIT- I

Structure, Reactivity and Bonding in Organic Molecules

Delocalized chemical bonding-conjugation, cross conjugation, resonance, hyperconjugation, bonding in fullerenes, tautomerism. Aromaticity in benzenoid and non-benzenoid compounds, alternant and non-alternant hydrocarbons, Huckel's rule, energy level of π- molecular orbitals, annulenes, antiaromaticity, ψ-aromaticity, homo-aromaticity, PMO approach. Bonds weaker than covalent addition compounds, crown ether complexes and cryptands, inclusion compounds, cyclodextrins, Catenanes and Rotaxanes.

UNIT- II

Reaction mechanism:

Types of mechanisms, types of reactions, thermodynamic and kinetic requirements, kinetic and thermodynamic control, Hammond's postulate, Curtin-Hammett principle. Potential energy diagrams, transition states and intermediates, methods of determining mechanisms, isotope effects. Hard and soft acids and bases.

Effect of structure on reactivity- resonance and field effects, steric effect, quantitative treatment. The Hammett equation and linear free energy relationships, substituent and reaction constants. Taft equation.

UNIT- III

Stereochemistry

Conformational analysis of cycloalkanes, decalins, effect of conformation on reactivity, conformation of sugars, steric strain due to unavoidable crowding.

Elements of symmetry, chirality, molecules with more than one chiral centre, threo and erythro isomers, methods of resolution, optical purity, enantiotropic and diastereotropic atoms, groups and faces, stereospecific and stereoselective synthesis. Asymmetric synthesis using chiral reagent, chiral catalysts, chiral auxiliary and chiral substrates (*Felkin-Anh* model and *Cram's* rule). Optical activity in the absence of chiral carbon (biphenyls, allenes, spiranes, transcycloalkene and metallocenes), chirality due to helical shape.

UNIT - IV : Aliphatic Nucleophilic Substitution

The SN_2, SN_1, SN_i mixed SN_1 and SN_2 and SET mechanisms. The neighbouring group mechanism, neighbouring group participation by σ and π bonds, anchimeric assistance, Nucleophilic substitution at an allylic, aliphatic trigonal and a vinylic carbon.

Reactivity effects of substrate structure, attacking nucleophile, leaving group and reaction medium, phase transfer catalysis and ultrasound, ambident nucleophile, regioselectivity.

UNIT - V

Aliphatic Electrophilic Substitution

Bimolecular mechanisms - SE_2 and SE_i. The SE_1 mechanism, electrophilic substitution accompanied by double bond shifts. Effect of substrates, leaving group and the solvent polarityon the reactivity.

Books Recommended

1. Advanced Organic Chemistry-Reactions, Mechanism and Structure, Jerry March, John Wiley.
2. Advanced Organic Chemistry, F.A. Carey and R. J. Sundberg, Plenum.
3. A Guide Book of Mechanism in Organic Chemistry, Peter Sykes, Longman.
4. Structure and Mechanism in Organic Chemistry, C. K. Ingold, Cornell University Press.
5. Organic Chemistry, R. T. Morrison and R. N. Boyd, Prentice-Hall.
6. Modern Organic Reactions, H. O. House, Benjamin.
7. Principles of Organic Synthesis, R.O.C. Norman and J.M. Coxon, Blackie Academic & Professional.
8. Pericyclic Reactions, S. M. Mukherji, Macmillan, India.
9. Reaction Mechanism in Organic Chemistry, S.M. Mukherjee and S.P. Singh, Macmillan.
10. Stereochemistry of Organic Compounds, Ernest L. Eliel and Samuel H. Wilen, Wiley.
11. Stereochemistry of Organic Compounds, D. Nasipuri, New Age International.
12. Basic Stereochemistry of Organic molecules, Subrata Sen Gupta, Oxford University Press; First edition.
13. Organic synthesis: Clayden, Greeves, Warren and Wouthers, Oxford Univ. Press.

SEMESTER - I

C-103

PHYSICAL CHEMISTRY-I

Marks- **100** (6 Credit)
Mid Sem: **30** marks
End Sem: **70** marks

Objective:

The topics covered under the course are inherently very fundamental and intended to provide the basic understanding at atomic and subatomic level. The objective of the course to study and understand the concept of energy, the transfer of energy into work, capacity of energy to function, entropy, enthalpy, chemical potentials, thermodynamic laws, criterion for determination of the feasibility or spontaneity of a given transformation, partial molar properties, their determinations. The course is designed in a manner in which a bridge between classical thermodynamics and quantum mechanics can be established.

Course Outcome:

Understanding the underlying concepts and realization of quantum mechanics will be useful in solving problems at realistic atomic and molecular level, in particularly in the field of spectroscopy and analytical chemistry. Understanding thermodynamics requires knowledge of how the microscopic world operates and importance of reversible and irreversible processes.

UNIT I

Introduction to Quantum Chemistry

Postulates of quantum mechanics, Schrodinger equation and discussion of solutions of the Schrodinger equation to some model systems viz., particle in a box, the harmonic oscillator, the rigid rotator, the hydrogen atom.

Approximate Methods

The variation theorem, linear variation principle. Perturbation theory (first order and non-degenerate). Applications of variation method and perturbation theory to the Helium atom.

UNIT- II

Angular Momentum

Ordinary angular momentum generalized angular momentum, eigenfunctions for angular momentum, eigenvalues of angular momentum, operator using ladder operators, addition of angular moments, spin, antisymmetry and Pauli exclusion principle.

Molecular Orbital Theory

Huckel theory of conjugated systems, bond order and charge density calculations. Applications to ethylene, butadiene, cyclopropenyl radical, cyclobutadiene etc.

UNIT - III

Thermodynamics

Classical Thermodynamics

Concept of free energy, chemical potential and entropy. Partial molar properties; partial molar free energy, partial molar volume and partial molar heat content and their significances and determinations. Concept of fugacity and determination of fugacity.

Non-ideal systems: Excess functions for non-ideal solutions. Activity, activity coefficient.

Non-Equilibrium Thermodynamics

Thermodynamic criteria for non-equilibrium states, entropy production and entropy flow, entropy balance equations for different irreversible processes (e.g., heat flow, chemical reaction etc.) transformations of the generalized fluxes and forces, non-equilibrium stationary states, phenomenological equations

UNIT - IV

Chemical Dynamics-I

Methods of determining rate laws, collision theory of reaction rates, steric factor, activated complex theory, Arrhenius equation; ionic reactions, primary kinetic salt effects, steady state kinetics, kinetics and thermodynamic control of recactions, treatment of unimolecular reactions, Lindemann reaction.

UNIT - V

Chemical Dynamics-II

Dynamic chain (hydrogen-bromine reaction, pyrolysis of acetaldehyde, decomposition of ethane), photochemical (hydrogen- bromine and hydrogen-chlorine reactions) and oscillatory reations (Belousov- Zhabotinsky reaction), homogeneous catalysis, kinetics of enzyme reactions, general features of fast reactions, study of fast reactions by stopped flow method, relaxation method, flash photolysis, Diffusion controlled reaction, dynamics of molecular motion.

Books Recommended

1. Physical Chemistry , P.W. Atkins and J. D. Paulo, Oxford, 2013, 10th edition New Delhi.
2. Introduction to Quantum Chemistry, A.K. Chandra, Tata McGraw Hill, 1997, 4th edition, New Delhi.
3. Quantum Chemistry, Ira N. Levine, Pearson, 2007, 5th edition, New Delhi.,
4. Quantum Chemistry, D. A. McQuarrie and Simon, Viva, 2007, 1st edition, New Delhi.
5. Molecular Quantum Mechanics, Atkins and Friedman, Oxford Univ. Press, 1997, 3rd edition, New York.
6. Quantum Chemistry, J. P. Lowe, Academic Press, 2nd edition, New York.
7. Quantum Chemistry, R.K. Prasad, New Age International (P) Ltd
8. Quantum Chemistry through problems and solution- R. K. Prasad, New Age International (P) Ltd
9. A textbook of Physical chemistry – H.K. Moudgil
10. Physical Chemistry, T. Engel and P. Reid, Pearson, 2006, 1st edition, New Delhi.
11. Thermodynamics, G. N. Lewis and M. Randall, McGraw Hill, 2nd edition, 1961, New York.
12. Molecular Thermodynamics, D. A. McQuarrie and Simon. Viva, 2009, 1st edition, New Delhi.
13. Non Equilibrium Thermodynamics, S.R. deGroot and Mazur, Dover, New York.
14. Introduction to thermodynamics of irreversible processes, 2nd edition, Interscience, 1961, New York.
15. Chemical Kinetics and Dynamics–2nd Edn. , J.I. Steinfild, J.S. Fransis Co, W.L. Hase , Beutic Hall (1999).
16. Chemical Kinetics, K.J. Laidler, Mcgraw-Hill.
17. Kinetics and Mechanism of Chemical Transformations, J. Rajaraman and J. Kuriacose, McMillan.

SEMESTER - I

C-104

SPECTROSCOPY - I

Marks- **100** (6 Credit)
Mid Sem: **30** marks
End Sem: **70** marks

Objective:

To provide theoretical basis of understanding the atomic, molecular, infrared, Microwave , Raman and photoelectron spectroscopies and their applications.

Course Outcome:

Completion of the course will enable the students (i) to explain the theory and applications atomic, molecular, infrared, Raman, and microwave spectroscopy (ii) to explain the basic principles of photoelectron spectroscopy and its application to chemical analysis.

UNIT - I

Atomic Spectroscopy

Energies of atomic orbitals, vector representation of momenta and vector coupling, electronic configuration, Russell-Saunders terms and coupling schemes, magnetic effects: spin-orbit coupling and Zeeman splitting, spectra of hydrogen atom and alkali metal atoms.

UNIT- II

Molecular Spectroscopy

Energy levels, molecular orbitals, vibronic transitions, vibrational progressions, Franck-Condon principle, Electronic spectra of diatomic molecules, electronic spectra of polyatomic molecules. Emission spectra; radiative and non-radiative decay, internal conversion,

UNIT - III

Photoelectron Spectroscopy

Basic principles; photo-electric effect, ionization process, Koopman's theorem. Photoelectron spectra of simple molecules (H_2, O_2, N_2, CO, H_2O), Spectroscopy of core electrons-Electron Spectroscopy of Chemical Analysis, Chemical information from ESCA. Auger electron spectroscopy basic idea.

UNIT- IV

Infrared Spectroscopy

Review of linear harmonic oscillator, vibrational energies of diatomic molecules, zero point energy, force constant and bond strengths; anharmonicity, Morse potential energy diagram, vibration-rotation spectroscopy, P, Q, R branches. Born-Oppenheimer approximation, Breakdown of Oppenheimer approximation; vibrations of polyatomic molecules

Selection rules, normal modes of vibration, group frequencies, overtones, hot bands, factors affecting the band positions and intensities, far IR region, normal co-ordinate analysis.

UNIT- V

Microwave Spectroscopy

Classification of molecules, rigid rotor model, effect of isotopic substitution on the transition frequencies, intensities, non-rigid rotor, Stark effect, nuclear and electron spin interaction and effect of external field, Applications.

Raman Spectroscopy

Classical and quantum theories of Raman effect. Pure rotational, vibrational and vibrational-rotational Raman spectra, selection rules, Mutual exclusion principle. Resonance Raman spectroscopy, coherent anti Stokes Raman spectroscopy (CARS).

Books Recommended

1. Modern Spectroscopy, J.M. Hollas, John Wiley, 4th edition, Sussex.
2. Applied Electron Spectroscopy for Chemical Analysis Ed. H. Windawi and F.L.Ho, Wiley Inter science.
3. NMR, NQR, EPR and Mossbauer Spectroscopy in Inorganic Chemistry, R.V. Parish, Ellis Harwood, 1st edition, 1990.
4. Physical Methods in Chemistry, R.S. Drago, Sauders College (1992).
5. Chemical Applications of Group Theory, F.A. Cotton. Wiley Inter science, 3rd ed., (1990).

6. Symmetry and Spectroscopy of Molecules, , K.V. Reddy, New Age International (P) Ltd., Ist Ed., (1998).
7. Introduction to Molecular Spectroscopy, G.M. Barrow, McGraw Hill
8. Basic Principles of Spectroscopy, R. Chang, McGraw Hill.
9. Theory and Applications of UV Spectroscopy, H.H. Jaffe and M. Orchin, IBH-Oxford.
10. Introduction to Photoelectron Spectroscopy, P.K. Ghosh, John Wiley.
11. Introduction to Magnetic Resonance, A. Carrington and A.D. Maclachalan, Harper & Row.
12. Inorganic spectroscopic methods, A.K. Brisdon, Oxford Chem. Primers, 1997, New York.
13. Spectroscopy, S. Walker and H. Straw, Chapman and Hall ltd.
14. Energy levels in atom and molecules, W.G. Richards and P.R. Scott, Oxford, Oxford Chemistry Primer vol. 26, 1994, New York.
15. Atomic Spectra, T.P. Softley, Oxford, Oxford Chemistry Primer, Vol. 19, New York.
16. Introduction to Spectroscopy, Pavia, Brooks/Cole Cenage, 4th edition, 2009, Belmont.
17. Electronic Absorption Spectrocopy and related Techniques- D. Sathyanarayanan
18. Fundamental concept of Inorganic Chemistry vol-7- A.K. Das and Mahua Das, CBS Publisher
19. Fundamental of Molecular Spectroscopy- C. N Banwell, Tata McGraw Hill

SEMESTER - I

C-105

INORGANIC CHEMISTRY

PRACTICAL

Marks- 100 (6 Credit)

Objective:

(i) Qualitative analysis of inorganic salts mixture containing acid and basic radicals with insoluble compound

(ii) To introduce multistep inorganic synthesis, separation and estimation of different metals from mixture.

Course Outcome:

(i) Ability to separate and identify different cations and anion from a mixture of inorganic salts.

(ii) Understanding the principles of separation and analysis of different ions and their applications in real fields.

(iii) Learn the techniques of chromatographic separation of mixture of cations and anions

(iv) Ensures the students to understand and have hands on experience to preparer inorganic (coordination) compounds in multi steps and acquire knowledge of separation of metals from mixture.

1. Qualitative analysis of the inorganic mixture

Semi-micro qualitative analysis of inorganic mixtures containing (not more than six radicals) three anions, common cations, less common metal ions (W, Mo, Ce, Th, Zr, V and U) and insoluble (sulphates, oxides, halides)

2. Quantitative Analysis

Separation and determination of two metal ions like Cu-Fe, Zn-Cu, Ni-Zn, and Cu-Ni. involving volumetric and gravimetric methods.

3. Preparation of the following compounds and their studies by elemental, IR, and electronic spectra measurement.

a) cis-$K[Cr(C_2O_4)C_2(H_2O)_2]$

b) $K_3[Fe(C_2O_4]$

c) $[Ni(NH_3)_6]CI_2$

d) $Ni(dmg)_2$

Books recommended

1. Inorganic Experiments, J. Derck Woollins., VCH.
2. Microscale Inorganic Chemistry, Z. Szafran, R. M. Pike and M. M. Singh, Wiley.
3. Practical Inorganic Chemistry, G. Marr and B. W. Rockett, Van Nostrand.
4. An Advanced Course of Practical Chemistry, Nad, Ghosal & Mahapatra, Central Publisher (2000).
5. Vogel's Qualitative Inorganic Analysis, 7th Ed, Revised by G. Svehela, 4th Ed., Person (2007).

SEMESTER - II

C-201

INORGANIC CHEMISTRY-II

Marks- **100** (6 Credit)
Mid Sem: **30** marks
End Sem: **70** marks

Objective:

(i) To introduce the concept of symmetry and group theory and their application in chemistry,

(ii) To understand the theoretical basis of boding of structurally different coordination compounds,

(iii) To understand the basis of electronic spectra of metal complexes as well as to understand the basis of anomalous magnetic behaviour of metal complexes,

(iv) To impart knowledge on preparative methods, structure and bonding of metal-p complexes and cultures.

Course Outcome:

On completion of this course student will be able to:

(i) understand importance group symmetry and group theory in chemistry, classifying different compounds in to point groups and derive the character tables for various applications.

(ii) Understand and explain the bonding in coordination and organometallic compounds. Describethe fundamental requirement to interpret the electronic spectra of metal complexes for prediction of their properties,

(iii) Describe the synthesis, structure and bonding of metal carbonyls, metal nitrosyls, dioxygen, dinitrogen complexes as well as metal clusters.

UNIT - I

Symmetry and Group Theory in Chemistry

Symmetry elements and symmetry operation, definitions of group, subgroup, relation between orders of a finite group and its subgroup. Conjugacy relation and classes. Generators, Point symmetry group.

Representations of group operators, The great orthogonality theorem (without proof) and its explanation. Irreducible and reducible representation. Bases of representation, Character of a representation. Character table and its meaning. Reduction formula.

UNIT - II

Metal-Ligand Bonding

Crystal Field Theory and its limitations, Elementary idea of Angular overlap model, Molecular orbital theory for octahedral, tetrahedral and square planar complexes, σ and π-bonding in molecular orbital theory.

UNIT - III

Electronic Spectra and Magnetic Properties of Transition Metal Complexes.

Spectroscopic ground states, correlation, Orgel and Tanabe-Sugano diagrams for transition metal complexes (d^1 - d^9 states), calculations of Dq, B and β parameters, charge transfer spectra, spectroscopic method of assignment of absolute configuration in optically active metal chelates and their stereo-chemical information, anomalous magnetic moments, magnetic exchanges coupling and spin crossover.

UNIT - IV

Transition Metal π- Complexes

Transition Metal p- Complexes with unsaturated organic molecules, alkenes, alkynes, allyl, diene, dienyl, arene and trienyl complexes, preparations, properties, nature of bonding and structural features. Important reactions relating to nucleophilic and electrophilic attack on ligands and to organic synthesis.

UNIT - V

Homogenous catalysis by Transition Metal Complexes

Coordinative unsaturation, oxidative addition and reductive elimination reactions. Insertion reactions (insertion of CO, SO_2 and alkenes). Reactions of coordinated CO in metal carbonyls. Homogenous hydrogenation of alkenes, hydroformylation of alkenes, isomerisation of olefins, Wacker's process, Zeigler-Natta Polymerization of ethylene, Monsanto acetic acid, Reduction of CO by hydrogen (Fischer-Tropsch reaction).

Books Recommended:

1. Advanced Inorganic Chemistry, F. A. Cotton, M. Bochmann, C. A. Murillo, G. Wilkinson, 6th Ed., Wiley India (2007).
2. Inorganic Chemistry, J. E. Huheey, E. A. Keiter, R. L. Keiter, O. K. Medhi, 4th Ed., Pearson Education (2006).
3. Chemistry of the Elements, N.N. B. Greenwood and A. Earnshow, Pergamon, 2nd Ed (1997)

4. Inorganic Electronic Spectroscopy, A.B.P.Lever, Elsevier.
5. Magnetochemistry, R.L.Carlin, Springer Verlag.
6. Chemical Applications of Group Theory, F.A. Cotton. Wiley Inter science, 3rd ed., (1990).
7. Symmetry and Spectroscopy of Molecules, , K.V. Reddy, New Age International (P) Ltd., Ist Ed., (1998).
8. The Organometallic Chemistry of the Transition Metals, R.H. Crabtree, 4th Ed, Willey (2005).
9. Fundamental Concepts of Inorganic Chemistry, Vol. 6; Asim K. Das, CBS Publisher, 2nd Ed., (2013).
10. Organometallic Chemistry, R.C. Mehrotra & A. Singh, New Age International, 2nd Ed (2013).

SEMESTER - II

C-202

ORGANIC CHEMISTRY-II

Marks- **100** (6 Credit)
Mid Sem: **30** marks
End Sem: **70** marks

Objective:

To impart knowledge of substitution reactions of aromatic compounds, addition reactions to carbon-carbon and carbon-heteroatom multiple bonds, and rearrangement of reactive intermediates.

Course Outcome:

Upon completion of this course students will be able to understand the basic principle of substitution reaction in aromatic compounds along with reaction mechanism, Understand the mechanism of addition reactions of carbon-carbon (C=C C=C, etc.) multiple bonds and carbon- heteroatom (C=O, C=N, etc.) multiple bonds, and the structure and reactivity of various reactive intermediates.

UNIT - I

Aromatic Electrophilic Substitution

The arenium ion mechanism, orientation and reactivity, energy profile diagrams. The ortho/para ratio, ipso attack, orientation in other ring systems. Quantitative treatment of reactivity in substrates and electrophiles. Diazonium coupling, Vilsmer reaction, Gattermann-Koch reaction.

Aromatic Nucleohilic Substitution

The S_NA_r, S_N1, Benzyne and $S_{RN}1$ mechanisms. Reactivity- effect of substrate structure, leaving group and attacking nucleophile. The von Richter, Sommelet-hauser, and Smiles rearrangements.

UNIT - II

Addition to Carbon-Carbon Multiple Bonds

Mechanistic and stereochemical aspects of addition reactions Hydrogenation, Halogenation, Hydrohalogenation, Hydroboration, Oxymercuration, Sulfenylation, Seleneylation, 1, 3-dipolar species addition, Hydoxylation: Prevost & Woodward hydroxylation, Using $KMnO_4$ and OsO_4, Epoxidation, Sharpless asymmetric epoxidation, Michael reaction, Prins reaction, Addition to cyclopropane ring, Addition to conjugated system.

UNIT - III

Addition to Carbon-Hetero Multiple Bonds

Mechanism of metal hydride reduction of saturated and unsaturated carbonyl compounds, acids, esters and nitriles. Addition of Grignard reagents, organozinic and organolithium regents to carbonyl and unsaturated carbonyl compounds. Wittig reaction.

Mechanism of condensation reactions involving enolates – Aldol, Konevenagel, Claisen, Mannich, Benzoin, Perkin and Stobbe reactions.

UNIT - IV :

Rearrangements

Generation, structure, stability and reactivity of Classical and nonclassical carbocations, phenonium ions, norbornyl system, carbanions, free radicals, benzyne, carbenes and nitrenes. General mechanistic considerations – nature of migration, migratory aptitude, memory effects. A detailed study of the following rearrangements

Pinacol-pinacolone, Wagner-Meerwein, Demjanov, Benzil-Benzilic acid, Favorskii, Arndt-Eistert synthesis, Neber, Beckmann, Hofman, Curtius, Schmidt, Baeyer-villiger, Shapiro reaction. Mechanism and orientation in pyrolytic elimination.

UNIT - V

Free Radical Reactions.

Types of free radical reactions, free radical substitution mechanism, mechanism at an aromatic substrate, neighbouring group assistance. Reactivity for aliphatic and aromatic substrates at abridgehead. Reactivity in the attacking radicals. The effect of solvents on reactivity.Allylic halogenatin (NBS), oxidation of aldehydes to carboxylic acids, auto-oxidation, coupling of alkynes and arylation of aromatic compounds by diazonium salts. Sandmeyer reaction. Free radical rearrangement. Hunsdiecker reaction.

Elimination Reactions

The E_2, E_1 and E_1CB mechanisms and their spectrum. Orientation of the double bond. Reactivity effects of substrate structures, attacking base, the leaving group and the medium.

Books Recommended

14. Advanced Organic Chemistry-Reactions, Mechanism and Structure, Jerry March, John Wiley, 6th Ed., (2006).
15. Advanced Organic Chemistry, F. A. Carey and R. J. Sundberg, Part A and B Springer, 5th Ed., (2005).
16. A Guide Book of Mechanism in Organic Chemistry, Peter Sykes, Longman.6th Ed., (1999).
17. Structure and Mechanism in Organic Chemistry, C. K. Ingold, Cornell University Press, 3rd Ed., (1957).
18. Organic Chemistry, R. T. Morrison and R. N. Boyd, Prentice-Hall.
19. Modern Organic Reactions, H. O. House, W.A. Benjamin. 2nd Ed., (1972).
20. Principles of Organic Synthesis, R.O.C. Norman and J. M. Cox, CRC Press 3rd Ed., (2014).
21. Reaction Mechanism in Organic Chemistry, S. M. Mukherjee and S. P. Singh, Macmillan.3rd Ed., (2009).

SEMESTER - II

C-203

PHYSICAL CHEMISTRY-II

Marks- **100** (6 Credit)
Mid Sem: **30** marks
End Sem: **70** marks

Objective :

Chemical kinetics is the study of the rates of chemical reactions, factors which are influential in the rates and the explanation of the rates with respect to the reaction mechanisms of chemical processes. The course content is designed to provide a fundamental of basic surface properties such as surface tension, capillarity and adsorption etc. Also the content describes the importance nd application of surfactants, starting from basic definition to micelle formation and factors responsible for micelle formation. This course contents have a balance between conventional and modern electrochemistry.

Course Outcome :

Students can follow the concept of rate of change associated with chemical reaction, recognizing that the rate of change and how it can be measured. Learning and discussion of surface chemistry certainly enable a student to solve problems associated with catalysis and nanochemistry, as most of the reactions are observed at the interface. It is believed that after going through the course a student will find its utility in chemistry of batteries, fuel cells, solar cells etc.

UNIT - I

Statistical Thermodynamics-I

Thermodynamic probability concept of ensemble. Ensemble averaging, postulates of ensemble averaging. Canonical, grand canonical and microcanonical ensembles, corresponding distribution laws (using Lagrange's method of undetermined multipliers) Maxwell- Boltzmann, Bose-Einstein and Fermi Dirac statistics.

UNIT - II

Statistical Thermodynamics-II

Partition functions-translational, rotational, vibrational and electronic partition functions, calculation of thermodynamic properties in terms of partition functions. Applications of partition functions.

Heat capacity behaviour of solids-chemical equilibria and equilibrium constant in terms of partition functions, Fermi–Dirac statistics, applications to metal. Bose-Einstein statistics- application to helium. Bose-Einstein condensate.

UNIT - III

Surface Chemistry

Adsorption

Surface tension, capillary action, pressure difference across curved surface (Laplace equation), vapour pressure of droplets (Kelvin equation), Gibbs adsorption isotherm, catalytic activity at surfaces estimation of surface area (BET equation), Surface catalysed oxidation of CO to CO_2,surface films on liquids Surface equation of state and its application, Electro-kinetic phenomenon.

Micelles

Surface active agents, classification of surface active agents, micellization, hydrophobic interaction, critical micellar concentration (CMC)/ Kraft temperature, factors affecting the CMC of surfactants, counter ion binding to micelles, thermodynamics of micellazation – phase separation and mass action models, solubilization, micro emulsion, reverse micelles.

UNIT - IV

Electrochemistry-I

Electrochemistry of solutions. Debye-Huckel–Onsager treatment and its extension, ion solvent interactions. Deby-Huckel-Bjerrum model. Solution of Strong electrolytes. Debye-Huckel theory for activity coefficient of electrolytic solutions; determination of activity and activity coefficients; ionic strength.

Thermodynamics of electrified interface equations. Derivation of electro-capillarity, Lippmann equations (surface excess), methods of determination. Structure of electrified interfaces, Helmltoz-Perrin, Guoy–Champman, Stern models.

UNIT - V

Electrochemistry-II

Over potentials, exchange current density, derivation of Butler– Volmer equation, Tafel plot. Polarography theory, Ilkovic equation; half wave potential and its significance, Cyclic voltametry.

Introduction to corrosion, homogenous theory, forms of corrosion, corrosion monitoring and prevention methods.

Books Recommended

1. Physical Chemistry , P.W.Atkins and J. D. Paulo, Oxford, 2013, 10th edition New Delhi.
2. Physical Chemistry, T. Engel and P. Reid, Pearson, 2006, 1st edition, New Delhi.
3. Physical chemistry of the surfaces, A.W. Adamson and A.P. Gast, John Wiley, 6th edition, 1997, New York.
4. Adsorption and Catalysis, D.K. Chakraborty, 1st edition, 1992, Narosa, New Delhi.
5. Surfactants and Polymers in aqueous solution, Krister Holmberg, Bo J¨onsson, Bengt Kronberg and Bjorn Lindman, 2002, John Wiley, Sussex.
6. Surfactants and interfacial phenomena, M.J. Rosen,John Wilay, 2nd edition, New Jeresy.
7. Modern Electrochemistry Vol.I and Vol.II. J.O.M.Bockris and A.K.N.Reddy, Plenum, 3rd edition, 1997, London.
8. Fast Reaction – D.N.Hague
9. Physical Chemistry- G. K Vemulapalli
10. Physical Chemistry- George Woodbury, Brooks cole Introductory Statistical Thermodynamics, T. Hill, Dover, 1986, New York.
11. Statistical Thermodynamics, Oxford, Oxford Chemistry Primer vol. 58, 1997.
12. Introduction to Statistical Mechanics, R. Bowley and M. Sanchez, Clarendon press,
13. Statistical Mechanics and Thermodynamics, C. Garrod, Oxford Univ. Press, 1995, New York.

SEMESTER - II

C-204

SPECTROSCOPY-II

Marks- **100** (6 Credit)
Mid Sem: **30** marks
End Sem: **70** marks

Objective:

To impart knowledge of different spectroscopic techniques such as UV, NMR, ESR, and Mass for structural elucidation of different compounds. To understand principle and applications of Mossbauer spectroscopy

Course Outcome:

Upon completion of this course students will be able to understand how Ultraviolet and Visible Spectroscopy, Nuclear Magnetic Resonance Spectroscopy, Electron Spin Resonance Spectroscopy and Mass Spectrometry are powerful technique to analyze the structural details of different compounds. Understand how Mossbauer spectroscopy is useful for structural determination of inorganic compounds

UNIT - I

Ultraviolet and Visible Spectroscopy

Various electronic transitions (185–800 nm), Beer–Lambert Law, effect of solvent on electronic transitions, ultraviolet bands for carbonyl compounds, unsaturated carbonyl compounds, dienes, conjugated polynes, Fleser-Woodward rules for conjugated dienes and carbonyl compounds, ultraviolet spectra of aromatic and heterocyclic compounds. Steric effect in biphenyls.

UNIT - II

Nuclear Magnetic Resonance Spectroscopy

Nuclear spin; nuclear resonance, saturation, shielding of magnetic nuclei, chemical shift and its measurements, factors influencing chemical shift, deshielding, spin-spin interactions, factors influencing coupling constant 'J'. Classification (ABX, AMX, ABC, A2B2 etc.), spin decoupling; basic ideas about instrument, NMR studies of nuclei other than proton–^{13}C, ^{19}F and ^{31}P. FT NMR, advantages of FT NMR, use of NMR in medical diagnostics.

UNIT - III

Electron Spin Resonance Spectroscopy

Basic principles, zero field splitting and Kramer's degeneracy, factors affecting the 'g' value. Isotropic and anisotropic hyperfine coupling constants, spin Hamiltonian, spin densities and McConnell relationship, measurement techniques, applications of ESR.

UNIT - IV

Mossbauer Spectroscopy

Basic principles, spectral line shape and natural line width, characteristics of Mossbauer nucleides, Dopplers effect, Mossbauer spectra of ^{57}Fe system, Mossbauer spectra of ^{119}Sn system, parameters to evaluate Mossbauer spectra: chemical shift or isomeric shift, qudrapole interaction, Magnetic field interaction. Application of the technique to the studies of (1) bonding and structures of Fe^{+2} and Fe^{+3} compounds including those of intermediate spin, Sn^{+2} and Sn^{+4} compounds, nature of M-L bond, structure and detection of oxidation state and inequivalent MB atoms.

UNIT - V

Mass Spectrometry

Introduction, ion production – E1, C1, FD and FAB, factors affecting fragmentation, ion analysis, ion abundance. Mass spectral fragmentation of organic compounds, common functional groups, molecular ion peak, metastable peak, McLafferty rearrangement. Nitrogen rule. High resolution mass spectrometry. Examples of mass spectral fragmentation of organic compounds with respect to their structure determination.

Books Recommended

1. Modern Spectroscopy, J.M.Hollas, John Wiley, 4th edition, Sussex.
2. Applied Electron Spectroscopy for Chemical Analysis Ed. H. Windawi and F.L.Ho, Wiley Inter science.
3. NMR, NQR, EPR and Mossbauer Spectroscopy in Inorganic Chemistry, R.V. Parish, Ellis Harwood, 1st edition, 1990.
4. Physical Methods in Chemistry, R.S.Drago, Sauders College.
6. Introduction to Molecular Spectroscopy, G.M.Barrow, McGraw Hill
7. Basic Principles of Spectroscopy, R.Chang, McGraw Hill.
8. Theory and Applications of UV Spectroscopy, H.H.Jaffe and M.Orchin, IBH-Oxford.
9. Introduction to Photoelectron Spectroscopy, P.K. Ghosh, John Wiley.
10. Introduction to Magnetic Resonance, A. Carrington and A.D. Maclachalan, Harper & Row.
11. Inorganic spectroscopic methods, A.K. Brisdon, Oxford Chem. Primers, 1997, New York.
12. Spectroscopy, S. Walker and H. Straw, Chapman and Hall ltd.
14. Introduction to Spectroscopy, Pavia, Brooks/Cole Cenage, 4th edition, 2009, Belmont.
15. EPR: Elemental theory and applications, J.A. Well. J.R. Bolton, Wiley, 2nd edition, 2007, New Jersey.
16. Electron Paramagnetic resonance of transition ions, A. Abraham and B. Bleaney, Clarendon Press, 1970, Oxford.

SEMESTER - II

C-205
ORGANIC CHEMISTRY
PRACTICAL

Marks**- 100** (**6** Credit)

Objective :

To introduce the theory and procedures of qualitative analysis of unknown organic compounds in a mixture by conventional methods. To synthesize small molecules from commercially available starting materials and to estimate the functional group present in organic compounds.

Course outcomes:

Upon completion of the course, the student will be able to

(i) Understand how to detect the presence of different functional groups,

(ii) Demonstrate/apply the techniques involved in organic binary mixture separation and identification,

(iii) Design the synthesis of simple organic compounds and execute them in the laboratory.

(iv) understand the different reactivity pattern of different reagents and understand how to synthesize different organic compounds.

1. Qualitative Analysis of Organic Compound

Separation and identification of components of a mixture of two organic compounds (solid- solid, solid-liquid, liquid-liquid).

2. Organic Synthesis (Single Step)

a) Preparatiion of p-bromoacetanilide.

b) Preparation of 3, 5 -dibromobenzoic acid.

c) p-bromo aniline preparation from aromatic electrophilic substitution reaction.

d) Preparation of p-chlorotoluene.

e) Preparation of Methyl orange.

f) Preparation of Aspirin

g) Preparation of Anthranilic acid.

3. Estimation

a) Estimation of Keto Group (>C=O)

b) Estimation of Acetyl group (-C - CH_3)

c) Determination of iodine value and saponification value of an oil sample

4. Separation

Acetylation of Cholesterol and separation of cholesteryl acetate by column chromatography.

Books Recommended:

1. Vogel's Text Book of Practical Organic Chemistry, Furniss, S. B.; Hannaford, A. J.; Smith, P. W. G.; Tatchell, A. R. 5th Ed.; Longman Scientific & technical, England,1989.

2. Laboratory Manual of Organic Chemistry, Dey and Sitaraman, Allied Publishers,1992.

3. Laboratory Manual of Organic Chemistry, Raj K Bansal, New Age International Publishers, 2008

4. Experiments and Techniques in Organic Chemistry, D. Pasto, C. Johnson, & M. Miller, Prantice Hall.

5. Systematic Qualitative Organic Analysis, H. Middleton, Edward Arnold (Publisher).

6. Hand Book of Organic Analysis, Qualitative & Quantitative, M.T. Clarke, Edward Arnold (Publisher).

7. Macroscale and Microscale Organic Experiments, K. L.Williamson, D.C. Heath.

SEMESTER - III

C-301

BIOINORGANIC & SUPRAMOLECULAR CHEMISTRY

Marks- **100** (6 Credit)
Mid Sem: **30** marks
End Sem: **70** marks

Objective:

1. To study the role on the role of metals in biological systems and medicine.
2. To introduce the student on structure, stereochemistry and biological functions of different metalloenzymes.
3. To study the structure and function of biomolecules in nitrogen fixation and photosynthesis.
4. To introduce concept molecular recognition, interactions in supramolecular systems and their applications

Course Outcome:

On completion of the course the student will

(i) Understand and acquire knowledge of effect of deficiency and toxicity of metals in both human and plant systems,

(ii) Describe the structural and functional relationships, mechanisms and importance of metaloenzymes,

(iii) Understand the fundamentals of supramolecules, supramolecular reactions and catalysis.

UNIT - I

Metal ions in biological systems and its storage transport and biomineralization

Essential and trace elements, Iron storage and transport: Ferritin, transferrin; Iron transport in microbes: siderophores.

Calcium in Biology

Transported regulation, Intracellular Ca^{2+} transport, Ca^{2+} ATpase, Na^{+}/Ca^{2+} exchange, mitochondrial influx and efflux. Inositol triphosphate, Ca^{2+} regulated intracellular processes: Calmodulin, Troponin C.

UNIT - II

Oxygen transport and oxygen uptake proteins

Properties of dioxygen (O_2): Thermodynamic and kinetic aspects of dioxygen as an oxidant, activation of dioxygen through complexation with metal ions. Heme proteins and oxygen uptake, structure and function of hemoglobin (Hb), myoglobin (Mb), hemocyanin and hemerythrin. Model compounds of iron, cobalt and copper for oxygen carriers (Vaska's complex and cobalt (III) – Schiff base complexes.

UNIT - III

Metalloenzymes

Zinc enzymes: Carboxypeptidase and carbonic anhydrase; Iron enzymes: catalase peroxidase and cytochromes, Cyt-P450; Copper enzymes: Superoxide dismutase; Molybdenum oxatransferase enzymes: xanthine oxidase. Coenzyme vitamin B12. Sulphur proteins

UNIT - IV

Nitrogen fixation

Biological nitrogen fixation, molybdenum nitrogenase, spectroscopic and other evidence, other nitrogenases model systems.

Photosynthesis

Chlorophylls, photo system I and photo system II in cleavage of water

UNIT - V

Supramolecular Chemistry.

Concepts and language

(A) Molecular recognition: Molecular receptors for different types of molecules including anionic substrates, design and synthesis of coreceptor molecules and multiple recognition.

(B) Supramolecular reactivity and catalysis.

(C) Transport processes and carrier design.

(D) Supramolecular devices, supramolecular photochemistry, supramolecular electronic, ionic and switching devices.

Some examples of self-assembly in supramolecular chemistry

Books Recommended

1. Principles of Bioinorganic Chemistry, S.J. Lippard and J. M. Berg., University Science Books.
2. Bioinorganic Chemistry, I. Bertini, H. B. Gray, S. J. Lippard and J. S. Valenting, University Science Books.
3. Inorganic Biochemistry vols I and II ed. G. L.Eichhom, Elsevier.
4. Progress in Inorganic Chemistry, Vols 18 and 38 ed, by J. J. Lippard, Wiley.
5. Bioinorganic Chemistry, Asim K. Das, Books and Allied, 2nd Ed., (2007).
6. Supramolecular Chemistry, J. W. Steed and J. L. Atwood, Willey, 2nd Ed., (2009).
7. Bioorganic, Bioinorganic and Supramolecular Chemistry, P. S. Kalsi, J. P. Kalsi, New Age International, 2nd Ed., (2012).
8. An Introduction of Supramolecular Chemistry, Asim K. Das, Books and Allied, 1st Ed., (2017).

SEMESTER - III

C-302

PERICYCLIC REACTION & PHOTOCHEMISTRY

Marks- **100** (6 Credit)
Mid Sem: **30** marks
End Sem: **70** marks

Objective:

To impart knowledge of pericyclic reactions, photochemistry of alkene, carbonyl compounds and aromatic compounds.

Course Outcome:

Upon completion of this course students will be able to understand the molecular origin of pericyclic reactions, understand the concept of interaction of organic compounds with light and subsequently trigger the reaction, understand the mechanism photochemistry of alkene, carbonyl compounds and aromatic compounds.

UNIT - I

Pericyclic Reactions. -I

Molecular orbital symmetry, Frontier orbitals of ethylene, 1,3 - butadiene, 1,3,5 - hexatriene and allyl system. Classification of pericyclic reactions. Woodward - Hoffmann correelation diagrams. FMO and PMO approach. Electrocyclic reactions - conrotatory and disrotatory motions, 4n, 4n+2 and allyl systems. Cycloadditions - antarafacial and suprafacial additions, 4n and 4n+2 systems, 2+2 addition of ketenes, 1,3 dipolar cycloadditions and cheleotropic reactions.

UNIT - II

Pericyclic Reactions.-II

Sigmatropic rearrangements - suprafacial and antarafacial shifts of H, sigmatroic shifts involving carbon moieties, 3,3 - and 5,5 - sigmatropic rearrangements. Some variants of Claisen rearrangement (Johnson, Ireland, Abnormal, Asymmetric aromatic), Cope, and Aza- cope, Oxy-cope rearrangements. Fluxional tautomerism, Ene reaction

UNIT - III

Photochemical Reactions

Interaction of electromagnetic radiation with matter, types of excitations, fate of excited molecule (singlet, triplet state), Jablonski diagram (fluorescence, phosphorescence, delayed fluorescence), Excimer, Exciplex, quantum yield/quantum efficiency, transfer of excitation energy (Sensitization & quenching), Actinometry. Types of photochemical reactions – photo- dissociation, gas-phase photolysis.

Photochemistry of alkenes

Intramolecular reactions of the olefinic bond – geometrical isomerism, cyclisation reactions, rearrangement of 1,4 – and 1,5 – dienes, Di-π methane rearrangement.

UNIT - IV

Photochemistry of Carbonyl Compounds

Intramolecular reactions of carbonyl compounds – saturated, cyclic and acylic, unsaturated and α, β-unsaturated compounds, Norrish type I and II reaction, Paterno-Buchi Reaction, Cyclohexadienones, Photodimerisation of carbonyl compounds.

UNIT - V

Photochemistry of Aromatic Compounds

Ring Isomerisations, additions, & substitutions, Cyclization reaction.

Miscellaneous Photochemical Reactions

Photo-Fries rearrangement, Photo-Fries reactions of anilides, Barton reaction. Singlet molecular oxygen reactions, Photochemical formation of smog, Photodegradation of polymers, Photochemistry of vision.

Book recommended:

1. Pericyclic Reactions, S. M. Mukherji, Macmillan, India.
2. Conversion of Orbital Symmetry, R.B. Woodward and R. Hoffman
3. Organic Reactions and Orbital Symmetry,R. C. Storr, T. L Gilchrist
4. Fundamentals of Photochemistry, K.K.Rohtagi-Mukherji, Wilcy-Eastern.
5. Molecular Photochemistry, N.J.Turro, W.a.Benjamin.
6. Introductory Photochemistry, A.Cox and T.Camp. McGraw-Hill.
7. Photochemistry, R.P.Kundall and A.Gibert, Thomson Nelson.
8. Organic Photochemistry, J.Coxon and B.Halton, Cambridge University Press.

SEMESTER - III

C-303

POLYMER CHEMISTRY

Marks- **100** (6 Credit)
Mid Sem: **30** marks
End Sem: **70** marks

Objective:

To study the fundamental concepts of polymer chemistry, structure of monomers, functionality, and classification of polymers on the basis of source, composition, conditions, molecular weight, geometry, industrial polymer fabrication process, and nomenclature of polymers.

Course Outcome:

After the completion of course students will be able to understand about the basics of polymer and the differences between crystalline melting temperature and glass transition temperature, as well as the effect of kinetics on both, develop specific skills, competencies, and thought processes sufficient to support further study or work in this field of polymer chemistry, evaluate the effect of factors such as polymer structure, molecular weight, branching and diluents on crystallinity, and apply knowledge to build up small scale industry for developing endogenous plastic product.

UNIT - I

Basics

Importance of Polymers, Basic concepts: Monomers, repeat units, degree of polymerization, Linear, branched and network polymers. Classification of Polymers. Polymerization Process-Condensation, Addition, Radical chain, Ionic and Co-ordination and Co-polymerization. Polymerization conditions and polymer reactions. Polymerization in homogeneous and heterogeneous systems.

UNIT - II

Polymer Characterization methods

Polydispersion-average molecular weight concept. Number weight and viscocity average molecular weights. Polydispersity and molecular weight distribution. The practical significance of molecular weight. Measurement of molecular weights-End-group, viscosity, light scattering, osmotic and ultracentrifugation methods. Analysis and testing of polymers-chemical analysis of polymers,

spectroscopic methods: IR, UV, X-ray diffraction. Microscopic analysis: optical, SEM, and TEM. Thermal analysis- TGA, DSC, DTA, DMA and Physical Testing-Tensile strength, Flexural strength, Fatigue, Impact strength, Tear resistance, Hardness and Abrasion resistance.

UNIT - III

Structure, morphology and properties of polymer

Morphology and order in crystalline polymers-configurations of polymer chains. Crystal structures of polymers- Crystalline, Amorphous structure. Factors affecting crystallinity, degree of crystallinity, techniques to determine the degree of crystallinity, morphology of crystalline polymer, strain induced morphology, properties affected by crystallinity, Glass transition temperature: effects of molecular weight, diluents, chemical structure, chain topology, branching and cross linking on glass transition temperature. Tm-melting points of homogeneous services: effect of chain flexibility, steric factor, entropy, and heat of fusion on Tm. Relation between Tg and Tm, Property requirements and polymer utilization.

UNIT - IV

Polymer Processing

Plastics, elastomers, and fibers. Resin, Compounding, Additives (crosslinking agent, UV stabilizer, fire retardant, coloring agent, plasticizer, and others). Processing techniques: Calendaring, die casting, rotational casting, film casting, injection molding, blow molding, extrusion molding, reinforcing, pultrusion and fiber spinning.

UNIT - V

Properties of Commercial Polymers

Polyethylene, polyvinyl chloride, polyamides, polyesters, phenolic resins, epoxy resins and silicone polymers. Functional polymers – Fire retarding polymers and electrically conducting polymers (PANI, Polyacetylene). Polymer in Biomedical applications: contact lens, dental polymers, artificial heart, kidney, skin, and blood cells.

Books Recommended

1. Text book of Polymer Science, F.W. Billmeyer, Jr.Wiley.
2. Polymer Science, V.R. Gowariker, N.V. Viswanathan and J. Sreedhar, Wiley-Eastern.
3. Functional Monomers and Polymers, K. Takemoto, Y. Inaki and R.M. Ottanbrite.
4. Contemporary Polymer Chemistry, H.R. Alcock and F.W. Lambe, Prentice Hall.

SEMESTER - III

C-305
PHYSICAL CHEMISTRY
PRACTICAL

Marks- **100** (6 Credit)
Mid Sem: **30** marks
End Sem: **70** marks

Objective:

The laboratory course is framed on the basis of instruments such as conductivity meter, pH meter and potentiometer, where a number of experiments based on conductivity measurement, pH measurement and potential measurement can be performed.

Course Outcome:

It is believed that students performing the experiments will be capable of handling the conductivity meter, pH meter and potentiometer. Also, it gives a real feel of the electrochemistry, such a verification of Debye-Huckel-Onsager equation, neutralisation of weak acids, determination of Ksp of sparingly soluble salt and conductometric titrations, which are taught in theory.

Adsorption

To study surface tension – concentration relationship for solutions (Gibbs equation)

Chemical Kinetics

(i) Determination of the effect of

(a) Change of temperature

(b) Change of concentration of reactants and catalyst and

(c) Ionic strength of the media on the velocity constant of hydrolysis of an ester / ionic reactions.

(ii) Determination of the velocity constant of hydrolysis of an ester / ionic reaction in micellar media.

(iii) Determination of the rate constant for the oxidation of iodide ions by hydrogen peroxide studying the kinetics as an iodine clock reaction.

Solutions

(i) Determination of the degree of dissociation of weak electrolyte and to study the deviation from ideal behaviour that occurs with a strong electrolyte.

Electrochemistry

A. Conductometry:

(i) Determination of the velocity constant, order of the reaction and energy of activation for saponification of ethyl acetate by sodium hydroxide conductometrically.

(ii) Determination of solubility and solubility product of sparingly soluble (e.g., PbSO4, BaSO4) conductometrically.

(iii) Determination of the strength of strong and weak acids in a given mixture conductometrically.

(iv) Determination of the activity coefficient of zinc ions in the solution of 0.002 M zinc sulphate using Debye Huckel's limiting law.

B. Potentiometry / pH metry:

(i) Determination of strengths of halides in a mixture potentionmetrically.

(ii) Determination of the valency of mercurous ions potentiometerically.

(iii) Determination of the strength of strong and weak acids in a given mixture using a potentiometer / pH meter.

(iv) Acid-base titration in a non-aqueous media using a pH meter.

(v) Determination of the dissociation constant of acetic acid in acetone by titrating it with KOH in what medium.

(vi) Determine the pK's of a dibasic acid by pH titration using a pH meter.

C. Polarimetry

(i) Determination of rate constant for hydrolysis / inversion of sugar using a polarimeter.

(ii) Enzyme kinetics – inversion of sucrose.

Books Recommended

1. Practical Physical Chemistry, A. M. James and F.E. Prichard, Longman.
2. Findley's Practical Physical Chemistry, B. P. Levitt, Longman.
3. Experimental Physical Chemistry, R. C. Das and B. Behera, Tata McGraw Hill, 1983, New Delhi.
4. Vogel's Text book of Quantitative Analysis, revised, J.Bassett, R.C.Denney, G.H. Jeffery and J.Mendham, ELBS.
5. Fundamentals of Analytical Chemistry, D.A.Skoog, D.M.West and F.J.Hollar. 7th Edition, Harcourt College Publishers, 1996.

SEMESTER - IV

C-401
ORGANIC SYNTHESIS

Marks- **100** (6 Credit)
Mid Sem: **30** marks
End Sem: **70** marks

Objective:

To impart knowledge of oxidation and reduction, protection of alcohol, amine, carbonyl and carboxyl compounds and disconnection approach in synthesis of various natural products.

Course Outcome:

Upon completion of this course students will be able to understand the philosophy of synthesis of various natural products, understand the reactivity pattern and underlying reaction mechanism of different oxidizing and reducing reagents, and understand the art of selective protection and deprotection of alcohol, amine, carbonyl and carboxyl groups in organic compounds.

UNIT - I

Oxidation

Oxidation of organic molecules using Ruthenium tetraoxide, Hypervalent iodine, thallium(III)nitrate, Dichlorodicyano benzoquinone (DDQ), Selenium dioxide, Dimethyl sulfoxide, Peracids, Oxone, Dioxiranes, Tetramethyl piperidine nitroxide, Singlet oxygen, Ozone, N-sulfonyl oxaziridine, Chromium Manganese, Silver, Ruthenium, Osmium, Molybdenum, Lead, Mercury based reagents. Suzuki coupling, Negishi coupling, Stille coupling, Heck Reaction

UNIT - II

Reduction

Reduction of organic molecules using Boron based reagents, Aluminum-based reagents, Free radical reagent, Silane based reagents, Dissolving metal reduction, Diimide reduction, Wolff-Kishner reduction, Hydrogenation using Pd, Pt, Rh, Ni on solid support.

UNIT - III

Protecting Groups

Principle of protection of alcohol, amine, carbonyl and carboxyl groups.

Disconnection Approach

An introduction to synthons and synthetic equivalents, disconnection approach, functional group inter-conversions, the importance of the order of events in organic synthesis, one group C-X and two group C-X disconnections, chemoselectivity, reversal of polarity, cyclisation reactions, amine synthesis.

UNIT - IV

One Group C-C Disconnection

Alcohols and carbonyl compounds, regioselectivity, Alkene synthesis, use of acetylenes and aliphatic nitro compounds in organic synthesis.

Two Group C-C Disconnections

Diels-Alder reaction, 1,3-difunctionalised compounds, , - unsaturated carbonyl compounds, control in carbonyl condensations, 1,5-difunctionalised compounds. Micheal addition and Robinson annelation.

UNIT - V

Ring Synthesis

Saturated heterocycles, synthesis of 3-, 4-, 5- and 6-membered rings, aromatic heterocycles in organic synthesis

Synthesis of some Complex Molecules

Application of the above in the synthesis of following compounds. Camphor, Longifoline, Cortisone, Reserpine, prostaglandin, Juvabione, Aphidicolin and Fredericamycin A.

Books Recommended

1. Designing Organic Synthesis, A programmed introduction to synthon approach, S. Warren, Wiley.
2. Organic Synthesis-Concept, Methods and Starting Materials, J.Fuhrhop and G.Penzillin, VCH, Weinheim, Germany.
3. Some Modern Methods of Organic synthesis. W. Carruthers, Cambridge Univ. Press.
4. Modern Synthetic Reactions, H.O. House, W.A. Benjamin
5. Advanced Organic Chemistry: Reactions, Mechanisms and Structure, J.March, Wiley.
6. Principles of Organic synthesis, R. Norman and J.M. Coxon, Blackie Academic & Professional.
7. Advanced Organic Chemistry Part B, F.A. Carey and R.J.Sundberg, Plenum Press.
8. Organic Chemistry: The disconnection approach, S. Warren, John Wiley and Sons.

SEMESTER - IV

C - 402

ANALYTICAL CHEMISTRY

Marks- **100** (6 Credit)
Mid Sem: **30** marks
End Sem: **70** marks

Objective:

1. To familiarize the students with some instrumental techniques of characterization of different sample.
2. To understand the basic/working principles, instrumentation, analysis of thermal and electrochemical methods.
3. To understand the basic/working principles and instrumentation of some spectroscopic techniques and their use in chemical analysis.

Course Outcome:

At the end of the students will be able

1. Explain the theoretical basis of different analytical techniques with understanding on operational procedure.
2. Selection of appropriate analytic techniques for analysis of sample and interpretation of analytical results
3. Interference in different analytical techniques and their elimination

UNIT - I

Analytical methods and Error Analysis

Classification of analytical methods: classical and instrumental, types of instrumental analysis, selection of analytical methods.

Errors in analytical chemistry, classification of errors, source and minimization of errors, absolute and relative error, accuracy and precision, significant figures, Statistical treatment for error analysis: mean, median, mode; average and standard deviation, range, confidence intervals. Student 't' test, rejection criteria, F & Q tests.

UNIT - II

Thermal analysis

Thermogravimetric analysis (TGA): Instrumentation, derivative thermogravimetric analysis (DTG), applications of thermogravimetry.

Differential Thermal Analysis (DTA): Principle, instrumentation and applications of differential thermal analysis, simultaneous TG-DTA curves. Differential scanning calorimetry (DSC): Principle, basic instrumentation and applications. Thermogravimetric titration: Principle and applications.

UNIT - III

Electroanalytical methods

Classification of electroanalytical methods, principles and applications of voltammetry, cyclic voltammetry, anodic stripping voltammetry, polarography, amperometry, coulometry, conductometry and ion selective electrodes (Extensive instrumentations are to be excluded).

UNIT - IV

Spectroscopic methods

Atomic adsorption spectroscopy: Principle and instrumentation, flame atomization, hollow cathode lamps, interference in AAS, applications of AAS in qualitative and quantitative analysis.

Flame photometric methods: Basic principle and instrumentation, interference in flame photometry, applications in quantitative analysis. Nephelometric method: Principle and instrumentation, applications in analysis.

UNIT - V

Chromatographic methods

Introduction & classification of chromatography. Principle, instrumentation & applications of ion chromatography, gas chromatography and high- performance liquid chromatography.

Book Recommended

1. Fundamentals of Analytical Chemistry, D.A.Skoog, D.M.West and F.J.Hollar. 7th Edition, Harcourt College Publishers, 1996.
2. Analytical Chemistry, Gary D. Christian, 6th Edition, John Wiley & Sons (Aisa) Pte Ltd (Wiley Student Edn) 2004.
3. Introduction to thermal analysis: Techniques an application, M. E. Brown, Kluer Academic Publisher, New York (2004).
4. Instrumental Methods of Analysis, H.H. Williard. L.L. Merritt and J.A. Dean East-West press, New Delhi, 1988.
5. Principles and Practice of Analytical Chemistry, F.A. Fifield & Dacid Kealy, Blackwell Publishing, 5th Edn, 2000.
6. Analytical Chemistry (Theory and practice) U. N. Dash

SEMESTER - IV

C-404

SEMINAR AND PRACTICAL

Marks- **100** (**6** Credit)

Seminar: **50** marks Practical: **50** marks

SEMINAR

Objective:

To in-depth understanding of a particular topic. To learn the art of making PowerPoint presentation slides. To improve the presentation and communication skills. To participate in the follow-up discussion to experience participative learning.

Course Outcome:

The student will have an in-depth understanding of the topic of the seminar with experience to prepare PPT. Also, it will improve the ability of the student in communication skills, question-answer discussion.

- Each student in 4th semester is required to present a seminar on a topic of his/her interest related to chemistry or the content of a published paper in the weekly seminar.

- The evaluation of the seminar will be done on the basis of the content of the seminar topic, PPT preparation, Presentation skills, and question-answer discussion by the internal faculty members/External.

ANALYTICAL CHEMISTRY
PRACTICAL

Objective:

To learn the conventional techniques of analysis of different water parameters and specific components in different samples by classical/instrumental methods.

Course Outcome:

After the completion of course students will be able (i) To perform the analysis of different water parameters using classical and instrumental methods, (ii) To understand the principles behind the experiment performed in the laboratory.

Analysis of water parameters

i. Determination of Dissolved Oxygen (DO),

ii. Determination of Chemical Oxygen Demand (COD)

iii. Determination of Biochemical Oxygen Demand (BOD)

iv. Determination of chloride titrimetry or turbidimetry

v. Determination of alkalinity and acidity

vi. Analysis of a ground water sample for sulphate by titrimetry or turbidimetry.

Spectrophotometric analysis

i. Determination of fluoride in drinking water/groundwater by spectrophotometry (alizarin red lake method).

ii. Analysis of phosphate by molybdenum blue method

iii. Spectrophotometric estimation of hexavalent chromium in water samples

iv. Verification of Beer-Lambert's law

Miscellaneous

i. Determination of Na^+ / K^+ ions in water sample/soil by flame photometry.

ii. Determination of the strength of commercial phosphoric acid/vinegar by conductometric titration.

Books recommended

1. A Laboratory Manual for Environmental Chemistry, R. Gopalan, Amirtha Anand, R. Wilgred Sugumar, I. K. International Pvt Ltd, 1st Edn., 2008.

2. Vogel's Text Book of Quantitative Chemical Analysis By J.Mendham, R.C.Denney, J.D.Barnes, M.J.K. Thomas, Pearson Education Publishers, 6thy Edition.

3. Hand book of Environmental analysis by Pradyot Patnaik, Lewis Publishers, USA (1997).

4. Standard Methods for the Examination of Water and Wastewater, APHA, AWWA, WPCF, Washington, DC, USA, 17th Edition.

SEMESTER - IV

C- 405

DISSERTATION

Marks - **100** (**6** Credit)

Objective:

Students will research or review articles on a particular topic

1. To train the student to design experiment-oriented project in the particular context
2. To search literature on the selected topic of project work
3. To conduct the experiments scientifically as per the selected topic and analyse the data
4. To develop the art of wiring the project report with proper citation of literature, data analysis, and presentation

Course Outcome:

After completion of the project work the students will

1. Learn the design of the experimental setup and perform the experimental as per specific problem selected for the project
2. Gain the knowledge and competency to search literature and write the dissertation.
3. Learn the skills for presentation of the project work.

Each student is required to submit a dissertation of project work before theory examination for evaluation.

The evaluation of the project will be done on the basis of the content of the project, work done, PPT preparation, Presentation skills, and question-answer discussion by the internal and external examiners.

ELECTIVE-A

EC-304

ENVIRONMENTAL CHEMISTRY

Marks- **100** (6 Credit)
Mid Sem: **30** marks
End Sem: **70** marks

Objective:

To acquaint the student with a basic understanding of the concept and structure of environment, about the chemical composition of the different matrices of the environment (air, water, soil) and the interaction involved between them, understand different types of air, water, soil and radiation pollution and its consequences, different steps of waste management, to study about different industrial effluents, pollution by industry and their remedies, global environmental issues and disasters, and green solution to environmental problems.

Course Outcome:

After the completion of course students will able to describe the structure and significance of the spheres of the environment, the important environmental issues and the factors responsible for their cause, explain the chemical nature and interaction of the air, water and soil, apply analytical tools to determine and measure pollutants in various environmental samples, explain environmental

pollution issues and the remedies thereof, and understand about green chemistry principles and their applications.

UNIT - I

Environment

Introduction, Composition of atmosphere, vertical temperature, heat budget of the earth atmospheric system, vertical stability atmosphere. Biogeochemical cycles of C, N, P, S and O. Biodistribution of elements.

UNIT - II

Hydrosphere

Chemical composition of water bodies: lakes, streams, rivers and wet lands etc. Hydrological cycle.

Aquatic pollution-inorganic, organic, pesticide, agricultural, industrial and sewage, detergents, oil spills and oil pollutants. Water quality parameters- dissolved oxygen, biochemical oxygen demand, solids, metalsm, content of chloride, sulphate, phosphate, nitrate and micro-organisms. Water quality standards

Analytical methods for measuring BOD, DO, COD, F, Oils, metals (As, Cd, Cr, Hg, Pb, Se etc.) residual chloride and chlorine demand. Purification and treatment of water.

UNIT - III

Soils

Composition, micro and macro nutrients, Pollution –fertilizers, pesticides, plastics and metals. Waste treatment.

Atmosphere

Chemical composition of atmosphere-particles, ions and radicals and their formation. Chemical and photochemical reactions in atmosphere, smog formation, oxides of N, C, S, O and their effect, pollution by chemicals, petroleum, minerals, chlorofluorophydrocarbons. Green house effect, acid rain, air pollution controls and their chemistry.

Analytical methods for measuring air pollutants. Continuous monitoring instruments.

UNIT - IV

Industrial Pollution

Pollution obtained due to Cement, sugar, distillery, drug, paper and pulp, thermal power plants, nuclear power plants, metallurgy , Polymers, drugs etc. industry and steps to reducepollution. Radionuclide analysis. Solid waste management. Disposal of wastes and their management.

Environmental Toxicology

Chemical solutions to environmental problems, biodegradability, principles of decomposition better.

UNIT - V

Green Chemistry

Basic concept, History, rules of green chemistry, Environmental impact, pollution control, industrial applications of green chemistry. Application of Green Chemistry in Sustainable Development.

Books Recommended

1. Environmental Chemistry , S.E. Manahan, Lewis Publishers
2. Environmental Chemistry, A.K. De, Wiley Eastern.

3. Environmental Chemistry with Green Chemistry, A. K. Das, Books & Allied (P) Ltd., Kolkata, 1st Edn, 2010.
4. Environmental Toxicology, Ed. J. Rose, Gordon and Breach Science Publication, Elemental Analysis of Airborne Particles, Ed. S. Landsberger and M. Creatchman, Gordon and Breach Science Publication.
5. Environmental Chemistry, C. Baird, W.H. Freeman
6. Hand Book of Environmental Analysis, Pradyot Patnaik, Lewis Publishers (1997)
7. Standard Methods for the Examination of Water and Wastewater, APHA, AWWA, WPCF, Washington D.C. 20005, USA, 17th Edition (1998)

EC-304
APPLICATIONS OF SPECTROSCOPY

Marks- **100** (6 Credit)
Mid Sem: **30** marks
End Sem: **70** marks

Objective:

To use symmetry in determination of vibrational modes different molecules. To understand the concept of resonance Raman spectroscopy and its applications. To understand the concept and applications of Optical Rotatory Dispersion and Circular Dichroism. To understand the mechanism

The course content is aimed at providing a very basic entry into the subject of shift reagents, in particular the influence of paramagnetic substances on a NMR signal. It also attempts to introduce a student in the field of NMR of metalloenzymes. Mossbauer spectroscopy is a versatile technique that can be used to provide information about the chemical bonding, chemical structural, oxidation states of a material. It is a useful technique involving gamma ray spectroscopy

Course Outcome:

The discussion on the course content is definitely beneficial in terms of a student getting idea of NMR of biomolecules and the application of shift/contrast reagents, used in MRI studies. Further, students will understand a Mössbauer spectrum, understand the concept of chemical shift, determine oxidation state, electric quadrapole interaction, determines the chemical structure and bonding, hyperfine interactions.

UNIT - I

Vibrational Spectroscopy

Normal modes of vibration, Determination of normal modes from Symmetry for AB2, AB3, AB4, AB5 and AB6 systems, symmetry of overtones and combination bands, mode of bonding of ambidentate ligands, ethylenediamine and diketonato complexes, application of IR spectra to complexes, Resonance Raman Spectroscopy and its application , particularly for the study of active sites of metallo-proteins myoglobin and hemoglobin.

Unit- II

Optical Rotatory Dispersion (ORD) and Circular Dichroism (CD)

ORD and CD – Circular birefringence and Circular dichroism; Plain dispersion curves - single and multiple cotton effect curves and their applications; Octant rule; -haloketone rule; Comparison of ORD and CD and their applications.

UNIT - III

Advanced ESR Spectroscopy

ESR - first and second order spectra of hydrogen atom; ESR spectra of organic radicals; Hyperfine coupling: mechanism, spin polarization, electron spin-spin interaction, spin-orbit coupling and significance of g-tensors, triplet energy levels; half-filled transitions; ENDOR; study of molecular rate processes; time scales of magnetic resonance experiments. Applications to transition metal complexes (having one unpaired electron) including biological systems.

Unit- IV

Advanced NMR Spectroscopy

Non first order spectra – simplification of complex spectra, high fields, deuterium substitution, shift reagents, satellite peaks and spin decoupling; Dynamic NMR – hindered rotation, ring reversal, atomic inversion and valence tautomerization.

C, H coupling – relationship between J and s character; Nuclear Overhauser effect (NOE). Resonance of other nuclei- F, P.

UNIT- V

^{13}Carbon NMR Spectroscopy

General considerations, chemical shift (Aliphatic, olefinic, alkyne, aromatic, heteroaromatic and carbonyl carbon), coupling constants. Two-dimension NMR spectroscopy with emphasis on the application of H-H COSY, NOESY and ROSY techniques.

Books recommended:

1. Physical Methods for Chemistry, R.S. Drago, Saunders Company.
2. Structural Methods in Inorganic Chemistry, E.A.V. Ebsworth, D.W.H. Rankin and S. Cradock, ELBS.
3. Infrared and Raman Spectra: Inorganic and Coordination Compounds, K.Nakamoto, Wiley.
2. Introduction to Spectroscopy, Pavia, Brooks/Cole Cenage, 4th edition, 2009, Belmont.
3. EPR: Elemental theory and applications, J.A. Well. J.R. Bolton,Wiley, 2nd edition, 2007, New Jeresy.
4. Electron Paramagnetic resonance of transition ions, A. Abraham andB. Bleaney, Clarendon Press, 1970, Oxford.
5. Fundamental concept of inorganic chemistry, Vol-7- A.K. Das and Mahua Das, CBS Publisher
7. William Kemp, Organic Spectroscopy, ELBS, New Delhi, 1982.
8. A. Carrigton and A.D.McLachlan, Introduction to Magnetic Resonance, Harper and Row, New York 1967.
9. William Kemp, NMR in Chemistry, MacMillan Ltd., 1986.
10. C.N.R. Rao and J.R. Ferraro, Spectroscopy in Inorganic Chemistry, Methven Co., London, 1968.
11. Raymond Chang, Basic Principles of Spectroscopy, Mc Graw Hill Ltd., New York, 1993.

EC-304

MATERIALS CHEMISTRY

Marks- **100** (6 Credit)
Mid Sem: **30** marks
End Sem: **70** marks

Course Objective:

- To provide knowledge about the importance of chemistry in understanding various common materials of industrial importance.
- To provide knowledge about nano chemicals and nano composites and their applications.
- To provide knowledge about organic conductors and organic electronics.
- To gain knowledge on Luminescent Materials and Conducting Polymers

Course Outcome:

Able to qualitatively describe the bonding scheme and its general physical properties, as well as possible applications of a given a type of material. Able to describe its physical origin, as well as strength of a bond. Be able to qualitatively derive a material's Young's modulus from a potential energy curve. Given the structure of a metal, be able to describe resultant elastic properties in terms of its 1D and 2D defects. Given a simple set of diffraction data, be able to index the peaks and infer the structure. Be able to describe a polymer's elastic behaviour above and below the glass transition.

Unit I

Materials and their classification:

Matter, materials science, broad classification of materials, - metal and alloys, polymers and elastomers, ceramics and refractories, semiconducting and electronic materials, super metal and super conductors, materials for nuclear technology and for aero-space technology, magnetic materials, dielectric materials, optical and opto-electronic materials, bio-medical materials, thermo-electrical materials, structural and construction engineering materials, special and nanomaterials, SMART materials.

Unit- II

General Strategies for preparation and production of materials:

Wet chemical processes, the sol-gel route, precursor synthesis, carbo-thermic and thermo-chemical treatments, hydrothermal, pyrochemical, metallurgical and chemical routes, heat treatment methods, surface deposition and film formation methods, special fabrication and processing techniques. Elementary ideas on basic properties of important materials (overview only): Mechanical properties and impact properties, brittle, malleable, and ductile properties, crystalline, polycrystalline materials. Phase rule and phase diagram its applications.

Unit- III

Dielectric and Magnetic Materials:

Dielectric materials: Electrical dipole moment, dielectrics, dielectric constants and polarization, microscopic displacement, temperature and frequency dependence of dielectric constant, dielectric break down. Synthetic strategies for preparation of dielectric materials. Ferro electrics. Piezoelectric. Pyroelectrics. Application of dielectric materials.

Magnetic materials: Concept/ origin of magnetism, diamagnetism, paramagnetism, ferromagnetism,

hysteresis- soft and hard magnets. Synthetic strategies. Ferrites, ortho-ferrites and plumba ferrites. Applications of magnetic material, magnetic bubbles.

Unit- IV

Semiconductor Materials:

Semiconductor and electronic materials: Band concept for insulator, conductor and semi–conductor (elementary), intrinsic and extrinsic semiconductor, conductivity, n- and p- type semiconductor, carrier and hole mobility and concentration Fermi level, density of electrons in the conduction band and density of holes in valence band, concentration of electrons in the CB of n-type and holes in VB of p-type semiconductor. Hall effect- hall voltage and Hall coefficient and application. Fabrication and processing of semiconductors. Film formation and surface coating techniques. Application of semiconductors.

UNIT - V

Luminescent Materials and Conducting Polymers:

Luminescence- photoluminescence, electroluminescence and cathodoluminescences; Fluorescent Phosphors-Calcium tungstate phosphor, Zinc silicate green phosphor, Magnesium fluogermanate red phosphor and Calcium halophosphate daylight phosphor

Conducting polymers: intrinsically conducting polymers, extrinsically conducting polymers, non-bridged polymers and chain bridged polymers; Synthetic methods; methods of doping- simple chemical doping, electrochemical doping and photochemical doping.

Books recommended

1. Eco-friendly Synthesis of Fine Chemicals, Edited by Roberto Ballini, James H. Clark and George A. Kraus, from RSC Green Chemistry Series, Royal Society of Chemistry, 1st Edn., 2009.
2. Aqueous Microwave Assisted Chemistry: Synthesis and catalysis, Ed. V. Polshettiwar and R. S. Verma, from RSC Green Chemistry Series, Royal Society of Chemistry, 1st Edn., 2010.
3. Fundamentals of Asymmetric Synthesis, G. L. David Krupadanam, Universities Press, 1st Edn. 2013
4. D. Curie, Luminescence in crystals, John Wiley & Sons, Inc., New York, 1963.
5. A.Skothem (Ed.), Hand book of conducting polymers – Vol. I and II, Marcel Dekkar, 1986.

ELECTIVE-B

EC- 403

SOLID STATE CHEMISTRY

Marks- **100** (6 Credit)
Mid Sem: **30** marks
End Sem: **70** marks

Objective:

To obtain knowledge on understanding solid state reactions, chemical synthesis methods, the structure of solids and crystal defects, insight into electronic structure and properties of crystals. Introduction to optical and magnetic properties of solids, with basic understanding of several

physical concepts such as optical reflectance, optical refraction and magnetic hysteresis. Also it gives an account of the generation of X-ray radiation and its effects of on matter. It includes neutron diffraction with a basic understanding of neutron properties and their utility in analysis of soft materials.

Course Outcome:

Students will learn the structure, properties and the synthesis of solid materials. More significantly, crystal defects, electronic properties of solid can be easily explained. Also it will enable the student to interpret of crystal structure by X-ray diffraction and neutron diffraction method. After going through the course, it is believed that the student will be self-confident to explain certain optical and magnetic properties of solid state materials.

UNIT - I

Solid State Reactions

General principles, experimental procedures, co-precipitation as a precursor to solid state reactions, sol-gel method

Crystal Defects and Non-Stoichiometry

Perfect and imperfect crystals, intrinsic and extrinsic defects–point defects- vacancies Schottky defects and Frenkel defects. Thermodynamics of Schottky and Frenkel defect formation, colour centres, non-stoichiometry defects, line defect- edge dislocation and Screw Dislocation and Plane defects- Grain boundaries, Tilt boundaries,

Unit- II

Electronic Properties of Solids

Metals, insulators and semiconductors, electronic structure of solids- Band theory, band structure of metals, insulators and semiconductors. Intrinsic and extrinsic semiconductors, doping semiconductors, p-n junctions, superconductors (low-temperature superconductor, BCS theory, High-temperature superconductor).

UNIT - III

Optical properties of solids

Optical reflectance, photoconduction-photoelectric effects, refraction, dispersion, polarization.

Magnetic Properties of Solids

Classification of materials. Quantum theory of paramagnetic- cooperative phenomena - magnetic domains, hysteresis.

Organic Solids

Electrically conducting solids, organic charge transfer complex, organic metals, new superconductors.

UNIT - IV

X-ray Diffraction

Generation of X-rays, Properties of X-rays: continuous spectrum, characteristic spectrum, Filters, Bragg condition, Miller indices, Structure factor and its relation to intensity, identification of unit cells from systematic absences in diffraction pattern. Structure factor calculation for NaCl, KCl, Description of the procedure for an X-ray structure analysis, Laue method, Bragg method, Debye-Scherrer method of X-ray structural analysis of crystals, indexing of crystals, Ramchandran diagram or [φ, ψ] plot.

UNIT- V

Neutron Diffraction

Properties of neutrons, comparison with x-ray probe, Principles of neutron scattering, coherent and incoherent scattering, scattering of neutrons by solids and liquids, magnetic scattering, measurement techniques, elucidation of the structure of magnetically ordered unit cell.

Books Recommended

1. Solid State Chemistry and its Applications, A.R.West, Wiley, 1989, Singapore. 2nd Ed., Singapore.
2. Principles of the Solid State, H.V.Keer, Wiley Eastern, 1993, New Delhi
3. Solid State Chemistry, N.B. Hannay.
4. Solid State Chemistry, D.K. Chakrabarty, New Age International., 1996, New Delhi
5. Understanding solids, The Science of Materials, R. J. Tilley, John Wiley & Sons, 2004, Sussex.
6. Solid state Physics, Aschroft and Mermin, Harcourt College Press, 1976, Florida.
7. Solid state Physics, J.P. Srivastava.
8. Applications of neutron Powder diffraction, Kisi and Howard, Oxford Science, 2008, New York.
9. Elements of X Ray Diffraction, B. D Cullity, Addison-Wesley Publishing Company Inc., 1956, USA.
10. Chemistry of solids: A.K. Galwey., Science paperbacks and Chapman and Hall Ltd.

EC-403
BIOORGANIC CHEMISTRY

Marks- **100** (6 Credit)
Mid Sem: **30** marks
End Sem: **70** marks

Objective:

To impart knowledge of biological catalysts, mechanism of enzyme action and reactions catalyzed by enzymes and co-enzyme.

Outcome:

Upon completion of this course students will be able to understand how enzyme catalyzes the reaction with outmost efficiency, acid-base catalysis and covalent catalysis of enzyme, strain and distortion during enzyme catalysis, structure and biological functions of various coenzymes, and the origin of mechanism of enzyme action.

UNIT - I

Introduction

Basic considerations Proximity effects and molecular Adaptation.

Enzymes

Introduction and historical perspective, chemical and biological catalysis, remarkable properties of enzymes like catalytic power, specificity and regulation. Nomenclature and classification,

extraction and purification. Fischer's lock and key and Koshland's induced fit hypothesis, concept and identification of active site by the use of inhibitors, affinity labelling and enzyme modification by site-directed mutagenesis.

UNIT - II

Mechanism of Enzyme Action

Kinetics of enzyme action, Michealis Menten and Lineweaver-Burk plots, reversible and irreversible inhibition. Transition-state theory, orientation and steric effect, acid-base catalysis, covalent catalysis, strain or distortion. Examples of some typical enzyme mechanism for chymotrypsin, ribonuclease, lysozyme and carboxypeptidase A.

UNIT - III

Reactions Catalyzed by Enzymes and Co-Enzyme Chemistry-I

Nucleophilic displacement on a phosphorus atom, multiple displacement reactions and the coupling of ATP cleavage to endergonic processes. Transfer of sulphate, addition and elimination reactions, enolic intermediates in isomerization reactions, ß-cleavage and condensation, some isomerization and rearrangement reactions.

Unit- IV

Reactions Catalyzed by Enzymes and Co-Enzyme Chemistry-II

Enzyme catalyzed carboxylation and decarboxylation. Cofactors as derived from vitamins, coenzymes, prosthetic groups, apoenzymes. Structure and biological functions of coenzyme. A, thiamine pyrophosphate, pyridoxal phosphate, NAD+, NADP+, FMN, FAD, lipoic acid, vitamin B12 Mechanisms of reactions catalyzed by the above cofactors.

UNIT - V

Vitamins and Antibiotics

Chemistry of the following antibiotics: penicillin, streptomycin, chloromycetin, oxy tetracycline and griseofulvin; Detailed chemistry and physiological action of Vitamin A, ascorbic acid, thiamin, riboflavin and elementary aspects of Vitamin B

Books Recommended

1. Biorganic Chemistry, A Chemical Approach to Enzyme Action, Hermann Dugas and C. Penny, Springer-Verlag.
2. Understanding Enzymes, Trevor Palmer, Prentice Hall.
3. Enzyme Chemistry: Impact and Applications, Ed. Collin J. Suckling, Chapman and Hall.
4. Enzyme Mechanisms Ed, M.I. Page and A. Williams, Royal Society of Chemistry.
5. Fundamentals of Enzymes: An Introduction and Applications in Biotechnology, Michael D. Trevan, John Wiley.
6. Immobilized Enzymes: An Introduction and Applications in Biotechnology, Michael D. Trevan, John Wiley.
7. Enzymatic Reaction Mechanisms C. Walsh, W.H. Freemain.
8. Enzyme Structure and Mechanism, A Fersht. W.H. Freeman.
9. Biochemistry: The Chemical Reactions of Living Cells, D.F. Metzler, Academic Press.

EC-403
COMPUTER FOR CHEMISTS

Marks- **100** (6 Credit)
Mid Sem: **30** marks
End Sem: **70** marks

Objective:

This is a theory-cum-Laboratory course with more emphasis on laboratory work. The objectives are to study different computer programmes, to learn various concepts and basic techniques essential for conduct of practical in computers and to study various computer languages useful in Chemistry.

Course Outcome:

After the completion of course students will able to acquire basic understanding about Computer, computer programmes, computer languages, understanding the basic concept associated with C- and C++ Language and program designing, develop different programs Run and Retrieve results, use of variables, arithmetic assignment operators and conditional operator, and in future student may be able to develop a big program(s)(Software) which may simulate the behaviour of the chemical reaction/processes/events.

UNIT - I

Computer Programming in C

Elements of the computer language, Constants and variables, Operations and symbols. Expressions, Arithmetic assignment statement. Input and Output, Format statement. Termination statements, Branching statements such as IF, ELSE-IF Statements; Nested loop, Loop control statement. FUNCTION (Students learn the programming logic and these language features by 'hands on' experience on a personal computer from the very beginning of this topic).

UNIT - II

Use of Computer Programmes -I

The students will learn how to operate a PC and how to run standard programmes and packages. Execution of linear regression, X-Y plot, numerical integration and differentation as well as differential equation solution programmes

UNIT - III

Use of Computer Programmes -II

Programmes with data preferably from Physical Chemistry Laboratory. Further, the students will operate the packages MS- WORD, POWER POINT AND EXCEL.

UNIT - IV

Programming in Chemistry -I

Development of small computer codes involving simple formulae in chemistry, such as van der Waals equation, pH titration, kinetics, radioactive decay. Evaluation of lattice energy and ionic radii from experimental data.

UNIT - V

Programming in Chemistry -II

Linear simultaneous equations to solve secular equations within the Huckel theory. Elementary structural features such as bond lengths, bond angles, dihedral angles etc. of molecules extracted from a database such as Cambridge data base.

Books Recommended

1. Computers and Common Sense, R. Hunt and J. Shelley, Prentice Hall
2. Computational Chemistry, A.C. Norris.
3. Microcomputer Quantum Mechanics, J.P. Killngbeck, Adam Hilger.
4. An Introduction to Digital Computer Design, V.Rajaraman and T. Radhakrishnan, Prentice Hall.
5. Computer and their applications to Chemistry, R. Kumari, 2nd Edn,Narosa (2005).

MASTER OF SCIENCE IN
COMPUTER SCIENCE

(SEMESTER PATTERN)

CHOICE BASED CREDIT SYSTEM SYLLABUS

TWO-YEAR FULL TIME PROGRAMME

COURSES OF STUDIES

(2023 -2024)

Buxi Jagabandhu Bidyadhar Autonomous College

Bhubaneswar - 751014

Accredited at the 'A' Level by

National Assessment and Accreditation Council (NAAC)

Telephone/Fax : 0674-2436971, Website : www.bjbcollege.ac.in

The Course of Study and the Scheme of Examinations

Year / Semester	Subject	Paper	Title of the Paper	Credit	Max. Marks		Total
					Mid Semester/ Seminar	End Semester/ Practical/ Assignment/ Project etc.	
I Year I Sem.	Core	C-1	Data Structure and Algorithms	4	30	70	100
	Core	C-2	Computer System Architecture	4	30	70	100
	Core	C-3	Database Systems & Implementation	4	30	70	100
	Core	C-4	Discrete Mathematical Structures	4	30	70	100
	Core Practical	C-5	Algorithms & Database Lab	4		100	100
I Year	Core	C-6	Computer Networks	4	30	70	100
II Sem.	Core	C-7	Computer Graphics	4	30	70 100	
	Core	C-8	Operating System Design	4	30	70	100
	Core	C-9	Theory of Computation	4	30	70	100
	Core Practical	C-10	Computer Graphics & OS Lab	4		100	100
II Year III Sem.	Core	C-11	Artificial Intelligence	4	30	70	100
	Core	C-12	Software Engineering	4	30	70	100
	Core Elective I	C-13 EC-1	Compiler Design (a) Network Security (or) (b) Advanced JAVA	4 4	30 30	70 70	100 100
	Core Practical	C-14	AI & SE Lab	4		100	100
II Year IV Sem.		C-15	Cloud Computing	4	30	70	100
		C-16 EC-2	Mobile Computing (a)Real Time System (or) (b) Data Mining	4 4	30 30	70 70	100 100
		C-17	Comprehensive Viva	4		100	100
		C-18	Project/ Dissertation	4		100	100
Total				**80**			**2000**

Program Specific Outcomes

After completing M.Sc. Computer Science,

1. Students understand the advanced computer fields with demonstration of all programming and theoretical concepts.
2. To make them employable according to current demand of IT Industry and Public Sectors.
3. Students understand all dimensions of the advanced concepts of software applications and projects.
4. Aware them to publish their work in reputed journals.
5. Students will be capable of oral and written scientific communications and will prove that they can think critically and work independently.
6. Students will demonstrate proficiency in different computing paradigm needed for a proper understanding of computer science.

CORE-1

DATA STRUCTURE & ALGORITHMS

Course Outcome

1. To learn the advanced data structure, implementation and application.
2. To develop programming skills which require solving given problems.
3. Know the strength and weakness of different data structures.

UNIT-I

Introduction, The Role of algorithms in computing, Growth of functions, Recurrences, Heapsort, Quicksort, Sorting in linear time.

UNIT-II

Elementary Data structures, Hash Tables, Binary Search Trees, Red-Black trees, B-trees, Data Structures for Disjoint sets.

UNIT-III

Elementary Graph algorithms, Representation of Graphs, BFS DFS And Topological Sort, Minimum Spanning Trees Shortest path(single source and all-Pairs), Maximum Flow.

UNIT- IV

Dynamic programming (Matrix Chain, TSP Optimal binary Search) Greedy algorithms, Amortized analysis, String Matching.

UNIT- V

P, NP and NP-Completeness, Approximate Algorithm, Computational Geometry.

Text Books:

T.H.Corman, C.E.Leiserson, R.L.Rivest and C. Stein : Introduction to Algorithms

Reference Books:

1. Gilles Brassard and Paul Bratley : Fundamentals of Algorithmics
2. A.V. Aho, J.E.Hopcroft and J.D.Ullman **:** The Design and Analysis of Computer Algorithms

CORE-2

COMPUTER SYSTEM ARCHITECTURE

Course Outcome

1. To understand the major architectural style and appreciate the compromises that they encapsulate.
2. To read outline description of real processor and understand in which way their designs fit into the frameworks described in the course.
3. To understand the impact of design choices in programming in the context of a specific architecture

UNIT-I

Computer Function and Interconnection: Computer Components, Computer Function, Interconnection Structures, Bus Interconnection, PCI. Cache Memory: Computer Memory System, Cache Memory Principles, Elements of Cache Design.

UNIT-II

External Memory : Magnetic Disk, RAID, Optical Memory, Magnetic Tape, External Devices, I/O Module, Programmed I/O, Interrupt-Driven I/O, Direct Memory Access, I/O Channels and Processors, FireWire and InfiniBand.

UNIT-III

CPU Structure and Function: Processor Organization, Register Organization, Instruction Cycle, Instruction Pipelining, The Pentium Processor. Reduced Instruction Set Computer (RISC): Instruction Execution Characteristics, Use of a Large Register File, Compiler- Based Register Optimization, Reduced Instruction Set Architecture, RISC Pipelining, MIPS R4000, SPARC, RISC versus CISC Controversy.

UNIT-IV

Instruction-Level Parallelism and Superscalar Processors: Overview, Design Issues, Pentium-4. IA-64 Architecture: Motivation, General Organization, Prediction, Speculation, and Software Pipelining, IA-64 Instruction Set Architecture, Itanium Organization.

UNIT-V

Parallel Organization: Multiple Processor Organizations, Symmetric Multiprocessors, Cache Coherence and MESI Protocol, Clusters, Non-Uniform Memory Access (NUMA), Vector Computation.

Text Book:

1. Stallings, W. Computer Organization and Architecture 4/ed. (PHI)

Reference Books

1. Mano. M . M.: Computer System Architecture 3/ed. (PHI)
2. Hayes, J.P.: Computer Architecture and Organization 3/ed. (Mc. Graw-Hill Int.)
3. Quinn, M. J.: Parallel Programming in C with MPI and OpenMP (TMH)

CORE-3
DATABASE SYSTEMS & IMPLEMENTATION

Course Outcomes

1. To identify advance database concepts and database model.
2. To apply and analyze various terms related to transaction management in centralized and distributed database.
3. To produce data modeling and database development process for object oriented DBMS.
4. To analyze and implement the concept of object relational databases in development of various real time software.

UNIT-I

Database System : Database System Applications, Database Systems versus File Systems, View of Data & Data Models, Database Languages, Database Users and Administrators, Transaction Management, Database System Structure, Application Architecture. Entity-Relationship Model : Basic Concepts & Constraints, Keys, Design Issues, Entity-Relationship Diagram, Weak Entity Sets, Extended E-R Features, Design of E-R Database Schema, Reduction of an E-R Schema to Tables, Overview of Relational Model and Relational Database Design.

UNIT-II

SQL : Basic Structure, Set Operations, Aggregate Functions, Null Values, Nested Sub-queries, Views, Complex Queries, Modification of the Database, Joined Relations, Data-Definition Language, Embedded SQL. Dynamic SQL. Integrity and Security: Domain Constraints, Referential Integrity, Assertions, Triggers, Security and Authorization, Authorization in SQL, Encryption and Authentication.

UNIT-III

Query Processing: Measures of Query Cost, Selection Operation, Sorting, Join and other Operations, Evaluation of Expressions. Query Optimization: Estimating Statistics of Expression Results, Transformation of Relational Expressions, Choice of Evaluation Plans, Materialized Views.

UNIT-IV

Object-Oriented Databases: Complex Data Types, Object-Oriented Data Model, Object-Oriented Languages, Persistent Programming Languages, Persistent C++ Systems, Persistent Java Systems. Object-Relational Databases: Nested Relations, Complex Types, Inheritance, Reference Types, Querying with Complex Types, Functions and Procedures, Object-Oriented Vs Object-Relational.

UNIT-V

Transactions: Transaction, Transaction State, Implementation of Atomicity and Durability, Concurrent Executions, Serializability, Recoverability, Implementation of Isolation, Transaction Definition in SQL, Testing for Serializability. Concurrency Control: Lock-Based, Timestamp- Based, Validation-Based Protocols Multiple Granularity, Multiversion Schemes, Deadlock Handling, Insert and Delete Operations, Weak Levels of Consistency, Concurrency in Index Structures. Recovery System : Failure Classification, Storage Structure, Recovery and Atomicity, Log-Based Recovery, Shadow Paging, Recovery with Concurrent Transactions, Buffer Management, Failure with Loss of Nonvolatile Storage, Advanced Recovery Techniques, Remote Backup Systems.

Text Book:

Silbcrschatz. A,. Korth, H.F., and Sudarshan.S. : Database System Concepts 4/ed. (McGraw-Hill Int.)

CORE- 4

DISCRETE MATHEMATICAL STRUCTURES

Course Outcomes

1. To express a logic sentence in term of predicates , quantifiers, and logical connectives.
2. To apply the rules of inference and method of proof including indirect proof forms, proof by contradiction, and mathematical induction.
3. To use tree and graph algorithms to solve problems.

UNIT- I

Fundamentals of logic, Prepositional equivalences, Predicates and Quantifiers, Nested Quantifiers, Methods of Proof, Sequences and summations, Mathematical Induction.

UNIT- II

Sets, set operations, properties of binary relations, equivalence relations and partitions, partial ordering relations and lattices, chains and anti-chains, functions and the pigeonhole principle.

UNIT- III

The basics of counting, permutations and combinations, recurrence relations, solving recurrence relations, generating functions, inclusion – exclusion

UNIT- IV

Introduction to graphs, graph terminology, Representing graphs and graph isomorphism, Euler and Hamilton paths, introduction to trees, applications of trees.

UNIT-V

Groups, subgroups, cosets and Lagrange's Theorem, Codes and group codes, homomorphisms and normal subgroups, Isomorphisms, Ring, Integral Domains and Fields.

Text Book:

1. C.L. Liu, "Elements of Discrete Mathematics", Mc Graw Hills International Second Edition.
2. Kenneth H. Rosen, Discrete Mathematics and its Applications, Mc Graw Hills International Fifth Edition.

Reference Books:

1. Bernardi Kolman, Robert C. Busby, Sharon Ross, "Discrete Mathematical Structure" Prentice Hall of India.
2. Mott, J.L, Kandel, A. & Baker, T.P..: Discrete Mathematics for Computer Science and Mathematics, 2/ed (P 1999)
3. N.Ch. S.N. Lyengar, Chankrasekaran, Venkatesh, Arunachalam, "Discrete Mathematics", Vikas Publication.

CORE - 6

COMPUTER NETWORKS

Course Outcomes

1. To describe how computer networks are organised with the concept of layered approach
2. To describe how signals are used to transfer data between nodes.
3. To implement a simple LAN with hubs, bridges and switches.
4. To describe how packets in the internet are delivered.

UNIT-I

Encoding & Modulation: Digital-To-Digital, Analog-to-Digital, Digital-to-Analog and Analog-t- Analog Conversions. Transmission of Digital Data, Interfaces and Modems: Digital Data Transmission, DTE-DCE Interface Standards, Modems, 56K Modem, Cable Modem. Multiplexing: Frequency Division, Wave Division and Time Division Multiplexing, Multiplexing in the Telephone System, Digital Subscriber Line (DSL), FTTC.

UNIT-II

Data Link Control: Line Discipline, Flow Control, Error Control. Data Link Protocols: Asynchronous Protocols, Character-Oriented Protocols, Bit-Oriented Protocols, Link Access Procedures. Local Area Networks: Project 802, Ethernet, Switched Ethernet, Fast Ethernet, Gigabit Ethernet, Token Bus, Token Ring, Fiber Distributed Data Interface (FDDI).

UNIT-III

Metropolitan Area Networks: IEEE 802.6 (DQDB), Switched, Multimegabit Data Services (SMDS). Switching: Circuit Switching, Packet switching, Message Switching. Point-To-Point Protocol: Transition States, PPP Layers, Link Control Protocol (LCP), Authentication, Network Control Protocol (NCP).

UNIT-IV

Integrated Services Digital Network: Services, Scribers Access to the ISDN, ISDN layers, Broad Band ISDN. X.25 : X.25 Layers. Frame Relay: Frame Relay Operation, Frame Relay Layers, Congestion Control, Leaky Bucket Algorithm, Traffic Control.

UNIT-V

ATM: ATM Architecture, Switching, Switch Fabrics, ATM Layers, Service Classes, ATM Applications. SONET: Synchronous Transport Signals, Physical Configuration, SONET Layers, SONET Frame, Multiplexing STS Frames, Applications. Networking & Internetworking Devices: Repeaters, Bridges, Routers, Gateways, Routing Algorithms (Distance Vector & Link State Routing).

Text Book :

1. Forouzan, B. A.: Data Communications and Networking, 2/Ed (TMH)

Reference Books :

1. Tanenbaum, A. S.: Computer Networks, 4/Ed (PHI)

CORE-7
COMPUTER GRAPHICS

UNIT-I

Overview of graphics Systems: Video display devices, Raster Scan Displays, Random Scan Displays, Input devices, Hard-copy devices, Graphics software. Output Primitives: Points and Lines, Line drawing Algorithms (DDA and Bresenham sLine algorithm), Mid-point circle algorithm, Ellipse generating algorithms, Filled-Area Primitives. Attributes of Output Primitives: Line Attributes, Curve Attributes, Color and Grayscale Levels, Area-Fill Attributes and Character Attributes, Bundled attributes and anti-aliasing.

UNIT-II

Two dimensional geometric Transformation: Basic Transformation(Translation, Rotation, Scaling), Matrix representation and Homogenous Coordination, Composite Transformation, Reflection Shear, Transformation between coordinate systems, Two dimensional viewing: The Viewing Pipeline, Viewing coordinate reference frame, window to viewport coordinate transformation, Line Clipping: (Cohen-Sutherland & Liang-Barsky algorithm) and Polygon Clipping (Sutherland-Hodgeman Algorithm).

UNIT-III

Three dimensional object Representation: Polygon Surfaces, Quadratic Surfaces, Spline Representation, Beizer Curves and Surfaces, B-Spline Curves and Surfaces, Fractal Geometry Methods: Fractal Generation Procedures, Classification of Fractals, Fractal Dimension, Geometric Construction of Deterministic Self Similar Fractals, Self Squaring fractals.

UNIT-IV

Three Dimensional Geometric and Modeling Transformations: Translation, Rotation, Scaling. Reflections, Shears, Composite Transformations, Modeling and coordinate Transformations. Three Dimensional Viewing: Viewing Pipeline, Viewing Coordinates.

UNIT-V

Projections (Parallel and Perspective) Clipping. Visible Surface Detection Methods: Classification of Visible-Surface Detection Algorithms, Back-Face Detection, Depth-Buffer Method, A-Buffer Method, Scan line and Depth Sorting.

Text Books:

1. Donald Hearn & M. Pauline Baker, “Computer Graphics 2004, Pearson Education, Inc. New Delhi.

Reference Books:

2. J.D. Foley, A.Dam, S.K. Feiner, J.F. Hughes: Computer Graphics Principle and Practice Addision Wisely.

CORE-8
OPERATING SYSTEM DESIGN

Course Outcomes

1. To identify the low level structure and internal mechanism of operating system.
2. To describe the main responsibilities of a contemporary operating system.
3. To list the most fundamental sub systems of an OS and functions that each subsystem is responsible.

UNIT- I

Operating System, Computer-System Organization, Computer-System Architecture, Operating-System Structure, Operating-System Operations, Process Management, Memory Management, Storage Management, Protection and Security, Distributed Systems, Special Purpose Systems, Computing Environments, Open-Source Operating Systems. Operating System Services, User Operating System Interface, System Calls, Types of System Calls, System Programs, Operating-System Design and Implementation, Operating System Structure, Virtual Machines, Operating System Debugging, Operating System Generations. System Boot.

UNIT- II

Process: Process Concept, Process Scheduling, Operations on Processes, Inter-Process Communication, Examples of IPC Systems, Communication in Client-Server Systems. Multithreaded Programming: Multithreading Models, Thread Libraries, Threading Issues, Operating-System Examples.

UNIT- III

Process Scheduling: Basic Concepts, Scheduling Criteria, Scheduling Algorithms, Thread Scheduling. Multiple-Process Scheduling. Synchronization: The Critical Section Problem, Peterson's Solution, Synchronization Hardware, Semaphores, Classical Problems of Synchronization, Monitors, Synchronization Examples, Atomic Transactions.

UNIT- IV

Deadlocks: System Model, Deadlock Characterization, Methods of Handling Deadlocks, Deadlock Prevention, Deadlock avoidance, Deadlock Detection, Recovery from Deadlock. Memory Management Strategies: Swapping, Contiguous Memory Allocation, Paging, Structure of the Page Table, Segmentation, Example: The Intel Pentium.

UNIT- V

Virtual-Memory Management: Demand Paging, Copy-on-Write, Page Replacement, Allocation of Frames, Thrashing, Memory-Mapped Files, Allocating Kernel Memory. File System: File Concept, Access Methods, Directory and Disk Structure, File-System Mounting, File Sharing, Protection.

TEXT BOOK:

Operating System Concepts**:** Silberschatz, Galvin, Gagne, 8/e (Wiley-India)

CORE-9

THEORY OF COMPUTATION

Course Outcomes

1. Model compare and analyze different computation model using combinatorial methods.
2. Apply rigorously formal mathematical methods to proof properties of language , grammar and automats.
3. Construct algorithms for different problems and argue formally about correctness on different restricted machine models of computation.
4. Identify limitations of some computational models and possible methods of proving them.

UNIT I: - Regular Languages & Finite Automata:

Deterministic Finite Automata, Non-deterministic Finite Automata, Equivalence of NFA, and DFA. Regular Expressions & Languages, Conversion of DFAs to Regular Expressions, and vice versa. Properties of Regular Languages: Pumping Lemma, Closure properties: Union, Intersection, Complement, Difference, Reversal, Homomorphism, and Inverse Homomorphism. Decision Problems for Regular Languages, DFA Minimization.

UNIT II: - Context Free languages & Pushdown Automata

Context Free Languages, Context Free Grammars, Derivation, Ambiguity, Parsing. Pushdown Automata: Definition of PDAs, Acceptance of PDAs by final state and by empty stack. Conversion of CFG to PDA and vice versa. DPDAs & DCFLs, Determinism & Parsing. Simplification of CFG's, Chomsky Normal Form. The Pumping Lemma for CFL's. Closure properties: union, concatenation, *, +, Homomorphisms, and Reversal. Nonclosure under reversal and complementation. Decision Problems for CFLs, CYK Algorithm, Undecidable Problems for CFLs.

UNIT III: - Turing Machines

TM Definition and Notation; Instantaneous Descriptions, NTM & DTM, Programming tricks for TMs, Examples involving TM Computations, Extensions & Restrictions to Basic TM Model, (Multi Tape, Multi Dimensional, Counter machine, Two Stack PDAs).

UNIT IV: - Decidability Theory

The Church-Turing Thesis, Universal Turing Machines and TM Encoding. Decidable and semi-decidable languages, Recursive Enumeration and Decidability, Many-one Reductions, Hardness, Undecidability, Closure Properties. The Diagonalization Language, The Halting Problem, Post's Correspondence Problem, Undecidable Problems from Language Theory, Rice's Theorem. Linear Bounded Automata (LBA).

UNIT V: - Complexity Theory

Measuring Complexity, The Big **Oh**, **Theta, Big Omega** Notations, Time Complexity classes: P, NP, NP-Completeness, Coping with NP-Completeness. Cook-Levin's Theorem, Some NP-Complete Problems: SAT, 3-SAT, Hamiltonian Path, Vertex Cover, Independent Set. Space Complexity classes: PSPACE, L, NL.

Text Book:

Introduction to Automata Theory, Language & Computation- Hopcroft, Motwani & Ullman

CORE-11

ARTIFICIAL INTELLIGENCE

Course Outcomes

1. Have fundamental understanding of the basic concepts of artificial intelligence.
2. Apply basic principles of AI in solutions that require problem solving, inference, perception, knowledge representation and learning.
3. Have fundamental understanding of various applications of AI technics in inteligent agents, export systems, artificial neural networks and other machine learning models.
4. Have knowledge of current scope and limitations and societal implications of AI.

UNIT-I

Introduction to AI , History of AI , State of Art Intelligent Agents, Problem Solving by Searching : BFS, Uniform Cost Search, DFS, IDS, Bi-directional Search, Constraint Satisfactory Search, Informed Search Best First Search, Heuristic Function, Memory bounded search, A* and IDA*, Game Playing: Min-Max search and Alpha-Beta pruning.

UNIT-II

Knowledge & Reasoning : Agents that reason logically, First Order Logic, Syntax and Semantics. Inference in First Order Logic : Inference Rules, Modus Ponems, Unification, Forward and Backward Reasoning, Resolutions Planning : A simple Planning Agent, from Problem Solving to Planning, Planning in Situation Calculus.

UNIT-III

Learning : Learning from Observations . A General Model of Learning Agents, Inductive Learning; Expert Systems, Architecture, Knowledge Acquisition, MYCIN ; Natural Language Processing : Syntactic Processing, Semantic Analysis, Efficient parsing.

UNIT-IV

Introduction to Pattern Recognition: Recognition & Classification Process, learning, Classification Patterns, Visual Image Understanding, Image Transformation; Perception: Image Formation, Image Processing Operations for easy Vision, Speech, Recognition. Introduction to Robotics.

UNIT-V

Prolog Programming : Basic Prolog Concepts, Facts, Rules, Structures, Lists, Executing and meaning of Prolog Programs, Recursive Programming, Backtracking with cuts.

Text Book:

Stuart Russel &, Peter Norvig: Artificial Intelligence A Modern Approach (Person Education Asia.) 3rd edition.

CORE-12

SOFTWARE ENGINEERING

Course Outcomes

1. Identify, formulate and solve complex problems by applying principles different principles of software Engineering.
2. Apply engineering design to produce solutions that meet specified needs with consideration of public health, sefty and wellfare as well as global, cultural, social, environmental and economic factors.
3. Communicate effectively with a range of audiences and recognise ethical and professional responsibilities in engineering situations and make informed judgements, which must consider the impact of engineering solutions in global economic environmental and societal contexts.
4. Develop and conduct appropriate experimentation , analysis and interpret data and use engineering judgement to draw conclusions.

UNIT- I

Computer-Based System Engineering: Emergent System Properties, Systems and their Environment, System Modeling, System Engineering Process, System Procurement. Software Processes: Software Process Models, Process Iteration, Software Specification, Design and Implementation, Software Validation and Evaluation, Automated Process Support. Project Management: Management Activities, Project Planning, Project Scheduling, Risk Management.

UNIT-II

Software Requirements: Functional and Non-Functional Requirements, User Requirements, System Requirements, Software Requirements Document. Requirements Engineering Processes: Feasibility Studies, Requirements Elicitation and Analysis, Requirements Validation, Requirements Management. System Models: Context Models, Behavioral Models, Data Models, Object Models, CASE Workbenches.

UNIT-III

Architectural Design: System Structuring, Control Models, Modular Decomposition, Cohesion and Coupling, Data Flow-oriented design. Distributed System Architectures: Multiprocessor Architectures, Client-Server Architectures, Distributed Object Architectures, CORBA. Object-Oriented design. Real-Time Software Design: System Design, Real-Time Executives, Monitoring and Control Systems, Data Acquisition Systems. Design with Reuse: Component- Based Development, Application Families, Design Patterns.

UNIT-IV

Verification and Validation: Verification and Validation Planning, Software Inspections, Automated Static Analysis, Clean-room Software Development. Software Testing: Defect Testing, Integration Testing, Object-Oriented Testing, Testing Workbenches. Software Cost Estimation: Productivity, Estimation Techniques, Algorithmic Cost Modeling, Project Duration and Staffing.

UNIT-V

Dependability: Critical Systems, Availability and Reliability, Safety, Security. Critical Systems Specifications: Software Reliability Specification, Safety Specification, Security Specification. Critical Systems Development: Fault Minimization, Fault Tolerance, Fault Tolerance Architectures, Safe System Design.

Text Book:

Sommerville, I: Software Engineering, 6/e

Reference Book

1. Pressman, R. S: Software Engineering, 4/e (McGRAW-HILL)
2. Aggarwal, K. K. & Singh, Y: Software Engineering (New Age International)

CORE-13
COMPILER DESIGN

Course Outcomes

1. Realise basics of compiler design and apply for real time applications.
2. Introduce different translation languages.
3. Understand the importance of code optimization.
4. Know about compiler generation tools and techniques.
5. Working of compiler and non compiler applications.

UNIT- I

Compilers & Translators, Need of Translators, Structure of a Compiler, Phases, Lexical Analysis, Syntax Analysis, Intermediate Code Generation, Code Optimization, Code Generation, Book Keeping, A Symbol Table in brief, Semantic Analysis, L-value, r-values, Error Handling.

UNIT - II

Rules of Lexical Analyser, Need for Lexical Analysis, Input Buffering, Preliminary Scanning, A simple Approach to the Design of Lexical Analysers, Transition Diagrams, Regular Expression, String & Languages, Finite Automata, Non-deterministic Automata, Deterministic Automata, From regular Expression to Finite Automata, Context free Grammars, Derivations & Parse Trees, Parsers, Shift Reduce Parsing, Operator- Precedence Parsing.

UNIT - III

Symbol Table Management, Contents of a Symbol Table, Names & Symbol table records, reusing of symbol table spaces, array names, Indirection in Symbol Table entries, Data Structures for Symbol Tables , List, Self Organizing Lists, Search Trees, Hash Tables, Errors, Reporting Errors, Sources of Errors Syntactic Errors, Semantic Errors, Dynamic Errors, Lexical Phase Errors, Minimum Distance Matching, Syntactic Phase Error, Time of Detection, Ponic mode, Case study on Lex and Yacc.

UNIT - IV

Principal Sources of Optimization, Inner Loops, Language Implementation Details Inaccessible to the User. Further Optimization, Algorithm Optimization, Loop Optimization , Code Motion, Induction Variables, Reduction in Strength, Basic Blocks, Flow Graphs, DAG Representation of Basic Blocks, Value Numbers & Algebraic Laws, Global Data Flow Analysis, Memory Management Strategies , Fetch Strategy, Placement Strategies, Replacement Strategies, Address Binding, Compile Time, Load Time, Execution Time, Static Loading, Dynamic Loading, Dynamic Linking.

UNIT - V

Problems in Code Generation, a Simple Code Generator, Next-Use Information, Register Descriptors, Address Descriptors, Code Generation Algorithm, Register Allocation & Assignment, Global Register Allocation, Usage Counts, Register Assignment for Outer Loops, Register Allocation by Graph Coloring , Code Generation from DAG's, Peep-Hole Optimization, Redundant Loads & Stores, Un-Reachable Code, Multiple Jumps, Algebraic Simplifications, Use of Machine Idioms.

Text Book:

Compilers, Techniques and Tools (2nd edition), A.V.Aho, M.S.Lam, Ravi Esthi and J.D.Ullman

EC-1

NETWORK SECURITY

Course Outcomes

1. Protect and defend computer systems and networks from cyber attacks.
2. Characterize privacy , ligal and ethical issues of information security.
3. Identify vulnerabilities critical to the information accets of an organization.
4. Define the security controls sufficient to provide a required level of confidentiality , integrity and availability in an organization's computer systems and networks.

UNIT - I

Overview of cryptography, substitution and affine cipher and their cryptanalysis, Perfect Security, Block cipher, Data Encryption Standard(DES), Differential and linear Cryptanalysis, Block Cipher Design Principles, Block Cipher modes of operation, Advanced Encryption Standard.

UNIT - II

Principles of Public- key Cryptosystems, The RSA Algorithm, Key Management, Diffie- Hellman Key Exchange, Authentication Functions, Message Authentication codes(MAC), Hash Functions, Security of Hash Functions and MAC, Secure Hash Algorithm, HMAC.

UNIT - III

Discrete Logarithms, ElGamal Cryptosystem, Algorithm for Discrete Logaritlun Problem, security of EIGamal System, Schnorr signature scheme, Baby step-Gaint step, Chinese reminder, The ElGamal signature scheme, The digital signature algorithm, Provable secure signature schemes.

UNIT - IV

Elliptic curve over the reals, Elliptic curves modulo a prime, Properties of Elliptic curves Point compression, Computing point multiples on Elliptic curves, Elliptic curve digital signature algorithm, Elliptic curve factorization, Elliptic curve primality test.

UNIT - V

Network Security Practice: Kerberos, X.509 Authentication Service, Public Key Infrastructure. E-Mail Security (Pretty Good Privacy), IP Security (Architecture, Authentication Header, Encapsulating Security Payload, Combining Security, Associations, Key Management), Web Security (Secure Sockets Layer and Transport Layer Security).

Text Books:

1. W.Sta1lings- Cryptography and Network Security Principles and Practice, Person Education Asia, 2000. (3rd Edition) Chapters: [1,3, 5 , 9, 10(10.1,10.2), II, 12(12.2,12.4), 13(13.3), 14,15,16,17].
2. D.Stinsori, Cryptography: Theory and Practice, CRC press, 2006. Chapters: [1,2(2.3),6,7,12].

References:

1. A. Menezes, P. Van Oorsch, S. Vanstans- Handbook of Applied Cryptography, CRCpress,1997. '
2. B. Schmeier- Applied Cryptography, New York, Wiley, 1996.
3. N.Koblitz: a course in number theory and cryptography, Springer verlag.

EC-1

ADVANCED JAVA

Course Outcomes

1. Know some concepts of advanced programming and practice on reusing components.
2. Write sofisticated java applications.
3. Use the java language for writing well organised, complex computer programs with both command line and graphical user interfaces.

UNIT - I

Introduction to JAVA & its various features, JAVA Virtual Machine its architecture. Installation of JDK and 'CLASSPATH' setting, A First Java Program, Compilation and Applications, The JDK Directory Structure ,Lexical issues of java Class, Object, Instance Data and Class Data, Methods, Constructors, Access Modifiers, Destroying Objects , inheritance, overriding , Dynamic method dispatch abstract class interface ,Wrapper class boxing unboxing autoboxing and autounboxing, Package, multithreading , exception handling ., console and File I/O

UNIT - II

GUI basic, introduction to swing difference between AWT and swing , Swing components and containers Layout managers, event handling , Applets ,life cycle of applets steps for making applet, JLabel,JButton, JCheckBox, JRadioButton, JScrollPane, JTextField , JTextArea ,JMenu, JTable ,dialog boxes.

UNIT - III

JDBC concept The JDBC Connectivity Model, JDBC drivers ,Database Programming, Connecting to Database, Working with database tables, SQLWarning Classes, Executing SQL Queries, ResultSet MetaData, PreparedStatement, Parameterized Statements, Stored Procedures and Transaction Management, Networking , Basics of Networking, Inet Address, TCP/IP Sockets ,Data Grams, Simple Client Server socket programming. Remote method invocation (RMI)

UNIT - IV

J2EE Overview, Client Tier, Middle Tier, Application Server Tier, The J2EE Platform, Servlet , life cycle of servlet steps for making servlet, deployment ,Deployment descriptor and its configuration , Session tracking The JSP Solution, JSP Syntax & Deployment, Variables and Expressions, Sessions in JSP, page and taglib Directives .

UNIT - V

Enterprise java beans(EJB) ,EJB architecture , Classification of EJB, Session Beans , Stateless and Stateful Session bean ,Bean class , Developing and running bean application ,MVC (Model View Control) architecture

JAR Concepts, Steps for creating simple jar files, Creating executable JAR Files.

Books:

1. JAVA The Complete Reference Herbert Schildt Tata McGraw-Hill
2. JAVA Server Programming Balck Book Kogent Dreamtech publication
3. Programming in JAVA Sachin Malhotra Saurabh Choudhury Oxford publication
4. Introduction to Java Programming Y. Daniel Liang Person publication

CORE-15

CLOUD COMPUTING

UNIT - I

Introduction to Cloud Computing: Definition, Characteristics, Components, Layered Structure of Cloud Computing , Services (SAAS, PAAS, IAAS) , Deployment Model (Public , Private , Hybrid), Cloud provider. Organizational scenarios of clouds, Administering & Monitoring cloud services, benefits and limitations, Issues and Challenges in Cloud Environment . Utility Computing, Elastic Computing .

UNIT - II

Virtualization Technology: Virtual machine technology, Study of Hypervisors , Virtual Machine Manager (VMM), Classification of Virtualization Technology: Para Virtualisation , O.S Virtualisation, Hardware Virtualisation, And Full Vitualisation , Virtual Machine Migration Concept, Virtualization applications in enterprises, Its associated issues and challenges .

UNIT - III

Load Balancing in Cloud : Introduction to Load Balancing , Reason of Load imbalance in cloud environment , Mathematical model for Load Structure , Different Schemes for Load Balancing such as FCFS ,RR , ESCEL , Throttled , Active Monitoring , Randomise , Min-Min , Min –Max , SCH , and PSO , GA .

UNIT - IV

Data in the cloud: Relational databases, Cloud file systems: GFS and HDFS, Big Table, HBase and Dynamo. Map-Reduce and extensions: Parallel computing, The map-Reduce model, Parallel efficiency of Map-Reduce, Relational operations using Map-Reduce, Enterprise batch processing using Map-Reduce, Introduction to cloud development, Example/Application of Map reduce, Features and comparisons among GFS,HDFS etc, Map-Reduce model.

UNIT - V

Cloud security :Fundamentals, Vulnerability assessment tool for cloud, Privacy and Security in cloud, Cloud computing security architecture: Architectural Considerations- General Issues, Trusted Cloud computing, Identity Management and Access control-Identity management, Access control, Autonomic Security. Dependability, data migration, streaming in Cloud. Quality of Service (QoS) monitoring in a Cloud computing environment.

Text Book:

1. Cloud Computing for Dummies by Judith Hurwitz, R.Bloor, M.Kanfman, F.Halper (Wiley India Edition)
2. Enterprise Cloud Computing by Gautam Shroff,Cambridge
3. Cloud Security by Ronald Krutz and Russell Dean Vines, Wiley-India

Reference Book:

1. Google Apps by Scott Granneman,Pearson
2. Cloud Security & Privacy by Tim Malhar, S.Kumaraswammy, S.Latif (SPD,O'REILLY)
3. Cloud Computing : A Practical Approach, Antohy T Velte, et.al McGraw Hill, 4. Cloud Computing Bible by Barrie Sosinsky, Wiley India 5. Stefano Ferretti et.al.,QoS–aware Clouds", 2010 IEEE 3rd International Conference on Cloud Computing

CORE-16

MOBILE COMPUTING

Course Outcomes

1. Understand the characteristics and limitations of mobile hardware devices including their user interface modalities.
2. Develop applications that are mobile device specific and demonstrate current practice in mobile computing contexts.
3. Design and development of context aware solutions for mobile devices.
4. Have professional and ethical issues, in particular those relating to security and privacy of user data and user behaviour.

UNIT - I

Personal Communications Services (PCS) Architecture, Cellular Telephony, Cordless Telephony and Low-Tier PCS, Third-Generation Wireless Systems. Wireless Transmission: Transmission concepts, Signal Propagation. Multiplexing Techniques: Space Division Multiplexing (SDM), Time Division Multiplexing (TDM), Frequency Division Multiplexing (FDM), Code Division Multiplexing (CDM), Modulation, Spread spectrum techniques, Cellular System. Medium Access Control (MAC): Issues relating to MAC, SDMA, FDMA, TDMA, CDMA.

UNIT - II

Mobility Management: Handoff, Roaming Management for SS7 and CT2. Handoff Management: Mobility detection, Channel Assignment, Hard Handoff and Soft Handoff for Radio Link Transfer. Switching: Circuit Switched Data Services on Cellular Networks, Packet Switched Data Services on Cellular Networks. Addressing Mobile quality of service, Access point control protocol.

UNIT - III

Global System for Mobile Communication (GSM): GSM Architecture, Location Tracking and Call Setup, Data Services, Protocol Model, Mobility Management, Short Message Service (SMS), Roaming Facility and Security. Analog Mobile Phone Service (AMPS): IS-136 North American TDMA Standard, IS-95: The North American CDMA Digital Cellular Standard. General Packet Radio Service (GPRS): GPRS Architecture, GPRS Network, Interfaces and Procedures.

UNIT - IV

Third Generation Mobile Services (3G): IMT-2000, W-CDMA, CDMA-2000, Quality of Service (QoS) in 3G, Wireless Operating System for 3G Handset. Wireless LAN: Infrastructure and Ad hoc networks, IEEE 802.11, Hiperlan, Blue tooth. Mobile Multimedia (MM): Wireless ATM (WATM), WATM services, Reference model

UNIT - V

Mobile Network Layer: Mobile IP, Dynamic Host Configuration Protocol (DHCP), Ad hoc Networks. Mobile Transport Layer: Traditional TCP, Indirect TCP, Snooping TCP, Mobile TCP, Security features. Wireless Application Protocol (WAP): WAP Model and Architecture, WAP Gateway, WAP Protocols, Wireless Markup Language (WML). Wireless Local Loop (WLL): WLL Architecture, WLL Technologies, and WLL Products.

TEXT BOOKS:

1. Yi-Bing Lin and Imrich Chlamtac, “Wireless and Mobile Network Architectures”, 2001, John Wiley and Sons.
2. Jochen Schiller, “Mobile Communication”, 2000, Pearson Education Asia.

REFERENCE:

1. Raj Pandya, “Mobile and Personal Communication Systems and Services”, 2001, Prentice Hall of India.
2. C.Y. William Lee, “Mobile Cellular Telecommunications: Analog and Digital System”, 2nd Edition, 1997, MC Graw Hill.

EC-2

REAL TIME SYSTEM

UNIT - I

Introduction to Distributed System: Introduction, Goals of Distributed OS, Hardware & Software concepts of distributed OS, Design issues of distributed OS, Communication issues in distributed OS, Layered protocol, ATM Networks, Client-Server model, RPC Concept.

UNIT - II

Clock Synchronization issues, Mutual Exclusion, Deadlocks issues, Threads, System Models , Processor Allocation, Scheduling in distributed Systems, Fault Tolerance .

UNIT - III

Introduction to real time systems: Concept of real time Systems, Jobs & Processes, Hard & Soft Real time Systems, Periodic, Aperiodic & Sporadic Task. Real time Scheduling: Clock driven Scheduling Algorithms, Round Robin & Weighted Round Robin, Priority Driven Approaches, Dynamic vs. static Systems, Rate monotonic analysis (RMA), Earliest Deadline First(EDF), off-line vs. on-line scheduling, Scheduling Sporadic Jobs, Algorithms for constructing schedule for static jobs, Fixed-Priority vs. Dynamic-Priority Algorithms.

UNIT - IV

Real time Resource control: Task scheduling with resource sharing, Priority inversion problem, Protocols for Non-Preemptive resource sharing, Priority Inheritance Protocol (PIP), Highest Locker Protocol (HLP), Priority Ceiling Protocol (PCP), Task Scheduling with Precedence Constraints, Scheduling in multi processor & Distributed Systems.

UNIT - V

Real time operating Systems: Basic Concepts of Real time operating Systems, Basic Kernel Services, RTOSs vs. General purpose Operating Systems, A Survey of Real Time Operating System, Commercial Real time Systems, Unix Sys_V as a RTOS, Extensions to Unix Sys_V, Host/Target Approach pSoS Vx Works, Real time POSIX, RT-Linux, Windows NT as a RTOS.

TEXT BOOKS:

1. Jain W. Liu, Real Time Systems, Pearson Education Asia,2001
2. Andrew S. Tanenbaum, Distributed Operating Systems.

REFERENCE BOOKS:

1. Krishna & Shin,RTS, McGraw Hill1999
2. Shrinivas & Murty, Advanced RTS
3. Philip A. Laplante, “RTS Design & Analysis”

EC-2

DATA MINING

UNIT - I

Introduction: Definition of data mining - data mining vs query tools - machine learning - taxonomy of data mining tasks - steps in data mining process - overview of data mining techniques.

UNIT - II

Data Pre-Processing And Characterization: Data Cleaning - Data Integration and Transformation Data Reduction - Discretization and Concept Hierarchy Generation - Primitives - Data Mining-Query Language - Generalization - Summarization - Analytical Characterization and Comparison

UNIT - III

Association Rule - Mining: Market basket analysis, frequent Itemset generations, The Apriori principle, Candidate Itemset generation and Pruning, Support counting using Hash tree, Multi Dimensional data from Transactional Database and Relational Database. FP-Growth Algorithm, objective measures of Interestingness

UNIT - IV

Classification: Classification - Decision Tree Induction - Bayesian Classification - Back Propagation, Lazy learners, nearest neighbor, Rule based classification, Accuracy, Prediction- Linear regression, Non-linear regression models

UNIT - V

Cluster analysis: Types of data, Distance measures, Evaluation criteria measures, Clustering Methods - Partitioning methods, K-Means, Density based method- DBSCAN, Model based clustering methods – Expectation-maximization, outlier analysis.

Text Books

1. Jiawei Han, Micheline Kamber, Data Mining: Concepts and Techniques, Morgan Kaufman Publishers, 2006.

Reference Books

1. Usama M.Fayyad, Gregory Piatetsky Shapiro, Padhrai Smyth, Ramasamy Uthurusamy, Advances in Knowledge Discover and Data Mining, The M.I.T.Press, 2007.
2. Ralph Kimball, Margy Ross, The Data Warehouse Toolkit, John Wiley and Sons Inc., 2002.
3. Alex Berson, Stephen Smith, Kurt Thearling, Building Data Mining Applications for CRM, Tata McGraw Hill, 2000.
4. Margaret Dunham, Data Mining: Introductory and Advanced Topics, Prentice Hall, 2002.
5. Daniel T. Larose John Wiley & Sons, Hoboken, Discovering Knowledge in Data: An Introduction to Data Mining, New Jersey, 2004.

MASTER OF SC/ARTS IN

MATHEMATICS

(SEMESTER PATTERN)

CHOICE BASED CREDIT SYSTEM SYLLABUS

TWO-YEAR FULL TIME PROGRAMME

COURSES OF STUDIES

(2023 -2024)

Buxi Jagabandhu Bidyadhar Autonomous College

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COURSE STRUCTURE FOR MA/MSC MATHEMATICS

Semester	Paper code	Paper Name	Marks		Full Marks	Credits
			Mid Semester	End Semester		
I	C-1	Real Analysis	30	70	100	4
	C-2	Differential Equation	30	70	100	4
	C-3	Topology	30	70	100	4
	C-4	Linear Algebra	30	70	100	4
	C-5	Data Processing & Numerical Computing (Pract)		100	100	4
II	C-6	Functional Analysis	30	70	100	4
	C-7	Complex Analysis	30	70	100	4
	C-8	Advanced Abastract Algebra	30	70	100	4
	C-9	Numerical Optimization	30	70	100	4
	C-10	Latex & C++ (Pract)		100	100	4
III	C-11	Numerical Analysis-I	30	70	100	4
	C-12	Number Theory & Cryptography-I	30	70	100	4
	C-13	Discrete Mathematics	30	70	100	4
	EC-1	**Elective-A**	30	70	100	4
	C-14	Python (Pract)		100	100	4
IV	C-15	Numerical Analysis-Ii	30	70	100	4
	C-16	Number Theory & Cryptography-Ii	30	70	100	4
	EC-2	Elective-B	30	70	100	4
	C-17	Seminar And Assignment	50(Seminar)	50(Assignment)	100	4
	C-18	Project/Dissertation	100marks		100	4
Total	**20 papers in Two Years**			**2000**	**80**	

N.B.: The department also offers the following elective papers **(Students are to choose anyone paper from each elective). C-Core, EC- Elective Course**

EC-1(Elective–A)

1. Integral Equation & Calculus of Variation
2. Differential Geometry
3. Numerical Solution of Partial Differential Equation-I
4. Data Science-I
5. Statistical Methods

EC-2(Elective–B)

1. Fluid Dynamics
2. Advanced Analysis
3. Numerical Solution of Partial Differential Equation-II
4. Data Science-II
5. Analytic Number Theory

DETAILED SYLLABUS

PROGRAMME SPECIFIC OUTCOME: After completing M.Sc. in Mathematics, students will get advanced knowledge of principles, methods and clear perception of innumerous power of mathematical ideas and tools. They will be able to apply their skills and knowledge, that is translate information presented verbally into Mathematical form select and use appropriate mathematical formulae or techniques in order to process the information and draw relevant conclusion. Student will get adequate knowledge about both pure as well as applied mathematics that will help them pursue higher education and also in research.

SEMESTER-I

C-1 (REAL ANALYSIS)

(Marks : 100)

Course Objectives:

Measure theory provides a foundation for many branches of mathematics such as harmonic analysis, ergodic theory, theory of partial differential equations and probability theory. It is a central, extremely useful part of modern analysis, and many further interesting generalizations of measure theory have been developed. It is also subtle, with surprising, sometimes counter-intuitive, results. The aim of this course is to learn the basic elements of Measure Theory, with related discussions on applications in probability theory.

Course Outcomes:

After the course the students are expected to be able to:

- Define and understand basic notions in abstract integration theory, integration theory on topological spaces and the n-dimensional space
- Describe and apply the notion of measurable functions and sets and use Lebesgue monotone and dominated convergence theorems and Fatous' Lemma
- Describe the construction of and apply the Lebesgue integral
- Describe the construction of product measures and use Fubini's Theorem
- Describe the notion of absolute continuity and singularities of measures and apply Lebesgue decomposition and the Radon-Nikodym theorem
- Apply Hölder's and Minkowski's inequalities and describe Riesz representation Theorem

UNIT- 1

Metric space, sequences and series of functions, uniform convergence, continuity, integrability, differentiability, equicontinuous functions, Weirstrass Approximation Theorem.

UNIT- 2

Measures and integration, open Sets, Cantor like sets, Lebesgue outer measure, measurable sets, regularity, measurable functions, Borel and Lebesgue measurability.

UNIT- 3

Integration of non-negative functions, the general integral, integration of series, Riemann and Lebesgue integrals.

UNIT- 4

The four derivatives, functions of bounded variation, Lebesgue differentiation theorem, differentiation and integration, The Lebesgue set.

UNIT- 5

The L_p- spaces, convex functions, Jensen's inequality. The inequalities of Holder and Minkowski, completeness of $L_p(\mu)$, convergence in measure, almost uniform convergence.

Text Book:

1. W.Rudin: Principles of Mathematical Analysis, Chapters 7.
2. G.De.Barra: Measure Theory and Integration (Wiley Eastern Ltd.). Chapters 1(1.6 & 1.7), 2(excluding 2.6), 3 , 4(excluding 4.2), 6, 7(7.1, 7.2).

Reference:

1. H.L. Royden, P.M . Fitzpatrick: Real Analysis (Fourth edition)
2. Tomm Apostol, *"Mathematical Analysis*", Narosa Publishers, New Delhi, 2002.

C-2 (DIFFERENTIAL EQUATION)

(Marks : 100)

Course Objectives:

Differential equations introduced by Leibnitz in 1676 models almost all physical, biological, chemical systems in nature. The objective of this course is to familiarize the students with various methods of solving differential equations and to have a qualitative applications through models. The students have to solve problems to understand the methods.

Course Outcomes:

A student completing the course isable to solve differential equation and is able to model problems in nature using ordinary differential equations. This is also prerequisite for studying the course in partial differential equations and models dealing with partial differential equations.

Unit-1

Existence and uniqueness of solutions: Lipschitz condition, Gronwall inequality, successive approximations, Picard's theorem, continuation and dependence on initial conditions, existence of solutions in the large, existence and uniqueness of solutions of systems, fixed point method. systems of linear differential equations: n^{th}- order equation as a first order system, systems of first order equations,existence and uniqueness theorem, fundamental matrix, non- homogeneous linear systems, linear systems with constant coefficients.

Unit-2

Non-linear differential equations: existence theorem, extremal solutions, upper and lower solutions, monotone iterative method and method of quasi linearization. stability of linear and non linear systems: critical points, systems of equations with constant coefficients, linear equations with constant coefficients, Lyapunov stability.

Unit-3

Boundary value problems for ordinary differential equations: Sturm-Liouville problem, eigen value and eigen functions, expansion in eigen functions, Green's function, Picard's theorem for boundary value problems. Series solution of Legendre and Bessel equations.

Unit-4

The Laplaces equation: boundary value problem for Laplace's equation, fundamental solution, integral representation and mean value formula for harmonic functions, Green's function for

Laplace's equation, solution of the Dirichlet problem for a ball, solution by separation of variables, solution of Laplace's equation for a disc.

Unit-5

The wave equation and its solution by the method of separation of variables, D'Alembert's solution of the wave equation, solution of wave equation by Fourier transform method

Text Book:

1. S.D. Deo, V. Lakshmikantham and V. Raghavendra: Text Book of Ordinary Differential Equations, 2nd edition,TMH. Chapters: 4(4.1-4.7), 5, 6(6.1-6.5), 7(7.5), 9(9.1-9.5).
2. J.Sinha Roy and S. Padhy: A Course on Ordinary and Partial Differential Equations, Kalyani Publishers. Chapters: 10, 15, 16 and 17.

Reference:

1. Somasundaram, Ordinary Differential Equations, Narosa Publ. House, Chennai-2002.
2. G.F. Simmons, Differential Equations with Applications and Historical Notes, McGraw Hill Education.

C-3 (TOPOLOGY)

(Marks : 100)

COURSE OBJECTIVES:

This is an introductory course in topology of metric spaces. The objective of this course is to impart knowledge on open sets, closed sets, continuous functions, connectedness and compactness in metric spaces.

- Work with topological definitions and theorems related to the content described
- Produce examples and counter examples that illustrate why theorem hypotheses are necessary or why a statement is untrue
- Draw pictures to represent topological ideas.
- Formulate conjectures about topological concepts, and test these conjectures.
- Use topological ideas (e.g., homeomorphisms, fundamental group)to classify spaces.

Course Outcomes:

On successful completion of the course students will learn to work with abstract topological spaces. This is a foundation course for all analysis courses in future.

UNIT- 1

Countable and uncountable sets, infinite sets, well-ordered sets. topological spaces, basis and sub basis for a topology, the order, product and subspace topology, closed sets and limit points

UNIT- 2

Continuous functions and homeomorphism, metric topology, connected spaces, connected subspaces of the real line, components and local connectedness.

UNIT- 3

Compact spaces, basic propertiesof compactness, compactness and finite intersection property, compact subspaces of the real line, compactness in metric spaces, limit point compactness, sequential compactness and their equivalence in metric spaces, local compactness.

UNIT- 4

First and second countable spaces, Lindel of space, separable spaces, separable axioms, and Hausdorff, regular and normal spaces.

UNIT- 5

The Urysohn lemma, completely regular spaces, the Urysohn metrization theorem, Tietz extension theorem, Tychonoff theorem.

Text Book:

1. Topology- J.R.Munkres, 2nd Edition

   Chapters:1 (7, 9, 10), 2 (12, 13, 14, 15, 16, 17, 18, 19, 20, 21), 3, 4 (30, 31, 32, 33, 34, 35), 5 (37).

Reference:

1. Foundations of Topology– C. Wayne Patty
2. J.Dugundji, Topology, Prentice Hall of India, New Delhi, 1975.
3. G.F. Simmons, Introduction to Topology and Modern Analysis, McGraw Hill Book Co, New York, 1963.

C-4 (LINEAR ALGEBRA)

(Marks : 100)

Course Objectives:

The main objective is to familiarize with algebra of linear transformations, representation of transformations by matrices, linear functional, double dual, the transpose of linear transformation, elementary canonical forms, triangulation, and diagonalization, Jordan forms, computation of invariant factors, inner product spaces and bilinear forms.

Course Outcomes:

After studying this course, the students will be able to

- Understand what is meant by linear transformations, algebra of linear transformation and represent transformation by matrices and vice-versa.
- Express a system of linear equations in a matrix form.
- do the elementary row operations for the matrices and systems of linear equations
- investigate the solution of a system
- find the different canonical forms of a given matrix, and test the similarity of two matrices.
- know about rational and Jordan forms, cyclic subspaces and annihilators, cyclic decompositions, inner product spaces with idea of adjoints.

UNIT- 1

Vector spaces and subspaces, linear independence of vectors, basis and dimension. linear transformations and matrices, kernel, nullity theorem, rank of a matrix.

UNIT- 2

Matrices: elementary operations, reduced row-echelon form, consistency of a system of equations, solutions of systems of equations, homogeneous system, inverse of a matrix.

UNIT- 3

Linear functional, similarity, double dual, characteristic polynomials, eigen values, theorems on eigen values and eigen vectors, Cayley-Hamilton theorem, properties of characteristic polynomials, the rational and Jordan form, diagonalization.

UNIT-4

Inner product spaces, c-sine quality, triangle inequality, orthonormal basis,Gram-Schmidt construction of orthonormal basis.

UNIT-5

Bilinear and quadratic forms, properties.

Text Book:

1. Kenneth Hoffman, Ray Kunze, Linear Algebra (2nd Edition)
   Chapters (1, 2 (2.1, 2.2, 2.3, 2.4, 2.5), 3, 4 (4.1, 4.2), 7 (7.2, 7.3, 7.4 (Upto Theorem 6), 8 (8.1, 8.2, 8.3), 10 (10.1, 10.2, 10.3).

Reference:

1. Dan Margalit, Joseph Rabinoff , Interactive Linear Algebra
2. Serge Lang, Introduction to Linear Algebra
3. G. Strang, Introduction to Linear Algebra, 2nd Edition, Prentice Hall of India Pvt. Ltd., New Delhi, 2013.
4. M.Artin, Algebra, Prentice Hall of India Pvt. Ltd., New Delhi, 2005.
5. S.H.Friedberg, A.J.Insel And L.E.Spence, Linear Algebra, 4th Edition, Prentice Hall of India Pvt. Ltd., New Delhi, 2009.

C-5 (DATA PROCESSING & NUMERICAL COMPUTING LAB.)

(Marks : 100)

End-term practical record: 15 marks, viva: 25 marks, Experiment: 60 marks (Minimum two Experiments.)

Introduction to Computers :

Application of information technology, computer system and cpu, input & output, secondary Storage, system and application software (windows & linux), communications & multimedia.

Numerical computation using C/Matlab/equivalent software.

basic elements of C, control structures, loops, I/O concepts, arrays, functions.

Implementation of the following by using C.

(i) Solution of the equation f(x) = 0 by (a) fixed point iteration method (b) Newton-Raphson method.

(ii) Solving a tridiagonal system of equations.

(iii) Solving a system of linear equations by (a) Matrix factorisation method. (b) Gauss-Seidel method.

(iv) Finding the inverse of a matrix.

(v) Finding least square polynomial fit to a given data.

(vi) Approximating a definite integral by (a) Newton-Cotes rules. (b) Gauss-Legendre rules.

(vii) Solution of an initial value problem by Runge-Kutta method of order 2.

(viii) Determination of eigen values of a matrix by power method/QR method.

Text Book:

1. J.H. Mathews: Numerical methods for Mathematics, Science and Engineering (2nd edition), Prentice-hall of india pvt. Ltd., new delhi.
2. B.W. Kernighan and D.M. Ritchie: Programming in Ansi-C, Prentice-Hall of India pvt. Ltd., New Delhi.

SEMESTER-II

C-6 (FUNCTIONAL ANALYSIS)

(Marks : 100)

Course Objectives:

The main objective of this course is familiarize the students to the ideas and some of the fundamental theorem of functional analysis, which is an important branch of mathematics developed with the purpose to cover theoretical needs of partial differential equation, measure theory and other branched of mathematics. It aims to study normed linear spaces, main properties of uniform boundedness along with open mapping theorem, different types of convergences in normed spaces and some of its applications, duality and inner product spaces with formation of orthonormal sets.

Course Outcomes:

- Recognize inner product spaces and identify duals of some normed spaces.
- Identify whether a real valued function defined on cartesian product of a vector space is inner product or not and an inner product space is Hilbert space or not.

Explain main theorems for normed spaces

- Explain Hahn-Banach Theorem
- Identify Open Mapping Theorem
- Explain Closed Graph Theorem

UNIT- 1

Normed linear spaces, continuity of linear maps, equivalent Norms, Hahn-Banach Theorem for real linear spaces, complex linear spaces and normed linear spaces.

UNIT-2

Banach spaces and examples, quotient spaces, Uniform Boundedness Theorem and some of its consequences, Open Mapping Theorem and Closed Graph Theorems, Bounded Inverse Theorem.

UNIT-3

Spectrum of a Bounded Linear Operator, Duals and Transpose, duals of Lp([A, B]) and C([A,B]).

UNIT-4

Weak And Weak*Convergence, Reflexive Spaces, Adjoint of Bounded Linear Operators.

UNIT-5

Inner Product Spaces, Hilbert Spaces and Examples, Orthonormal Sets, Bessel‘s Inequality, Complete Orthonormal Sets and Parseval‘S Identity, Approximation and Optimization, Projection Theorem, Riesz-Representation Theorem.

Text Book:

1. B.V. Limaye: Functional Analysis, New Age International Ltd (2nd Edn.), 1995.
   Chapters: II (Art. 5, 6, 7 (Except 7.12), 8), III (Art.9 (9.1, 9.3), 10, 11, 12 (up to 12.6), IV (Art. 13, 14 (14.6, 14. 7), 15, 16), VI (Art. 21, 22, 23, 24 (up to 24.6).

Reference:

1. Kreyszig, E.(2007) Introductory Functional Analysis With Applications, Wiley.
2. P.K.Jain, O.P.Ahuja, Functional Analysis, New Age International.
3. Conway, J.B. (1994) A Course In Functional Analysis, 2nd Edition, Springer Verlag.

C-7 (COMPLEX ANALYSIS)

(Marks : 100)

Course Objectives:

The course on complex analysis is aimed to introduce the theories of functions of complex variables; analytic functions and their power series representation; Mobius transformation; application of Cauchy's theorem, Cauchy integral formula and residue theorem to evaluate contour integration.

Course Outcomes:

The student should be able to represent complex numbers algebraically and geometrically, define and analyze limits and continuity for complex functions as well as consequences of continuity, apply the concept and consequences of analyticity and the Cauchy-Riemann equations and of results on harmonic and entire functions Including the fundamental theorem of algebra, analyze sequences and series of analytic functions and types of convergence, evaluate complex contour integrals directly and by the fundamental theorem, apply the Cauchy integral theorem in its various versions, and the Cauchy integral formula and represent functions as Taylor, Power and Laurent series, classify singularities and poles, find residues and evaluate complex integrals using the residue theorem.

UNIT-1

Topology of complex plane, elementary properties of analytic functions, analytic functions,Cauchy-Riemann equations.

UNIT-2

Analytic functions as mappings, Mobius transformations,Complex integration: Curves in the complex plane, Complex line integral, Morera's theorem, Cauchy's integral Formula, Cauchy's integral formula for derivatives, Cauchy's inequality.

UNIT-3

Power series, power series representation of analytic functions, zeros of an analytic functions. Liouville's theorem,Fundamental theorem of algebra.

UNIT-4

Index of a closed curve, Cauchy's theorem and integral formula, counting zeros, Open mapping theorem, Cauchy-Goursat theorem, Identity/Uniqueness theorem.

UNIT-5

Singularities and classifications, Laurent series, Cauchy's residues, evaluation of integrals, Argument principle, Rouche's theorem.

Text Book:

Foundation of Complex Analysis - S.Ponnusamy Narosa Publishing House, 2nd Edition. Chapters: 1(1.5), 3[3.1, 3.2 (3.44), 3.3), 4[4.1, 4.2(Upto example- 4.6), 4.3 (Theorem- 4.28), 4.5, 4.7 (Upto Example- 4.83), 4.8, 4.11, 4.12], 5(5.2), 6 [(6.1), 6.4 (Except Theorem- 6.60), 6.6, 6.7], 7 (7.1,7.2, 7.3, 7.5), 8(8.1-8.5).

Reference:

1. J.B Conway, Functions of One Complex Variable, Narosa Publ. House, New Delhi, 1980.
2. S. Lang, Complex Analysis, 4th Edition, Springer Verlag.
3. W.J.Brown and V.R.Churchil, Complex Variables And Applications, 9th Edition, McGraw Hill.

C-8 (ADVANCED ABSTRACT ALGEBRA)

(Marks : 100)

Course Objectives:

The main objective of this course is to imbibe in the minds of the students the deeper idea of abstract algebra. Having fundamental ideas of group theory, ring theory, matrices and linear algebra, the students will acquire advanced phase of knowledge of abstract algebra.

Course Outcomes:

A student learning this coursegets idea on concept and examples of groups and their properties. He understands cyclic groups, permutation groups, normal subgroups and related results. After this course he can opt for courses in ring theory, field theory, commutative algebras, and linear classical groups etc. And can be apply this knowledge to problems in physics, computer science, economics and engineering.

Unit- 1

Introduction to groups, subgroups, normal subgroups, isomorphism theorems, automorphisms, Permutation groups: cyclic decomposition &alternating group A_N.

Unit- 2

Structure theorems for groups: Direct product, finitely generated Abelian groups. Sylow's theorem.

Unit- 3

Unique factorization domains & Euclidean domains: Unique factorization domain, Principal ideal domains, Euclidean domains, polynomial rings over UFD.

Unit- 4

Algebraic extensions of fields: Irreducible Polynomials and Einstein criterion, adjunction of roots, algebraic extensions. Algebraically closed fields, normal separable extensions :splitting fields, normal extensions.

Unit- 5

Normal separable extensions: Multiple roots, finite fields, separable extensions.Splitting fields, normal extensions

Text Book:

1. David S. Dummit, Richard M. Foote, Abstract Algebra, 3rd Edition.
   Chapter:1, 2(2.1, 2.2, 2.3), 3(3.1, 3.2, 3.3 (Theorem16), 3.5), 4(4.3, 4.4, 4.5, 4.6), 5(5.1, 5.2), 7(7.1, 7.2, 7.3, 7.4), 8, 9(9.1, 9.2, 9.3, 9.4), 13(excluding 13.3)

Reference:

1. P.B.Bhattacharya, S.K.Jain, S.R.Nagpaul. Basic Abstract Algebra
2. M.Artin,*"Algebra",* Prentice-Hall of India, New Delhi, 1991.
3. V.K.Khanna And S.K.Bhambri,*"A Course in Abstract Algebra"*, Vikas Publishing House Pvt Limited 1993.
4. J.B.Fraleigh-A First Course in Algebra, Pearson, 7th Ed., 2013.
5. J.Gallian-Contemporary Abstract Algebra, Brooks/Cole Pub Co; 8th Edition,2012

C-9 (NUMERICAL OPTIMIZATION)

(Marks : 100)

Course Objectives:

- Find acceptable approximate solutions when exact solutions are either impossible or so arduous and time-consuming as to be Impractical.
- Devise alternate methods of solution better suited to The capabilities of computers;
- Formulate problems in their fields of research as optimization problems by defining the underlying Independent variables, the proper cost function, and the governing constraint function

Expected Outcomes:

- Understand how to assess and check the feasiblity and optimality of a particular solution to a General Constrained Optimization Problem;
- Use the optimality conditions to search for a local or global solution from a starting point;
- Formulate the dual Problem of some general Optimization types and assess their duality gap using Concepts of Strong and Weak duality;

UNIT- 1

One Dimensional Optimization: Introduction Function, Comparison Methods, Polynomial Interpolation, Iterative Methods.

UNIT- 2

Gradient Based Optimization Methods (i): Calculus on R^n, Method of Steepest Descend, Conjugate Gradient Method, The Generalized Reduced Gradient Method, Gradient Projection Method. ·

UNIT- 3

Gradient Based Optimization Methods(Ii): Newton Type Methods (Newton's Method, Marquardt's Method), Quasi Newton Methods.

UNIT- 4

Linear Programming: Convex Analysis, Simplex Method, Two Phase Simplex Method, Duality Theory, Dual Simplex Method.

UNIT-5

Constrained Optimization Methods: Lagrange Multipliers, Kuhn-Tucker Conditions, Convex Optimization, Penality Function Techniques, Method of Multiplier, Linearly Constrained Problems Cutting Plane Method.

Textbook:

1. 1. M.C. Joshi and K.M. Moudgalya, Optimization: Theory and Practice, Narosa Publishing
2. House, 2015. Unit-I Chapter-2; Unit-Ii Chapter-3, Unit-Iii Chapter-4; Unit-Iv Chapter-5.

Reference:

1. M.C.Joshi And K. Moudgalya, Optimization Theory And Practice, Narosa Publishing House, New Delhi, 2004
2. J.A. Snyman, Pratical Mathematical Optimization ,Spinger Sciences,2005

C-10 (C++ LAB & LATEX.)

Marks : 100 (VIVA: 25, RECORD: 15, EXPERIMENT: 60)

Part-A-Use of Latex

Understanding latex compilation, basic syntax. Writing equations, matrix, tables. Building latex Documents. Page layout – titles, abstract chapters, sections references, equation references, Citation. List making environments, table of contents, generating new commands. Figure handling, Numbering. List of figures, list of tables, generating index. Presentation (beamer) Overlays - themes assignments and examinations the exam class - the exsheets package - the Probsoln package - using the data tool package for exams or assignment sheets - random numbers. Flow charts

Part-B– Introduction To C++

Programming paradigms, characteristics of object oriented programming languages, brief history of C++, structure of C++ program, differences between C and C++, basic C++ operators, comments, working with variables, enumeration, arrays and pointer. Functions

List Of Experiments Using C++:

1. Calculate the sum of the series 1/1+1/2+1/3+⋯+1/n.
2. Enter 100 integers into an array and sort them in an ascending/descending order.
3. Addition, subtraction, multiplication of two matrices (order upto 4×4).
4. Solution of the equation $F(X) = 0$ by (a) Bisection method (b) Secant method.
5. Gauss Elimination method.
6. Gaussian Quadrature method.
7. Gauss-Chebyshev method.
8. Modified Euler's method.
9. Runge-Kutta 2^{nd} and 4^{th} order methods.
10. Lagrange interpolation method.
11. Cubic spline interpolation method.
12. Shooting method for BVPS (ODE)
13. Finite difference method for BVP (ODE).

Experiments Using Latex:

1. Creating Documents Using Latex.
2. Creating Beamer Presentations.

Books Recommended:

1. ADVANCED LATEX BY TIM LOVE,2006.
2. LATEX FOR ADMINISTRATIVE WORK BY NICOLAL.C.TALBOT, DICKIMAW BOOKS,2015.

3. HTTP://WWW.H.ENG.CAM.AC.UK/HELP/DOCUMENTATION/DOCSOURCE/LATEX_ADVANCED.PDF.

4. OBJECT-ORIENTED PROGRAMMING WITH C++, E BALAGURUSAMY, MC GRAW HILL,7E.

SEMESTER-III

C-11 (NUMERICAL ANALYSIS- I)

(Marks : 100)

Course Objectives:

To provide the numerical methods of solving the non-linear equations, interpolation, differentiation, and integration. To improve the student's skills in numerical methods by using the numerical analysis software and computer facilities.

Expected Outcomes:

Apply numerical methods to find our solution of algebraic equations using different methods under different conditions, and numerical solution of system of algebraic equations. Apply various interpolation methods and finite difference concepts. Work out numerical differentiation and integration whenever and wherever routine methods are not applicable. Work numerically on the ordinary differential equations using different methods through the theory of finite differences. Work numerically on the partial differential equations using different methods through the theory of finite differences

UNIT- 1

Solution of Equations in One and Two Variables: Fixed point Iteration method, accelerate on of convergence, zeros of polynomials and Muller's method, fixed points for functions of several variables, Newton's method.

UNIT- 2

Interpolation: Hermite Interpolation, Cubic Spline Interpolation, Parametric curves, Hermite, Bézier and bspline curves.

UNIT- 3

Least Square Approximation, Discrete L.S.-Approximation, Orthogonal polynomials, Chebyshev polynomials and Economization, Rational Approximation.

UNIT- 4

Numerical Integration: Elements, Composite Integration, Romberg Integration, Gauss quadrature.

UNIT- 5

Approximation of Multiple Integrals: Composite Simpson Rule. IVP of ODE.

Text Book:

1. R. L. Burden, J. D. Faires: Numerical Analysis, Brooks/Cole Cengage Learning, 9th Edition.

   Chapters: 2(2.2-2.6), 3(3.4-3.6), 4(4.3- 4.5, 4.7, 4.8), 5(5.1- 5.4).

Reference:

1. M.K.Jain, S.R.K. Iyengar and R.K. Jain: Numerical Methods for Scientific and Engineering Computation, New age International publishers, sixth edition

2. Bradie, B., A Friendly Introduction to numerical analysis. Pearson Prentice Hall, 2006.

3. Atkinson, K. E., Introduction to numerical analysis, 2nd Edition. John Wiley, 1989.

C-12 (NUMBER THEORY AND CRYPTOGRAPHY- I)

(Marks : 100)

Course Objectives:

The main objective of this course is to build up the basic theory of the integers, prime numbers and their primitive roots, the theory of congruence, quadratic reciprocity law and number theoretic functions, Fermat's last theorem, to acquire knowledge in cryptography especially in RSA encryption and decryption.

Course Outcomes:

Upon successful completion of this course students will able to know the basic definitions and theorems in number theory, to identify order of an integer, primitive roots, Euler's criterion, the Legendre symbol, Jacobi symbol and their properties, to understand modular arithmetic number-theoretic functions and apply the MTO cryptography.

UNIT-I

Divisibility and primes, modular arithmetic, time estimates for doing arithmetic.

UNIT-II

Cryptography: Classical cryptosystem and their vulnerability public scheme.

UNIT-III

Primality testing and factoring, primitive roots, Eigamal system. Signature scheme, quadratic congruences and applications.

UNIT-IV

Continued fractions, factoring methods, Diophantine approximations.

UNIT-V

Diophantine equations, arithmetical functions and Dirichlet series, quadratic reciprocity law.

Text Book:

1. Ramanujachary Kumanduri and Christina Romero: Number Theory with Computer Applications, Prentice Hall, New Jersy, 1998.
2. Neal Koblitz: A Course of Number Theory and Cryptography, Second Edition, Springer Verlag, New York, 1987.
3. William Stein, Elementary Number Theory: Primes, Congruences & Secrets

Reference:

1. David M. Burton , Elementary Number Theory, Tata Mcgraw Hill.

C-13 (DISCRETE MATHEMATICS)

(Marks : 100)

Course Objectives:

This is a preliminary course for the basic courses in mathematics and all its applications. The objective is to acquaint students with basic counting principles, set theory and logic, matrix theory and graph theory.

Course Outcomes:

The acquired knowledge will help students in simple mathematical modeling. They can study advance courses in mathematical modeling, computer science, statistics, physics, chemistry etc.

Unit-I

Fundamentals of logic, logical inferences, methods of proof of logical inferences, first order logic, inference for quantified propositions, order relations, posets, lattices, enumerations, Hasse diagrams, path and closure, discrete graphs, and adjacency matrices.

Unit-II

Boolean algebra, Boolean functions, switching mechanisms, canonical forms, minterms, minimization of Boolean functions.

Unit-III

Graphs: Basic concepts, isomorphic graphs, sub-graphs, trees and properties, spanning trees, directed trees and binary trees.

Unit-IV

Planar graphs, Euler formula, multi graphs and Euler circuits, Hamiltonian graphs, chromatic numbers.

Unit-V

Network flows: Graphs as models of flow of commodities, flows, maximal flows, and minimal cuts, max-flow min-cut theorem.

Text Book:

1. J.L. Mott, A. Kendel and, T.P. Baker: Discrete Mathematics for Computer Scientists and Mathematicians, Chapters-I (1.5-1.9), Iv(4.4-4.7), V(5.1-5.11), Vi(6.1-6.5), Vii(7.1-7.4).

Reference:

1. C.L. Liu, Elements of Discrete Mathematics, McGraw Hill, 1985.
2. Tremblay and Manohar, discrete mathematical structures with applications to Computer Science, McGraw Hill Book Co., 2004.
3. E.Rosen, Discrete Mathematics & Its Application, McGraw Hill International.

ELECTIVE - A

EC-1 (INTEGRAL EQUATION & CALCULUS OF VARIATION)

(Marks : 100)

Course Objectives:

The objective of this course is to familiarize the students with various methods of solving different integral equations and to have qualitative applications to differential equations. The students have to solve problems to understand the methods.

Course Outcomes:

Demonstrate working knowledge of Laplace and Fourier transforms. It also demonstrates working knowledge of solving integral equations like Fredholm and Voltera integral equations. This course will also help in finding the extremal of functionals.

Unit- I

Laplace Transforms: Definitions, properties and Laplace transforms of some elementary functions, convolution theorem, inverse Laplace transformation and applications.

Unit- II

Fourier transforms, definitions, properties, Fourier transforms of some elementary functions, convolution, and Fourier transforms as a limit of Fourier series, applications to PDE.

Unit- III

Volterra Integral Equations: Basic concepts, relationship between linear differential equations and Volterra integral equations, resolvent kernel of Volterra integral equations, solution of integral equations by resolvent kernel, the method of successive approximations, convolution type equations, solutions of integral differential equations with the aid of Laplace transformations.

Unit- IV

Fredholm Integral Equations: Fredholm equations of the second kind fundamental, iterated kernel, constructing the resolvent kernel with the aid of iterated kernels, integral equations with degenerate kernels, characteristic numbers and eigen functions, solution of homogeneous integral equations with degenerate kernel- non homogeneous symmetric equations Fredholm alternative.

Unit-V

Calculus of Variations: Extremal of Functionals: The variation of a functional and its properties, Euler's equations, field of extremals, sufficient conditions for the extremum of a functional conditional extremum moving boundary problem, discontinuous problems, one sided variations, Ritz method.

TEXT Book:

1. A Course on Ordinary and Partial Differential Equations (With Applications). J.Sinha Roy, S. Padhy, Kalyani Publisher (Chapter-9 (Except 9.6, 9.13.1), 14).
2. Introduction to Integral Equations with Applications, A.J. Jerri, John Wiley and Sons
3. Calculus of Variations with Applications, A.S.Gupta, Phi Learning Private Limited.

EC-2 (DIFFERENTIAL GEOMETRY)

(Marks : 100)

Course Objectives:

- To get introduced to the concept of a regular parameterized curve in N.
- To understand the concept of curvature of a space curve and signed curvature of a plane curve.
- To understand the idea of orientable/ non-orientable surfaces.
- To understand the normal curvature of a surface, its connection with the first and second fundamental form and Euler's Theorem
- To understand the Weingarton equations, mean curvature and Gaussian curvature.
- To prove Theorem a Egregium of Gauss.
- To understand geodesics as distance minimizing curves on surfaces.
- To discuss Gauss Bonnet Theorem and its implication for a geodesic triangle

Course Outcomes:

Students should be able to:

- Define the equivalance of two curves.
- Find the derivative map of an isometry.
- Defines surfaces and their properties
- Express definition and parametrization of surfaces.
- Define the concept of manifolds.

Unit- I

Preliminary comments on R^n, Topological manifolds, differentiability for functions of several variables, differentiability of mappings and Jacobians, the space of tangent vectors at a point of R^n.

Unit- II

Definition of a differential manifold, example of differential manifolds, differentiable functions and mappings, the tangent space at a point of a manifold, vector fields, tangent covectors, covectors on manifolds, covector fields and mappings, bilinear forms, the Riemannian metric, Riemannian manifolds as metric spaces, tensors ona vector space

Unit- III

Lie groups, the action of a lie group on a manifold, the action of a discrete group on a maifold, one parameter groups acting on a manifold

Unit- IV

Tensor fields, mapping and covariant tensors, symmetrising and alternating transformations, multiplication of tensors on a vector space, multiplication of tensor fields, exterior multiplication of alternating tensors, exterior algebra on manifolds, exterior differentiation.

Unit- V

Differentiation of vector field along curves in R^n, the geometry of space curves, differentiation of vector fields on submanifolds of R^n, formulas for covariant derivatives, differentiation on Riemannian manifolds, the curvature tensor, the Riemannian connection and exterior differential forms, basic properties of Riemannian curvature tensor, the curvature forms and the equations of structure

Text Book:

1. William Boothby: An Introduction to Differentiable Manifolds and Riemannian Geometry, Academic Press, New York.

EC-3 (NUMERICAL SOLUTION OF PARTIAL DIFFERENTIAL EQUATIONS -I)

(Marks : 100)

Course Objectives:

To provide the numerical methods of solving the non-linear equations, interpolation, differentiation, and integration. To improve the student's skills in numerical methods by using the numerical analysis software and computer facilities. A major advantage of numerical method is that a numerical solution can be obtained for problems, where an analytical solution does not exist.

Course Outcomes:

1. Apply a range of techniques to find solutions of standard partial differential equations (PDE)
2. Understand basic properties of standard PDE's.
3. Demonstrate accurate and efficient use of Fourier analysis techniques and their applications in the theory of PDE's.
4. Demonstrate capacity to model physical phenomena using PDE's (in particular using the heat and wave equations).
5. Apply problem-solving using concepts and techniques from PDE's and Fourier analysis applied to diverse situations in physics, engineering, financial mathematics and in other mathematical contexts.

Unit- I

Introduction to finite differences (finite difference approximation of partial differential equations (pde), derivation of difference equations), convergence and consistency of difference schemes for initial value problems and initial-boundary value problems.

Unit- II

Stability of difference schemes for initial-value problems and initial-boundary value problems, the Lax theory, implicit schemes, analysis of stability, finite Fourier series and stability.

Unit- III

Parabolic equations : Difference schemes for two dimensional parabolic equation,convergence, consistency and stability,alternating direction implicit schemes(Peaceman- Rachford scheme, stability consistency and implementation; Douglas-Rachford scheme and its stability), difference schemes in polar cordinates.

Unit- IV

Hyperbolic Equations : Initial-value problems (ivp), explict & implicit difference schemes for ivp (one sided, centred, Lax-Windroff and Crank-Nicolson schemes), initial-boundary-value problem and their difference schemes, two dimensional hyperbolic equations and difference schemes, CFL conditions, computational considerations.

Unit- V

Review of classical iterative methods (Gauss-Jacobi, Gause-Seidel, SOR, gradient methods, conjugate gradient and the minimal residual method, pre-conditioning, multigrid methods, convergence of multigrid methods, computation of starting values using multigrid method, non-linear multigrid method.

Text Book :

1. J.W. Thomas: Numerical Partial Differential Equations (Fintie Difference Methods), Springer Verlag, 1995. Chapters: 1, 2,3,4,5.
2. D.Braess: Finite Elements, Cambridge University Press, 1997. Chapters: IV, V.

References:

1. K.W.Morton and D.F.Mayers: Numerical Solution Of Partial Differential Equations, Cambridge University Press, 1994.
2. J.C.Strikwerda: Finite Difference Schemes and Partial Differential Equations, Wadsworth and Books, 1889.
3. W.Hackbusoh: Interative Solution of Large Sparse System of Equations, Springer-Verlag, 1994.

EC-4 (DATA SCIENCE -1)

(Marks : 100)

Course Objectives:

- To explore, sort and analyze megadata from various sources in order to take advantage of them and reach conclusions to optimize business processes or for decision support.

Course Outcomes:

- Students will developrelevant programming abilities.
- Students will demonstrate proficiency with statistical analysis of data.
- Students will develop the ability to build and assess data-based models.
- Students will execute statistical analyses with professionalstatistical software.
- Students will demonstrate skill in data management.
- Students will apply data science concepts and methods to solve problems in real- world contexts and will communicate these solutions effectively

Unit- I

Linear Methods for Regression and Classification: Overview of supervised learning, Linear regression models and least squares, Multiple regression, Subset selection, Ridge regression, least angle regression and Lasso , Linear Discriminant Analysis, Logistic regression .

Unit- II

Model Assessment and Selection :Bias, Variance, and model complexity, Bias-variance trade off, Optimism of the training error rate, Estimate of In-sample prediction error, Effective number of parameters, Bayesian approach and B. IC, Cross-validation, Boot strap methods, Conditional or expected test error. Dimensionality reduction (Factor analysis, PCA, Kernel PCA, Independent Component analysis, ISOMAP, LLE, feature Selection)

Unit- III

Additive Models, Trees and Boosting: Generalized additive models, Regression and classification

trees, Boosting methods, Exponential loss and AdaBoost, Numerical Optimization via gradient boosting, Examples (Spam data, California housing, New Zealand fish, Demographic data)

Unit- IV

Support Vector Machines(SVM),and K-nearest -Neighbor: Basis expansion and regularization, Kernel smoothing methods, SVM for classification, Reproducing Kernels, SVM for regression, K-nearest –Neighbour classifiers (Image Scene Classification)

Unit- V

Unsupervised Learning and Random forests: Cluster analysis (k-means, Hierarchical clustering, spectral clustering), Gaussian mixtures and EM algorithm, Random forests and analysis.

LABWORK

Implementation of following methods using PYTHON

Simple and multiple linear regressions, Logistic regression, Linear discreminant analysis, Ridge regression, Cross-validation and boot strap, Fitting classification and regression trees, K-nearest neighbours, Principal component analysis , K-means clustering.

Recommended Texts

1. Trevor Hastie, Robert Tibshirani, Jerome Friedman, The Elements of Statistical Learning-Data Mining, Inference, and Prediction, Second Edition , Springer Verlag, 2009.
2. G. James, D.Witten, T. Hastie, R. Tibshirani -An introduction to statistical learning with applications in R, Springer, 2013.

References:

1. C. M. Bishop – Pattern Recognition and Machine Learning, Springer, 2006
2. L. Wasserman - All of statistics

EC-5 (STATISTICAL METHODS)

(Marks : 100)

Course Objectives:

1. Students should be familiar with the terminology and special notation of statistical analysis. The terminology consists of the following:
   - A. Statistical terms
     - i. Population
     - ii. Sample
     - iii. Parameter
     - iv. Statistic
     - v. Descriptive statistics
     - vi. Inferential statistics
     - vii. Sampling error
   - B. Measurement terms
     - i. Operational definition
     - ii. Nominal
     - iii. Ordinal
     - iv. Interval
     - iv. Ratio
   - C. Research terms
     - i. Correlation method
     - ii. Experimental method
     - iii. Independent variable
     - iv. Dependent variable
2. Students should learn how statistical techniques fit into the general process of science
3. Students should learn the notation, particularly summation notation.
4. Students should be able to organize data into a regular or a grouped frequency distribution table, and understand data that are presented in a table.

Course Outcomes:

Students should be able to:

- Distinguish types of studies and their limitations and strengths.
- Describe a data set including both categorical.
- Apply laws of probability to concrete problems.
- Perform statistical inference in several circumstances and interpret the results in an applied context.
- Use a computer for the purpose of simulation in probability and statistical inference.
- Communicate concepts in probability and statistics using both technical and non-technical language.

unit- I

Review of descriptive statistics: Detailed study on the interpretation, analysis and measurements of various numerical characteristics of a frequency distribution.

Unit- II

Concepts of univariate and bivariate distributions, curve fittings, regression and correlation analysis, rank correlation, correlation ratio, intra-class correlation.

Unit- III

Concept of multivariate distribution, multiple regression analysis, partial and multiple correlations and their properties, random sampling, sampling distribution and standard error, standard errors of moments and functions of moments.

Unit- IV

Exact sampling distributions- T, F and Chi-square distributions, sampling from bivariate normal distribution of sample correlation coefficient (nullcase) and regression coefficient, tests based on T, F, and Chi-square distributions.

Unit- V

Theory of attributes: Classes, its order, class frequencies, consistency of data, independence and association of attributes, coefficients of association and colligation.

Text Book:

1. Mukhopadhyaya, P., Mathematical Statistics, New Central Book Agency, Calcutta.
2. Gun, A.M., Gupta, M.K. And Dasgupta, B., An Outline of Statistical Theory, Vol II(4^{th} Edition), World Press
3. Kale, B. K., A First Course in Parametric Inference, Narosa Publishing House
4. Kingman, J.F.C. and Taylor, S. J., Introduction to Measure and Probability, Cambridge University Press.

C-14 (PYTHON) (LAB)

(Marks : 100)

Course Objectives:

This course aims to introduce to students PYTHON programming. To learn PYTHON coding to implement algorithms for mathematical problems.

Course Outcomes:

This course enable the students to get solution to their various mathematical problems quickly through PYTHON programming. Implement the skill to find out the solution to dynamical systems given as differential equations. Do computational mathematics easily.

Unit- 1

Introduction to PYTHON basic syntax, variable types, basic operators, numbers, strings, lists, tuples, functions and input/output statements. Some simple programs to understand the relational, conditional and logical operators. Compare two numbers (less than, greater than) using if statement. Sum of natural numbers using while loop; finding the factors of a number using for loop; to check the given number is prime or not (use if... else statement); find the factorial of a number (use if...if...else).; simple programs to illustrate logical operators (and,or, not).

Unit- 2

Matrices, differential calculus & analytical geometry of three dimensions PYTHON commands to reduce given matrix to echelon form and normal form with examples. PYTHON program/command to establish the consistency or otherwise and solving system of linear equations. PYTHON command to find the nth derivatives. PYTHON program to find nth derivative with and without Leibnitz rule. Obtaining partial derivative of some standard functions verification of Euler's theorem, its extension and Jacobian. PYTHON program for reduction formula with or without limits. PYTHON program to find equation and plot sphere, cone, cylinder.

Unit- 3

Roots of high-degree equations- systems of linear equations introduction, simple iterations method-finite differences method, Gauss elimination method: algorithm, Gauss elimination method, Jacobi's method, Gauss-Seidel's method.

Unit- 4

Numerical differentiation, integration and ordinary differential equations, introduction & Euler's method, second order Runge-Kutta method, fourth order Runge- Kutta: plotnumerical and exact solutions.

unit- 5

Two-point boundary value problems: Introduction to two- point boundary value problems: Second order differential equations - higher order differential equations- solution of second order differential equation using finite difference method.

Text Book:

1. www.PYTHON.org
2. www.rosettacode.org
3. http://faculty.msmary.edu/heinold/PYTHON.html
4. J.Kiusalaas, Numerical Methods in Engineering with PYTHON. Cambridge University Press, 2013.
5. H.P.Langtangen, Solving PDES in PYTHON: The Fenics Tutorial .Springer Open,2016

Reference:

1. Hans Fangohr, Introduction to PYTHON for Computational Science and Engineering (A Beginner's Guide), University of Southampton, 2015.
2. J. Crank, H. G. Martin, and D. M. Melluish, Non-Linear Ordinary Differential Equations. Oxford University Press.
3. Brain Heinold, A Practical Introduction to PYTHON Programming, Department of Mathematics and Computer Science, Mount St. Maru's University, 2019.
4. H. P. Langtangen and Anders Logg, Solving PDEs in PYTHON, Springer Open, 2017

SEMESTER- IV

C-15 (NUMERICAL ANALYSIS - II)

(Marks : 100)

Course Objectives:

To design and analysis of techniques to give approximate but accurate solutions to hard problems, the variety of which is suggested by the following: advanced numerical methods are essential in making numerical weather prediction feasible.

Course Outcomes:

Student can derive numerical methods for various mathematical operations and tasks, such as interpolation, differentiation, integration, the solution of linear and non linear equations, and the solution of differential equations. Analyse and evaluate the accuracy of common numerical methods.

Unit- 1

Solution of linear system of equations, direct methods, Gauss elimination method, pivoting strategy, matrix factorization techniques Crout, Do little and Cholesky's method.

Unit- 2

Itterative techniques for linear systems: gauss Jacobi and Gauss-Seidel techniques, approximating eigen values - Gerschgovin circle theorem, power method.

Unit- 3

Numerical solution of initial value problem: Euler method, Taylor method, Runge- Kutta method, control of error in Runge-Kutta method.

Unit- 4

Multi step methods: Adam Moulton and Adam-Bash for the methods, variable step size methods, stability.

Unit- 5

BVP for ODE: the shooting method, finite difference methods.

Text Book:

1. R. L. Burden, J. D. Faires: Numerical Analysis, Brooks/Cole Cengage Learning, 9th Edition. Chapters: 5(5.2-5.6), 6(6.1, 6.2, 6.5, 6.6), 7(7.3), 11(11.1-11.4).

Reference:

1. Introduction to Numerical Analysis by A.Z.Aitkinson, Mc-Graw Hill

C-16 (NUMBER THEORY CRYPTOGRAPHY - II)

(Marks : 100)

Course Objectives:

- To discover interesting and unexpected relationships between different sorts of numbers and to prove that these relationships are true.
- To understand fundamental number- theoretic algorithms such as the Euclidean algorithm, the Chinese remainder algorithm, binary powering, and algorithms for integer arithmetic.
- To understand fundamental algorithmsfor symmetric key and public-key cryptography.
- To understand the number- theoretic foundations of modern cryptography and the principles behind their security.

Course Outcomes:

- To implement and analyze cryptographic and number- theoretic algorithms.
- To be able to use MAPLE to explore mathematical concepts and theorems.

Unit- I

Finite fields and quadratic residues,Knapsack problem in public key cryptography, zero knowledge protocols.

Unit- II

Primality and Factoring: Factoring by continued fractions, Quadratic sieves .

Unit- III

Distribution of primes, binary quadratic forms.

Unit- IV

Discrete logarithms ,Elgamal cryptosystem, algorithm for discrete logarithm problem, security of Elgamal system, Schnorr signature scheme, the Elgamal signature scheme, the digital signature algorithm, provable secure signature schemes

Unit- V

Elliptic curves over the reals, elliptic curves modulo a prime, properties of elliptic curves, point compression and ECIES, computing point multiples on elliptic curves, elliptic curve digital signature algorithm, elliptic curve factorization, elliptic curve primality test.

Text Book:

1. Ramanujachary Kumanduri & Christna Romero: Number Theory with Computer Applications, Prentice Hall, New Jersey 1998.
2. Neal Koblitz: A Course of Number Theory and Cryptography (2nd Edn.), Springer verlag, New York, 1987.
3. I.P. Blake, G. Seroussi and N.P. Smart: Elliptic Curves in Cryptography, Cambridge Univ. Press, Cambridge, 1999.
4. Douglas R. Stinson: Cryptography: Theory and Practice (3rd Edn.), Chapman Hall/Crc, 2006.

Reference:

1. J. Hoffstein, J.Pipher,J.H. Silverman , An Inroduction to Mathematical Cryptography

ELECTIVE - B

EC-1 (FLUID DYANAMICS)

(Marks : 100)

Course Objectives :

To provide methods for studying the evolution of stars, ocean currents, weather patterns, plate tectonics and evenblood circulation. Some important technological applications of fluid dynamics include rocket engines, wind turbines, oil pipelines and air conditioning systems.

Course Outcomes:

- The student will understand stress strain relationship in fluids, classify their behavior and also establish force balance in static systems. Further they would develop dimensionless groups that help in scale-up and scale down of fluid flow systems.
- Students will be able to apply Bernouli principle and compute pressure drop in flow systems of different on figurations
- Students will compute power requirement in fixed bed system and determine minimum fluidization velocity in fluidized bed

- Students will be able to describefunction of flow metering devicesand apply Bernoulli equation todetermine the performance of flow-metering devices
- Students will be able to determineand analyze the performance aspects of fluid machinery specifically for centrifugal pump and reciprocating pump

Unit- I

Basic concepts, continuum hypothesis, stress in a fluid at rest and in motion, relation between stress and rate of strain components, thermal conductivity, law of heat conduction.

Unit- II

Methods of describing fluid motion, velocity and acceleration of a fluid particle, equation of continuity, boundary conditions, stream lines and path lines, velocity potential methods of describing fluid motion,

Unit- III

Navier-Stokes equations,energy equations, vorticity and circulation in viscous flow,Bernoulli's equation.

Unit- IV

Dimensional similarity and analysis, Reynold's law, Pai-theorem, physical importance of non-dimensional parameters, important non-dimensional parameters, method of finding out π product, important non-dimensional coefficients in the dynamics of viscous fluid

Unit- V

Exact solution of Navier-Stokesequations: Flow between parallelplates and flow in circular pipes(velocity and temperature distribution).

Text Book:

1. J.L. Bansal- Viscous Fluid Dyanamics, IBH Publication. Chapters: 1, 2, 3(3.1-3.9), 4, (4.1-4.4).
2. M.D. Raisinghania- Fluid Dynamics, S. Chand and co., Chapters: 2(2.1-2.11, 2.17-2.26), 4(4.1-4.3).

EC-2 (ADVANCED ANALYSIS)

(Marks : 100)

Course Objectives:

To study how signed measures are essentially got by taking the difference of two measures. The notion of absolute continuity is introduces and the famous Radon-Nikodym theorem is proved for σ–finite signed measures. The notion of singularity, of one measure with respect to another.

Course Outcomes:

Students taking this course will develop an appreciation of the basic concepts of measure theory. These methods will be useful for further study in arange of other fields, e.g. stochastic calculus, quantum theory and harmonic analysis. The above outcome are related to the development of the science faculty graduate attributes, in particular: research inquiry and analytical thinking abilities, communication, information literacy

Unit- I

Signed measure, Hahn decomposition theorem, mutually singular measures, Raydon-Nikodym theorem, Lebesgue decomposition, Riesz representation theorem, extension theorem (Caratheodary).

Unit- II

Completion of a measure, Lebesgue- Stieltjes measure, absolutely continuous functions, integration by parts, product measures, Fubini's theorem.

Unit- III

Spaces of analytic functions, Montel's theorem, Weierstrass factorization theorem, Gamma function and its properties, Riemann Zeta function.

Unit- IV

Schwarz reflection principle, monodromy theorem, harmonic functions on a disc, Harnack's inequality and theorem, Dirichlet problem, Green's function

Unit- V

Canonical products, Jensen's formula, Poisson-Jensen formula, Hadamard three circle's theorem, order of an entire function, exponent of convergence, Borel's theorem, Hadamard's factorization theorem, the range of an analytic function, Bloch's theorem, the little Picard's theorem, Schottky's theorem, Montel Caratheodary and the great Picardtheorem.

Text Book:

1. G. D.Barra: Measure Theory and Integration, Wiley Eastern Ltd.,1981.
2. J.B. Conway: Functions of One Complex Variable, Springer-Verlag, International Student-Edition, Narosa Publishing House,1

EC-3 (NUMBERICAL SOLUTION OF PARTIAL DIFFERENTIAL EQUATIONS- II)

(Marks : 100)

Course Objectives:

Classification of second order equations 0 finite-difference approximations 0 elliptic equations to partial derivative so solution of Laplace equation, solution of Poisson's equation solution of elliptic equations by relaxation, parabolic equations method, solution of one- dimensional heat equation solution of two-dimensional heat equation, Hyperbolic equations, solution of wave equation

Course Outcomes:

On successful completion of this course students will be able to:

1. Use knowledge of partial differential equations (PDES), modelling.
2. Formulate physical problems as pdes using conservation laws.
3. Understand analogies between Mathematical descriptions of different (wave) phenomena in physics and engineering.
4. Classify pdes, apply analytical methods, and physically interpret the solutions.
5. Solve practical pde problems with finite difference methods, implemented in code, and analyse the consistency, stability and convergence properties of such numerical methods.

Unit- I

Sobolev spaces, variational formulation of elliptic boundary value problems of second order, the Neumann boundary-value problem, the Ritz Galerkin method, standard finite elements, computational considerations.

Unit- II

Sobolev spaces, variational formulation of elliptic boundary value problems of second order, the Neumann boundary-value problem, the Ritz Galerkin method, standard finite elements, computational considerations.

Unit- III

Saddle point problems, mixed finite element methods, the Stokes equation, finite element method for the stokes equation, a posteriori error estimates.

Unit- IV

Finite element method for parabolic equations :one-dimensional problem, semi-discretization in space, discretization in space and time, error estimate for fully discrete approximation, non-linear parabolic problem, the incompressible Euler equation.

Unit- V

Domain decomposition method- One level algorithms: alternating Schwarz method, approximate solvers, many subdomains, convergence behaviour, implementation issues.Two level algorithms, simple two level method, general two level methods, coarse grid corrections, convergence behavior

Text Book:

1. D.Braess: Finite elements,Cambridge university press,1997.Chapters: II,III.
2. C.Johnson, Numerical Solution of Partial Differential Equations by the Finite Element Method, Cambridge University Press, 1990. Chapter : 8.
3. B. Smith, P. Bjorstad and W. Gropp: Domain Decomposition - Parallel Multilevel Methods for elliptic Partial Differential Equations, Cambridge Unversity Press, 1996. Chapters: 1,2.

Reference:

1. S.C.Brennerand, L.R.Scoh:The Mathematical Theory of Finite Element Methods, Springer Verlag, 1994.
2. W.Hackbusch: Iterative Solution of large Sparse Systems of Equations, Springer Verlag,1994.

EC-4 (DATA SCIENCE II)

(Marks : 100)

Course Objectives:

- To empowers better business decision-making through interpreting, modeling, and deployment. This helps in visualizing data that is understandable for business stakeholders to build future roadmaps and trajectories.

Course Outcomes:

- Students will develop relevant programming abilities.
- Students will demonstrate proficiency with statistical analysis of data.
- Students will develop the ability to build and assess

Unit- I

Graphical Models - Directed graphical models (Bayesian networks) Markov and hidden Markov models, Markov random fields, conditional random fields, exact inference for graphical models, learning undirected Gaussian graphical models

Unit- II

Reinforcement Learning and Control- MDP, Bellman equations, value iterations and policy iteration, linear quadratic regulation, LQG, Q- learning value functionapproximation, policy search, reinforce pomdps

Unit- III

Neural networks- Perceptron, mlp and back propagation, Methods of acceleration of convergence

Regularization for Deep Learning: Parameter norm penalties, norm penalties as constrained optimization, Regularization and under-constrained problems, dataset augmentation, noise robustness, semi-supervised learning, multi task learning, early stopping, parameter tying and parameter sharing, sparse representations, bagging and other ensemble methods, adversarial training, tangent distance, tangent prop and Manifold tangent classifier.

Optimization for Training Deep Models: How learning differs from pure optimization, challenges in neural network optimization, Basic algorithms, parameter initialization strategies, Algorithms with adaptive learning rates, approximate second-order methods, optimization strategies and meta- algorithm

Unit- IV

Convolutional Networks: The convolution operation, motivation, pooling, convolution and pooling as an infinitely strong prior, variants of the basic convolution function, structured outputs, data types, efficient convolution algorithms, random or unsupervised features, the neuro scientific basis for convolutional networks, convolutional networks and the history of deep learning.

Recurrent and recursive nets: Unfolding computational graphs, recurrent neural networks, bidirectional lrnns, encoder-decoder sequence-to-sequence architecture, deep recurrent networks, recursive neural networks, the challenge of long-term dependencies, echo state networks, leaky units and other strategies for multiple timescales, the long short-term memory and other gate drnns, optimization for long-term dependencies, explicit memory

Unit- V

Practical Methodology: Performance metrics, default baseline models, determining whether to gather more data, selecting hyper parameters, debugging strategies, example-multi-digit number recognition.

Linear Factor Models: Slow feature analysis, sparse coding,

Auto Encoders: Under complete auto encoders, regularized auto encoders, representational power, layer size and depth, stochastic encoders and decoders, denoising auto encoders, learning manifolds with auto encoders, contractive autoencoders, predictive sparse decomposition, applications of auto encoders,

Deep Generative Models: Boltzmann machines, restricted Boltzmann machines, deep belief networks.

Implementation of the following algorithms:

i. Convolution neural network(CNN)

ii. Recurrent neural network(RNN)

Text Books

1. Deep Learning, Ian good fellow, Yoshuabengio and Aaroncourville, Themitpress, 2016
2. Machine Learning-A probabilistic prospective, Kevinp. Murphy, Mitpress, 2012
3. Machine Learning, Tom Mitchel, Mcgraw Hill.

EC-5 (ANALYTIC NUMBER THEORY)

(Marks : 100)

Course Objectives:

- To illustrate how general methods of analysis can be used to obtain results about integers and prime numbers
- To investigate the distribution of prime numbers
- To consolidate earlier knowledge of analysis through applications

Course Outcomes:

The number theory helps discover interesting relationships between different sorts of numbers and to prove that these are true. Number theory is partly experimental and partly theoretical.

Experimental part leads to questions and suggests ways to answer them. The best known application of number theory is public key cryptography, such as RSA algorithm. Public key cryptography in turn enables many technologies we take for granted, such as the ability to make secure online transactions.

Unit- I

The unique factorization theorem, congruences.

Unit- II

Rational approximation of irrationals & Hurwitz's theorem, quadratic residues & the representation of a number as a sum of four squares.

Unit- III

Arithmetical functions & lattice points.

Unit- IV

Chebyshev theorem on the distribution of prime numbers.

Unit- V

Weyl's theorems on uniform distribution & Kronecker's theorem.

Text Book:

1. K. Chandrasekharan: Introduction to Analytic Number Theory, Springer-Verlag, 1968. Chapters: 1, 2, 3, 4, 6, 7, 8.

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Choice Based Credit System FIRST SEMESTER			
Theory	**Credit Point**	**Teaching Hours**	**Marks**
PHY101 Classical Mechanics	4	60-65	100
PHY102 Mathematical methods in Physics	4	60-65	100
PHY103 Quantum Mechanics-I	4	60-65	100
PHY104 Classical Electrodynamics	4	60-65	100
Practical			
PHY105: Modern Physics, Optics/Computational Physics	4	150-180	100
Total	credit = 20,	Total Mark =	500
SECOND SEMESTER			
PHY201 Quantum Mechanics-II	4	60-65	100
PHY202 Basic Electronics	4	60-65	100
PHY203 Basic Condensed Matter Physics	4	60-65	100
PHY204 Introduction to Nanoscience and Nanotechnology	4	60-65	100
Practical			
PHY205: Modern Physics, Optics /Computational Physics	4	150-180	100
Total	credit = 20,	Total Mark =	500
THIRD SEMESTER			
PHY301 Advanced Quantum Mechanics	4	60-65	100
PHY302 Basic Material Characterisation	4	60-65	100
PHY303 Electronics(Elective)/ Advanced Condensed Matter Physics(Elective)	4	60-65	100
Practical			
PHY304: Electronics(Elective)/ Advanced Condensed Matter Physics(Elective)	4	60-65	100
PHY305: Basic Electronics Practical	4	150-180	100
Total	credit = 20,	Total Mark =	500
FOURTH SEMESTER			
PHY401 Statistics Mechanics	4	60-65	100
PHY402 Basic Nuclear and Particle Physics	4	60-65	100
PHY403 Electronics(Elective)/ Advanced Condensed Matter Physics(Elective)	4	60-65	100
PHY404 Project and Seminar	4	60-65	100
Practical			
PHY405 Electronics(Elective)/ Advanced Condensed Matter Physics(Elective)	4	150-180	100
Total	credit = 20,	Total Mark =	500
Grand Total credit of 4 semesters =	80 ;	Grand Total Mark	2000

1st SEMESTER

(PHY101)

Classical Mechanics

Full marks = **100** Credit-**04**

Course Objectives:

Students will be able to:

- Know the physical concepts and familiar with classical mechanics and also its mathematical form.
- Solving problem of different systems using classical mechanics.
- To demonstrate the knowledge and understanding of the following fundamental concepts in:
  - The dynamics of system of particles,
  - Motion of rigid body,
  - Lagrangian and Hamiltonian formulation of mechanics
  - Transformations and Hamilton Jacobi theory
  - Small oscillation problems
  - Develop equations of motion using Lagrangian and Hamiltonian formulation for complicated mechanical systems.

Unit- I:

Mechanics of a System of Particles, Lagrangian Formulation, Velocity-Dependent Potentials and Dissipation Function, Conservation Theorems and Symmetry Properties, Homogeneity and Isotropy of Space and Conservation of Linear and Angular Momentum, Homogeneity of Time, and Conservation of Energy.

Hamiltonian Formulation:

Calculus of Variations and Euler-Lagrange's Equation, Brachistochrone Problem, Hamilton's Principle, Extension of Hamilton's Principle to Non-Holonomic Systems, Legendre Transformation and the Hamilton Equations of Motion, Physical Significance of Hamiltonian, Derivation of Hamilton's Equations of Motion from a Variational Principle, Rout's Procedure, Ä-Variation, Principle of Least Action

Unit- II:

Canonical Transformations:

Canonical Transformation, Types of Generating Function, Conditions for Canonical Transformation, Integral Invariance of Poincare, Poisson Bracket, Poisson's Theorem, Lagrange Bracket, Poisson and Lagrange Brackets as CanonicalIn variant, Infinitesimal Canonical Transformation and Conservation Theorems, Liouville's Theorem.

Unit- III:

Hamilton Jacobi Theory:

Hamilton-Jacobi Equation for Hamilton's Principal Function, Harmonic Oscillator and Kepler's problem by Hamilton-Jacobi Method, Action-Angle Variables for completely Separable System, Kepler's Problem in Action- Angle Variables, Geometrical Optics and Wave Mechanism

Unit- IV:

Small Oscillation:

Problem of Small Oscillations, Example of Two coupled Oscillator, General Theory of Small Oscillations, Normal Coordinates and Normal Modes of Vibration, Free Vibrations of a Linear Tri-atomic Molecule.

Unit- V:

Rigid Body Motion:

The Independent of Co-ordinates of a Rigid Body, Orthogonal Transformations. The Euler's angles. The Cayley-Klein parameters; Euler's Theorems on the Motion of a Rigid body, Infinitesimal Rotations, Rate of Change of a Vector, The Coriolis Force.

Rigid Body Dynamics:

Angular Momentum and Kinetic Energy of Motion about a Point. The Inertia Tensor and Moment of Inertia, Eigen values of Inertial Tensor and the Principal AxisTransformation. The Euler Equations of Motion, Torque-free motion of a rigid body. The Heavy Symmetrical Top with One Point Fixed. Elementary Idea about Nonlinearity and Chaos.

Text Book :

- Classical Mechanics - H. Goldstein

Reference Books :

- Mechanics - Landau and Lifshitz
- Analytical Mechanics, L. Hand, and J. Finch
- Classical Mechanics - Corben & Stehle
- Classical Dynamics - Marion & Thornton
- Classical Mechanics - J. C. Upadhyaya

Course Outcomes:

- Understand the basic mechanical concepts related to discrete and continuous mechanical systems.
- Describe and understand planar and spatial motion of a rigid body and understand the motion of a mechanical system using Lagrange-Hamilton formalism.
- Demonstrate a working knowledge of classical mechanics and its application to standard problems such as central forces.

(PHY102)

Mathematical Methods in Physics

Full marks = **100** Credit-**04**

Course Objective:

- It will provide students with basic skills necessary for the application of mathematical methods in physics.
- Introduction of various existing mathematical methods in order to analyses theories, methods, and interpretations.

- Develop understanding among the students how to use methods within his/her field of study of research and in the field of scientific knowledge to work independently.

Unit- I:

Complex Variables:

Cauchy's Integral Theorem, Cauchy's integral formula, Calculus of Residues, Cauchy's residue theorem, Evaluation of definite integrals.

Unit- II:

Tensor Analysis and Differential geometry:

Cartesian tensors in three-space, Curves in three space and Frenet formula, General Tensor Analysis, Covariant derivative and Christoffel symbol, Riemann & Ricci tensor. Tensor algebra (addition, subtraction, outer product, inner multiplication) relative tensors, Kronecker delta and Levi-Civita tensor density. Symmetry property of tensors, Pseudo-tensors, Metric tensor, and properties.

Unit- III:

Differential equations and their solutions: Bessel's differential equation, power series solution, Bessel function, Recurrence relation, Generating function. Integral representation of Jn', Orthogonality Condition, Bessel functions of half odd order.

Laguerre differential equation and its solution, Laguerre polynomial, Generating function for Laguerre, Rodrigue's formula, Recurrence relation, Orthonormality condition, integral representation. orthonormality relations.

Unit- IV:

Hypergeometric equation, solutions and properties, Gauss formula, Linear relationships of hypergeometric functions, Confluent hypergeometric function and properties, Integral representation.

Solution of non-homogenous equation : Green's function. Symmetry of Green's functions, Green's functions in 1D, 2D and 3D problems, eigen function expansion technique.

Definition, Properties and Representations of Dirac Delta Function.

Unit- V:

Groups and Group Representations:

Definition of groups, Finite groups, examples from Solid State Physics, Sub- groups and classes, Group Representations, Characters, Infinite groups and Lie groups, Irreducible representation of SU(2), SU(3) and O(3), SO(3,1).

Books:

- Mathematical methods for Physicists : G.B. Arfken and H.J. Weber and Harris(Elsevier)
- Mathematical Methods of Physics : J Mathews and R.L. Walker(Pearson)
- Group Theory: M. Hamermesh
- Mathematics for Physicists and Engineers: Pipes.(McGraw Hill)

Course Outcomes:

- Demonstrate the utility and limitations of a variety of powerful calculation techniques and to provide adeeper understanding of the mathematics and useful in theoretical physics.
- Understand elementary ideas in linear algebra, special functions, and complex analysis.

- Will be able to apply these to solve problems in classical, statistical and quantum mechanics, electromagnetism as well as solid state physics.

(PHY103)

QuantumMechanics-I

Full marks = **100** Credit-**04**

Course Objectives:

Students will be able to:

- Study postulates and formalism of quantum mechanics
- Study operator formulation of quantum mechanics
- Study time evolution of a state and operator and apply Schrodinger equation to 1D harmonic oscillator
- Study operator algebra of orbital angular momentum and spin angular momentum operator
- Study motion in spherical symmetric potential and apply Schrodinger equation to solve hydrogen atom.

Unit- I:

General Principles of Q.M.:

Linear Vector Space Formulation : Linear Vector Space (LVS) and its generality, Vectors – scalar product, metric space, basis vectors, linear independence, linear superposition of general quantum states, orthonormality of basis vector, completeness, Schmidt's ortho normalization procedure, Dual space, Bra, and Ket vectors.

Operators – linear, Adjoint, Hermitian, unitary, inverse, anti-linear operators, Non-commutativity and uncertainty relation, complete set of compatible operators, Simultaneous Measurement, Projection operator, Eigen values and eigen vectors of linear, Hermitian, unitary operators, Matrix representation of vectors and operators, matrix elements, eigen value equation and expectation values, algebraic result on eigen values, transformation of basis vectors, similarity transformation of vector and operator representation, diagonalization. Vectors of LVS and wave function in coordinate, momentum, and energy representations.

Unit-II:

Quantum Dynamics:

Time evolution of quantum states, Time evolution operator and its properties, Schrodinger picture, Equation of motion of Schrodinger picture, Heisenberg picture, Equation of motion of Heisenberg picture, Interaction picture, Equations of motion, Operator method solution of 1D Harmonic oscillator, Matrix representation of 1D harmonic oscillator,Time evolution of creation and annihilation operators, Density matrix.

Unit- III:

Rotation and Orbital Angular Momentum:

Rotation Matrix, Angular momentum operators as the generators of rotation, L_x, L_y, L_z and L^2 and their commutator relations, Raising and low ering operators. (L_+ and L_-). L_x, L_y, L_z and L^2 in spherical polar coordinates, Eigen values and Eigen functions of L_z, L^2 (OP method) spherical harmonics, Matrix representation of L_+, L_- and L^2.

SpinAngularMomentum:

Spin ½ particles, Pauli spin matrices and their properties, Eigen values and Eigen functions, Spinor transformation under rotation.

Unit- IV:

Addition of angular momentum:

Total angular momentum J. Eigen value problem of J_z and J^2, Angular momentum matrices. Addition of angular momenta, C.G. co-efficient and its calculation, Angular momentum states for composite systems in the angular momenta (1/2, 1/2) and (1,1/2),

Unit- V:

Motion in Spherically symmetric field:

Hydrogen atom, Reduction to equivalent one body problem, Radial equation, Energy eigen values and eigen functions, degeneracy, radial probability distribution. Free particle problem incoming and outgoing spherical waves, expansion of plane waves in terms of spherical waves, Bound states of a 3-D square well, particle in a sphere.

Text Books :

- Quantum Physics – S. Gasiorowicz
- Quantum Physics by N. Zeteli
- Quantum Mechanics- L-I Schiff/ J.Sukurai/ E.Merzbacher/ A.Messiah, Vol.I
- Advanced Quantum Mechanics – P.Roman
- Quantum Mechanics –R. Shankar
- Quantum Mechanics –A. Ghatak and S. Lokanathan
- Quantum Mechanics – S. N. Biswas

Reference Books:

- Quantum Mechanics – A. Das
- Elementary Theory of Angular Momentum – M.E. Rose
- Principles of Quantum Mechanics – P. A. M. Dirac
- Quantum Mechanics (Non-relativistic theory) – L. D. Landau and E. M. Lifshitz

Course Outcomes:

- State basic postulates of quantum mechanics
- Understand the Hermitian operators, projection operators, unitary operators etc.
- Solve Schrodinger equation of harmonic oscillator problem completely using operator method
- State addition of angular momentum theorems and spin angular momentum statistics
- Solve for the hydrogen atom using Schrodinger equation

(PHY104)
CLASSICAL ELECTRODYNAMICS

Full marks = **100** Credit-**04**

Course Objectives:

Students will be able to:

- Study the Maxwell's wave equation in different dielectric media and free space
- Understand vector and scalar potential and their importance in electromagnetics
- Study electromagnetic energy transport and Poynting vector
- Understand Lorentz and Coulomb gauge conditions, covariant form of Maxwell's equation.
- Study laws of geometrical optics using Maxwell's equation
- Study Kramer Kronig relation on reflection and absorption of electromagnetic wave
- Study and understand propagation of electromagnetic waves in different types of waveguides.
- Study of retarded potential and solving it by Green's Function techniques for different types of charge
- distributions
- Study electric, magnetic dipole, and quadrupole radiation
- Study electromagnetic radiation due to moving point charge and accelerated charge

Unit- I:

Maxwell's Equations and Conservation laws:

Maxwell's equations in free space and linear isotropic media, boundary conditions on the fields at interfaces,Vector and scalar potentials, Gauge and Gauge Invariance, Lorentz and Coulomb Gauge, Poisson's equation and Laplace's equation, Green's function solution for Retarded and Advanced Green's function, Poynting's theorem and conservation of energy and momentum.

UNIT - II:

Relativistic Electrodynamics:

The four-vector notation, Lorentz transformation of particle kinematics, covariant formulation of Maxwell's equations, Lorentz invariance of Maxwell's equation, electromagnetic field tensor, covariant definitions of electromagnetic energy and momentum, transformation of electromagnetic field components, Lagrangian for a charge particle in presence of external electromagnetic field, Maxwell equations as Euler-Lagrange equation,

Unit - III:

Electromagnetic waves in conducting and non-conducting media:

Plane electromagnetic waves in non-conducting medium and conductors, Solution of the wave equation by Green's function formalism, Reflection, and refraction of electromagnetic waves at a plane surface between dielectrics, Linear and circular polarisation, Polarisation by reflection, Group velocity, Frequency dispersion characteristics of dielectrics, conductors, and plasma, Plane waves in conduction media; Reflection and transmission at a conducting surface, Waves in dispersive media, Kramer Kronig Relation

Unit - IV:

Radiation Systems:

Fields and radiation of a localized oscillating source: electric and magnetic dipole fields and radiation, center fed linear antenna with sinusoidal current, Multipole expansion for localized source,Scattering by a small dielectric sphere in long wavelength limit, Rayleigh scattering. Magnetic dipoles and Electric quadrupole radiations

Unit - V:

Radiations by moving charges:

Lienard -Wiechert potential and field due to a point charge, Field of a moving charge, Radiated power from an accelerated charge at low and high velocities, Larmour's power formula, Angular distribution of radiation from an accelerated charge, Thomson scattering of radiation.

Text Books:

- Introduction to Electrodynamics - D.J. Griffiths, Pearson Education Ltd. 3rd Edition, New Delhi, 1991.
- Classical Electrodynamics - J.D. Jackson, John & Wiley Sons Pvt. Ltd, New York, 2004.
- Classical Theory of Electrodynamics - L.D. Landau and E.M. Lifshitz, Addison, Wesley, 3rd Edition, 1971.

Reference Books:

- Introduction to Electrodynamics - A. Z. Capri and P.V. Panat, Narosa Publishing House 2010.
- Classical electricity & Magnetism- Panofsky and Phillips, Addison Wesley, 2nd Edition, 1989
- Classical Electromagnetic Radiation - J.B. Marion, Academic Press, New Delhi, 1995.
- Classical Electricity and Magnetism- Wolfgang K. H. Panofsky and Melba Phillips, Dover Publications, 2nd Edition 2005

Course Outcomes:

Students will be able to:

- Demonstrate and analyse Maxwell's wave equation in different media
- Derive scalar and vector potential in presence of different sources
- Derive the Poynting theorem
- Apply Gauge invariance condition to Maxwell's equation
- Derive Maxwell's equation in co-variant form
- Derive covariant form of Maxwell's equations
- Derive relation between reflection coefficient and absorption coefficient
- Calculate different modes of electromagnetic waves in waveguides
- Calculate angular distribution of radiation and power emitted by dipole
- Show that accelerating charge produce electromagnetic radiation

Practical(PHY105)

Modern Physics and Optics

Full marks = **100** Credit-**04**

Course Objectives:

- To analyze various situations or phenomena associated with modern physics and opticsphysics using basic principles.
- This course will introduce the student to a broad range of physical phenomenainvolving optics, and modern physics.

1. Measurement of Rydberg constant
2. Babinet's compensator
3. Michelson Interferometer
4. Fabry-Perot Interferometers
5. Constant deviation spectroscope
6. e/m measurement by Magnetron Valve Method
7. e/m measurement by Thomson Method
8. Magnetic field measurement by search coil
9. Ferroelectric transmission point by Dielectric Constant Measurement
10. Verification of Richardson's $T^{3/2}$ law
11. Determination of Planck's constant by Reverse Photoelectric effect method
12. Measurement of attenuation and phase shift of A.C. in L.C.R. network
13. Study of power supply
14. Calibration of an oscilloscope
15. Stefan's constant measurement
16. Existence of discrete energy level by Frank Hertz experiment.
17. e/m measurement by Braun tube
18. Rectification by junction Diode using various filters
19. Characteristics of a Transistor
20. Dielectric constant of solid (wax) by Lecher Wire
21. Determination of Planck's constant by total Radiation Method
22. Hysteresis loop tracer
23. Determination of 'e' by Millikan's oil drop experiment
24. RF characteristics of coil
25. Verification of Brewster's Law
26. Measurement of wavelength of Laser Source.
27. Verification of Malus Law
28. Single slit diffraction using Laser beam

Course Outcomes:

Students will be able to:

- To verify experimentally some of the laws and principles associated with modern physics and optics.

Practical(PHY105)

Computational Methods in Physics

Full marks = **100** Credit-**04**

Course Objectives:

Students will be able to:

- To learn computer programming using PYTHON and C.
- To solve physics problems through different numerical techniques
- Use computer programming for simulation and data analysis

Unit - I (50 Marks)

- Introduction to computational physics, computer architecture overview, tools of computational physics, introduction to storage in computer memory, stored programme concepts, storage media, computer operating system, compilers, Machine representation, precision, and errors.
- Introduction to Python, Structure of a python program, Input, and output statements, Control statements, Arrays, Sub programs, Data Files, examples of writing python programming of computational methods.
- **Programming in C:** Structure of C program, compilation, constants, variables & data types, initializing variables, arithmetic operators, data input and data output, control structures, decision making and looping statements, arrays, examples of writing C- programming of computational methods.
- **Numerical Techniques:** Interpolation, solution of algebraic equation, least-square curve fitting, linear algebra and matrix manipulations, inversion, eigenvectors and eigen values, numerical differentiation, numerical integration, Numerical solution of ordinary differential equations: Euler and Runge-Kutta methods, random number generation.

Unit- II (50 Marks)

Computer Programming: (Using Python and C)

Exercises for acquaintance:

1. Find the largest or smallest of a given set of numbers
2. Generate and print first hundred prime numbers
3. Sum of an AP series, GP series, Sine series, Cosine series
4. Factorial of a number
5. Area of circle, area of square, volume of sphere, value of ð.
6. Transpose a square matrix
7. Matrix multiplication, addition
8. Trace of a matrix

9. Evaluation of log and exponentials
10. Solution of quadratic equation
11. Division of two complex numbers
12. Find the sum of the digits of a number
13. Write a program to compute distance between two points taking input from the user (Pythagorean Theorem)
14. Write a program to count the numbers of characters in the string and store them in a dictionary data structure
15. Write a program to print each line of a file in reverse order.

- **Numerical Analysis:**

1. Interpolation by Lagrange method
2. Numerical solution of simple algebraic equation by Newton- Raphson method.
3. Least Square fit using rational functions
4. Numerical integration: Trapezoidal method, Simpson's method, Romberg integration,
5. Gauss quadrature method
6. Eigen values and eigen vectors of a matrix
7. Solution of linear homogeneous equations
8. Matrix inversion.
9. Solution of ordinary differential equation by Runge-Kutta Method
10. Solution of Radioactive decay equation, Simple harmonic oscillator, Schrödinger equation

Books:

1. PYTHON PROGRAMMING: USING PROBLEM SOLVING APPROACH, Reema Thereja, Oxford University Press; First edition (2017).
2. Python Made Simple: Learn Python Programming In Easy Steps With Examples, Rhythm Beri, BPB Publications; 1st edition (2019).
3. Mathematical Methods for Physics and Engineers, K.F. Riley. M.P. Hobson and S. J.20 Bence, 3rd ed., 2006, Cambridge University Press.
4. Complex Variables, A.S. Fokas and M.J. Ablowitz, 8th Ed., 2011. Cambridge Univ. Press.
5. First course in complex analysis with applications. D.G. Zill and P.D.Shanahan, 1940, Jones
6. and Bartlett.
7. V. Rajaraman, Fundamentals of Computers (Prentice Hall, India)..
8. Brain W. Kernighan and Dennis. M. Ritchie, The C Programming Language, New Delhi: Prentice-Hall of India.
9. Byron S. Gottfried. Schaum's outline of Theory and Problems of Programming with C, New Delhi: Tata McGraw-Hill.
10. A. Klein and A. Godunov, Introductory Computational Physics, Cambridge University Press .
11. An Introduction to Computational Physics, T. Pang, Cambridge University Press.

12. Computer Oriented Numerical Methods- R.S.Salaria.
13. Hildebrand, F. B., Introduction to Numerical Analysis, Tata McGraw-Hill.
14. E. Balagurusamy, Numerical Methods, New Delhi: Tata McGraw-Hill.
15. Numerical Recipes: The Art of Scientific Computing, by William H. Press, Saul A. Teukolsky, William T. Vetterling, Brian P. Flannery.

Course Outcomes:

Students will be able to:

- Write computer programs using PYTHON and C.
- Use different numerical methods to solve problems using computer programs.
- Simulate physical systems using Monte Carlo Method.

2nd Semester

(PHY201)

Quantum Mechanics-II

Full marks = **100** Credit-**04**

Course Objectives:

Students will be able to:

- Understand the importance of perturbation theory in quantum mechanics
- Study time independent and time dependent perturbation theory and apply those to various physical
- problem
- Understand fine structure of hydrogen atom, Stark effect, Zeeman effect,
- Understand interaction of radiation with matter, selection rules
- Understand quantum mechanical description of scattering
- Understand variational principle and its application

Unit- I :

Approximation Method for stationary states:

Rayleigh Schrodinger Method for Time-independent Non degenerate Perturbation theory, First and second order correction, perturbed harmonic oscillator, Anharmonic oscillator, The stark effect, Quadratic Stark effect and polarizability, Degenerate perturbation theory, Removal of degeneracy

Unit- II :

Application of Time independent degenerate perturbation Theory to Hydrogen:

Parity selection rule, Linear stark effect of hydrogen atom, Spin orbit Coupling, Relativistic correction, Fine structure of Hydrogen like atom, Normal and anomalous Zeeman effect, The strong- field Zeeman effect, The weak-field Zeeman effect and Lande's g-factor, Elementary ideas about field quantization.

Unit- III:

Variational and WKB- Methods:

General formalism, Application of variational method for 1D harmonic oscillator problem, Ground state of H atom and He atom, H_2 molecule,General Formalism, Validity of WKB Approximation Method, Connection Formulas, Bohr Somerfield Quantization Rule, Application to Harmonic Oscillator, Bound States for Potential Wells with One Rigid Wall and Two Rigid Walls, Tunneling Through a Potential Barrier, ColdEmission, Alpha Decay and Geiger-Nuttal relation.

Unit- IV:

Time dependent perturbation Theory:

Transition probability, Constant and harmonic perturbation, Fermi golden rule and Electric dipole Radiation and Selection Rule, Time-Dependent Perturbation Theory with Application to Atomic Systems, Relativistic and QED Effects

Unit- V:

Scattering Theory and its applications:

Scattering amplitude and Cross section, Application of 3D Green's function, Born approximation, Application to Coulomb and Screened Coulomb potential, Partial wave analysis, Effective range and Scattering length, Optical theorem, Black disc scattering, Hard sphere scattering, Resonance Scattering from a square well potential.

Text Books:

- Quantum Mechanics Concepts and Applications – Nouredine Zettli, 2nd Edition 2009.
- Introduction to Quantum Mechanics- David J. Griffith, Cambridge University Press, 2nd Edition, 2004.
- Quantum Mechanics – A. Ghatak and S. Lokanathan, Kluwer Academic Publisher, London, 5th Edition, 2004.

Reference Books:

- Quantum Mechanics – S. Gasiorowicz, Wiley, 3rd Edition, 2003
- Quantum Mechanics – J. J. Sakurai, J. Napolitano, Cambridge University Press, 2nd Edition, 2011
- Quantum Mechanics – R. Shankar, Springer, 2nd Edition, 2008.
- Quantum Mechanics (Non Relativistic theory) – L.D. Landau and E. M. Lifshitz, Pergamon Press, 3rd Edition, 1977
- Introductory Quantum Mechanics, R. L. Liboff, Pearson Press, 3rd Edition, 2009.

Course Outcomes:

Students will be able to:

- Derive energy and wave function for physical system using time independent perturbation theory
- Derive transition probability under time dependent perturbation theory
- Explain Stark effect, origin of polarizability and dipole moment, fine structure of hydrogen atom and Zeeman effect
- Understand the dipole selections rules in various atomic transitions

- Solve the scattering cross-section for various scattering process such as black sphere scattering, hard sphere scattering and inelastic scattering
- Apply variational principle to find out the ground state energy of the various physical system

(PHY202)

Basic Electronics

Full marks = **100** Credit-**04**

Course Objectives:

- Understand Different type of Amplifiers using Hybrid parameters
- Understand operational principle, model, and analysis of various operational amplifiers
- Understand operation model and analysis of various oscillators
- Understand the working, model, and analysis of various digital circuits
- Understand model and analysis of radio communication and antenna

Unit- I

Power electronics: SCR, FET, MOSFET, DIAC, TRIAC (Principle, working and application); Multivibrator: Astable, Monostable and Bi-stable multivibrator

Unit- II

Operational amplifier: Differential amplifier (Circuit configuration and properties) Ideal operational amplifier as inverting amplifier, non-inverting amplifier and application as scale changing, phase shifting, voltage follower, adder, subtractor, integrator, differentiator, and comparator

Unit- III

Voltage source, Current source and source conversion, Logic families: RTL, DTL, TTL, CMOS(principle and analysis logic gates); Sequential circuits: SR, JK, Master-slave JK flip flop, registers, and counters

Unit- IV

Oscillator Circuits: Feedback criteria for oscillation, phase shift, Wien bridge oscillator, crystal controlled oscillator, klystron Oscillator, Clapp Oscillator, RC oscillator.

Unit- V

Radio Communication: Ionospheric propagation(ground wave, sky wave, space wave), Radio wave propagation – Description and basic theory of AM, and FM transmitter (Block diagram study), Antenna: Basic antenna action, Types of antennae: Horn antenna, Reflector antenna, Yagi antenna.

Reference Books:

1. Electronic Fundamental and application – J.D. Ryder
2. Int. Digital Electronics – Heap and Martin
3. Integrated Electronics – Millman and Halkias
4. Digital Electronics : Gothmann
5. Digital Principles and Applications: Malvino, Leach, Saha(TMH)

Course Outcomes:

- Explain frequency response of linear amplifiers, feedback amplifier
- Explain and design differential amplifier, sum and integrator etc
- Explain feedback criteria for oscillation, crystal-controlled oscillator, Klystron oscillator, principle of multivibrator
- Explain basic logic operations of NOT, AND, OR, NAND, NOR, XOR and flip-flops
- Explain basic principles of radio communications and antennas
- Explain basic principles optical fibres, and electromagnetic wave propagation in optical fibre.

(PHY203)

Basic Condensed Matter Physics

Full marks = **100** Credit-**04**

Course Objectives:

Students will be able to:

- Know the diffraction condition in reciprocal space
- Understand the crystal bonding types in solid
- Understand the specific heat of solid and metals
- Know Kramer Kronig-penny model of electron ion interaction.
- Know the properties of semiconductor materials
- Know the properties of superconductor and high Tc superconductor

Unit- I :

Diffraction of electromagnetic waves by crystals:

X-rays, Electrons and Neutrons, Symmetry operations and classification of Bravais lattices, common crystal structures, reciprocal lattice, space groups, translational symmetry of crystals, symmetry operations in space groups, Brillouin zone, X-ray diffraction, Bragg's law, Von Laue's formulation, diffraction from non-crystalline systems. Geometrical factors of SC, FCC, BCC, and diamond lattices; Basis of quasi crystals.

Crystal Binding: Bond classifications – types of crystal binding, covalent, molecular, and ionic crystals, London theory of van der Waals, hydrogen bonding, cohesive and Madelung energy.

Unit- II:

Lattice Dynamics:

Failure of the static lattice model, adiabatic and harmonic approximation, vibrations of linear monatomic lattice, one-dimensional lattice with basis, models of three-dimensional lattices, quantization of lattice vibrations, Einstein and Debye theories of specific heat, Specific heat of metal, phonon density of states, neutron scattering.

Unit- III:

Band theory of Solids:

Periodic potential and Bloch's theorem, Kronig-Penney model, weak potential approximation, density of states in different dimensions, energy gaps, Fermi surface and Brillouin zones. Origin of energy bands and band gaps, effective mass, tight-binding approximation, and calculation of simple band structures. Motion of electrons in lattices, Wave packets of Bloch electrons, semi-classical equations of motion, motion in static electric and magnetic fields, theory of holes, cyclotron resonance.

Unit- IV:

Semiconductors:

Intrinsic and impurity semiconductors, band gap, drift velocity, mobility and conductivity in the intrinsic semiconductor, law of mass action, intrinsic carrier concentration, Theory of p-type and n-type conductor, p-n junction, Barrier potential, Width of depletion region,p-n junction rectification, Rectifier equation.

UNIT- V:

Superconductivity:

Phenomenology, review of basic properties, Meissner effect, Type-I and Type-II superconductors, thermodynamics of superconductors, London's phenomenological theory, flux quantization, Copper instability, BCS theory of superconductivity, Superconducting ground state and gap equation at T= 0K. Josephson effects, Ginzburg- Landau theory, SQUID, High Tc superconductors: Elementary ideas.

Text Books:

1. C. Kittel, Introduction to Solid State Physics, Wiley.
2. N. W. Ashcroft and N.D. Mermin, Solid State Physics, Brooks/Cole.
3. J. M. Ziman, Principles of the Theory of Solids, Cambridge University Press.
4. A. J. Dekker, Solid State Physics, Macmillan.
5. Superconductivity by V. L. Ginzburg and E. A. Andryushin (World Scientific, 1994)
6. Introduction to Superconductivity and high-Tc materials by Michel Cyrot and Davor Pavuna, (World Scientific, 1992).
7. Fundamentals of Crystallography, C. Giacovazzo, H. L. Monaco, D. Viterbo, F. scordari, G. Gilli, G. Zanotti, M. Cattl (Oxford University Press).
8. Elementary solid state physics, M. Ali Omar,

Reference Books:

1. G. Burns, Solid State Physics, Academic Press.
2. M. P . Marder, Condensed Matter Physics, Wiley.
3. P. M. Chaikin and T. C. Lubensky, Principles of Condensed Matter Physics, Cambridge University Press.
4. M. Tinkham, Introduction to Superconductivity, CBS
5. T. Inui, Y. Tanabe and Y. Onodera, Group Theory and Its Applications in Physics (Springer Series in Solid-State Sciences).

Course Outcomes:

- Understand the difference in direct space and Reciprocal lattice space
- Understand the mode of vibrations and Dispersion relation
- Derive Specific heat equation for the metal and insulator
- Derive the Law of mass action relation for the semiconductor material
- Understands the Cooper pair and energy gap in Superconductor

(PHY204)

Introduction to Nanoscience and Nanotechnology

Full marks = **100** Credit-**04**

Course Objectives:

Students will be able to:

- Know about effect of size on crystals.
- Know preparation techniques of nano materials.
- Know about types of nano structures
- Understand 0D, 1D, 2D, 3D nano structures
- Know about applications of nano materials

Unit- I

Nucleation

Influence of nucleation rate on the size of the crystals- macroscopic to microscopic crystals and nano crystals – large surface to volume ratio, top-down and bottom-up approaches-self-assembly process-grain boundary volume in nano crystals-defects in nano crystals-surface effects on the properties.

Types of Nano structures

Definition of a Nano system – Types of Nanocrystals-One Dimensional (1D)-Two dimensional (2D) -Three Dimensional (3D) nano structured materials – Quantum dots – Quantum wire- Core/ Shell structures.

Unit- II

Zero Dimensional (OD) structures: Nano particles

Homogenous Nucleation - diffusion and surface controlled growth process - synthesis of metallic nano particles - semiconductor nanoparticles - metal oxide nano particles - vapor phase reactions - solid state phase segregation - Heterogenous nucleation - kinetically confined nano particles.

One Dimensional (1D) nano structures: Nano wires and Nano tubes

Evaporation-condensation - Vapor- liquid - solid (VLS) - VLS model - Nucleation and growth - surface and bulk diffusion - kinetics - growth of various nano wires - control of size - precursors and catalysts - single - and multi- wall CNT - Si nano wires - density and diameter - doping in nano wires.

Unit- III

Two dimensional (2D) Nanostructures: Thin films

Thin films- Environment for thin film deposition (Gas and Plasma) - Introduction to vacuum technology-physical vapour deposition techniques (Reactive sputtering (DC and RF), laserablation); Epitaxy - different types of Epitaxies - Lattice mismatch - Liquid Phase Epitaxy (LPE) - Molecular Beam Epitaxy (MBE)-Chemical vapour deposition (CVD) - Atomic layer deposition (ALD).

Unit- IV

Applications of Nanomaterials:

Molecular electronics and nanoelectronics - Quantum electronic devices - CNT based transistor and Field Emission Display - Biological applications - Biochemical sensor - Membrane based water purification.

Unit- V

Nanotechnology in Carbon Material:

Carbon Nanotubes(CNT), Types, Synthesis of Carbon Nanotubes, Separation of metallic and semiconducting nanotubes, Structure of Carbon Nanotubes, Properties of Carbon Nanotube, Electrical, Mechanical and Thermal properties of CNT, Applications of CNT. Application to transport in bilayer Graphene, and propagation of long-wavelength waves in elastic media.

Reference Books:

1. M. Wilson, K. Kannangara, G Smith, M. Simmons, B. Raguse, Nanotechnology: Basic science and Emerging technologies, Overseas Press India Pvt Ltd, New Delhi, First Edition, 2005.
2. C.N.R. Rao, A. Muller, A.K. Cheetham (Eds), The chemistry of nanomaterials: Synthesis, properties and applications, Wiley VCH Verlag Gmbh&Co, Weinheim, 2004.

Course Outcomes:

- Understand crystal behavioural changes with change in size
- Understand nanostructures and preparation methodologies
- Distinguish between different types of nanostructures
- Understand the growing importance of nanostructures and applications

Practical(PHY205)
Modern Physics and Optics
(Practical Paper)

(100 marks**)**

Course Objectives:

- To analyze various situations or phenomena associated with modern physics and opticsphysics using basic principles.
- This course will introduce the student to a broad range of physical phenomenainvolving optics, and modern physics.

1. Measurement of Rydberg constant
2. Babinet's compensator
3. Michelson Interferometer
4. Fabry-Perot Interferometers
5. Constant deviation spectroscope
6. e/m measurement by Magnetron Valve Method
7. e/m measurement by Thomson Method
8. Magnetic field measurement by search coil
9. Ferroelectric transmission point by Dielectric Constant Measurement
10. Verification of Richardson's T3/2 low
11. Determination of Planck's constant by Reverse Photoelectric effect method
12. Measurement of attenuation and phase shift of A.C. in L.C.R. net work
13. Study of power supply
14. Calibration of an oscilloscope
15. Stefan's constant measurement
16. Existence of discrete energy level by Frank Hertz experiment.
17. e/m measurement by Braun tube
18. Rectification by junction Diode using various filters
19. Characteristics of a Transistor
20. Dielectric constant of solid (wax) by Lecher Wire
21. Determination of Planck's constant by total Radiation Method
22. Hysteresis loop tracer
23. Determination of 'e' by Millikan's oil drop experiment
24. RF characteristics of coil
25. Verification of Brewster's Law
26. Measurement of wavelength of Laser Source.
27. Verification of Malus Law
28. Single slit diffraction using Laser beam

Course Outcomes:

Students will be able to:

- To verify experimentally some of the laws and principles associated with modern physics and optics.

Practical(PHY205)

Computational Methods in Physics

(**100**marks)

Course Objectives:

Students will be able to:

- To learn computer programming using PYTHON and C.
- To solve physics problems through different numerical techniques
- Use computer programming for simulation and data analysis

Unit- I (50 Marks)

- Introduction to computational physics, computer architecture overview, tools of computational physics, introduction to storage in computer memory, stored programme concepts, storage media, computer operating system, compilers, Machine representation, precision, and errors.
- Introduction to Python, Structure of a python program, Input, and output statements, Control statements, Arrays, Sub programs, Data Files, examples of writing python programming of computational methods.
- **Programming in C:**Structure of C program, compilation, constants, variables & data types, initializing variables, arithmetic operators, data input and data output, control structures, decision making and looping statements, arrays, examples of writing C- programming of computational methods.
- **Numerical Techniques:** Interpolation, solution of algebraic equation, least-square curve fitting, linear algebra and matrix manipulations, inversion, eigenvectors and eigen values, numerical differentiation, numerical integration, Numerical solution of ordinary differential equations: Euler and Runge-Kutta methods, random number generation.

Unit-II (50 Marks)

Computer Programming: (Using Python and C)

Exercises for acquaintance:

16. Find the largest or smallest of a given set of numbers
17. Generate and print first hundred prime numbers
18. Sum of an AP series, GP series, Sine series, Cosine series
19. Factorial of a number
20. Area of circle, area of square, volume of sphere, value of ð.
21. Transpose a square matrix
22. Matrix multiplication, addition
23. Trace of a matrix

24. Evaluation of log and exponentials
25. Solution of quadratic equation
26. Division of two complex numbers
27. Find the sum of the digits of a number
28. Write a program to compute distance between two points taking input from the user (Pythagorean Theorem)
29. Write a program to count the numbers of characters in the string and store them in a dictionary data structure
30. Write a program to print each line of a file in reverse order**.**

- **Numerical Analysis:**

11. Interpolation by Lagrange method
12. Numerical solution of simple algebraic equation by Newton- Raphson method.
13. Least Square fit using rational functions
14. Numerical integration: Trapezoidal method, Simpson's method, Romberg integration,
15. Gauss quadrature method
16. Eigen values and eigen vectors of a matrix
17. Solution of linear homogeneous equations
18. Matrix inversion.
19. Solution of ordinary differential equation by Runge-Kutta Method
20. Solution of Radioactive decay equation, Simple harmonic oscillator, Schrödinger equation

Books:

1. PYTHON PROGRAMMING: USING PROBLEM SOLVING APPROACH, Reema Thereja, Oxford University Press; First edition (2017).
2. Python Made Simple: Learn Python Programming In Easy Steps With Examples, Rhythm Beri, BPB Publications; 1st edition (2019).
3. Mathematical Methods for Physics and Engineers, K.F. Riley. M.P. Hobson and S. J.20 Bence, 3rd ed., 2006, Cambridge University Press.
4. Complex Variables, A.S. Fokas and M.J. Ablowitz, 8th Ed., 2011. Cambridge Univ. Press.
5. First course in complex analysis with applications. D.Gzill and P.D.Shana–han, 1940, Jonesand Bartlett.
6. V. Rajaraman, Fundamentals of Computers (Prentice Hall, India).
7. C. Xavier, Fortran 77 and Numerical methods.
8. Brain W. Kernighan and Dennis. M. Ritchie, The C Programming Language, New Delhi: Prentice-Hall of India.
9. Byron S. Gottfried. Schaum's outline of Theory and Problems of Programming with C, New Delhi: Tata McGraw-Hill.
10. A. Klein and A. Godunov, Introductory Computational Physics, Cambridge University Press.
11. An Introduction to Computational Physics, T. Pang, Cambridge University Press.

12. Computer Oriented Numerical Methods- R.S.Salaria.
13. Hildebrand, F. B., Introduction to Numerical Analysis, Tata McGraw-Hill.
14. E. Balagurusamy, Numerical Methods, New Delhi: Tata McGraw-Hill.
15. Numerical Recipes: The Art of Scientific Computing, by William H. Press, Saul A. Teukolsky, William T. Vetterling, Brian P. Flannery.

Course Outcomes:

Students will be able to:

- Write computer programs using PYTHON and C.
- Use different numerical methods to solve problems using computer programs.
- Simulate physical systems using Monte Carlo Method.

3rd Semester

(PHY301)

Advanced Quantum Mechanics

Full marks = **100** Credit-**04**

Course Objectives:

- Understand the importance Covariant form
- Understand Klein-Gordon equation, Dirac equation in relativistic quantum mechanics
- Understand Lagrangian and Hamiltonian Formulations, Noether's theorem
- Understand Quantization of free fields

Unit- I

Relativistic Quantum Mechanics: Klein-Gordon equation and its drawbacks, Dirac equation, Properties of Dirac matrices, Nonrelativistic reduction of Dirac equation, magnetic moment, Darwin's term, Spin-Orbit coupling, Poincare transformation, Lorentz group, Covariant form of Dirac equation, Bilinear covariant, Gordon decomposition.

Unit- II

Dirac equation, Probability density and continuity equation, Non-Relativistic limit, magnetic moment of electron, covariant form of Dirac equation, properties of gamma matrices, Proof of covariance, Bilinear covariant, Gordon decomposition.

Unit- III

Free particle solution of Dirac equation, Projection operators for energy and spin, Physical interpretation of free particle solution, Zitterbewegung, Hole theory, Charge conjugation, space reflection and time reversal symmetries of Dirac equation.

Unit- IV

Dirac equation with central potential, commutation of the total angular momentum operator with the Hamiltonian in a spherically symmetric potential. Continuous systems and fields. Transition from discrete to continuous systems, Lagrangian and Hamiltonian Formulations, Noether's theorem.

Unit- V

Quantization of free fields: Second quantization, Equal Time Commutators, Normal Ordering, Quantization of scalar, Dirac fields,covariant quantization of electromagnetic field, Propagators for scalar, spinor, and vector fields.

Text Books:

- Advanced Quantum Mechanics – J. J. Sakurai
- Relativistic Quantum Mechanics – J. D. Bjorken and S. D. Drell
- Relativistic Quantum Fields – J. D. Bjorken and S. D. Drell
- Quantum Field Theory – F. Mandl and G. Shaw

Reference Books:

- Quantum Field Theory – C. Itzykson and J. Zuber
- Quantum Field Theory – M. E. Peskin and D. V. Schroeder
- Quantum Field Theory – L. H .Ryder
- Quantum Field Theory – S. Weinberg

Course Outcomes:

Students will have achieved the ability to:

- Explain the relativistic quantum mechanical equations, namely, Klein-Gordon equation and Dirac equation.
- Describe second quantization and related concepts.

(Phy302)
Basic Material Characterisation

Full marks = **100** Credit-**04**

Course Objectives:

Students will be able to understand different characterization techniques implemented to study the material properties for better understanding of material system.

UNIT - I

X-Ray diffraction and X-Ray photo electron spectroscopy: X-Ray spectrum; Production of X-Rays; Detection of X-Ray, Bragg's law of X-Ray diffraction, Diffraction methods, Scherrer formula; X-Ray diffractometer, Crystal structure determination by XRD analysis, X-ray photoelectron spectroscopy (XPS).

UNIT - II

Molecular Vibrational Spectroscopy: Modes of vibrations in molecules, Fourier transform IR, IR Detectors, Sample preparation for FTIR, Reflectance and diffused reflectance spectroscopy. Fundamentals of Raman Spectroscopy, Condition for Raman activity, Instrumentation and principle of working of Raman Spectrometer, Working principle and line diagram of UV-visible spectrometer, Beer-Lambert Law, Calculation of Band gap from UV-Vis spectra

UNIT - III

Resonance Spectroscopy: Construction and line diagram and working principle of Electron spin resonance (ESR), Instrumental arrangements and detection of line diagram in Nuclear magnetic resonance spectroscopy (NMR).

UNIT - IV

Microscopy: Construction, line diagram and working principle of Optical microscopy, Principle and ray diagram of scanning electron microscopy (SEM), Depth of field and depth of focus, Resolution of microscopes, Interaction of electrons with specimen, Energy dispersive X-ray spectroscopy (EDS).

UNIT – V:

Thermal Analysis: Working principle of Differential Scanning Calorimeter, Interpretation of DSC curve, Principle of working and elementary idea on analysis of Thermogravimetry Analysis (TGA) and Differential Thermal Analysis (DTA), Design and drawing of experiments.

TEXT BOOKS:

1. Element of X-ray Diffraction: B. D. Cullity, Addison-Wiley, 2ND edition, 1978
2. Electron microscopy and Analysis: P. J Goodhew, J Humphrey, R Beanland, Taylor and Francis, 3rddition,2001
3. Fundamentals of Molecular Spectroscopy – C. N. Banwell, E. M. Mc Cash, McGraw-Hill, 4th edition,1983

REFERENCE BOOKS:

1. Physical Methods for Materials Characterisation – P. E. F. Flewitt and R. K. Wild, Institute of Physics (IOP) Publishing Ltd., 2ND EditiON,2003
2. Encyclopaedia of Materials Characterization – C.R. Brundle, C. A. Evans Jr., and S. Wilson, Butterworth- Heinemann and Manning Publications Co., 1992
3. Materials Characterization: Y Leng, Wiley-VCH, 2ND edition, 2008
4. Mass Spectroscopy – H. E. Duckworth, R. C. Barbar and V. S. Venkatasubramanian, Cambridge University Press, 2ND edition, 1988

Open Sources:

https://nptel.ac.in/courses/115/105/115105110/

https://nptel.ac.in/courses/115/105/115105121/

https://nptel.ac.in/courses/115/105/115105120/

Course Outcomes:

Students will be able to:

- Understand X-ray diffraction, and implement to find structure of given material system.
- Understand spectroscopy methods and study interaction between matter and radiations.
- Understand vibrational characteristics of material system.

(PHY303)

ELECTRONICS-I(Elective)

Full marks = **100** Credit-**04**

Course Objective:

Students will be able to:

- Understand network analysis and network theorems and its applications.
- Know about resonant circuit and transmission lines.
- Know about wave guide and cavity resonators.
- Understand different types of generators.

Unit- I:

Network analysis:

Mesh and node circuit analysis, Four terminal network (T and ð representation and conversion, bridged T- network, Lattice network), Network Theorem, Maximum Power Transfer Theorem, Superposition Theorem, Thevenin's Theorem, Norton's Theorem, Millman Theorem, Substitution theorem, compensation theorem, Tellegen's theorem and their application to the network with linear elements.

Unit- II:

Resonant Circuit:

Series resonance and parallel resonance. Microwave oscillators and amplifiers: Klystron oscillator, Reflex Klystron, Cavity magnetron, Traveling wave tube.

Transmission line:

Distributed line parameters of parallel wire and coaxial line, Telegrapher's equations and solutions, input impedance of line, reflection on the line. Line distortion and its elimination, Line termination. Location of fault on line

Unit- III:

Wave guide and Cavity resonators

Cylindrical wave guide, TM mode- Wavelength, velocity of propagation, Characteristics impedance and cut off frequency, Pass band, Stop band, TE mode in cylindrical wave guide, Impossibility of TEM wave in a waveguide, Transmission line analogy for waveguide, Comparison of waveguide and coaxial line, Cylindrical resonance cavity, Resonant frequency

Unit- IV:

Wave shaping circuit:

Linear wave shaping (High pass and low pass R-C with different input voltage), Non-linear wave shaping (shunt diode clippers, Series diode clippers, Double ended clippers), Clamping circuits (DC resistors), Zero level clamping circuit, Clamping at a given reference DC voltage.

Unit- V:

Voltage and current sweep generator:

Basic RC sweep voltage generator, Transistor constant current sweep generator, Miller integrating sweep circuit, Boot strap sweep generator, Current time base generator, Blocking oscillator, Triggered transistor blocking oscillator.

Reference Books :

1. Networks, lines, and fields :- J.D. Ryder(PHI)
2. Microwave circuits and passive devices : M.L. Sisodia& G.S. Raghuvanshi (Willy Ester Ltd.)
3. Handbook of Electronics : Gupta and Kumar (Pragati Prakashan)

Course Outcomes:

Students will be able to:

- Solve network problems associated with networks using network analysis and theorems.
- Understand different types of resonances occur in circuits
- Understand different wave guides and modes associated with it.
- Know about amplifiers and generators.

(PHY303)

ADVANCED CONDENSED MATTER PHYSICS-I

Full marks = **100** Credit-**04**

Course Outcomes:

- Understand Born Oppenheimer approximation
- Understand the Normal mode of vibrations
- Understand the electron-phonon interaction and second quantization
- Understand Energy gap in solid
- Experimental method for the Fermi surface study
- Understand the electron-electron interaction
- Understand the Transport properties.

Unit- I:

Lattice Vibrations : Born-Oppenheimer Approximation, Hamiltonian for lattice vibrations in the harmonic approximation, Normal modes of the system and quantization of lattice vibrations – phonons. Electron-phonon interaction.

Energy Bands: Wave equation for an electron in a periodic potential, Bloch functions, Brillouin zones, E-k diagram under free electron approximation, Nearly free electron approximation – Diffraction of electrons by lattice planes and opening of gap in E-k diagram. Effective mass of electrons in crystals, Holes.

UNIT- II:

Fermi Surface: Construction of Fermi surface, Experimental methods of study of Fermi surface, CyclotronResonance, de Hass van Alphen effect.

Electron Interaction: Perturbation formulation, Hartree Equation, Hartree-Fock Equation, Dielectric function of an interacting electron gas (Lindhard's expression), Static screening, Thomas-Fermi theory of Screening, Screened impurity, Kohn effect, Friedel Oscillations and sum rule, Dielectric constant of semiconductor, Plasma oscillations.

UNIT- III:

Magnetism : Quantum theory of dia, Para magnetism, transition and rare-earth elements, Ferromagnetic, anti-ferromagnetic and Ferri-magnetic order, molecular fields, direct and indirect exchange interaction, Heisenberg and Ising model, domain theory, Bloch wall, spin waves, magnons, magnetic resonance, principle, and application of NMR, EPR, ESR.

UNIT- IV:

Mechanical Properties: Stress-strain behaviour, An-elasticity and elasticity of materials, Mechanical behaviour of metals ,Tensile properties, True-stress, and strain, Compressive, Shear and torsional deformation, Mechanical behaviour of ceramics, Stress-strain behaviour, Macroscopic deformation, Hardness, Hardness of ceramic materials.

UNIT- V

Optical and electrical Properties: Theory of refraction and absorption, Reflection and transmission, Atomic theory of optical properties, Absorption in materials, Beer and Lambert law, Photoluminescence, Jablonski diagram, Photoluminescence efficiency, Electrical Properties: C-V characteristics, I -V characteristics , mobility, and Transport Properties: The Boltzmann equation, Electrical conductivity, General Transport coefficients,Thermal conductivity, Thermoelectric effect, Hall effect, Elementary ideas on Quantum Hall Effect,Magnetoresistance, Elementary ideas on Giant magneto-resistance and Colossal magnetoresistance

Books:

1. Fundamentals of Materials Science and Engineering, 5th Edition, William D. Callister, Jr, John Wiley & Sons, Inc. , 2001.
2. Solid State Physics, C Kittel
3. Solid State Physics. A.J. Decker
4. Solid State Physics: AshcroftMerman
5. An introduction to materials engineering and science for chemical and materials engineers, Brian S. Mitchell, John Wiley & Sons, Inc., Publication, 2004
6. An Introduction to Nanomaterials and Nanoscience; A.K. Das, D. Mahua, CBS Publishers, and distributors Pvt. Ltd.

Course Outcomes:

- Explain the significance and value of condensed matter physics, both scientifically and in the wider community.
- The subject treats materials from an experimental viewpoint, solid state theory and properties.
- Understanding of the interplay between classical – and quantum mechanical phenomena, in condensed matter physics.
- Demonstrate the electron-phonon interaction and second quantization
- Understand electron –ion interaction for energy gap in solid
- Understand the Transport properties

Practical(PHY304)

Full marks = **100** Credit-**04**

Course Objectives:

- To study basic electronic components.
- To observe characteristics of electronic devices.
- To study different types of multivibrators.
- To study characteristics of oscillator and amplifiers.
- To study structural, optical and magnetic and vibrational behaviour of material system.

(PHY304(a)
Electronics(Elective)

1. Frequency response of transistor amplifier with the without feedback
2. Characteristics of Hartley oscillator
3. Study of multivibrator – Astable
4. Study of multivibrator – Bistable
5. Study of multivibrator – Monostable
6. VSWR in a microwave transmission line
7. Modulation of detection
8. Lock-in-amplifier
9. Design of operational amplifier circuit
10. Design of a field-effect transistor crystal oscillator
11. Characteristics of Colpitts oscillator
12. Characteristics of UJT.

(PHY304(b)
Advanced Condensed Matter Physics(Elective)

1. Determination of energy gap of semiconductor using p-n junction diode.
2. Determination of lattice parameter and Miller indices of unknown structure obtained from X-Ray diffraction data.
3. Determination of Hall voltage, Hall co-efficient and mobility of a given sample.
4. Determination of magneto-resistance of given sample.
5. Measurement of transition temperature of high temperature superconductor and demonstration of Meissner–Ochsenfeld effect.
6. Study of B-H curve of given sample
7. Determination of band gap of a thin film sample using UV-Vis spectrophotometer
8. Determination of thermal activation energy of a given sample.
9. Determination of dielectric constant of unknown sample using LCR meter.
10. Measurement of Remnant polarization and Coercive field of an unknown sample.
11. Determination of concentration of unknown liquid using UV-Vis spectroscopy.
12. Determination of energy band gap of unknown liquid sample from UV-Vis spectroscopy

Practical(PHY305)

Full marks = **100** Credit-**04**

Course Objectives:

- To study basic electronic components
- To observe characteristics of electronic devices

Basic Electronics

1. Study of step-up and step-down transformer and measure its efficiency.
2. Study of OPAMP (Inverting, No Inverting, Integrator, Differentiator, Comparator)
3. Study of Voltage Regulators (7805, 7812).
4. Study of clipping and clamping circuits.
5. Setting of a transistor amplifier and determination of the amplification factor at various frequencies.
6. Determination of different parameters of transistor
7. Study of square wave response of R.C. Network.
8. Study of digital voltmeter and frequency counter.
9. Study of feedback amplifier.
10. Study of truth tables different types of flip-flop circuit
11. Study of input and output impedance of an amplifier
12. Study of clipping and clamping circuits.
13. Study of voltage regulation by Zener Diode
14. Verification of Truth Table of different Logic gates (AND, OR, NOT, NAND,NOR).

Course Outcomes:

- To study basic electronic components.
- To observe characteristics of electronic devices.
- Verification of truth table operations.
- Study of transistor, amplifier characteristics.

4th Semester

(PHY401)

Statistical Mechanics and Applications

Full marks = **100** Credit-**04**

Course Objective:

Students will be able to:

- Know about classical approach of statistical mechanics
- Understand ensemble system to solve problems of statistical mechanics.
- Know about quantum approach of statistical mechanics
- Know about BE condensation and fermi energy
- Understand phase transition

Unit- I :

Classical statistical mechanics:

Binomial Distribution of probability, Poisson's Distribution, Gaussian distribution, Random walk problem, Phase space, Macroscopic and Microscopic states, Statistical ensemble, Liouville's theorem, Micro canonical Ensemble, Equi-partition theorem, Classical ideal gas, Gibbs paradox.

Unit- II:

Canonical and Grand Canonical ensemble:

Canonical ensemble, Probability distribution, Partition function, Calculation of thermodynamic parameter, Classical Ideal gas, and energy fluctuation. Grand canonical ensemble, the chemical potential, Probability distribution, Partition function, Calculation of thermodynamic parameter and gas equation, density fluctuation.

Unit- III:

Quantum statistical mechanics:

The density matrix, Ensembles in quantum mechanics: Micro canonical Ensemble, Canonical Ensemble and Grand Canonical Ensemble.

Ideal gas: micro canonical and grand canonical ensemble, Equation of state for Bose gas and Fermi gas

Unit- IV:

Bose and Fermi gas:

Photons, phonons, Debye-specific heat, electronic specific heat, Bose-Einstein Condensation, Fermi energy, Ground state, Low temperature properties, Mean energy of fermions at absolute zero, Theory of White – Dwarf stars.

Unit- V:

Applications:

Thermodynamics description of Phase Transitions, Phase Transitions of second kind, Definition of the Ising model, one dimensional Ising model, Classical density functional theory, Cahn-Hilliard-Ginzburg-Landau (CHGL) Approach, Microscopic Density Functional Theory.

Text Books:

- Statistical Mechanics: R. K. Pathria
- Statistical physics, K. Huang, 2nd edition, Willy Student edition 2014.
- Fundamental of statistical & thermal physics, F. Reif, 1st Indian edition, Levant Books, 2010.
- Fundamental of statistical mechanics, B. B. Laud, 2nd Edition, New age international Pvt. Ltd, 2012.

Reference Books:

- Statistical physics, Landau and Lifsitz, 3rd Edition, Pergamon Press, 2013
- Elementary statistical physics, C.Kittel, John Wiley & Sons, Inc.2008.
- Statistical mechanics - A set of lectures, R.P.Feynman, The Benjamin publishing company, Inc. (2008)
- Introduction to Statistical Physics, Kerson Huang, Taylor & Francis, 2002.

Course Outcomes:

After completing this course, the students should be able to:

- Understand the concept of statistical physics and thermodynamics as logical consequences of the postulates of statistical mechanics.
- Interpret the concept of types of ensembles and calculation of general probability statements for variety of situation of physical interest.
- Analyse the problems involving gases at low temperature or high densities and problems encountered in connection with the indistinguishable particles.
- Apply Fermi-Dirac and Bose-Einstein statistics to different physical systems.
- Apply different model for phase transitions through statistical techniques to simulate the structure of a physical substance.

(PHY402)

BASIC NUCLEAR AND PARTICLE PHYSICS

Full marks = **100** Credit-**04**

Course Objective:

Students will be able to:

- Understand the basic nuclear properties and nuclear stability.
- Determine the magnetic moment and quadruple moment of Deuteron.
- Interpret the nuclear models associated with nuclear structure and stability.
- Explain process associated with alpha decay and beta decay.
- Identify the quantum mechanical properties of elementary particles on the basis of strong and weak interactions.

Unit- I

General nuclear properties:

Nuclear scattering, nuclear radius, Mass binding energy, Nucleon separation energy, Angular momentum, Magnetic dipole moment, Parity of Nuclei, , Parity conservation, Nuclear quadrupole, Electromagnetic moments, Characteristics of Nuclear force with examples.

Unit- II

Two Nucleon Problems:

Central and non-central forces, Deuteron and its magnetic moment and quadruple moment, Force dependent on isospin, Exchange force, Charge independence and charge symmetry of nuclear force, Mirror nuclei.

Unit- III

Nuclear models:

Liquid drop model, Fission, Magic numbers, Shell model, Analysis of shell model predictions, Collective rotations & vibrations, Nuclear Structure: Form factor and charge distribution of the nucleus, Hofstadter form factor.

Unit- IV

Nuclear reaction:

Conservation laws, Classification of nuclear reaction, Radioactive decay, Radioactive decay law, Production and decay of radioactivity, Radioactive dating, Alpha decay: Gamow theory, Beta decay: energetic angular momentum and parity selection rules, Compound nucleus theory, Resonance scattering, Breit- Wigner formula, Fermi's theory of beta decay, Selection rules for allowed transition, Parity violation,

Unit- V

Particle Physics:

The Standard model of particle physics, particle classification, fermions and bosons, lepton flavors, quark flavors, electromagnetic, weak, and strong processes, Spin and parity determination, Isospin, strangeness, hypercharge, and baryon number, lepton number, Gell- Mann-Nishijima Scheme, Quarks in hadrons: Meson and baryon octet,Elementary ideas of SU(3) symmetry, charmonium, charmed mesons and B mesons, Quark spin and colour.

Books:

1. Nuclear Physics- Dr. S. N. Ghosal. (Revised Enlarged edition), 2016.
2. Nuclear Physics - R. R. Roy and B. P. Nigam, 2nd Edition, 1996.
3. Atomic and Nuclear physics - Satyendra Sharma, 1st Edition (2008)
4. Theoretical Nuclear Physics - J. M. Blatt and V. F. Weisskof, Wiley, New York (1979)
5. Introductory Nuclear Physics- Samuel S. Wong, Prentice Hall International Inc., (1990)

Course Outcomes:

Students will be able to:

- Understand the basic nuclear properties and stability.
- Determine the magnetic moment and quadruple moment of Deuteron by applying the concept of non-central nature of nuclear force.
- Interpret the nuclear models associated with nuclear structure and stability.
- Explain process associated with alpha decay and beta decay.
- Identify the quantum mechanical properties of elementary particles on the basis of strong and weak interactions.

(PHY403)

ELECTRONICS-II(Elective)

Full marks = **100** Credit-**04**

Course Objectives:

Students will be able to:

- Understand the applications of OPAMP
- Know about multivibrators
- Understand logic expressions and operations
- Understand working of multiplexors and converters
- vUnderstand memory organization.
- Understand LASERS and MASERS.

UNIT - I

Application of OPAMP- Active RC filters, Analog computation, Logarithmic amplifier, Antilogarithmic amplifier, Bridge amplifier, Voltage regulator, Saw-tooth wave generator, Ramp generator, Schmitt trigger, Multivibrator using 555 IC timer.

UNIT- II

Boolean logic expression (SOP and POS), Simplification using Kamaugh map for three and four variables, 5,6 variable switching function , Don't care condition, Encoder, Decoder, BCD-to-7 segment decoder, Digital comparator, Multiplexer, Demultiplexer, D/A converter, A/D converter(counter-type method with D/A, dual slope integrated method, successive approximation method).

Unit- III

Computer: Memory organization, Memory parameter(with Binary weighted registers with R and 2R resistors, simultaneous comparison method), semiconductor memory cell, 2D organisation of semiconductor memory, 2-1/2 organisation of semiconductor memory, organisation of large station memory, Read only memory, Random access memory, Static RAM, Dynamic RAM, Error detection and correction in memories, Special semiconductor memories, Dual ported RAM, First-in, First-out memory(FIFO), Last-in, First-out(LIFO/STACK), Magnetic memories- magnetic core memory, magnetic disk memory, hard disk system, magnetic bubble memory, optical disc memory, Microprocessor (Basic concept, architecture, qualitative idea on 8085 microprocessors.

Unit- IV

Elements of LASERS and MASER: Principle of LASER: Optical pumping, electrical pumping, Chemical Pumping, LASER cavity: Resonator mode, absorption, spontaneous and stimulated emission, Population inversion, Boltzmann distribution and Thermal equilibrium, creating population inversion, energizing the amplifying medium, LASER oscillator, Three level LASER system, Four-level LASER system, Types of LASER: Gas LASER(He-Ne), N- LASER, Solid state LASER-Ruby LASER, ND-YAG LASER, Semi-conductor LASER or LASER diode, Liquid LASER or dye LASER, Quantum well LASER, Application of LASERS.

Concepts leading to origin of MASERs, Basic principle of MASER operation, Gas MASER, Solid state MASER, Inversion MASER, Multilevel MASER.

Unit- V

Fiber optics Optical fibre: Basic mechanism, wave propagation in step index fibre, single mode optical fibre, chromatic dispersion and pulse spreading, graded index fibre, pulse dispersion in step index fibre, mode of propagation- single mode propagation, losses in fibres, light sources and light detectors used in optical fibre, Advantages, and applications of optical fibre

Course Outcomes:

Students will be able to:

- Understand OPAMP applications in electronic circuits.
- Know about multivibrators and use of 555IC timer
- Understand logic expressions and operations
- Understand working of multiplexors and converters
- Understand memory organization and microprocessors
- Understand concept of MASER, and fibre optics.

(PHY403)

ADVANCED CONDENSED MATTER PHYSICS-II

Full marks = **100** Credit-**04**

Course Objectives:

Students will be able to:

- Know different material preparation techniques
- Derive Kramer- Kronig relation
- Understand phono and electron interaction with photons
- Understand different types of band transitions
- Understand defects present in the material system
- Know about measurement of magnetic properties of materials.

UNIT- I

Materials Preparation Techniques: Crystal growth techniques, Idea on Thick and Thin films, surface deposition, nucleation growth and structure development; Surface structure, role of surfaces in nano-sciences, Epitaxial growth, lattice mismatch and strain, growth modes, self-organization, self-aligned nanostructures, heterostructures; Growth of quantum structures, Glass, and Glass Transition. Synthesis of low dimensional materials, Lithography, Sputtering and Plasma CVD, deposition by electron beams, arc plasma and pulsed laser, Molecular beam epitaxy and metal-organic CVD, Chemical solution-based deposition processes, , Electrochemical deposition

UNIT- II

The dielectric function: the dielectric function for a harmonic oscillator, dielectric losses of electrons, Kramer- Kronig relations, Interaction of phonons and electrons with photons, Inter-band transition, direct and indirect transition; Absorption in insulators; Polaritons; One-phonon absorption; Optical properties of metals, skin effect and anomalous skin effect.

UNIT- III

Defect studies: Luminescence, Colour center, Point defects in solid, Diffusion in an ionic crystal, Ionic conductivity, Line defect, Plane defect, types of bonding. Dielectrics in AC, Ferroelectric characteristics & their classification Polarization catastrophe, Origin of ferroelectricity, Landau's theory of ferroelectric transition.

UNIT- IV

Quantization of orbit in a magnetic field {Landau levels}, De Haas Van Alphen Effect, Magnetic breakdown, Boltzmann transport equation & applied to metals to find electrical conductivity, Quantum theory of dia-, para-magnetism, transition and rare-earth elements, Ferromagnetic, anti-ferromagnetic and Ferri-magnetic order, molecular fields, direct and indirect exchange interaction, Heisenberg and Ising model, domain theory, Bloch wall, spin waves, magnons, magnetic resonance

UNIT- V

Magnetic measurements using vibrating sample magnetometer (VSM) & SQUID, I-V- Hall - Quantum Hall effects - Kelvin-probe measurements, principle, and application of NMR, EPR, ESR.

Reference Books

- Solid State Physics, C Kittel
- Solid State Physics Part-III Magnetic properties of Solids, M. S. Dresselhaus
- Solid State Physics. A.J Decker
- Solid state physics , Christmaan- (academic press)
- Solid state Theory Walter A Harrison
- James F Shackelford, " Introduction to Materials Science for Engineers", 7th Edition, Pearson, Prentice Hall, 2009
- Callister W D, "Materials Science and Engineering : An Introduction", 7th Edition, John Wiley & Sons, Inc., 2007
- Kenji Uchino," Ferroelectric Devices", Marcel Dekker, INC, 2000.
- Rao V V, Ghosh T B and Chopra K L, "Vacuum Science and Technology', Allied publishers Ltd., 1998.
- Leon I Maissel and ReinardGlang, "Hand Book of Thin Film Technology", McGraw Hill, 1970.
- Kelsall Robert W, Ian Hamley and Mark Geoghegan, "Nanoscale Science and Technology", Wiley Eastern, 2004.
- Bharat Bhushan, "Springer Handbook of Nanotechnology", 2004.
- Michael Kohler, Wolfgang and Fritzsche, "Nanotechnology: Introduction to Nano-structuring Techniques", Wiley –VcH, 2004.
- Charles P Poole, Frank J Owens, "Introduction to Nanotechnology", John Wiley and Sons, 2003.

Course Outcome:

Students will be able to:

- vKnow preparation techniques of different materials
- Derive Kramer- Kronig relation, phonon, and electron interaction with photons
- Understand optical properties

- Understand different types of band transitions
- Understand defects present in the material system
- Know about measurement of magnetic properties of materials.

PROJECT and SEMINAR(PHY404)

Full marks = **100** Credit-**04**

PRACTICAL (PHY405)

ELECTRONICS (Elective)

Full marks = **100** Credit-**04**

Course Objectives:

- To study characteristics of OPAMP.
- To study multiplexor and de-multiplexor characteristics.
- To study chacteristics of opto-electronic devices.
- To study half adder and full adder characteristics.

1. Study of characteristics of operational amplifier. (inverting, non-inverting, scale changing, unity follower; summing and difference OPAMP)
2. Study of characteristics of diac.
3. Study of given multivibrator, multi-stage (ERC) coupled amplifier.
4. Study of Multiplexer and verification of Truth Table.
5. Study of De-multiplexer and Truth Table.
6. Study of characteristics of optoelectronic devices. (Phototransistor, Photodetector, Photo-voltaic cell, and opto-couples)
7. Study of wave shape (frequency) of op-AMP based Wien Bridge oscillator.
8. Study of Quality factor of the given coil.
9. Study of Gain and bandwidth of R-C coupled amplifier with varied load.
10. Calibration of electronic voltmeter for A.C. and D.C.
11. Study of characteristic of class A and AB amplifier.
12. Study of characteristic of given triac.
13. Study of wave forms (and frequency) of blocking oscillator
14. Study of FET characteristics.
15. Verification of Truth Table of Half Adder and Full Adder
16. Verification of Truth Tables of Half and Full Subtractor.

Course Outcomes:

After performing laboratory activities, the students will have

- Knowledge about characteristics of OPAMP.
- Knowledge about multiplexor and de-multiplexor characteristics.
- Understanding on chacteristics of opto-electronic devices.
- Knowledge of half adder and full adder characteristics

Practical(PHY 405)

Advanced Condensed Matter Physics(Elective)

Full marks = **100** Credit-**04**

Course Objective:

- To study structural and optical properties of power samples.
- To understand electrical conduction and charge transport process in the given material system.
- To understand polar properties and calculate dipole moment of liquid samples.

1. Determination of particle size from XRD data
2. Determination of energy band gap of unknown powder from UV-Vis spectroscopy.
3. Determine the functional groups present in unknown powder sample.
4. Estimation of strain in thin film/powder from XRD spectrum.
5. Study of impedance and modulus data of given unknown powder using LCR meter.
6. Study of conductivity of given unknown powder using LCR meter.
7. Measurement of dielectric constant of polar liquid/ liquid mixture.
8. Measurement of dipole moment of polar liquids.

Course Outcomes:

After performing experiments students will gain

- Understandingof structural and optical properties of power samples.
- Understanding of electrical conduction and charge transport process in the given material system.
- Understanding of polar properties and calculate dipole moment of liquid samples.

MASTER OF SCIENCE IN

ZOOLOGY

(SEMESTER PATTERN)

CHOICE BASED CREDIT SYSTEM SYLLABUS

TWO-YEAR FULL TIME PROGRAMME

COURSES OF STUDIES

(2023 -2024)

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Bhubaneswar - 751014

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Distribution of courses in Semester Pattern for M. Sc. (Zoology) Programme effective from 2023-24

Semester	Paper code	Paper Name	Marks		Full Marks	Credits
			Mid Semester / Seminar	End Semester/ Pract./Assign-ment/Pro.etc.		
I	**C-101**	Bio Systematic and Non Chordates	30	70	100	6
	C-102	Genetics	30	70	100	6
	C-103	Cell Biology	30	70	100	6
	C-104	Bio-instrumentation and Biostatistics	30	70	100	6
	C-105	Practical Paper		100 marks Pract.	100	6
II	**C-201**	Chordates and Comparative Anatomy	30	70	100	6
	C-202	Biochemistry	30	70	100	6
	C-203	Animal Physiology	30	70	100	6
	C-204	Animal Behaviour and Economic Zoology	30	70	100	6
	C-205	Practical Papers		100 marks Pract.	100	6
III	**C-301**	Molecular Biology	30	70	100	6
	C-302	Developmental Biology	30	70	100	6
	C-303	Evolutionary Biology and Zoo-Geographical Realms	30	70	100	6
	EC-304	Genetic Engineering and Biotechnology	30	70	100	6
	C-305	Practical Paper		100 marks Pract.	100	6
IV	**C-401**	Microbiology and Immunology	30	70	100	6
	C-402	Environmental Biology and Wildlife Conservation	30	70	100	6
	EC403	Aquaculture	30	70	100	6
	C-404	Seminar / Assignment/ Practical	50 (seminar)	50 (Assgn./Pract.)	100	6
	C-405	Project / Dissertation/ Field Study		100	100	6
Total		**20 Papers**			**2000**	**120**

N.B.: The department also offers the Elective Papers (Student are to choose any one paper)
Elective - A- EC-304, Elective-B-EC-403,
EC-304= I- Genetic Engineering & Biotechnology, II- Parasitology
EC-403= I- Aquaculture, II- Neurobiology

PROGRAMME OUTCOME

The course aims to provide students with a comprehensive understanding of theoritical and practical aspects of animal science, enhancing their curriculum and technical expertise in biosciences. This approach is intended to foster a positive attitude towards career development, research, and employability. Each semester is structured systematically to facilitate academic progress.

The first semester focuses on fundamental concepts such as biosystematics, invertbrate biology, cell biology, genetics, bioinstrumentation and biostatistics, emphasizing current technological aplications.

The second semester explores chordates, biochemistry, animal physiology, animal behavior and economic zology, emphasizing the commercial significance of animals.

The third semester introduces students to parasistology, covering major pathogens, their pathogenic mechanisms and prophylactic measures. It also delves into molecular biology, including DNA replication, transcription, translation and genome mapping techniques.

The fourth semester covers microbiology, immunology, environmental biology, wildlife conservation, aquaculture and neurobiology. A project report provides scientific training in organismal biology, ecology, diversity, structure, physiology, behavior, classification, distribution and evolution of animals.

Overall, this curriculum establishers a strong foundation in biological sciences, enbling students to tailor their coursework according to their interests in animal biology.

SEMESTER - I

CORE-101

BIOSYSTEMATICS AND NON-CHORDATES

Course Outcome

In this course, students will achieve the following learning outcomes :

Demonstrate a thorough understanding of advanced biosystematic concepts and theories and proficiently apply them. They will also be capable of showcasing comprehensive knowledge in managing biosystematics collections and databases. The students will also galin insights into the life functions and ecological significance of animals across various phyla, spanning from unicellular to multicellular organisms. they will be also able to analyse the diverse categories of invertebrates and their ecological impacts on ecosystem.

Unit-I : Biosystematics

Concepts of Biosystematics; Importance and applications of biosystematics; Trends in biosystematics: conventional and newer aspects of taxonomy; Dimensions of speciation and taxonomic characters; Species concepts: species category, different species concepts, subspecies and other intraspecific categories; Theories of biological classification.

Unit-II: Taxonomy

Taxonomic procedures: Taxonomic collections, Preservation, Curetting, Taxidermy; International Code of Zoological Nomenclature (ICZN): Operative principles, Interpretation and application of important rules; Evaluation of biodiversity indices: Shannon-Winner index, Dominance index, Similarity and Dissimilarity index, and Association indices.

Unit-III : Basics of Bioinformatics

Introduction to genomics and proteomics databases- Nucleic acid sequence databases: Gene bank, EMBL, DDBJ, protein sequence databases: Swiss-prot, Uniport, PDB, BLAST, PSI-BLAST (steps involved in use and interpretation of results) and BLAST vs FASTA, file formats- FASTA, GCG and ClustalW; Introduction to sequence alignment, Needleman and Wunsch algorithm; Local alignment of sequences, Smith and Waterman algorithm; Basic Local alignment Search

Tool, Multiple Sequence alignment and Molecular Phylogenetics., Protein structure prediction; Homology modeling.

Unit-IV : Invertebrate-I

Protozoan parasites (*Entamoeba histolytica, Plasmodium vivax, Trypanosoma, Trichomonas*); Reproduction in sponges; Coral Reef formation and significance, Polymorphism in Coelenterates; Evolutionary significance of Ctenophora; Evolution of Coelom and metamerism, Excretion in Annelida; Vision in insects, Respiration in Arthropoda.

Unit-V : Invertebrate-II

Respiration in Mollusca, Shell in Mollusca, Larval forms in echinoderms and affinity with chordates; Evolutionary significance of Onychophora; Helminth parasites (*Taenia, Fasciola, Wuchereria, Ancyclostoma*) and human diseases, Parasitic adaptations in Helminthes.

Suggested Readings :

- G.G. Simpson. Principle of animal taxonomy. Oxford IBH Publishing company.
- B.K. Tikadar. Threatened Animal of India. ZSI publication Calcutta.
- V.C. Kapoor. Theory and Practice of Animal Taxonomy. Oxford & IBH Publishing Co.
- Arthur, M.L. Introduction to Bioinformatics Oxford University Press, New Delhi.
- Higggins D. and Taylor, W. Bioinformatics; Sequence, Structure and Databanks. Oxford University Press, New Delhi.
- Baxevanis, A. and Ouellette, B.F. Bioinformatics: A practical guide to the analysis of genes and proteins. Wiley Interscience, Hoboken, New Jersey, USA.
- Arthur M. Lesk. Introduction to Protein structure. Oxford University Press, New Delhi.
- Durbin, R., Eddy S. R., Korgh, A. and Mitchison, G. Biological sequence Analysis Cambridge University Press, Cambridge, U.K.
- Richard C. Brusca. Invertebrates, Sinauer publications.
- Waterman. A.J. Chordate Structure and Function. McMillan Co.London.
- Cox F" E.G. Modern Parasitology- A Text book of Parasitology, Blackwell Scientific Publication.
- Young, J. Life of Vertebrates. Clarendon Press, Oxford.

SEMESTER - I

CORE - 102

GENETICS

Course Outcomes

In this course, the student will acquire foundational knowledge in human genetics and heredity, covering topics such as DNA, RNA, replication, mutations, and DNA repair mechanisms. Additionally, students will explore the aplications of transgenic animals in the pharmaceutical industry, as well as the signficance of cloning.

Unit-I: Mendelian and Non-Mendelian Inheritance

Laws of heredity; Varieties of gene expression: lethal genes, multiple alleles, pleiotropic genes, gene interactions, epistasis; Polygenic inheritance: heritability and its measurements; Two factor and three factor crosses.

Unit-II: Linkage, Crossing over and Recombination

Linkage and crossing over, Cytological basis of crossing over, Molecular mechanisms of crossing over including models of recombination, Recombination frequency as a measure of linkage intensity, Homologous and non-homologous recombination, Transposable Genetic Elements in Bacteria, Maize, Drosophila and Humans. Methods of gene mapping

Unit-III: Mutation and Chromosomal Disorders

Types of gene mutations (Classification), Structural and numerical alterations of chromosomes and meiotic consequences; Chromosomal disorders and common human syndromes; Euploids and aneuploids-classification, origin, induction, role of polyploidy in evolution and practical significance in crop improvement, Detection of mutations: CLB method, attached X method.

Unit-IV: Extrachromosomal Inheritance

Extrachromosomal inheritance: mitochondrial, maternal inheritance; Sex-chromosome systems; Different mechanisms of sex determination in Drosophila and Man and their molecular mechanism.

Unit-V: Population Genetics

Gene pool concept, Hardy-Weinberg equilibrium, Amniocentesis and its application; Biology of twins; Polyembryony; Free Martin; Genetic counselling; Gene Therapy; Pedigree analysis; C value paradox; Lod score for linkage testing; Interference and coincidence.

Suggested Readings :

- Watson. J.D. Hopkins, N.H., Roberts, J.W., Steitz, J.A. and Weiner, A.M. Molecular Biology of the Gene. WE.A. Benjamin/Commings Co., New York.
- Sinnot. E.W., Dunn. L.C., Dobzhansky, T.H. Principles of Genectics. McGraw Hill Co., New Delhi.
- Daniel L. Hartl. Genetics. Jones and Barflaff Publishing, Boston.
- Curs Sten. Principles of Human Genetics. W.H. Freeman and Co., New York.
- Gardner E.J. Simmons, M.J. and Snustad, D.P. John. Principles of Genetics. Wiley & Sons, New York.
- Tamarin R. H. Principles of Genetics, McGraw Hill Co., New Delhi.
- T. A. Brown., Genomes 4. Garland Science. Tailor & Francis group, USA
- Daniel L. Hartl and Andrew G. Clark. Principles of population genetics. Sinauer Associates and Oxford University Press.
- Strikberger, MW. Evolution. Jones and Bartett Publishers, Boston London.
- P.H. Clevelan Jr, Larry. S. Roberts, A. Larson, Biology of Animals, McGraw-Hill.

SEMESTER - I

CORE-103

CELL BIOLOGY

Course Outcomes

In this course, students will grasp the structures and functions of fundamental components in prokaryotic and eukaryotic cells, with a focus on macromolecules, membranes, and organelles. Further more, they will comprehend how these cellular components facilitate the generatioin and utilization of energy within cells.

Unit-I : Biomembranes and Transport

Plasma membrane: composition and dynamics, membrane carbohydrates and their role in cell recognition, membrane modifications; Types of membrane transport (active, passive, cotransport, symport and antiport); Cell Junction: Zonula occludens, Zonula adherens, Macula adherens, Gap junction (Nexus); Extra-cellular matrix; Ion channels, Transporters and Receptors

Unit-II : Cytoskeletons and Intracellular Transport

Cytoskeleton: Microtubules, intermediate filaments and microfilaments, macromolecular trafficking; Mitochondria: Structure, genome organization, biogenesis and function; Protein sorting: Transport of proteins into mitochondria, lysosomes, peroxisomes and nucleus; Endoplasmic Reticulum, Golgi Complex and Intracellular vesicular trafficking: Coated and un-coated vesicles, transport of secretory materials, endocytosis.

Unit- III: Nucleus and Chromosomes

Nucleus: Ultrastructure and function of nuclear envelope, nuclear pore complex, nucleolus. Chromatin organization: Histones and nonhistone chromosomal proteins, nucleosomes and higher order structures, centromere, kinetochore and telomere, lampbrush chromosome, polytene chromosome, B-chromosome, Inter-phase chromatin, euchromatin and heterochromatin, karyotype and its significance; Chromosomal banding (C, G, R and NOR banding).

Unit- IV: Cell Cycle and Apoptosis

Molecular events & mechanisms of cell division: Cell cycle (molecular models and events, checkpoints in cell cycle and its regulation), Necrosis, programmed & induced cell death and autophagy; Process of apoptosis: Initiation, Execution: cytochrome C, caspases, Phagocytosis, intrinsic and extrinsic pathways of apoptosis, extracellular & Intracellular regulation of apoptosis.

Unit-V: Cell Signalling

Signal transduction: Concept of cell-signalling; Signalling through intracellular receptors: Lipophilic hormones; Signalling through cell surface receptors- G protein linked receptors; signalling via cAMP, PKA, PKC, IP3, Ca+2 /calmodulin, Ca-MAPK; RTK signalling, JAKSTAT pathway, PTP signalling pathway; Serine/threonine kinase receptor; Signalling through proteolytic cleavage: notch-delta, Nf-kb, Wnt signaling

Suggested Readings :

- De Robertis. E.D.F. and De Robertis. E.M.F. Cells and Molecular Biology, B.I. Publications Pvt. Ltd., India.
- Howland J.L. Cell Physiology, McMillan Publishing Co., New York.
- Karp, G. Cell Biiology. McGraw Hill Ltd., Japan.

- Albert, B and Watson. J.D. Molecular Biology of the cell. Garland Publishing, Lonldon.
- Lodish, H., Berk A., Matsudaira, P., Kaiser, C.A., C.A., Krieger, M., Scott, M.P., Zipursky, S.L. and Darnell, J. Molecular Cell Biiologyl. W.H. Freeman & Co., New York.
- Voet D. and Voet J.G., Biochemistry, John Willey and Sons.
- Nelson D.L., Cox M.M. Lehninger, Princeiples of Biochemistry, MacMillan, USA.
- Cooper GM. The Cell : A Molecular Approach Sunderland (MA): Sinauer Associates.

SEMESTER - I

CORE - 104

BIO-INSTRUMENTATION AND BIOSTATISTICS

Course Outcomes

Upon successful completion of this subject, students will be proficient in the following areas: designing and constructing biomedical instruments that meet regulatory standards for medical devices, detailing essential considerations for generating and measuring biological signals, and applying basic biostatistics within the realm of zoololgy.

Unit-I: Microscopy

Microscopy: principle of operation and instrumentation of light, Phase-Contrast, Fluorescent, Electron, Atomic force and Confocal microscopy; Flow cytometry.

Unit-II: Centrifugation, Chromatography and Electrophoresis

Centrifugation: Principle of sedimentation, different types of centrifugation, differential and density gradient Chromatography; Principle and application of chromatography (Molecular exclusion, Ion exchange, Gas, liquid and HPLC. Affinity; Principle and application of electrophoresis (Paper, Cellulose acetate, Starch, Agarose, Native-PAGE, SDS-PAGE, Isoelectric focusing and Two Dimensional).

Unit-III: Spectrophotometry and Radioactivity

Spectrophotometry: principle and application of ultraviolet and visible spectrophotometry; Spectrofluorimetry; Mass spectrometry: MALDITOF; X-ray diffraction crystallography; Radioisotopic techniques: Nature of radioactivity, application of radioactivity in biology (carbon dating, liquid scintillation counting, autoradiography).

Unit-IV: Immuno Assays and Imaging Techniques

ELISA; RIA (Radio-immuno assay); PET (Positron Electron Tomography); MRI (Magnetic Resonance Imaging); CAT (Computer Aided Tomography); Polymerase Chain reaction (including Real Time PCR); Microarray.

Unit-V: Biostatistics

Sampling techniques; Measures of central tendency (Mean, Median, Mode); Measures of dispersion, Standard error, standard deviation, Coefficient of variation; Correlation and Regression; Measure of Probability; Normal, Poisson and Binomial distribution; Tests of significance (t-test and chi-square tests); Simple correlation and regression; Analysis of variance (single factor design); Nonparametric test: Wilcoxon Rank test, Mann-Whitney test; Principal component.

Suggested Readings :

- Wilson, K. and WEalker, K. Principles & Techniques of Practical Biochemistry, Cambridge Uni. Press.
- Plummer, D.T. Practical Biochemistry, Tata McGraw-Hills.
- Robert Braun. Introduction to Instrumental analysis, McGraw Hill International Educatiion.
- Thomas Spence Work, Elizabeth Work. Techniques in biochemistry and molecular biiology. North-Holland Publishing Company.
- David Wild. The Immuoassay Handbok: Theory ;and Applicatioins of Ligand binding. ELISA and related techniques. Elsevier.
- Green, R.H., Sampling design and statistical methods for environmental biiologists, John Wiley & Sons, New York.
- Snedecor, G.W. andW.G. Cochran, Statistical methods, Affiliated East-West Press, New Delhi.

SEMESTER - I

CORE - 105

PRACTICAL

SEMESTER - II

CORE - 201

CHORDATES AND COMPARATIVE ANATOMY

Course Outcomes

After completion of this course, the students will be able to know about comparative anatomy which serves as a crucial tool for assessing evolutionaly relationships among organisms and determining whether they share common ancestors. Moereover, they will understand the anatomical similarities between organisms compelling evidence to suport the concept of evolution, suggesting descent from a shared ancestor.

Unit-I: Proto-chordates

General characters & interrelationship of Proto chordates, Affinities of Proto chordates, Larval forms of Protochordates, retrogressive metamorphosis in Ascidians, feeding and respiration in protochordates.

Unit-II: Pisces, Amphibia and Reptiles

Peculiarities and affinities of Cyclostomes, General organizations and significance of Dipnoi, Accessory respiratory organs in fishes, Origin of Amphibia, Sphenodon and its peculiarities, Classification of reptiles based on skull pattern, Types, composition, and function of Venom, Venom antidotes.

Unit-III: Bird and Mammal

Flight adaptation in Birds, Air sacs in bird, General characteristics of prototherians and metatherian, Aquatic Mammals (structural peculiarities), Evolution of Viviparity.

Unit-IV: Circulatory and Urinogenital system

General plan of blood circulation in various groups: Evolution of heart, Aortic arches and Portal systems, Structural modification of urinogenital system in vertebrates, Ultrastructure of kidney, Evolution of reproductive passages.

Unit-V: Nervous system and sense organs

Nervous system and sense organs (structure and function); General plan of brain structure, Evolution of cerebral hemispheres and cerebellum, Comparative anatomy of brain and spinal cord, Peripheral nervous system.

Suggested Readings :

- Prosser, CL. & Brown, Jr. FA. Comparative Animal Physiology, Saunders. USA Hobart M. Smith. Evolution of Chordate Structure. Holt, Rinehart and Winston. Inc. New York.
- Hyman, L.H. Comparative Vertebrate Anatomy. The University of Chicago Press, Chicago.
- Waterman. A. J. 1971. Chordate Structure and Function. McMillan Co.London.
- Jolie, M. Chordate Morphology. East West Press. Pvt., Ltd.,
- Romer, A.S. and Parson, T.S. 1978 Vertebrate Body. w.B. SDaunders Co., Philadelphia.

SEMESTER - II

CORE - 202

BIOCHEMISTRY

Course Outcomes

Upon completing this course, students should demonstrate the ability to formulate scientific questions or problems and conduct investigations and analyses that yield insights into the fundamentals of biochemical process and mportance of bioimolecules. They weill also gain knoweledge on enzymatic reactions in relation to metabolic activities.

Unit - I: Chemical foundations

Chemical basis of life: Chemical composition and bonding, three-dimensional structure (configuration and conformation, Isomerism and stereospecificity); Chemical Reactivity: Oxidation-reduction reactions, Nucleophilic substitution, Internal rearrangements, Group transfer reactions, Condensation; Ionization of water, Weak Interactions in aqueous solution (Dipole movement, van der Waal's, ionic and hydrophobic interactions, Hydrogen bonding and ion bridge); Weak acids and bases, pH and buffer systems; Bioenergetics: Laws of Thermodynamics, entropy, enthalpy and free energy, standard free energy, chemical equilibrium. Phosphoryl group transfer and ATP.

Unit - II: Carbohydrates

Carbohydrates: Structure and classification; Glycoconjugates (Proteoglycans, Glycoproteins and Glycolipids); Metabolism of carbohydrates: Glycolysis, Fermentation; Pentose-phosphate pathway, TCA cycle, Gluconeogenesis, Glycogen metabolism: Oxidative phosphorylation; Electron transport chain and ATP synthesis; Regulation of carbohydrate metabolism.

Unit - III: Proteins

Amino acids: Types of amino acids and their properties; The Peptide bond; Biologically active peptides; Metabolism of amino acids: Transamination and oxidative deamination; Urea cycle. Proteins: Properties of proteins; Sequence of amino acids in proteins and its importance; Threedimensional structure of proteins (Primary, secondary, tertiary and quaternary structure); Ramachandran plot; Denaturation and Renaturation of Proteins, Protein degradation by ubiquitination.

Unit - IV: Lipids and Nucleic Acid

Lipids: Structure and classification; Biosynthesis of fatty acids; Metabolism of lipids: betaoxidation of fatty acids; Storage lipids; Structural lipids in membranes; Lipids as signals, cofactors, pigments, coenzymes and vitamins. Nucleic acids: Structure; Synthesis and degradation of nucleic acids; Importance of free nucleotides; Types of Organelle DNA, RNA World Hypothesis.

Unit - V: Enzymes

Enzymes: Classification and properties; Kinetics and mechanism of action; Enzyme inhibition and Enzyme repression; Coenzymes; Regulation of enzymes (allosteric, phosphorylation and proteolytic cleavage).

Suggested Readings :

- Murray, R. K, Granner, D.K. Maynes, P.A and Rodweli, V.W. Harper's Biochemistry. McGraw Hill, New York.
- Hames, B.D., Hoopa, N.M. and Houghton, J.D. Instant notes in Biochemistry. Viva Books Pvt.Ltd., New Delhi.
- Jain, J. L. Jain, S. And Jain N. Fundamental of Biochemistry, S. Chandra & Co. Ltd. New Delhi.
- Vadudevan, D.M. and Sreekumar. S. Text of Biochemistry for Medical students, Jaypee Brothers, Medical Publishers (P) Ltd., New Delhi.
- Rama Rao, A.V.S.S. Text Book of Biochemistry, L. K. & S Publishers, A.P.
- Lehninger, A.L. Principles of Bioichemistry. CBS Publishers, New Delhi.
- Voet, D and Voet, J.G., Biochemistry, John Wiley and Sons, Inc.

SEMESTER - II

CORE- 203

ANIMAL PHYSIOLOGY

Course Outcomes

After completion of this course, students weill exhibit proficiency in animal physiology especially the functional anatomy and physiology of digestive system, respiratory system, circulatory system, excretory system, neuro-muscular physiology, reproductive system & Endocrine system.

Unit - I: Digestion and Respiration

Functional anatomy of digestive system. Digestion and absorption. Neuroendocrine regulation of gastro - intestinal movements and secretions. Breathing movements and exchange of respiratory gases at the pulmonary surface. Respiratory quotient Respiratory Pigments Transport of respiratory gases. Neural and hormonal control of breathing. Respiratory acidosis and alkalosis and regulation of blood PH.

Unit- II: Circulation and Excretion

Cardiac physiology: physiology of heartbeat, Rhythmicity, and diseases associated with heart. Components of blood and functional significance. Cascade of biochemical reactions (factors) involving in blood coagulation. Functional anatomy of mammalian kidney and its renal units. Physiology of urine formation. The significance of Henley's loop. Role of hormones in renal physiology. Formation of nitrogenous excretory products NH_3, Urea & Uric acid.

Unit - III: Neuro-Muscular Physiology

Structure of neurons, Fundamentals of nerve impulse- resting potential, Action potential, role of ion channels. Types of synapses- electrical and chemical, gap junctions, ligand gated channels and the Mechanism of synaptic transmission, cholinergic and adrenergic, Neuromuscular junction. Types of muscles: striated, non-striated and cardiac muscles. Ultra structure of striated muscle. Muscle contraction – Muscle proteins, sliding filament theory, Energetics of muscle contraction.

Unit-IV: Reproduction

Spermatogenesis and its hormonal regulation. Accessory reproductive organs (glands) and semen composition. Sexual cycles, oogenesis and their hormonal regulation. Fertilization, Implantation, Gastrulation, Parturition, lactation and structure and function of mammary glands.

Unit - V: Endocrine Glands

Endocrine glands, their hormones and classification of hormones. Bio synthesis, storage and mechanism of hormonal action. Hormonal receptors and mechanism of hormonal action. Hormonal regulation of Carbohydrates, Lipids and endocrine disruptors.

Suggested Readings:

- Hoar, W.S. General and Comparative Physiology. Prentice Hall of India, New Delhi.
- Prosser, C.L. Comparative Animal Physiology, WE.B. Saunders & Co., Philadelphia.
- Barrington, E.J.W. An introduction to General and Comparative Endocrinology Clarendon Press, Oxford.
- Bentley, P.J. Endocrine and osmoregulatioin, Springer Verlag, New York.
- Welson, A. Principles of Animal Physiology. McMillan Publishing Co. Inc. New York.
- Schmidt Nelsse, K. 1985. Animal Physiology. Adaptatioin and Envirioinment Club, London.
- Herkat, P.C. and Mathur, P.N. Text Book of Animal Physioilogy,. S. Chand Coi. Pvt. Ltd., New Delhi.
- John E. Hall. Guyton and Hall Textbook of Medical Physiology. Elsevier.
- Tortora GJ and Brian D. Tortora's Principles of Anatomy and Physioilogy. Willey
- Stuart Ira Fox, Fox's Human Physiology.

SEMESTER - II

CORE - 204

ANIMAL BEHAVIOUR AND ECONOMIC ZOOLOGY

Course Outcomes

This course delves deeply into the bahavioral dynamics of animals concerning both intra-species and inter-species interactions. Additionally, students will develop a strong understanding of economic zoology.

Unit - I: Introduction to animal behaviour

Historical outline, patterns of behaviour, objectives of behaviour, mechanism of behaviour; Reflexes- reflex action, types of reflexes, reflex arch, characteristics of reflexes and complex behaviour. Orientation primary and secondary orientation; kinesis – orthokinesis, klinokinesis; taxis – different kinds of taxis; sun-compass orientation, dorsal- light reaction.

Unit - II: Eusociality

Social organization in honeybee(polyphenism and its neural control, flower recognition, displacement and translocation experiment, various type of communications, production of new queen and hive, swarming, honeybee as super organism) and Termites. Fixed action pattern: mechanism, deprivation experiment, controversies. FAP- characteristics and evolutionary features. Learning and instincts: conditioning, habituation, sensitization, reasoning.

Unit - III: Innate releasing mechanisms

key stimuli, stimulus filtering, supernormal stimuli, open and closed IRM, mimetic releaser, code breakers. Homeostasis and behaviour: motivational system, physiological basis of motivation, control of hunger drive in blow fly and thirst drive in goat, role of hormone, motivational conflict and decision making, displacement activity, models of motivation, measuring motivation. Hormones and pheromones influencing behaviour of animals.

Unit-IV: Altruism

Reciprocal altruism, group selection, kin selection and inclusive fitness, cooperation, alarm call. Parental care, parental manipulation, evolutionarily stable strategy, cost benefit analysis of parental care with suitable case studies. Sexual selection: intra sexual selection (male rivalry), inter-sexual selection (female choice), infanticide, sperm competition, mate guarding, sexual selection in human, consequences of mate choice for female fitness, monogamous verses polygamous sexual conflict.

Unit-V: Economic zoology

Earthworm and vermicomposting; Silk moth and sericulture; Honeybee and apiculture; Lac insects and lac culture; Insect vectors of medical and veterinary importance with special reference to mosquitoes and flies; Termites as pests; Economic importance of molluscs. Economic importance of coral reefs; Prawn and shrimp farming; Induced breeding; Composite fish culture; Ornamental fish culture; Diseases of fishes; Bio fouling and predation.

Suggested Readings :

- Palmen, J.D. Brown, I.R and Hastings, J.WE. Biological clocks, Acadmic Press, London.
- Agarwal VK. Animal Behaviour (Ethology), S Chand Publications, New Delhi.
- Krebs & Davis. Behaviour Ecology. Blackwell Publishing.
- Reena mathur. Animal Behaviour. Rastogi Publicatioin.
- Aubery Manning. An Introductiion to animal behaviour. ELBS Publicatioin.
- Niko Tinbergen. Animal Behaviour. Time Life Internatiional, Netherland.
- John Alcock. Animal behaviour : An Evolutioinary Approach Sinauer Associates.

SEMESTER - II

CORE - 205

PRACTICAL

SEMESTER - III

CORE - 301

MOLECULAR BIOLOGY

Course Outcomes

Students will exhibit proficiency in the central dogma of biology, predicting outcomes of the process. They will apply evolutioinalry theory and associated equations to model and forcast population dynamics or stability. Furthermore, they will assess the effects of structural or component modicications on biological systems and interrelationships betwen systems. Additionally, students will demonstrate effective communication skills in conveying knowldge on research topics, encompassing organizatioin, critical analysis, content, presentation and formatting.

Unit-I: Nucleic Acid Structure and DNA Replication and Repair

Physicochemical properties of nucleic acids, DNA double helical structure, types, structural peculiarities, size, sequence, organization in chromatin, supercoiling, sequencing methods of nucleic acids (conventional Sanger dideoxy sequencing and Next Generation Sequencing platforms); Denaturation & renaturation kinetics of DNA, Cot curve, C value paradox, unique and repetitive DNA sequences in telomere and centromere. DNA topology DNA replication: Replication in prokaryotes & eukaryotes, D-loop model of DNA replication, DNA replication in single stranded DNA, rolling circle replication, DNA synthesis by reverse transcription, telomere replication. DNA damage and repair: mismatch repair, base excision, nucleotide excision, direct repair, SOS repair

Unit-II: Transcription and Post Transcriptional Modifications

Prokaryotic transcription: Mechanism of transcription, Processing of tRNA and rRNA; Eukaryotic transcription and regulation: RNA polymerases structure and assembly, Eukaryotic promoters and enhancers, General and specific transcription factors, transcriptional repressors, Transcriptional and post-transcriptional gene silencing. Modifications in RNA: 5'-cap formation, transcription termination, 3'-end processing and polyadenylation, splicing, editing, synthesis and processing of non-coding RNAs.

Unit-III: Translation and Post Translational Modifications

Genetic Code, Prokaryotic and eukaryotic translation: The translation machinery, mechanism of initiation, elongation and termination; Co- and post-translational modifications of proteins. Post translational translocation and co-translational translocation of proteins.

Unit-IV: Transcriptional Regulation and Translational Regulation

Transcription regulation in prokaryotes: Principles of transcriptional regulation with examples from lac operon and trp operon, Positive and negative control (inducible and repressible); Transcription regulation in eukaryotes: Activators, repressors, enhancers, silencer elements; Gene silencing, RNA interference, miRNA, siRNA.

Unit-V: Mapping of Genome

Genetic and physical maps, physical mapping (restriction mapping, fluorescence in situ hybridization, sequence tagged site mapping), map based cloning, choice of mapping population, simple sequence repeat loci, southern and fluorescence in situ hybridization for genome analysis, molecular markers in genome analysis (RFLP, RAPD, AFLP, SSLPs, STRs and SNPs); Methods for measuring transcript levels: nucleic acid hybridization, FRET, nuclear run-off assays, subtractive hybridization; Epigenome and Epigenetics

Suggested Readings :

- Essential Cell Biiology by Alberts et al; Garland (2015).
- Genome by T.A. Brown.
- Cell and Molecular Biiology by DeRobertis & DeRobertis; Lee & Febiger (1987).
- Essential Genetics: A Genomic Perspective by Hartl & Jones: Jones & Bartlet (2002).
- Cell and Molecular Biiology by Karp; John Wiley & Sons (2002).
- Molecular Cell Biology by Lodish et al; Freeman (2016).
- Principles of gene manipulation by Primrose, Twyman and Old.
- Principles of Genetics by Gardner et al: John Wiley (1991).
- Genetics by Russell, Benjamin Cummings.
- Principles of Genetics by Snustad and Simmons; John WEiley (2003).

SEMESTER - III

CORE - 302

DEVELOPMENTAL BIOLOGY

Course Outcomes

This course explores the evolutionary history of complex multicellular life forms, examines environmental influences on the development and homeostasis of animals and teaches students to interpret, analyse, and present erxperimental results and conclusions in a scientific manner.

Unit-I: History

History of developmental biology (Contributions of Spemann, Hilde Mangold, Holtfreter, Needham, Waddington, Spratt, Briggs and King, Patric Steptoe and Robert Edwards); Model organisms in developmental biology (*Caenorhabditis elegans, Drosophila*, Zebra fish, amphibians, chick and mouse).

Unit-II: The molecular basis of fertilization

Molecular aspects of spermatogenesis and oogenesis; Fertilization: morphological aspects and biochemical events; Nucleo-cytoplasmic interactions; Nuclear transplantation in vertebrate embryos; parthenogenesis.

Unit-III: Organogenesis

Organogenesis: Morphogenesis and morphogenetic movement of cells, Nieuwkoop Centre and Primary Organizer; Embryonic induction; Movement of cells over long distance (Neural crest and primordial germ cells); Embryonic adaptations: Placentation and implantation in mammals.

Unit-IV: Growth and regeneration

Growth: Growth at cellular and intracellular level, Growth at organismic level, Growth curves; Regeneration in invertebrates and vertebrates; Biochemical aspects of metamorphosis in insects and amphibians; Homeotic genes and homeotic transformation in anuran tadpoles.

Unit-V: Patterning

Late embryonic development: Vulva formation in Caenorhabditis elegans, Formation of neural tube and patterning in vertebrates; Vertebrate limb development; Biotic, abiotic and symbiotic regulation of development, Any example from *Drosophila* (eye).

Suggested Readings :

- Developmental biology by Scott F. Gilbert, Michael J.F. Barresi.
- Introductioin to embryology by B.I. Balinsky, Cengage Learning India.
- Culture of animal cells by R.I. Freshney.
- Principles of Development, Lewis Wolpert, Cheryll Tickle, Alfonso Martinez Arias, Oxford University press.
- The Cellular Basis of Morphogenesis (Vol-II), Leon W. Broweder, Springer Publicatioin.

SEMESTER - III

CORE - 303

EVOLUTIONARY BIOLOGY ZOO-GEOGRAPHICAL REALMS

Course Outcomes

Upon successfully completing the course, students will have a comprehensive understanding of Evolutionary Biology, ecompassing ecological and evolutionary processes such as genetic variatioin, heredity, natural selection, and their implications for the orgins and evolution of modern humans and biology. Additionally, they will gain knowledge about the global distribution of animals.

Unit-I: Theories, Evidence of Evolution and Extinction

Life's Beginnings: Chemogeny, RNA world, Biogeny, Origin of photosynthesis, Evolution of eukaryotes. Historical review of evolutionary concept: Neo-Darwinism; Geological time scale, Sources of variations: Heritable variations and their role in evolution. Extinctions, Background and mass extinctions (causes and effects), detailed example of K-T extinction.

Unit-II: Process of Evolutionary changes

Population genetics: Hardy-Weinberg Law (statement and derivation of equation, application of law to human Population); Evolutionary forces upsetting H-W equilibrium; Natural selection (concept of fitness, selection coefficient, derivation of one unit of selection for a dominant allele, genetic load, mechanism of working, types of selection, density-dependent selection, heterozygous superiority, kin selection, adaptive resemblances, sexual selection).

Unit-III: Species concept and Speciation

Product of evolution: Micro evolutionary changes (inter-population variations, clines, races, Species concept, Isolating mechanisms, modes of speciation-allopatric, sympatric and Parapatric speciation. Adaptive radiation/ macroevolution (exemplified by Galapagos finches). Genetic Drift (mechanism, founder's effect, bottleneck phenomenon); Role of Migration and Mutation in changing allele frequencies.

Unit-IV: Paleontological evidence of Evolution

Evolution of Horse and elephant; Origin and evolution of man, Unique hominin characteristics Vs. primate characteristics, primate phylogeny, molecular analysis of human origin, Cultural evolution of humans.

Unit-V: Paleontology

Fossils and their significance; modes of fossilization, Study of morphology, range and broad classification of major invertebrate phyla viz. coelenterata, brachiopoda, mollusca, arthropoda (trilobite) and echinodermata (echinoidea), Micro fossils; Evolution of vertebrates, Origin of Jaws (Class Placodermi: Armour-Plated Monsters, Class Chondrichthyes: The First Sharks, Class Acanthodii the Spiny Skins), *Archaeopteryx*, Flightless Birds: Division Palaeognathae, Ice Age Extinction of Large Mammals.

Suggested Readings:

- The Causes of Molecular Evolutioin. New York: Oxford Univ. Press.
- The Evolutioin of Life Histories. New York: Chapman and Hall.
- Molecular Systematics, second edition. Sunderland, MA: Sinauer.
- Evolutioinary Biiology by Douglas JF; Sinauer Associates, USA.
- Evolution by Ridley M; Blackwell Publishing, USA.
- Evolution by Barton NH, Briggs DEG, Eisen JA, Goldstein DB and Patel NH; Cold Spring Harbour Laboratory Press.
- Genetics and the Origin of Species. New York: Columbia Univ. Press.
- Basic Concepts in Population, Quantitative and Evolutioinary Genetics. New York: W H. Freeman.

SEMESTER - III

EC - 304

GENETIC ENGINEERING AND BIOTECHNOLOGY

Course Outcomes

Upon completing the courses, students will possess the ability to articulate the organization of genomes in higher organisms, describe kinetic classes of DNA and gene-families, comprehend the processes involved in recombinant DNA technology, and elucidate the construction of DNA and cDNA libraries along with their practical applicatioins.

Unit I : Molecular tools in Genetic Engineering

Enzymes (Nucleases, Restriction endonucleases, Phosphomonoesterase, Alkaline phosphatase, Polynucleotide kinase, DNA ligase, DNA polymerases, Reverse transcriptase, terminal deoxynucleotidyl transferase, Poly A polymerase), Hosts (E. coli, yeast, animal cells and Plant cells) and Vectors (Plasmids, Bacteriophages, Cosmids, Phagemids and artificial chromosomes). Basics of DNA cloning: Methods of cloning. Cloning of different vectors – plasmids, phages, and phage-derived PACs, BACs and YACs, Selection and screening of clones. Polymerase chain reaction PCR technique, real time-PCR (basic principle and procedure, variation); Genome sequencing (Shortgun and paired end strategies and comparative genome analysis).

Unit II: Molecular Cloning and Expression of Heterologous genes

DNA transfection: Physical methods (microinjection, electroporation, biolistics, somatic cell fusion, Gene transfer by pronuclear microinjection), Chemical method (liposomes), Virus mediated transfection. Molecular Cloning and Expression Strategies for Heterologous genes: Bacterial expression systems, Saccharomyces cerevisiae expression systems (S. cerevisiae vectors, intracellular cellular production of heterologous proteins, secretion of heterologous proteins by S. cerevisiae)

Unit- III: Mapping and quantifying transcripts

Mapping and quantifying transcripts: S1 mapping, RNase protection assay, Primer extension, Run-off Transcription and G-less cassette transcription, Nuclear Run-on transcription and Reporter gene assays (Beta-galactosidase, Luciferase assay, Chloramphenicol acetyl transferase); DNA-protein interactions: EMSA; DNase foot printing, Methyl interference assay; CHIP Protein-protein interaction: Yeast two hybrid system, Phage display

Unit - IV: Animal Cell Culture and Transgenesis

Design and layout of culture room, Basic equipment used in cell culture, Sterilization and aseptic techniques; Culture media: Natural media, Synthetic media, Nutritional compounds of media, Role of serum in cell culture; Primary culture and its maintenance: Various techniques of tissue disaggregation, Monolayer and Suspension cultures, Growth curve, Culture of Cell lines, LSE culture; Scaling up of cultured cells, anchorage dependent cell culture, Suspension culture, maintenance of cell lines. Production of transgenic animals: Retroviral method, DNA microinjection method, embryonic stem cell method, nuclear transplantation; Study of gene expression: Transgenic and Knockout animals, Gene silencing.

UNIT - V: Applications of Biotechnology

Biotechnology in Health: Gene therapy, Production of recombinant hormones & vaccines, diagnosis of diseases (AIDS, tuberculosis, cystic fibrosis, cancer, muscular dystrophy). Forensic science (DNA fingerprinting for criminal identity & paternity testing). Human genome project, Enzyme and whole cell mobilization and its industrial application. Ethical issues concerning: Transgenesis, Biosafety and Intellectual Property rights, Good Laboratory Practices

Suggested Readings:

- Molecular Biotechnology: Principles and applications of recombinant DNA technology by BR Glick, JJ Pasternak & CL Patten, 4th Edition; ASM Press.
- Gene cloning and DNA analysis an introductiion by TA Browen, Blackwell publishers.
- Principles of Gene Manipulation by Old & Primrose, 7th Editioin; Blackwell Publishers.
- Molecular Biotechnology: Principles and aplicatiions of recombinant DNA technology by BR Glick, JJ Pasternak & CL Patten, ASM Press.
- Biotechnology by U Satyanarayana, 3rd Edition; Books and Allied Sciences Publishers.
- Concepts of Biotechnology by Balasubrahmanian et al., Revised edition; University press.
- Biotechnology : Expanding Horizons by Ridley M; Kalyani Publishers (2004).

OR

PARASITOLOGY

Course Outcomes

In this course, students will learn to identify parasites that are significant for human health and can cause diseases. They will distinguish betwen specific and nonspecific parasites affecting humans and gain an understanding of the biological characteristics of human parasites.

Unit-I: Introduction to Parasites

Introduction to parasites of man, scope and definition of parasites/parasitology Animal Association, Types of Parasites and Hosts; Interrelationship between Host and Parasites,

responses of hosts to parasitic infection; Mode of transmission of parasite, Host specificity and parasitic adaptation

Unit-II: Protozoa and Cestoda

Parasitic Protozoans and parasitic cestodes upto orders: Geographical distribution, Morphology, Life-cycle, Transmission, Pathogenecity, Treatment and Prophylaxis of: Protozoan parasites: Entamoeba Sps, Trypanosoma Sps., Leishmania Sps. Intestinal flagellates Giardia Sps, *Trichomonus* Sps; Cestodes: *Taenia* Sps, *Diphilabothrium* Sps. Classification of

Unit-III: Trematoda and Nematoda

Biodiversity & Taxonomic overview of Helminth Parasites,Geographical distribution, Morphology, Life-cycle, Transmission, Pathogenecity, Treatment and Prophylaxis of Trematodes: *Schistosomo* Sps, *Fasciola* Sps, *Echinococcus* Sps. Nematodes: *Wuchereria* Sps, *Ancylostoma* Sps, *Dracunculus* Sps. Plant & Soil nematodes: Cyst nematode, citrus nematode

Unit-IV: Immunology, Genetics & Molecular Biology of Parasites - I

Trypanosoma: Diploid & Sexual stage, Molecular characteristics of surface coat, Variable surface glycoprotein (VSG) and VSG gene expression. *Plasmodium*: Diploid & haploid stages, Chromosome polymorphism, gene encoding Circum sporozoite protein & merozoites S- antigens, surface antigen diversity. Resistance of Malaria to drugs, its mechanism & assessment.

Unit-V: Immunology, Genetics & Molecular Biology of Parasites - II

Platyhelminthes: Inseminative behaviour, parthenogenesis and polyspermy, sex determination, sex linked inheritance in Schistosomes. Nematoda: chromosome germ line limited DNA & chromatin diminution in *Ascaris*.

Suggested Readings:

- A text book of zoology (vol-I & II) by TJ parker & WEA Haswell.
- The invertebrates Vol-I to VI by LH hyman.
- Brusca and Brusca: Invertebrates, Sinaur Publisher.
- Black: Microbioilogy - Principle and exploratiion, John Wiley and SDons.
- Michael Jr: Microbiiology, Tata McGrawe Hill.
- Chatterjee: Parasitology, Chatterjee Medical Publishers.
- Chandler & Read: Introductiion to Parasitology, Wiley.
- Marr et al: Miolecular Medical Parasitology, Elsevier.
- Smiteh: Animal Paraeseeitologyi, CEaembridge University Press.

SEMESTER - III

CORE - 305

PRACTICAL

SEMESTER - IV

CORE - 401

MICROBIOLOGY AND IMMUNOLOGY

Course Outcomes

Upon successful completion of this course, students will be proficient in the folloiwng areas: grasping the fundamentals of fermentation technology, screening techniques, and microbial culture preservation methods; comprehending inoculum development concepts and media sterilization for fermentation processes. Additionally, the course aims to equip students with foundational knowledge about the immune system's operations, inflammation, immune responses to infectious agents and cancer, major alterations in immune responses, vaccines, and immunotherapy.

Unit - I: Basics in microbiology

Classification of microbes, Isolation, culture and maintenance of microorganisms, Microbial growth, continuous culture (chemostat), factors influencing growth of microbes. Bacteria: General features and Structure of Archaea and Eubacteria; General characteristics and classification of viruses, morphology and chemistry of virus. Virion, viroid and Prions.

Unit - II: Microbial genetics

Genetic Recombination in bacteria (Transformation, Conjugation and Transduction), General features and pathogenicity of Mycoplasma, Rickettsia and Spirochaetes. Transmission of virus, virus-vector relationship; Lytic and lysogeny cycle. Structure, transmission, pathogenicity and replication of HIV, SARS.

Unit-III: Microbes in human welfare

Bacterial diseases of man (microbes in air, water and soil) Industrial microbiology: Biomineralization, Microbial leaching. Probiotics and Single Cell protein (SCP). Biofermentation; Microbial toxins: types, mode of actions and pathogenicity, bacterial toxins (endo and exotoxins). Chemotherapeutic agents: Antibiotics and their mode of action (penicillin, fluoroquinolones, tetracycline and aminoglycoside; Role of microbes in industry: Production of antibiotics, beverages, enzymes, milk product, vaccines production, Fermentation.

Unit-IV: Basic immunology

Basic Elements of the Immune System: Exterior defences to infection (Skin & mucosal surface, Physiological Barriers, Phagocytic barriers, Inflammation); Innate and adaptive immune system. Cellular (Lymphocytes, Phagocytes, Auxiliary cells and others) and Humoral components of the immune system Adaptive Immune System: Primary and secondary lymphoid organs; Lymphocyte heterogeneity - concept of T cell and B cell, Natural Killer cells; Antigens - Structure, properites, types, Epitopes, Haptens Antigen Receptor Molecules: Immunoglobulins, Structure, classes and biological activities; Genetic basis of antibody heterogeneity – Isotypic, Allotypic and Idiotypic variations; T-cell antigen receptor (TCR); Major Histocompatibility Complex (MHC) – Class I and Class II molecules; HLA.

Unit-V: Advanced immunology

Immune Effector Mechanisms: Lymphocyte activation, Antigen presentation, Clonal selection,Immunological memory; Antigen Recognition: Antigen-antibody binding, kinetics, specificity- Affinity and Avidity; monoclonal antibody; Cell-mediated immune reactions. Cytokines and Lymphokines: interleukins, interferons, TNF, CSF. Complement system: classical and alternate pathway of activation; 3. Immuno-pathology: Basic ideas about Transplantation and autoimmunity; Immunodeficiency and AIDS; Hypersensitive reactions (Type I, II, III and delayed type (DTH);

Acquired immunity –Vaccines (Development and types).

Suggested Readings:

- Prescott's Microbiology, Christopher J., Wolvertom, Joanne M Wiley, et al, McGrawe Hill Publicatioin.
- Cellular and Molecular Immunology by Abbas KA and Lechtman HA, Saunders Publicatioin, Philadelphia.
- Immunology by David M, Jonathan B, David RB and Ivan R, Elsevier Publicatioin, USA.
- Immunology by Kindt TJ, Goldsby RA, Osborne BA and Kuby J., WE.H. Freeman and Company, New York.
- Roitt: Essential Immunology, Mosby.
- Janeway's Immunobiology, Kenneth Murphy and Casy Weaver, Garland Science, Tailor and Franscis group.

SEMESTER - IV

Core - 402

ENVIRONMENTAL BIOLOGY AND WILDLIFE CONSERVATION

Course Outcomes

Students will gain the ability to apply their knowledge to address issues in wildlife conservation and management. They will also develop a deeper understanding of th economic and environmental implicatioins of wildlife conservation and management, both presently and in the future.

Environmental Biology

Unit-I: Ecology

Ecological niche, Resource partitioning, population growth curves, life history statistics (R & K selection); Metapopulations; Community Ecology: Nature of communities, community structure and attributes; Edges and ecotones; Species interaction: competition (Lotka-Voltera equations), predation, herbivory, disease and parasitism.

Unit-II Global warming and Climate change

Fate of carbon in the atmosphere: carbon emission, carbon footprint, carbon sequestration and carbon trading; Water footprint; Water harvesting and sustainable use; Ozone layer depletion; Acid rains; Greenhouse effect; Wastewater treatment; Solid waste management; Bioremediation; Bioleaching; Biosensors; Global warming and climate change.

Wildlife

Unit-III Zoogeographic realms:

Theory of island biogeography; Biogeographic zones of India; Rare and Endangered species concept; Protected area network; Wildlife of Odisha; Sea turtle conservation; Project crocodile; Project Tiger; Project Elephant; General methods of wildlife census; Human-wildlife conflict.

Unit-IV: Environment legislation

Environment Protection Act (1986); Forest Conservation Act (1980); Wildlife (Protection) Act (1972); Organizations associated with conservation; International conventions and treaties; Conventions on biodiversity.

Unit-V: Assessment and Conservation of Biodiversity

Remote sensing and its application; Biodiversity conservation (*in situ* and *ex situ* methods); Biodiversity hotspots; Keystone species; Cryopreservation (Germplasm conservation, Gene bank, frozen zoo)

Suggested Readings :

- Fundamentals of ecology, M.C. Dash and S. P. Dash, Tata McGraw Hill publicatioin, Delhi.
- Ecology and Environment, P.D. Sharma, Rastogi Publicatiion.
- Ecology and Animal Behaviour, B N Pandey, Tata McGrawe Hill Publicatiion, Delhi.
- Fundamentals of Ecology, E P Odum and H T Odum, W.B. Saunders company, London.
- Fundamentals of Wildlife Management by Gopal Rajesh; Natraj Publishers.
- Wildlife Ecology and Management by Caughley, G., and Sinclair, A.R.E.; Blackwell Science.
- People and WIdlife, Conflict or Co-existence By Woondroffe R., Thirgood, S. And Rabinoweitz, A.: Cambridge University.
- Research and Management Techniques for Wildlife and Habitats by Bookhout, T.A., The Wildlife Society, Allen Press.

EC - 403

AQUACULTURE

Course Outcomes

After completion of this course, students will acquire extensive knowledge in the filed of Fishery Science and Aquaculture, including the skills to conduct thorough analyses, manage hatcheries effectively, conduct experiments and handle marketing aspects.

Unit I: Systematics, Morphology and Physiology of Culturable Fishes

Systematic classification of native/exotic fishes (upto classes), Types of fins and their modifications; Locomotion in fishes; Hydrodynamics; Types of scales, Use of scales in classification and determination of age of fish; Gills and gas exchange; Swim bladder; Reproductive strategies with reference to Indian fishes; Electric organs; Bioluminescence; Mechanoreceptors; Schooling; Migration

Unit II: Basics of Fisheries

Inland fisheries; Marine fisheries; Environmental factors influencing the seasonal variation in fish; Fishing crafts and Gears; Depletion of Fisheries resources; Fisheries laws and regulations.

Unit III: Pisciculture

Sustainable aquaculture; Extensive, semi-intensive and intensive culture of fish; Polyculture; Composite fish culture; brood stock management; Induced breeding of fish; Management of fin fish hatcheries; Preparation and maintenance of fish aquarium. Factors affecting aquaculture.

Unit IV:Fish Pathology and Transgenesis

Fish diseases: viral, bacterial, fungal and parasitic; Preservation, diagnosis and treatment, Processing of harvested fish, Fishery byproducts; Transgenic fish, zebrafish as a model organism in research.

Unit V : Aquacultures of other economically important species

Prawn farming; Culture of crab; Pearl culture and Culture of air breathing fishes.

Suggested Readings:

- Aquaculture, G Burtle, M Newman and J Lee, Pearson education.
- Aquaculture, Principles and Practices, G Gilbert, Syrawood Publishing House.
- Fresh Water Aquaculture. S H Ahemed and A K Singh, Daya Publishing House.
- Fish Pathology, Ronald J, Robertse BVMS, Willey-Blackwell Publishing Ltd.
- Duijin: Diseases of Fishes, London Iliffe Books.
- Evans: The Physioilogy of Fishes, CRC Press.
- Hall: Ponds and Fish Culture, Agro Botanical Publishers.
- Jhingran: Fish and Fisheries of India, Hindustan Publishing Corporation.
- Khanna and Singh: Textbook of Fish Biology and Fisheries, Narendra Publishing Hous.

OR

NEUROBIOLOGY

Course Outcomes

Upon completing this course, studentse will grasp the concept of neurobniology, which delves into the biological mechanisms of neuroal regulation of behaviour. The course predominantly emphasizes neurobiology and the study of molecular basis of nervous system.

Unit - 1 : Neurons and Glia

The Neuron Doctrine, Components of neurons and glial cells Classification of neurons and glial cells. The Nissl and Golgi stains, Cell specific markers for neurons and glial cells. Structure and function of neurons and glial cells. Different types of neurons. Different types of glial cells; Type of astrocytes-type I & II astrocytes, fibrous and protoplasmic astrocytes Function of other glial cells: oligodendrocyte and microglial cells. Glial and neuronal relationship in the CNS Importance of astrocytes in glutamate metabolism and blood brain barrier, Glial - neuronal interplay in the CNS

Unit - 2 : Neuroanatomy

Organization of nervous system -Brain structure, Cerebrospinal fluid, Neural network, Blood brain barrier, Autonomic nervous system and Central Nervous System.

Unit-3 : Synaptic Transmission

Synaptic Transmission: Synaptic vesicles; Principles of synaptic transmission: Electrical and chemical synapses; Calcium hypothesis: Control of transmitter release; Synthesis and trafficking of neuronal proteins, EPSP and IPSP; Temporal and spatial summation; Presynaptic modulation; Voltage dependent calcium channel and their blockers; Neurotransmitters: synthesis, storage, release; Neuropeptides: mode of action, role of neuropeptides and coexistence of neuropeptides with other neurotransmitters; Learning and Memory; Neurodegenerative Disorders : Parkinson's and Alzheimer's diseases, Senile dementia, Myasthenia Gravis.

Unit-4 : Molecular basis of sensory transduction

Somatosensory System , Visual System, Olfactory and Gustatory Systems, Motor System; Plasticity of Nervous System

Unit- 5 : Molecular basis of memory

Overview of learning and memory. Patient HM. Animal model systems to study memory. Commonly studied types of memories Non - associative memory (habituation, sensitization, dishabituation in Aplysia) Associative memory (operant conditioning and classical conditioning-contextual fear conditioning, cued fear conditioning), Spatial memory. Different phases of memory. Massed and spaced training. Consolidation, reconsolidation. Extinction; Long-term potentiation (LTP) and Long-term depression (LTD); Concepts of: Synaptic tagging, synaptic plasticity and Local protein synthesis.

Suggested Readings:

- Endocrinology by Mac E Hadleyd and Jon Levin, Prentice Hall of India Ltd.
- General Endocrinology by C D Turner & J T Bagnara, Affiliated East-west Press Pvt. Ltd., Delhi.
- Comparative vertebrate endocrinology by P J Bentley, Cambridge University Press.
- Human physioilogy by Tortora, Willey Publicatioin.
- William's textbook of Endocrinology by Shlomo M, Richard J A, Allison B G, Ronald J K, Califford J R, Elsevier India.

SEMESTER - IV

CORE - 404

PRACTICAL/SEMINAR

Course Outcomes

Students will be allowed to carry out related practical and will present seminars on respective topics

SEMESTER - IV

CORE - 405

PROJECT WORK

Course Outcomes

Students will be trained and allowed to carry out independent project work and research related to the topics taught