AURCET - 2013 SYLLABUS
COMMON TO ALL SCIENCE SUBJECTS
PAPER – I

General information on Science and its interface with society to test the candidates' awareness of science, aptitude of scientific and quantitative reasoning. Questions would be so designed to judge the creativity, analytical ability and research aptitude of a candidate.

The questions to test the knowledge at the basic level would be setup in each of the subject areas of NET, viz.,

1. Chemical Sciences. (8 multiple questions)
2. Earth, Atmospheric, Ocean & Planetary Sciences. (8 multiple questions)
3. Life Sciences. (8 multiple questions)
4. Mathematical Sciences. (8 multiple questions)
5. Physical Sciences. (8 multiple questions)

8 X 5 = 40 Marks.

COMMON ELEMENTARY COMPUTER SCIENCE

(Applicable to all candidates offering any subject area; A few questions dealing with basic computer awareness and uses). 10 Marks

(i) Programming Instructions

(ii) Simple algorithms and Computational methods.

AURCET - 2013 SYLLABUS

TEST NO. 01 & 86: APPLIED MATHEMATICS AND ENGINEERING MATHEMATICS

PAPER – II

(I) REAL AND COMPLEX ANALYSIS

a) **REAL ANALYSIS**: Basic Topology, Limit and Continuity, The Riemann-Stieltjes integral, Multivariable Differential Calculus, Sequences and series of functions

b) **COMPLEX ANALYSIS:** Functions of a complex variable, Analytic functions, Cauchy-Riemann equations, Contour integration, Taylor and Laurent series, Singularities, Calculus of Residues , Conformal mapping.

(II) DIFFERENTIAL EQUATIONS

a) ORDINARY DIFFERENTIAL EQUATIONS: Linear equations with variable coefficients, the wronskian and linear independence, reduction of the order of a homogeneous equations, the non-homogeneous equations. Homogeneous equations with analytic coefficients. Linear equations with regular singular points, Euler's equations and series solutions. Existence and uniqueness of solutions of 1st order equations, exact equations, Picard's method of successive approximations, existence & uniqueness of solution to systems.

b) PARTIAL DIFFERENTIAL EQUATIONS: Equations of the form $\frac{dx}{P}=\frac{dy}{Q}=\frac{dz}{R}$, Orthogonal trajectories, Pfaffian differential equations, 1st order partial differential equations; Charpit's method and some special methods. Jacobi's method. Second order Partial differential equations with constant & Variable coefficients, canonical forms, separation of variables method.

(III) DISCRETE MATHEMATICAL STRUCTURES AND THEORY OF COMPUTER SCIENCE

a) **DISCRETE MATHEMATICAL STRUCTURES :** Mathematical logic, Theory of Inference, Relations and ordering , Lattices- Lattices as partially ordered sets, properties of Lattices, Lattices as algebraic systems, sub-Lattices, direct product and homomorphism, some special Lattices, Boolean Algebra - subalgebra, direct product and Homomorphism, Boolean forms and free Boolean Algebras, values of Boolean expressions and Boolean functions.

b) **THEORY OF COMPUTER SCIENCE** : The Theory of finite Automata, Formal Languages-Chomsky classification of Languages, Languages and their relation, Recursive and recursively enumerable sets, operations of languages, Languages and Automaton, Regular sets and Regular Grammars, Context-free Languages, Turing Machines

(IV) NUMERICAL METHODS AND C- LANGUAGE

a) Numerical techniques of solving transcendental and polynomial equations: Bisection methods, secant method, Newton-Raphson method, Chebyshev method, Rate of convergence, Iteration methods of first and second orders. Methods for multiple roots. Numerical techniques of solving system of lineal Algebraic equations: Triangularization method, Gauss elimination method, Gauss-Jordan method, Iterative methods: Jacobi method, Gauss-Seidel method. Numerical techniques of determining the eigen values and eigen vectors of a matrix: Jacobi method, power method and Rutishausher method Interpolation and Approximation, Numerical techniques for evaluating derivatives and integrals, Numerical techniques for solving ordinary differential equations, Numerical methods for solving elliptic partial differential equations.

b) PROGRAMMING LANGUAGE-C: Data types, Operators and Some statements, Writing a Program in C, Control statements, Functions and Program Structures, Arrays, Pointers.

(V) METHODS OF APPLIED MATHEMATICS

a) **CALCULUS OF VARIATIONS**: Euler's equations, Functional dependence on higher order derivatives, variational problems in parametric form and applications

b) **TENSOR ANALYSIS** : Covariant and Contravariant vectors, contraction, second & higher order tensors, quotient law, fundamental tensor, associate tensor, angle between the vectors, principal directions, Christoffel symbols, covariant and intrinsic derivatives.

c) **INTEGRAL EQUATIONS:** Solutions of integral equations, Volterre and Fredholm integral equations.

d) **INTEGRAL TRANSFORMS:** Fourier and Laplace Transforms, its applications to ordinary and partial differential equations.

(VI) MECHANICS

a) **CLASSICAL MECHANICS**: Lagrangian Formulation- D'Alembert's principle , Hamilton's principle, conservation theorems and symmetry properties, , Hamiltonian formulation- Legendre transformations and the Hamilton equations of motion, the principle of least action, Poisson and Lagrange brackets, Jacobi's identity; Poisson's Theorem., Hamilton Jacobi Equations for Hamilton's principal function, New concept of space and time, Lorentz transformation equations

b) **CONTINUUM MECHANICS:** Analysis of strain, deformation, geometrical interpretation of the components of strain, compatibility, Analysis of stress, equations of equilibrium, Mohr's diagram, Kinematics of fluids, real and ideal fluids, velocity of fluid at a point, streamlines and path lines, velocity potential, velocity vector, local and particle rates of change, equation of continuity, Acceleration of fluid conditions at a rigid boundary. General analysis of fluid motion. Euler's equation of motion and Bernoulli's equation, Kelvin's circulation theorem, Vortex motion.

(VII) STATISTICAL METHODS

Random variables, distribution functions, Mathematical expectation and Generating functions, Probability Distributions (Binomial, Poisson and Normal distributions), Correlation and Regression.

AURCET - 2013 SYLLABUS
TEST NO. 02: BIOCHEMISTRY
PAPER – II

1. MOLECULES AND THEIR INTERACTION RELAVENT TO BIOLOGY

A. Composition, structure and function of biomolecules (carbohydrates, lipids, proteins, nucleic acids and vitamins).

B. Principles of biophysical chemistry (pH, buffer, reaction kinetics, thermodynamics, colligative properties).
Bioenergetics, glycolysis, oxidative phosphorylation, coupled reaction, group transfer, biological energy transducers.

C. Principles of catalysis, enzymes and enzyme kinetics, enzyme regulation, mechanism of enzyme catalysis, isozymes.

D. Conformation of proteins (Ramachandran plot, secondary, tertiary and quaternary structure; domains; motif and folds).

E. Conformation of nucleic acids (A-, B-, Z-, DNA), t-RNA, micro-RNA).

2. CELLULAR ORGANIZATION

A. Membrane structure and function: Structure of model membrane, lipid bilayer and membrane protein diffusion, osmosis, ion channels, active transport, ion pumps, mechanism of sorting and regulation of intracellular transport, electrical properties of membranes.

B. *Structural organization and function of intracellular organelles*: Cell wall, nucleus, mitochondria, Golgi bodies, lysosomes, endoplasmic reticulum, peroxisomes, plastids, vacuoles, chloroplast, structure & function of cytoskeleton and its role in motility.

C. Organization of genes and chromosomes: interrupted genes, gene families, structure of chromatin and chromosomes, unique and repetitive DNA, heterochromatin, euchromatin, transposons.

3. FUNDAMENTAL PROCESSES

A. DNA replication, repair and recombination: Unit of replication, enzymes involved, replication origin and replication fork, fidelity of replication, extra-chromosomal replicons, DNA damage and repair mechanisms.

B. RNA synthesis and processing: Transcription factors and machinery, formation of initiation complex, transcription activators and repressors, RNA polymerases, capping, elongation and termination, RNA processing, RNA editing, splicing, polyadenylation, structure and function of different types of RNA, RNA transport.

C. Protein synthesis and processing: Ribosome, formation of initiation complex, initiation factors and their regulation, elongation and elongation factors, termination, genetic code, aminoacylation of tRNA, tRNA-identity, aminoacyl tRNA synthetase, translational proof-reading, translational inhibitors, post- translational modification of proteins.

D. Control of gene expression at transcription and translation level: Regulation of phages, viruses, prokaryotic and eukaryotic gene expression, role of chromatin in regulating gene expression and gene silencing.

4. CELL COMMUNICATION AND CELL SIGNALING

A. Cell signaling: Hormones and their receptors, cell surface receptor, signaling through G-protein coupled receptors, signal transduction pathways, second messengers, regulation of signaling pathways, bacterial and plant two-component signaling systems, bacterial chemotaxis and quorum sensing.

B. Cellular communication: Regulation of hematopoiesis, general principles of cell communication, cell adhesion and roles of different adhesion molecules, gap junctions, extracellular matrix, integrins, neurotransmission and its regulation.

C. Cancer: Genetic rearrangements in progenitor cells, oncogenes, tumor suppressor genes, cancer and the cell cycle, virus-induced cancer, metastasis, interaction of cancer cells with normal cells, apoptosis, therapeutic interventions of uncontrolled cell growth.

D. Innate and adaptive immune system: Cells and molecules involved in innate and adaptive immunity, antigens, antigenicity and immunogenicity. B and T cell epitopes,

structure and function of antibody molecules, generation of antibody diversity, monoclonal antibodies, antibody engineering, antigen-antibody interactions, MHC molecules, antigen processing and presentation, activation and differentiation of B and T cells, B and T cell receptors, humoral and cell-mediated immune responses, primary and secondary immune modulation, the complement system, Toll-like receptors, cell-mediated effector functions, inflammation, hypersensitivity and autoimmunity, immune response during bacterial (tuberculosis), parasitic (malaria) and viral (HIV) infections, congenital and acquired immunodeficiencies, vaccines.

5. APPLIED BIOLOGY:

A. Microbial fermentation and production of small and macro molecules.
B. Application of immunological principles (vaccines, diagnostics). tissue and cell culture methods for plants and animals.
C. Transgenic animals and plants, molecular approaches to diagnosis and strain identification.
D. Genomics and its application to health and agriculture, including gene therapy.
E. Bioremediation
F. Biosensors.
G. Clinical Enzymology, Liver and Kidney Function tests, Plasma proteins and their variations in diseases, Anemia, Endocrine disorders of Pancreas,

6. METHODS IN BIOLOGY

A. **Molecular biology and recombinant DNA methods:** Isolation and purification of RNA , DNA (genomic and plasmid) and proteins, different separation methods; analysis of RNA, DNA and proteins by one and two dimensional gel electrophoresis, isoelectric focusing gels; molecular cloning of DNA or RNA fragments in bacterial and eukaryotic systems; expression of recombinant proteins using bacterial, animal and plant vectors; isolation of specific nucleic acid sequences; generation of genomic and cDNA libraries in plasmid, phage, cosmid, BAC and YAC vectors; in vitro mutagenesis and deletion techniques, gene knock out in bacterial and eukaryotic organisms; protein sequencing methods, detection of post-translation modification of proteins; DNA sequencing methods, strategies for genome sequencing; methods for analysis of gene expression at RNA and protein level, large scale expression analysis, such as micro array based techniques; isolation, separation and analysis of carbohydrate and lipid molecules; RFLP, RAPD and AFLP techniques.
B. **Histochemical and immunotechniques:** Antibody generation, detection of molecules using ELISA, RIA, western blot, immunoprecipitation, flowcytometry and immunofluorescence microscopy, detection of molecules in living cells, *in situ* localization by techniques such as FISH and GISH.
C. **Biophysical methods:** Analysis of biomolecules using UV/visible, fluorescence, circular dichroism, NMR and ESR spectroscopy, structure determination using X-ray diffraction and NMR; analysis using light scattering, different types of mass spectrometry and surface plasma resonance methods.
D. **Statistical Methods:** Measures of central tendency and dispersal; probability distributions (Binomial, Poisson and normal); sampling distribution; difference between parametric and non-parametric statistics; confidence interval; errors; levels of significance; regression and correlation; t-test; analysis of variance; X^2 test.
E. **Radiolabeling techniques:** Properties of different types of radioisotopes normally used in biology, their detection and measurement; incorporation of radioisotopes in biological tissues and cells, molecular imaging of radioactive material, safety guidelines.
F. **Microscopic techniques:** Visualization of cells and sub-cellular components by light microscopy, resolving powers of different microscopes, microscopy of living cells, scanning and transmission microscopes, different fixation and staining techniques for EM, freeze-etch and freeze-fracture methods for EM, image processing methods in microscopy.
G. **Computational methods:** Nucleic acid and protein sequence databases; data mining methods for sequence analysis, web-based tools for sequence searches, motif analysis and presentation.

AURCET - 2013 SYLLABUS
TEST NO. – 03: BIOTECHNOLOGY
PAPER - II

1: CELL BIOLOGY

Structure of typical bacterial, plant and animal cells and functions of cell organelles. Mechanism of cell division. Cell cycle – Molecular events including cell cycle check points and Cdk – cyclin complexes and their role in cell cycle regulation. Ultra structure of plasmamembrane - Components and membrane asymmetry. Transport processes - active transport, ionophores and ion channels. Exo and endocytosis. Phago and pinocytosis.

General morphology and functions of endoplasmic reticulum. Signal hypothesis. Ribosomes - eukaryotic and prokaryotic. Ribosomal proteins. Role of Golgi in protein secretion. Lysosomes and peroxisomes. Cytoskelatal elements. Cell – cell interaction.

Mitochondria - structure, biogenesis and enzymatic compartmentation. Organization of mitochondrial respiratory chain, mechanism of oxidative of phosphorylation. Ultra structure of the chloroplast. Photosynthesis - photophosphorylation. Carbon dioxide fixation in C-3, C-4 and CAM plants. Photorespiration.

Organic evolution: Origin of life. Species concept, population, dones, races, and subspecies. Mechanisms of speciation. Role of isolating mechanisms. Lamarckism, Darwinism, Neo-Darwinism, synthetic theory of evolution. Micro, macro and mega evolution, sequential and divergent evolution. Natural selection.

2: BIOMOLECULES

Chemical foundations of Biology – pH, pK, acids, bases, buffers, weak bonds and covalent bonds. Classification, structure, properties and biological significance of carbohydrates. Monosaccharides, Disaccharides, and Polysaccharides. Biological role of peptidoglycans, glycosamino glycans and Lectins. Lipids - classification, structure and properties of fatty acids, triglycerides, phospholipids, sphingolipids and cholesterol.

Amino acids - Classification, structure and physico-chemical properties. Chemical synthesis of peptides – solid phase peptide synthesis. Proteins - classification, purification and criteria of homogeneity. Structural organization, sequence determination and characterization of proteins. Confirmation of proteins – Ramachandran plots. Denaturation of proteins. Hetero cyclic compounds – Heme and Chlorophylls.

Structure and properties of purines, pyrimidines, nucleosides, and nucleotides. Covalent structure of DNA and different forms of DNA - A,B and Z. DNA super coiling. Types of RNA and covalent structure of t-RNA. Classification, structure and physiological roles of Vitamins.

Hormones- classification and mechanism of action of steroid and protein hormones. Signal transduction Cascade by cyclic AMP, Phosphoinositate and calcium (Ca^{+}), G-proteins, growth factors and membrane receptor tyrosine kinases. Phytohormones and their physiological roles.

3: MICROBIAL PHYSIOLOGY & GENETICS

Classification and cultivation of bacteria. Bacterial reproduction and growth curve. Preparation of bacteriological media. Staining techniques. Differences between gram positive and gram negative bacteria. Methods of sterilization, pasteurization and disinfection. Microbiology of water, milk, air, soil and sewage. Microbes as pathological agents in plant and animals. Clinically important bacteria. Biohazards - safety precautions.

Chemical nature and classification of bacteriophages. Parasitic and temperate phages. Plant and animal viruses – multiplication of viruses. General characteristics of T Phase, ϕx174, SV40, TMV. Clinically important viruses, retroviruses, HIV, Hepatitis B Virus and viral infections. General account of algae, molds and yeasts. Economic importance of algae and fungi. Clinically significant protozoans.

Microbial genetics: Recombination in prokaryotes, Transformation, conjugation, transduction and sexduction. Mapping of prokaryotic gene. Transposons, retrotransposons and

mechanism of transposition. Viral genetics. Biology of plasmids. Extra chromosomal inheritance.

Genetics of Eukaryotes: Gene & Environment, Genotype and phenotype, Mendel's experiments, Dominance relationships. Multiple alleles, Gene Interaction, Gene mutations, Sex determination, Sex linkage, Linkage and recombination in diploids. Tetrad analysis. Elements of gene mapping, Pedigree analysis

4: ANALYTICAL TOOLS AND TECHNIQUES IN BIOTECHNOLOGY

Principles and applications of light, phase contrast, fluorescence, scanning and transmission electron microscopy. Properties of electromagnetic radiations. Principles, instrumentation and applications of UV, visible, infrared, ORD, CD, NMR spectroscopy. Spectrofluorimetry and mass spectrometry, X-ray diffraction. Flow cytometry.

Principles and applications of gel-filtration, ion-exchange and affinity chromatography. TLC, GLC and HPLC. Basic principles of sedimentation. Applications of preparative and analytical ultra centrifuges. Principles and applications of lyophilization.
General principles of electrophoretic techniques. Poly Acrylamide Gel Electrophoresis. Iso-electric focusing. Isotachophoresis. 2-D Electrophoresis. Capillary electrophoresis. Agarose gel electrophoresis of DNA and RNA. Blotting techniques. DNA fingerprinting.
Stable and radioactive isotopes. Detection and measurement of radioactivity. Applications of radioisotopes in biological sciences. Autoradiography. Non-isotopic tracer techniques. Principles and range of electrochemical techniques. Operation of pH electrodes. Principles and applications of Ion-selective and gas sensing electrodes. Oxygen electrodes.

1: ENZYMOLOGY & METABOLISM

Classification and Nomenclature of Enzymes. Enzyme kinetics. Factors affecting the rates of enzyme catalysed reactions. Assay of enzyme activity – units of enzyme activity. Multisubstrate reactions. Enzyme – substrate (protein ligand) binding. Methods for measurement of km. Coenzymes, metalloenzymes, and isoenzymes with examples.

Active site determination. Mechanism of enzyme action of Chymotrypsin & Trypsin, carboxy peptidase-A and ribonuclease A. Multienzyme systems. Covalent modification. Zymogen activation. Enzyme inhibition – Competitive, non-competitive and uncompetitive. Allosteric enzymes, Ribozymes and catalytic antibodies.

Glycolysis, Glycogenolysis, glycogenesis, gluconeogenesis, HMP shunt path way and their regulation. Tricarboxylic acid (TCA) cycle, Glyoxylate cycle and its significance. Biosynthesis and oxidation of fatty acids. Metabolism of cholesterol. Ketone bodies. Biosynthesis of Heme and chlorophylls.

Protein turnover. General metabolic reactions of amino acids. Urea cycle. Nitrogen fixation. Essential and non-essential amino acids. Biosynthesis and degradation of aromatic and branched chain aminoacids. Inborn errors of amino acid metabolism. Biosynthesis of purine and pyrimidine nucleotides and their regulation. Catabolism of purines and pyrimidines.

2: MOLECULAR BIOLOGY

Organization of genetic material - Packing of DNA in to chromatin - protein components of chromatin, histones, nucleosome organization. Solenoids loops, domains & scaffolds. Gene amplification, polytene chromosomes. DNA replication – apparatus, enzymes involved and mechanism. Replication at telomeres. DNA damage and repair mechanism. Nuclear genome.C - value paradox. Mitochondrial & plastid genomes and genes. Fine structure of the eukaryotic gene. Split genes. Different kinds of genes: overlapping, assembled, polyprotein & nested genes.

Transcription in prokaryotes and eukaryotes. Mechanism of transcription, enzymes and transcription factors, zinc finger, leucine zipper mechanism. Maturation and processing of m-RNA, splicing, 5' end capping & 3' end tailing. RNA editing and transport. RNAi and small RNAs.

Translation in prokaryotes and eukaryotes: Genetic code - properties of the genetic code, deciphering of the genetic code. Ribosome as a translation factory. t - RNA as an adaptor, its mode of function. Post translational modifications. Leader sequences & protein targeting.

Regulation of gene expression in prokaryotes - The operon concept, lac & tryp operons. Transcriptional control. Post translational control. Regulation in eukaryotes - Control by promoter, enhancer and silencers. Cis-trans elements. Environmental & developmental regulation. DNA methylation & gene expression. Chromatin structure & gene expression.

3: GENETIC ENGINEERING

Isolation of DNA and RNA. Restriction mapping, DNA sequencing by chemical and enzymatic methods. Nucleic acid blotting – southern and northern blotting. DNA cloning. Enzymes used in genetic engineering : Restriction endonucleases - types, nomenclature and properties. DNA polymerase-I, polynucleotide kinase, DNA ligase, terminal nucleotide transferase, Reverse transcriptase, alkaline phosphatase, S_1 nuclease.

Salient features of cloning vectors, types of cloning vectors - plasmids, cosmids, phages (lamda and M13 phages), animal (SV40, Baculo) and plant (CMV) viruses, Artificial chromosomes - YACs and MACs. Ligation of foreign DNA to vectors - cohesive and blunt end methods - homopolymer tailing and adaptors. Preparation of gene libraries and c-DNA libraries .

Techniques of gene transfer - transformation , transfection, micro injection, electroporation, lipofection and biolistics. Selection of r-DNA clones and their expression. Nucleic acid probes, colony and fluorescent in-situ hybridization.

Polymerase Chain Reaction and its applications. DNA micro array technology. Applications of genetic engineering in agriculture, animal husbandry, medicine and in industry. Genomics – genome sequencing by shot gun and hierarchical method. Genome annotation – identification of genes, promoters and exon – intron boundries

4: BIOLOGY OF IMMUNE SYSTEM

Types of immunity – innate, acquired, passive and active. Organisation and structure of lymphoid organs – bone marrow, thymus, spleen and lymphnodes. Cells of the immune system – B-Lymphocytes, T-Lymphocytes. T-cell receptor – structure and function. Macrophages. Types of cell mediated immunity and lymphokine activatd killer cells. Clonal nature of immune response, Immunological memory. Immuno regulation. Adjuvants and immunological tolerance.

Nature of antigens and antibodies. Structure and function of antibodies. Isotypes, Allotypes and Idiotypes. Antigen – antibody interactions. The generation of antibody diversity, antigen receptors on B & T lymphocytes. Major Histocompatibility Complex (MHC). Human leukocyte antigens (HLA), MHC restriction and typing. Lymphokines, effector cell mechanisms, genetic control of immune response. Complement system.

Immunological techniques - ELISA, RIA, Western Blot, Immunoblot and Immuno fluorescent techniques. FACS. Hybridoma technology - production and applications of monoclonal antibodies. Antibody engineering, chimeric antibodies.

Hypersensitivity - types of hypersensitivity - immediate and delayed hypersensitivity, autoimmune diseases, transplantation and immunity, immunity to infectious agents. Vaccines and Vaccination, types of vaccines including new generation vaccines. Tumor immunology.

1: CELL CULTURE TECHNOLOGY AND TISSUE ENGINEERING

Plant tissue culture technology: culture media – composition and preparation. Factors governing in vitro behaviour, Somatic embryogenesis, organogenesis and plant regeneration. Culture types. Micro propagation, Haploids, somaclonal variations, , metabolite production in cultures. Isolation of protoplasts, protoplast fusion and culture. Somatic hybridization.

Animal cell and tissue culture. Primary culture, balanced salt solutions and simple growth medium. Serum and protein free defined media. Cell lines, primary and established cell line cultures. Basic techniques of mammalian cell culture in vitro. Tissue and organ culture. Production and use of artificial tissues and organs – Skin, liver and pancreas. Apoptosis - mechanism and significance.

The biology of stem cells – Different types of stem cells – embryonic stem cells, fetal tissue stem cells, adult stem cells; stem cell differentiation, stem cell plasticity – Differentiation versus stem cell renewal. Isolation and propagation of embryonic stem cells; chimeras; generation of knockout mice and knock-in technology.

Hematopoietic stem cells and bone marrow transplantation: Cells for hematopoietic reconstitution – Cord blood stem cells; cells for adoptive cellular immunotherapy; bone marrow transplantation - advantages and disadvantages. Allogenic, autologous, syngenic

and congenic transplantation. Clinical applications of stem cell therapy; neurodegenerative diseases – Parkinson's disease, Alzheimers, spinal cord injury and other brain syndromes.

2: PLANT BIOTECHNOLOGY

Plant Genetic engineering: Gene cloning techniques, Techniques for gene transfer into plants. Mechanism of gene transfer by T_I and R_I plasmids as vectors. Reporter genes, transient gene assays and identification of transgenic plants. Molecular markers and their significance. RFLP, , AFLP and QTL in plants. RAPD for molecular mapping and crop improvement.

Agricultural Biotechnology: Engineering of herbicide tolerance in plants, production of disease resistant plants by gene transfer; Development of insect resistant plants. Biotechnological strategies for engineering stress tolerance.

Altering protein and oil quality traits in seeds. Chloroplast transformation – advantages in tobacco and potato, plants for expression of bacterial, viral and eukaryotic genes. Edible vaccines and plantibodies. The genetic manipulation of crop yield by enhancement of photosynthesis.

Algal Biotechnology: Laboratory culture of micro algae. Large scale biomass production. Marine micro algae/sea weeds and their products. Edible sea weeds and their cultivation. Biofertilizers – Blue green algal fertilizers – Azolla, Anabaena, symbiotic association. Sea weed fertilizers. Mycorrhizal biofertilizers, bacterial fertilizers. Biopesticides in agricultural production.

3: ANIMAL BIOTECHNOLOGY

Types and causes of male and female infertility, sperm collection, Cryopreservation, artificial insemination, Oocyte recovery, superovulation, oocyte maturation in vitro, In vitro fertilization in humans and cattle. Embryo culture, embryo transfer in farm animals. Immunocontraception - hormonal methods. Biotechnological approaches for the management of pests, mosquitoes and nematodes. Live stock improvement

Production of transgenic animals - mice, sheep and fish. Molecular pharming and animal cloning. Somatic cell nuclear transfer in humans – Legal and ethical aspects. Potential applications of transgenic animals – Animal models for diseases and disorders. Transgenic poultry and transgenic insects as bioreactor.

The concept of aquatic biotechnology and blue revolution. Economically important aquatic resources from fresh water, brackish water and marine habitats – the finfish, shellfish, lime fish, algae, corals, and holothurians. Bioactive compounds from corals. Fish bioproducts. Pearl culture technology – principles and applications.

Aquaculture - Fresh water fish culture practices and types. Freshwater prawn culture. Brackish water fish, shrimp and crab culture practices. Fresh water fish hatchery and seed production. Hypophysation and induced breeding techniques. Eyestalk oblation. Techniques involved in transgenic fish production. Post harvest technology. Diagnosis of shrimp & fish diseases caused by bacterial, fungal and viral pathogens using molecular methods.

4: MEDICAL AND ENVIRONMENTAL BIOTECHNOLOGY

Health care products. Products from recombinant DNA Technology - insulin, growth hormone, factor VIII, tissue plasminogen activator, interferons, lymphokines and Hepatitis-B vaccines.

Disease diagnosis: DNA probes, Enzyme probes - glucose oxidase, lactate oxidase, monoamine oxidase. PCR amplification and diagnosis - Applications in forensic medicine. Genetic diseases and gene therapy. Current strategies for development of vaccines against HIV, Malaria, Tuberculosis.

Environmental pollution – types, sources and control. Reduction of environmental impact of industrial effluents, chemical herbicides and fertilizers. Removal of oil spills. Environmental monitoring and biomonitoring. Bioremediation - solid and liquid waste treatment. Biomass and energy production from waste. Bioleaching – Microbial recovery of metals and acid mine drainage. Water pollution and its control. Microbiology of waste water treatment.

Environment and energy: Renewable sources of energy – Biogas, waste materials, energy crops, cellulose. Production of energy and fuel using microorganism – Biofuels and Biodiesal.

Global environmental problems: Ozone depletion, UV-B, Green house effect. Biodiversity - benefits to mankind - Conservation; Ecology and sustainable development.

1: HETEROLOGOUS EXPRESSION AND DOWN STREAM PROCESSING

Heterologous Expression: Expression vectors and hosts Generally Regarded As Safe (GRAS) organisms. Production of active recombinant proteins of mammalian/Eukaryotic origin in prokaryotes. Large scale production of proteins from recombinant microorganisms. Principles of microbial growth – Batch fermentation, feed-batch fermentation – continuous fermentation, high density cell cultures – Bioreactors – Large scale fermentation system – tandem Airlift reactors – Single stirred tank reactors.

Down stream processing: Harvesting microbial cells – Membrane filtration system, high speed semi continuous centrifugation – disrupting microbial cells. Gram scale purification of recombinant proteins – Chromatography systems and analytical methods for large scale purification. Stabilization of the proteins.

PROCESSING TECHNOLOGY: Microbial metabolites - Organic solvents (Alcohol, Acetone, Butanol), Organic acids (Citric acid, lactic acid), Wines and beers, Antibiotics (penicillin, streptomycin, tetracycline, semi synthetic penicillins), Vitamins (Vitamin B_{12} and Riboflavin), Amino acids (lysine, glutamic acid). Production of single cell proteins.

ENZYME TECHNOLOGY: Sources production, isolation and purification of enzymes for the industrial use. Application of enzymes in pharmaceutical, food processing and other industries. Different techniques of immobilization of enzymes, applications and kinetics of immobilized enzymes. Design and operation of immobilized enzyme systems and bioreactors. Whole cell immobilization. Biosensors - principle and types.

2: BIOINFORMATICS AND BIOSTATISTICS

Scope of computers in current biological research. Basic operations, architecture of computer. Introduction of digital computers. Organization, low level and high level languages, binary number system. The soft side of the computer – Different operating systems – Windows, Linux. Introduction of programming in C. Introduction to Internet and its applications.

Introduction to Bioinformatics – Genomics and Proteomics. Bioinformatics – Online tools and offline tools. Biological databases. Types of data bases – Gen bank, Swiss port, EMBL, NCBL, and PDB. Database searching using BLAST and FASTA.

Multiple sequence alignment and Dynamic programming. Gene and Genome annotation – Tools used. Physical map of genomes. Molecular phylogeny - Concept methods of tree construction. Protein secondary structure prediction. Protein 3D structure prediction. Protein docking. Introduction to homology modeling, Computer Aided Drug Design (CADD) in Drug discovery.

Brief description and tabulation of data and its graphical representation. Measures of central tendency and dispersion - mean, median, mode, range, standard deviation, variance. Simple linear regression and correlation. Types of errors and level of significance. Tests of significance – F & t tests, chi-square tests, ANOVA.

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AURCET - 2013 SYLLABUS
TEST NO. – 04: BOTONY
PAPER - II

UNIT – I

Recent trends in the classification of Algae.

Thallus organization and life history in Algae.

Economic importance of Algae.

Fungi as partners of Plants.

Microbes – Nitrogen fixation and cycle.

Transmission of plant viruses

UNIT – II

Advancements in Plant Embryological research with the application of modern techniques.

Ultra structure and biochemical aspects of pollen and embryo sac.

Significance of anatomical characters in phylogeny

Modern concepts on fertilization in angiosperms.

Comparative morphology and taxonomy: role of anatomy, Embryology, Palynology and Phytochemistry.

Recent achievements in Tissue Culture in Agriculture and Forestry.

UNIT – III

Vegetational types of India.

Ecology and human welfare; Conservation and management of Natural resources; Water and Air Pollution.

Growth hormones and their role in Plant systems.

Minerals and their role in growth and development.

Photosynthetic productivity in field Crops in relation to carbon dioxide fixation mechanisms.

UNIT – IV

PLANT GENOME: nuclear genome – concept of nucleotype; extent and organization of repeated DNA sequences. Structure, Organization and expression of Chloroplast and Mitochondrial genomes.

MODERN CONCEPT OF GENE: Historical account; Complementation and genetic resolution; fine structure analysis in Plants.

BIOLOGY OF CELL CYCLE: Determination of mitotic and meiotic cycle duration; metabolic aspects of mitotic and meiotic cycles; experimental control.

SOMATIC CELL HYBRIDIZATION: Protoplast culture, Transformation, fusion, somatic hybrids and transgenic Plants.

GENETIC ENGINEERING: General principles of recombinant DNA technology and applications.

CONSERVATION OF CROP GENETIC RESOURCES: Necessity; Cryopreservation; Gene Banks – significance.

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AURCET - 2013 SYLLABUS
TEST NO. – 05: ENVIRONMENTAL SCIENCES
PAPER - II

Definition of Ecology – Energy Flows, Ecological Pyramids, Food Chains and Food Webs- Ecological Succession – Population and Communities - Ecosystem- Structure- Components (Abiotic and Biotic factors) and Functions. - Terrestrial and Aquatic (Fresh Water and Marine) Ecosystems. Ecotones - Ecological Niches- Classification of Biomes and Bio-geographical Regions of the World.

Bio diversity- Definition & Significance of Biodiversity - Ecological, Economical and Aesthetic importance. Distribution of climatic regions of India and Vegetation types- Biodiversities of Tropical and Temperate regions of the World-Measures of Bio Diversity- Alfa, Beta and Gamma diversities. Conventions on Biological Diversity - Forest and Environmental Protection Acts, Wildlife (Protection) Act 1972, Biosphere reserves, National Parks, and Wildlife Sanctuaries, Man & Biosphere Programmes.

Microbial groups: Bacteria, Fungi, Algae, Viruses, and Protozoa; their place in the classification of living world; their biology, nutrition, metabolism and reproduction – Types and composition of culture media and sterilization – Physical factors (Temperature and light, Osmotic pressure, Hydrostatic pressure), Chemical factors (pH, O_2 and CO_2), Diversity of Microbial Habitats: (Air, Soil and Water), their general physical features.

STRUCTURE OF ATMOSPHERE: Temperature Profile – Air Pollutants: Oxides of Sulphur – Oxides of Nitrogen – Carbon monoxide – Particulate matter, and impacts – Photochemical smog – Green house effect – Ozone depletion – Acid Rains – Sources and effects of noise pollution, – impacts of Air Pollution-.Classification of water and Water bodies – Abnormal properties of water – Water cycle- Water Quality Parameters – Water Pollution – Sources – Classification, nature, types and Toxicology of water pollutants: – Eutrophication – Ground water pollution – Marine pollution – Ecological and Economic impacts of water pollution. Soil Texture – Ecological and Economic impacts of soil erosion and soil pollution.
Environmental Problems of India and some Ecofriendly Solutions-Over population, Food security, Health security, Energy security, Environmental security, Negative side of green revolution, Desertification, Deforestation. Concepts of Environmental Risks Definitions for Environmental Risk – concepts of Hazard, exposure, dose and response with special reference to Risk – Public perception of Environmental Risk – Communication of Risk – Developmental activities/projects/programmes required to carry out Risk assessments and propose Contingency Plans for Risk Management.

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AURCET - 2013 SYLLABUS
TEST NO. – 06: GEOGRAPHY
PAPER - II

1). GEOMORPHOLOGY: Development in Geomorphology. Geomorphological processes. Landforms in relation climate, rock type, structure and tectonics. Processes – weathering, pedogenesis, mass movement, erosion, transportation and deposition. Geomorphic processes and landforms – fluvial, glacial, eolian, coastal and karst. River forms and processes – stream flow, stage-discharge relationship; hydrographs and flood frequency analysis. Submarine relief. Geomorphology and topographic analysis including DEM, Environmental change – causes effects on processes and landforms.

2). CLIMATOLOGY: Fundamental principles of climatology. Earth's radiation balance; Latitudinal and seasonal variation of insolation, temperature, pressure, wind belts, humidity, cloud formation and precipitation, water balance. Air masses, Monsoon, Jet streams, tropical cyclones, and ENSO. Classification of climates – Koppen's and Thornthwaite's scheme of classification. Climate change.

3). ENVIRONMENTAL GEOGRAPHY: Man and Environment.. Biogeochemical cycles Natural and man-made hazards – droughts, floods, cyclones, earthquakes, landslides, tsunamis. Ecological balance, environmental pollution and deterioration. Environmental planning and Management. Environmental Impact assessment.

4). GEOGRAPHY OF INDIA: Psysiography, drainage, climate, soils and natural resources. The Himalaya, Gannga-Brahmaputra Plains and Peninsular India. Precambrian schield, the Gondwana rift basins, Deccan Plateau. Indian climatology with special reference to seasonal distribution and variation of temperature, humidity, wind and precipitation; Climate zones of India. Agricultural geography of India. Population – its distribution and characteristics. Urbanization and migration.. Environmental problems and issues

5). POPULATION GEOGRAPHY: World population, distribution and composition. India's population, composition and distribution. Factors affecting the growth and distribution of population. Malthus theory of population and his contribution – Demographic transition theory and theory of optimum population. Components of population growth – Fertility, mortality and migration. Factors affecting fertility, mortality and migration.

6). GEOGRAPHY OF HEALTH: Geographical factors affecting human health (1). Physical factors – refief, climate, soils and vegetation (ii) Social factors – population, densitiy, literacy, social customs and poverty (iii) Economic factors – food and nutrition, occupation and standard of living (iv) Environmental factors – urbanization and congestion, water, air and noise pollution and solid waste. Ecology, etiology and transmission of major diseases: cholera, malaria, tuberculosis, hepatitis, leprosy, cardiovascular, cancer, AIDS and STDS. Diffusion of diseases and causes. Deficiency disorders and problems of mal-nutrition in India.

7). URBAN & REGIONAL PLANNING: Classification of urban settlements on the base of size and function. Urbban Growth and theories, Central place theory- Christaller and Losch theories, Rank size rule. Urban morphology and urban land use structure, Urban morphological theories (Concentric, sector and multi-nuclei theory), Urban problems. Regional concept in Geography, Conceptual and theoretical frame work; Merits and limitations. Types of regions: Formal, functional, uniformal and nodal, single purpose and multipurpose regions.

8). CARTOGRAPHY: Basic principles of Cartography – scales, projections, symbolization and generalization. Cartography as graphic means of Communication. Theory of Visual perception. Visual variables, graphic elements, colour and pattern, typography and lettering. Types of maps and their uses. Cartographic techniques for different purposes – Socio-economic data, Weather and Climatic data, Physiography. Computer Assisted Cartography, Integration of Cartography and GIS.

9). REMOTE SENSING: Energy sources and Radiation principles. Electromagnetic Spectrum – Energy interactions with Atmosphere, Earth's Surface features. Spectral reflectance patterns, Atmospheric windows. Types and scales of aerial photographs – photographic resolution. Mosaics. Geometry of vertical aerial photographs – Image displacement – Stereoscopy – Parallax measurement.. Modern remoste sensing platforms. Sensors-characteristics, Visual and Digital image processing. Applications of remote sensing techniques.

10). GEOGRAPHIC INFORMATION SYSTEMS: General database concept: Spatial and Non-spatial data – Database Management Systems – Geographic data sources – Sources of error and data quality. Data structure – Rastar and Vector and their capabilities – Data conversions – Relational database model; Data compression of spatial objects. GIS Functioning: Data capture – digitizing and scanning – preprocessing – Data manipulation analysis. Mapping concepts – Coordinate system and geocoding: Common coordinate system – grids – UTM. Integration of Remote Sensing and GIS – Use of GPS, GIS and DEMs – Concepts of DTM, DEM and TIN. Land information Systems. Applications of GIS.

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AURCET - 2013 SYLLABUS

TEST NO. – 07: GEOLOGY AND DELTA STUDIES

PAPER - II

1) MINERALOGY AND PETROLOGY:

Concept of point group, space group, reciprocal lattice, diffraction and imaging. Concepts of crystal field theory and mineralogical spectroscopy, TEM and SEM applications. Lattice defects (Point, line and planar). Electrical, magnetic and optical properties of minerals. Bonding and crystal structures of common oxides, sulphides, and silicates. Transformation of minerals – polymorphism, polytypism, and polysomatism. Solid solution and exsolution.

Steady-state geotherms. Genesis, properties, emplacement and crystallization of magmas. Phase equilibrium studies of simple systems, effect of volatiles on melt equilibria. Magma-mixing, mingling and immiscibility.

Metamorphic structures and textures; isograds and facies. Mineral reactions with condensed phases, solid solutions, mixed volatile equilibria and thermobarometry. Metamorphism of pelites, mafic-ultra mafic rocks and siliceous dolomites. Material transport during metamorphism. P-T-t path in regional metamorphic terrains, plate tectonics and metamorphism.

Petrogenetic aspects of important rock suites of India, such as the Deccan Traps, layered intrusive complexes, anorthosites, carbonatites, charnockites, khondalites and gondites.

2) STRUCTURAL GEOLOGY AND GEOTECTONICS:

Theory of stress and strain, Behavior of rocks under stress. Mohr circle. Various states of stress and their representation by Mohr circles. Different types of failure and sliding criteria. Geometry and mechanics of fracturing and conditions for reactivation of pre-existing discontinuities. Paleostress analyses. Common types of finite strain ellipsoids. L-, L-S-, and S-tectonic fabrics. Techniques of strain analysis. Particle paths and flow patterns. Progressive strain history and methods for its determination. Deformation mechanisms. Role of fluids in deformation processes. Geometry and analyses of brittle-ductile and ductile shear zones. Sheath folds. Geometry and mechanics of development of folds, boudins, foliations and lineations. Interference patterns and structural analyses in areas of superposed folding. Fault-related folding. Gravity induced structures. Major tectonic features and associated structures in extensional-, compressional-, and strike-slip-terrances. Geological and geophysical characteristics of plate boundaries. Geodynamic evolution of Himalaya.

3) PALEONTOLOGY AND ITS APPLICATIONS:

Theories on origin of life. Organic evolution – Punctuated Equilibrium and Phyletic Gradualism models. Mass extinctions and their causes. Application of fossils in age determination and correlation. Paleoecology, Life habitats and various ecosystems, Paleobiogeography. Modes of preservation of fossils and taphonomic considerations. Types of microfossils. Environmental significance of fossils and trace fossils. Use of microfossils in interpretation of sea floor tectonicm. Application of micropaleontology in hydrocarbon exploration. Oxygen and Carbon isotope studies of microfossils and their use in paleoceanographic and paleoclimatic interpretation. Important invertebrate fossils, vertebrate fossils, plant fossils and microfossils in Indian stratigraphy.

4) SEDIMENTOLOGY AND STRATIGRAPHY:

Clastic sediments- gravel, sand and mid; biogenic, chemical and volcanogenic sediments. Classification of conglomerates, sandstones and mudstones, and carbonate rocks. Flow regimes and processes of sediment transport. Sedimentary textures and structures. Sedimentary facies and environments, reconstruction of paleoenvironments. Formation and evolution of sedimentary basins. Diagenesis of siliciclastic and carbonate rocks.

Recent developments. In stratigraphic classification. Code of stratigraphic nomenclature – Stratotypes, Global Boundary Stratotype Sections and Points (GSSP). Lithostratigraphic, chronostratigraphic and biostratigraphic subdivisions. Methods of startigraphic correlation including Shaw's Graphic correlation. Concept of sequence stratigraphy. Rates of sediment accumulation, unconformities. Facies concept in Stratigraphy – Walther's law. Methods for paleogeographic reconstruction. Earth's Climatic History. Phanerozoic stratigraphy of India with reference to the type areas- their correlation with equivalent formations in other regions. Boundary problems in Indian Phanerozoic stratigraphy.

5) GEOCHEMISTRY:

Structure and atomic properties of elements, the Periodic Table; ionic substitution in minerals; Phase rule and its applications in petrology, thermodynamics of reactions involving pure phases, ideal and non-ideal solutions, and fluids; equilibrium and distribution coefficients. Nucleation and diffusion processes in igneous, metamorphic and sedimentary environments, redox reactions and Eh-pH diagrams and their applications. Mineral/mineral assemblages as 'sensors' of ambient environments. Geochemical studies of aerosols, surface-, marine-, and ground waters. Radioactive decay schemes and their application to geochronology and petrogenesis. Stable isotopes and their application to earth system processes.

6) ECONOMIC GEOLOGY:

Magmatic, hydrothermal and surface processes of ore formation. Metallogeny and its relation to crustal evolution; Active ore-forming systems, methods of mineral deposit studies including ore microscopy, fluid inclusions and isotopic systematics; ores and metamorphism-cause and effect relationships. Geological setting, characteristics, and genesis of ferrous, base and noble metals. Origin, migration and entrapment of petroleum; properties of source and reservoir rocks; structural, stratigraphic and combination traps. Methods of petroleum exploration. Petroliferous basins of India. Origin of peat, lignite, bitumen and anthracite. Classification, rank and grading of coal; coal petrography, coal resources of India. Gas hydrates and coal bed methane. Nuclear and non-conventional energy resources.

7) PRECAMBRIAN GEOLOGY AND CRUSTAL EVOLUTION:

Evolution of lithosphere, hydrosphere, atmosphere, biosphere, and cryosphere;, lithological, geochemical and stratigraphic characteristics of granite – greenstone and granulite belts. Stratigraphy and geochronology of the cratonic nuclei, mobile belts and Proterozoic sedimentary basins of India. Life Precambrian. Precambrian – Cambrain boundary with special reference to India.

8) QUATERNARY GEOLOGY:

Definition of Quaternary. Quaternary Stratigraphy – Oxygen Isotope stratigraphy, biostratigraphy and magnetostratigraphy. Quaternary climates – glacial-interglacial cylces, eustatic changes, proxy indicators of paleoenvironmental/paleoclimatic changes, - land, ocean and cryosphere (ice core studies). Responses of geomorphic systems to climate, sea level and tectonics on variable time scales in the quaternary,. Quaternary dating methods, - radiocarbon, Uranium series, Luminescence, Amino-acid, relative dating methods. Quaternary stratigraphy of India – continental records (fluvial, glacial, Aeolian, palaeosols and duricrust); marine records; continental-marine correlation of Quaternary record.

Evolution of man and Stone Age cultures. Plant and animal life in relation to glacial and interglacial cycles during Quaternary.

Tectonic geomorphology, neotectonics, active tectonics and their applications to natural hazard assessment.

9) MINERAL EXPLORATION:

Geological, geophysical, geochemical and geobotanical methods of surface and sub-surface exploration on different scales. Sampling, assaying and evaluation of mineral deposits.

10) HYDROGEOLOGY:

Groundwater, Darcy's law, hydrological characteristics of aquifers, hydrological cycle. Precipitation, evapotranspiration and infiltration processes. Hydrological classification of water-bearing formatins. Fresh and salt-water relationships in coastal and inland areas. Groundwater exploration and water pollution. Groundwater regimes in India.

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AURCET - 2013 SYLLABUS
TEST NO. – 08: GEOPHYSICS
PAPER - II

Origin of the earth- the universe and our galaxy, chemical evolution of galaxy, formation of the earth and planets, primary differentiation of the earth. Composition of the various zones, abundance of elements in the earth, the rotation of the earth, the moon, salient concepts of plate tectonics.

Earth and stratified rocks- importance of stratigraphy – geological cycle on time scale. Stratigraphic nomenclature and classification. Sargur, Dharwar, Singhbhum super groups, Aravallis and Eastern Ghat Mobile Belts, Cuddapahs, Vindhyans and Kurnool systems, Deccan basalts, Cretaceous formations, and Quarternary formations – Boundary problems in stratigraphy.

Physiography and divisions of seas and world oceans –Properties of sea water: temperature, salinity and density - Littoral zone, Continental margin: continental shelf, continental slope and continental rise – Hotspot mechanism, seamounts and guyots - abyssal plains – turbidity currents - Mid - oceanic ridge system - Coral reefs and their formation- Island arcs – trenches - Deep sea sediments, placers on the beach and shelves, conditions for formation of polymettallic nodules.

Matrices: Principles and definitions, Single value decomposition method. Introduction to various generalized inversion techniques and their properties. Least square polynomial approximation: the principle of least squares, least square approximation over discrete sets of points, Chebysev Polynomial.

Numerical Analysis; finding the roots by numerical methods- bisection method, False position method, Newton Raphson method. Interpolation: Finite difference, symbolic relations. Interpolation by Newtons formula. Gauss's Central difference formula, Bessel's formula, Lagrangian formula and Richardson's extrapolation. Numerical differentiation and Integration: Maximum and minimum of a tabulated function. Numerical Integration- Trapezoidal rule, Simpson' s rule, Romberg integration, Weddle's formula.

Groundwater in Igneous, metamorphic, sedimentary rocks. Exploration Geophysics: Geological and Geochemical techniques. Importance Of geophysical techniques.

Hydrology - definition, hydrologic cycle, vertical distribution of groundwater types of aquifers, Darcy's law, porosity, permeability - laboratory measurement, well hydraulics - steady and unidirectional flow, quality of groundwater, concepts of water balance, sea water intrusion in coastal aquifers.

Gravity methods: Principles, instruments, survey & Interpretation techniques and application to Sub-surface exploration.

Magnetic methods: principles, instruments, survey & interpretation techniques, application to sub-surface techniques.

Seismic method; Principles, instruments, refraction survey, reflection surveys, survey techniques, depth determination of different sub-surface layers.

Electrical methods, Instruments, Sounding &Profiling, SP techniques& interpretation techniques – Principles of Induced polarization, Principles of magneto tellurics

Electromagnetic techniques, Principles, Instruments, Survey& Interprétation techniques

Bore hole geophysics: Well logging, techniques- Electric log, Resistivity and density log, sp log, radiation logging, sonic logging.

Fundamentals of Remote Sensing: Introduction: Basic principles of remote sensing; electromagnetic spectrum; Planck's law and wien's displacement law; concept of incoming short wave and outgoing long wave radiation: passive and active remote sensing, interaction of electromagnetic radiation with matter; interaction of electromagnetic radiation with atmosphere; selective and non-selective scattering; impact of scattering on remotely sensed data; atmospheric windows and absorption bands.

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AURCET - 2013 SYLLABUS
TEST NO. – 09: HUMAN GENETICS
PAPER - II

GENERAL GENETICS:

Cell – cell growth – cell cycle and cell death Chromosomal basis of Heredity – distribution of chromosomes during mitosis, meiosis and Gametogenesis. Human Chromosomes – types. Mendel's Laws of inheritance, Gene action, Simple single factor inheritance (autosomal dominant ; autosomal recessive, X – linked dominant, X – linked recessive and Y – linked characters) Sex influenced and sex – limited characters.

CYTOGENETICS:

History and development of Human Cytogenetics The Human Chromosomes: Introduction – Morphological variability of the human chromosome; Banded chromosome and individual characterization of the human chromosomes; Standardization in Human Cytogenetics; General remarks; The origin and transmission of chromosomal abnormalities–Introduction, numerical changes resulting from disturbances of chromosome distribution ; structural chromosomal abnormalities,

MEDICAL GENETICS:

Scope of Medical Genetics. Skin- Ichthyosis, baldness, psoriasis, hereditary Hemorrhagic telangiectasia, epiloia, multiple neurofibromatosis, the porphyrias, blooms, syndrome. The skeletal system – Marfan's syndrome, Nail patella syndrome, Brachydactyly, syndactyly, Polydactyly, Spina bifida and anencephaly, Ankylosing spondylitis, Rheumatoid arthritis, Osteogenesis imperfecta. Muscle – Muscular dystrophies, Myotonia.

POPULATION GENETICS AND BIOSTATISTICS:

Mendelian Population and scope of population genetics. Gene and genotype frequencies, mating patterns, Hardy-Weinberg principle, heterozygotes, extention of H-W principle to multiple alleles, sex-linked alleles. Non-random matings, inbreeding and assortative matings, inbreeding coefficient. Factors that change allelic frequencies Importance of population studies, sampling techniques, classification of data and tabulation. Measures of central tendency- mean, median and mode. Measures of dispersion - variance and standard deviation.

BIOCHEMICAL AND IMMUNOGENETICS:

The concept of Biochemical polymorphism, enzyme and protein polymorphisms – Hemoglobin, Acid Phosphotase and Haptoglobin. Metabolic disorders, Phenylketonuria, Hypercholesteremia, Lasch Nyhan Syndrome, Orotic aciduria, mukopolysaccharidoses, DNA studies of PKU and Hemoglobinopathies.

Immune responses – innate immune system and adaptive immune system. Immunoglobulins. The major histocompatability complex – HLA and Complement system.Human blood group systems. Immunodeficiency diseases – autoimmunity and acquired immunodifficiences. DNA level studies in HLA systems.

GENETIC SCREENING AND COUNSELLING:

Scope of genetic screening- Prenatal and Post natal screening. Population screening for genetic diseases, family screening.

Scope of genetic counseling- methods of genetic counseling, educating the counselee, presenting the risks and options and guiding. Social, ethical and legal issues. Patterns of inheritance and risk assessment, chromosomal disorders, autosomal dominant and recessive disorders, X-linked disorders, multifactorial-polygenic disorders. Reproductive failures, consanguinity.

Prenatal screening methods- Amniocentesis- Chronic Villous sampling, Ultrasonography, fetoscopy, maternal blood sampling.Post-natal screening- chromosomal abnormalities, cytogenetic disorders and molecular methods.

MOLECULAR GENETICS:

DNA structure ; chromatin organization ; internal organization of gene ; nuclear genome ; mitochondrial genome organization ; unique sequences and reiterated sequences, transposons, Pseudogenes; gene families.

DNA replication – Meselson and stahl experiment, enzymes involved in replication, Mechanism of replication.

DNA damage and repair, Central dogma. Transcription – Types of RNA, mechanism of transcription, processing of m RNA Translation – Gene code, protein synthesis, post translational modification. Regulation of gene expression-Transcriptional- promoters, transcription factors, inducible gene expression, Alternate promoters. Post transcriptional-alternative splicing, alternate polyadenylation, RNA editing; Epigenetic mechanisms- DNA mathylation.

GENOMICS AND PROTEOMICS:

Introduction to genomics, genetic mapping of human chromosomes, mapping of genetic disease locus to chromosome location, multilocus mapping of human chromosome, physical mapping of human genome, cloning human disease genes, human genome project.

DNA sequencing, bio chips, DNA micro arrays, gene annotation, gene structure predictions, gene ontology consortium recommendations, structural and functional genomics

Protein structure and its determination, structural hierarchy, domains, folds, motifs. Secondary structure prediction methods, fold recognition and abinitio structure prediction, homology- comparative modeling of proteins.

AURCET - 2013 SYLLABUS
TEST NO. – 10: INORGANIC & ANALYTICAL CHEMISTRY, ORGANIC & FOOD, DRUGS, & WATER CHEMISTRY, PHYSICAL NUCLEAR CHEMISTRY & CHEMICAL OCEANOGRAPHY, ENGINEERING CHEMISTRY

PAPER - II

GENERAL CHEMISTRY

BASIC QUANTUM CHEMISTRY:

Wave equation – interpretation of wave function – properties of wave function – normalization and orthogonalisation – operators-linear and non-linear, commutators of operators. Postulates of quantum mechanics – setting up of operators observables – Hermitian operator – Eigen values of Hermitian operator.

Wave mechanics of simple systems with constant potential energy, particle in a box – factors influencing colour transition – dipole integral, rigid rotator – simple harmonic oscillator. Hydrogen atom – solution of R(r), i (-) (-) i and 0 (0) equations probability density in orbitals – shapes of orbitals.

Perturbation theory – time independent perturbataion – (Only first order perturbations to be dealt with) – applications to ground state energy of helium atom-variation principle – applications – calculation of zero point energy of harmonic oscillator – Many electron atom – Hartree-Fock self-consistent field method (Qualitative treatment only).

Valence bond approach – directed valence – hybridization covalent bond- calculation of ionic and covalent bond contributions in hydrogen molecule.

Molecular orbital theory – LCAO approximation – hydrogen molecule ion – hydrogen molecule (fundamental concepts only)

MOLECULAR SPECTROSCOPY:

Basic concepts of symmetry and group theory – symmetry elements – axioms of group theory – classification of molecules into point groups – representation of point groups – matrix representation – reducible and irreducible representations – reduction of a reducible representation to an irreducible one – orthogonality theorem – character table and its anatomy (character table not to be derived) – use of character tables – application of group theoretical concepts to vibrational spectroscopy (infra-red and Raman).

ROTATIONAL AND VIBRATIONAL SPECTRA:

Rotational spectra of diatomic molecules – isotope effect-selection rules.

Infra-red spectra of diatomic molecules – isotope effect – selection rules – anharmonic oscillator – normal modes of vibration – simultaneous vibrations – rotational spectra-combination bands – overtones – Fermi resonance – concept of group frequencies – Raman effect (classical approach) – applications of IR and Raman spectra.

Electronic spectrum of a diatomic molecule – coars structure – classification of bands – fine structure – band head and band shading – types of electronic transitions in molecules – applications of electronic spectra – charge transfer spectra.

ELEMENTS OF COMPUTER PROGRAMMING:

Basic components of computers – comparison of micro, main frame and super computers – synopsis of software packages in chemistry – Basic commands of MSDOS Format, copying operation, concept of directories, batch files, compilation of Fortran files, flowcharting MS Fortran : Integer and real variables and constants – Assignment and replacement statements – conditional statements (if-then-else, Goto) – repetition (Do statements with – read and write with I, F and G formats – concept of function and subroutine subprograms.

The following programs are to be practiced:

1. Rate constant of a first order reaction or Beer's law by least squares Method (derivation not needed).
2. Roots of a quadratic equation – application to hydrogen ion Concentration of a strong acid.
3. Solving van der – Was equation or hydrogen ion concentration of a monoprotic weak acid (Gauss-Newton method).
4. Standard deviation and variance of univariate data.
5. Basics of Database III – creating structures for a bibliographic Database and properties of chemical elements (Retrieval programs not needed.)

INORGANIC CHEMISTRY

Term symbols – Russell – Saunders coupling – Derivation of terms Symbols for various configurations.

Chemical Bonding : Application of VB, MO and VSEPR theories in explaining the structure of simple molecules – role of 'P' and 'd' orbitals in hybridization and bonding.

Chemistry of main group elements: General trends in properties – boron hydrides. Carboranes, intercalation compounds, nitrogen – phosphorous, boron – nitrogen and sulphur – nitrogen cyclic compounds.

Chemistry of transition elements: Comparative study of the first, second and third transition series. Metal cluster compounds – Favorable conditions for formation – Structure and bonding in halide and carboxlate metal compounds.

Chemistry of Inner Transition elements: Chemistry of Lanthanides – electronic configurations, Oxidation states – Lanthanide contraction and its consequences – magnetic and spectral properties – separation of lanthanides.

Chemistry of actinides – Synthesis of transuranium elements electronic configurations, oxidation states – position in the periodic table – actinide contraction – comparison of magnetic and spectral properties with those of lanthanides.

Coordination compounds: Crystal field theory – crystal field splitting patterns in octahedral, tetrahedral, tetragonal, square planar, square pyramidal and trigonal bipyramidal geometries – Determination of crystal field splitting energy-calculation of crystal field stabilization energies – Factors affecting crystal field splitting energies – spectrochemical series – Jahn – Teller effect – Ligand field theory.

Electronic spectra of transition metal complexes – Selection rules – break down of selection rules – Orgel and Tanabe – Sugano diagrams – Spectra of octahedral and tetrahedral complexes.

Magnetic properties of free ions – spin and orbital moment and spin – orbit coupling Quenching of orbital momentum by crystal fields in complexes.

Stability of complexes – Factors affecting stability – chelate effect – Determination of stability constants of complexes – Spectrophotometric method and pH metric method.

Inorganic reaction mechanisms: Inert and liable complexes – Explanation of liability on the basis of CFSE.

Substitution reactions of metal complexes – Id Ia and A mechanism – Ligand replacement reactions of octahedral complexes-Acid hydrolysis, Anation and Base hydrolysis of cobalt(III) Complexes Ligand displacement reactions of square planar complexes of platinum(II) – Trans effect – Mechanism of trans effect (theories) – Electron transfer reactions of complexes – Inner and outer sphere mechanisms.

ORGANIC CHEMISTRY

Structure and reactivity – localized and delocalized convalent bond – concent of resonance and aromaticity – Huckel's rule aromaticity in benzenoid and non-benzenoid compounds – anti aromaticity and homo aromaticity, Naature of Organic reaction – energy and kinetic considerations – types of Organic reactions – reagents – reactive intermediates, their formation and stabilization – inductive and mesomeric effects.

Stereochemistry and stereoisometrism – conformational isomerism and analysis in acyclic and simple cyclic systems – substituted ethanes, cyclopentane, cyclohexane, cyclohexane, cyclooctance and decalins – Optical isomerism – optical activity molecular dissymmetry and chirality – elements of symmetry.

Fischer's projection – D.L. and R.S. – configurations – relative and absolute configuration – optical isomerism due to a symmetric carbon atoms optical isomerism in biphenyl, allenes and spirans – optical isomerism of nitrogenous compounds – recemisation and resolution – geometrical isomerism and E.Z. configurations Properties of geometrical isomers.

Aromatic substitution reactions – electrophilic, nucleophilic and through benzynes – radical substitution of arenes – orientation Nucleophilic substitution at a saturated carbon, SNI, SN2, ENi – reaction – effect of structure of nucleophile, leaving group, solvent and neighbouring groups. Addition Reactions: Addition to C=C and C=O double bond. Additions involving electrophiles, nucleophiles and free radicals.

Elimination reactions – E1, E1CB, E2 reactions – elimination versus substitution reactions.

Machanisms of some name reactions – aldol, Parkin, Benzoin, Cannizaro, Witting, Griganard Reformatsky, Wagner – Meerwein – Hofmann, Clasen and Favorsky, rearrangements – Hydroboration – Openauer Oxidation, Clemmensen reduction, Wolf-Kischner reduction – Meerwein – Pondorf and Varley and Birch reductions.

Chemistry of heterocyclic compounds – synthesis and reactivity of the following systems – pyridine; pyridine, quinoline, isoquinoline, indole, benzefuran, benzothiophene – pyrazole, imidazole, exazole, isooxazole, thiazole, isothiazole, pyridazine, pyrimidine and pyrazine.

Spectra and structure – application of organic spectroscopy UV IR – HNMR and Mass spectral data.

Chemistry of some typical natural products – A study of the following compounds involving their isolation, structure elucidation, systhesis and biogenesis – Flavonoids – luteolin, quercein, cyaniding and genesterin, Terpenoids – citral, α-terpeneol, methal, α-pinene, ophor farnesol.

Alkaloids – priperine, apropine, cocaine, nicotins, papverine and quinine Purines – caffions.

PHYSICAL CHEMISTRY

States of Matter: Transport properties of gases – Thermal conductivity, viscosity and diffusion. Theories of liquid structure – calculation of collision numbers.

SOLIDS: X-ray diffraction studies – crystal structure determination – lattice types and lattice dimensions – crystal defects – linear point and edge defects – Band theory of solids – Theories of specific heats of solids – semiconductors and their properties. Physical Methods for the elucidation of molecular structure – magnetic properties of molecules – theories of magnetic susceptibility- Application of magnetic susceptibility measurements to coordination compounds – spin-spin interactions – Chemical shift and its origin – experimental methods – application of NMR studies in structural-elucidation – application to structure of ethanol, acetophenone, aceltamide, dimethyl formamide and styrene – electron spin resonance – principle and experimental technique – line shapes and line widths – g-value – hyperfine interactions – application of ESR Studies to the structure of free radical, metal complexes and biological systems.

THERMODYNAMICS : Free energy, entropy and enthalpy – Chemical equilibrium – thermodynamic criteria of the chemical equilibrium – effect of temperature on equilibrium constant – Vant Hoff isochore – Maxwell relations – Gibbs-Duhem equation Duheme – Margules equation – classius –clapeyron equation – Nernst heat theorem and third law of thermodynamics – determination of absolute entropy.

KINETICS: Theories of reaction rates – collision and transition state theories – study of fast reactions using flow and relaxation methods – Kinetic isotope effects – reactions in solution – primary and secondary kinetic salt effects – Effect of dielectric constant – elementary ideas of linear free energy relations – Hammett and Taft equations – Chain reactions – consecutive, parallel and opposing reactions involving uni-molecular steps only – catalysis – homogeneous and heterogeneous – acid-base and redox catalysis.

PHOTOCHEMISTRY: Laws of photochemistry – photophysical processes fluorescence – delayed fluorescence and phosphorescence – Stern – volmer equation – Inter system crossing – internal conversion – photolysis – photosensitization and photochemical equilibrium.

Electrochemistry : Theories of strong electrolytes – Debye – Onsager equation – electrochemical cells – concentration cells with and without transference – effect of complexation on redox potential Determination of activity coefficients from E.M.F. data.

AURCET - 2013 SYLLABUS
TEST NO. – 11: MARINE LIVING RESOURCES
PAPER - II

THE SEA AS A BIOLOGICAL ENVIRONMENT.
Classification of Marine Environment; general characteristics of the populations of the Primary biotic Divisions: plankton, Nekton and Benthos
Effect of Environmental parameters –Light, temperature, Salinity and Density; tides, waves , upwelling and sinking, constancy of composition of sea water, pH, CO_2 systems, POM and DOM in the sea and its properties.

THE SHORE ENVIRONMENT: Physicochemical and biological factors of intertidal zone; Distribution of life on rocky shores, sandy shores and muddy shores. Zonation and adaptations of organisms in the interdial habitats. Coral reefs their special features and distribution.

MANGROVE SYSTEMS: Special features distribution of plants & animals.
Larval Ecology, settlement of larvae of benthic organisms.
ESTUARINE ENVIRONMENT: Classification and physico - chemical characters.
Remote sensing Applications in coastal zone Management, Coastal Zone regulations.
General Account of Systematic classification of fishes based on degree of movement and mode of Reproduction. Natural populations (or) stocks as biological entities, factors limiting abundance of stocks.
Criteria for distinguish units (or) Multiple species concept of Unit stock – its relevance to tropical marine fish.
Population dynamics: Recruitment, growth and mortality, length – weight relationship, condition factor.
Application of Statistics in Research: Measures of central Tendency: Mean, Median, Mode. Standard deviation, standard error, concept of correlation, ANOVA, ANCOVA, Chi square Test, t-Test, F-Test Random sampling.
General Account of reproduction and spawning of fishes, food and feeding habits of fishes, fish eggs and larvae.
Fishing craft: types of boats used in India, maintenance of fishing boats.
Gear material: Natural and synthetic, properties, testing and preservation, floats and sinkers, their properties, size and shape, Hooks and baits.
Handlines, Troll lines, Pole lines, long lines, Trawl nets, purse – seines, gill nets
Fish curing and processing Methods
By products, processing of low cost fish, mincing meat, fish oil, fish meal, fish sausages, isinglass, glue, fishes silage, chitosan, chitin, pearl essence, Alginates, Agar, Agarose, Corals.
Methods of exploitation of living Resources from sea. Overexploitation of resources.

Criteria for selection of candidate species for Aquaculture Survey and site selection, technical considerations
CULTURE SYSTEMS: Ponds, cages, pens, rafts, long lines, raceways
CULTURE PRACTICES: Open sea farming, Monoculture, Monosex culture, Polyculture. Integrated farming, organic farming, Laws pertaining to aquaculture.
Diseases in aquaculture organisms, Prevention and treatment methods
Water Quality management in the culture systems. Use of Antibiotics and other chemicals and their impacts. Environmental impact assessment in Aquaculture.
Eradication of weed fishes, predatory fishes, Aquatic weeds and Insects, sea ranching.
Live feed organisms: Microalgae, Rotifers, Artemia, Copepod, culture of chiranomiid larvae

Supplementary feeding: dry feeds, wet feeds, roller Artificial feeds, feed ingredients, nutritional quality.
Nutritional requirement of finfish and shell fish
Hatchery management and seed production of mullets. Milk fish, seabass, shrimps, crabs lobsters, oysters, pearl oysters and mussels. Culture practices of sea weeds.
Role of genetics in aquaculture, Genetic Selection.
In-breeding, Cross breeding, Hybridization, Hybrid vigour.
Induction of ploidy, production of ployploids.

Chromosomes set manipulation – gynogenesis and androgenesis.
Trangenesis and its application in aquaculture to produce more growth, cold – resistant, and disease – resistant varieties.
Genetic modification in sea weeds: application to commercial utilization and cultivation.

MICROBES IN THE SEA : Viruses, bacteria, fungi, microalgae and protozoa, distribution in the marine environment. Micro algae, fungi and protozoans : classification and culture.

MANGROVE MICROBIOLOGY: Mangrove microbial processes and organisms involved.
Microbial fermentation, decomposition, recycling, biofertilizer. Biofermentator– Designing.
Biomolecules – carbohydrates, proteins, lipids, aminoacids vitamins, hormones and Minerals; Structure, biological significance, role in metabolism, Bioenergetics. Biosynthesis of carbohydrates, proteins, Amino acids and lipids.
Enzymes structure and properties: classification, activity, factors affecting enzyme catalysis, control of enzyme action, immobilization, co-enzymes, cofactors, activators, inhibitors, allosteric enzymes, ribozymes and abzymes, Engyme kinetics, Enzymes of Industrial and diagnostic application. Moulting and growth regulating factors.
Cell ultrastructure, nutrient transport, cytoskeleton organization.
Gene structure and function, transduction and conjugation.
DNA as genetic material, easy phages to study T1, T2, T3 and T7.
DNA replication, cell cycle, Mutations, Molecular basis of Mutations.
Recombinant DNA technology: Techniques and tools used in gene modification. Sequencing of proteins and nucleic acids; PCR, Regulation of gene expression in Prokaryotes and Eukaryotes. environmental regulation of gene expression.

TRANSCRIPTION: Mechanism of Transcription in Prokaryotes and Eukaryotes.
Cell & Tissue culture Techniques and tools of tissue culture.
Single cell proteins and nutritional quality.

IMMUNOGLOBULINS: Structure properties, B & T cells. Immunity types, Cytotoxicity mechanisms. Immunology of invertebrate organisms.

TECHNIQUES IN IMMUNOLOGY: Precipitation & agglutination, Immunoelectrophoresis, Immunotherapy, Monoclonal antibodies, Hybridoma technology, RIA, ELISA.

BIOACTIVE MARINE NATURAL PRODUCTS: Antibacterial and antiviral substances of Pharmaceutical importance

MARINE POLLUTION: GESAMP Definition, types of pollution, Agents, Transport paths, monitoring and treatment methods. Lethal and sub lethal effects of pollutants, toxicity tests, Bioassay.
Marine corrosion, Marine biodeterioration, application of Biotechnology to control biodeterioration.

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AURCET - 2013 SYLLABUS
TEST NO. – 12: MATHEMATICS
PAPER - II

ANALYSIS: Elementary set theory, finite, countable and uncountable sets, Real number system as a complete ordered field, Archimedean property, supremum, infimum.

Sequences and series, convergence, limsup, liminf.

Bolzano Weierstrass theorem, Heine Borel theorem.

Continuity, uniform continuity, differentiability, mean value theorem.

Sequences and series of functions, uniform convergence.

Reimann sums and Reimann integral, Improper Integrals.

Monotonic functions, types of discontinuity, functions of bounded variation, Lebesgue measure, Lebesgue integral.

Functions of several variables, directional derivative, partial derivative, derivative as a linear transformation.

Metric spaces, compactness, connectedness. Normed Linear Spaces. Spaces of Continuous functions as examples

ALGEBRA: Permutations, Combinations, Pigeon – hole principle, inclusion – exclusion principle, dearrangements.Groups, subgroups, normal subgroups, quotient groups, homomorphisms, cyclic groups, permutation groups, Cayley's theorem, class equations, Sylow theorems.

Rings, ideals, prime and maximal ideals, quotient rings, unique factorization domain, principal ideal domain, Euclidean domain.

Polynomial rings and irreducibility criteria.

Fields, finite fields, field extensions

TOPOLOGY: Finite sets, Countable and uncountable sets, infinite sets and the axiom of choice, well ordered sets, the maximum principle.Topological Spaces, Basis for a topology, the ordered topology, the product topology on X x Y, The subspace topology, closed sets and limit points. Continuous functions, the product topology, Metric spaces, the metric topology.Connected spaces, connected subspaces of the real line, compact spaces, compact subspaces of the real line, limit point compactness, local compactness. The countability axioms, the separation axioms, normal spaces, the Urysohn's lemma, the Urysohn's metrization theorem, The Tietz extension theorem, the Tychnoff's theorem, the stone-cech compactification. Local finiteness, The Nagata-Smirnov metrization theorem, complete metric spaces. Compactness in metric spaces, pointwise and compact convergence, Ascoli's theorem. Baire space.

COMPLEX ANALYSIS: Algebra of complex numbers, the complex plane, polynomials, Power series, transcendental functions such as exponential, trigonometric and hyperbolic functions.

Analytic functions, Cauchy – Rieann equations.

Contour integral, Cauchy's theorem, Cauchy's integral formula, Liouville's theorem, Maximum modulus principle, Schwarz lemma, Open mapping theorem.

Taylor series, Laurent series, calculus of residues.

Conformal mappings, Mobius transformations.

LINEAR ALGEBRA: Vector spaces, subspaces, linear dependence, basis, dimension, algebra of linear transformations.

Algebra of matrices, rank and determinant of matrices, linear equations.

Eigenvalues and eigenvectors, Caley – Hamilton theorem.
Matrix representation of linear transformations. Change of basis, canonical forms, diagonal forms, triangular forms, Jordan forms.
Inner product spaces, orthonormal basis.
Quadratic forms, reduction and classification of quadratic forms.

DISCRETE MATHEMATICS: Graphs, diagraphs, networks, multigraphs, Elementary results, structure based on connectivity, characterization, theorems on trees, tree distances, binary trees.

Eulerian graphs, Hamiltonian graphs, spanning trees, Fundamental cycles, unrestricted graphs, minimal spanning trees, Kruskal algorithm, Prim's algorithm.

Relation, partial order relation, definition of lattices, Modular lattices, distributive lattices, Boolean algebras, Boolean rings.

BASIC PROPERTIES: Boolean polynomials, ideals, minimal form of Boolean polynomials, Application of lattices, Switching circuits, Karnaugh diagrams.

ORDINARY DIFFERENTIAL EQUATIONS (ODES): Existence and uniqueness of solutions of initial value problems for first order ordinary differential equations, singular solutions of first order ODEs, system of first order ODEs.

General theory of homogeneous and non – homogeneous linear ODEs, variation of parameters.

FUNCTIONAL ANALYSIS: Banach Spaces- Examples- continuous linear transformations. The Hahn Banach Theorem - The Natural imbedding of N into N**. The open mapping Theorem.The conjugugate of an operator-Hilbert Spaces- examples and some simple properties-Orthogonal compliments - Orthonormal sets-The Conjugage space H*-The adjoint of an operator-Self adjoint operators-Unitary operators and Projections.

PARTIAL DIFFERENTIAL EQUATIONS (PDES): Lagranges and Charpit methods for solving first order PDEs, Cauchy problem for first order PDEs.

Classification of second order PDEs, General solution of higher order PDEs with constant coefficients, Method of separation of variables for Laplace, Heat and Wave equations.

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AURCET - 2013 SYLLABUS

TEST NO. – 13: METEOROLOGY & OCEANOGRAPHY

PAPER - II

1. Physical and Dynamical Climatology:

Introduction: Weather and climate concepts - World climate system - climate of the hemispheres. Global distribution of temperature, precipitation pressure and winds - Circulation pattern during winter and summer seasons. Jet streams. Monsoons – Asia, Australia, E. Africa and North America; Systems of climatic classification - Koppen - Thornthwaite.

General circulation of the atmosphere - convective and meridional circulation - Rossby's tricellular model - Palmen's modified model - Circulation indices - Experiments of General Circulation – Dishpan experiment; Dynamics of atmospheric circulation-- Maintenance of the General circulation – Kinetic energy, angular momentum, absolute vorticity balance. NAO and Pacific oscillations.

Fundamentals of Climate change - local and planetary evidences - carbon dating - theories of climate changes; Paleoclimate - Climate change and variations in Earth's orbit; Climate trends - ENSO - teleconnections of the world climate system - Ozone hole; Nuclear winter ; Global warming -Consequences of global warming; Volcanic eruptions and aerosols; Impact of climate change on weather and climate; Climate change and agriculture.

2. Dynamic Meteorology:

Inertial and Non Inertial frames- Fundamental Forces-Pressure Gradient Forces, Gravitational Force. Friction or Viscous Force. Apparent forces- Centrifugal Force, Coriolis force, Affective Gravity. Momentum Equations- Cartesian Coordinate System, Spherical – Polar coordinate system. Scale analysis of momentum equations. Hydrostatic approximation. Balanced motion - Geotropic Wind, Gradient Wind, Thermal wind.

Continuity equation – Horizontal divergence, Vertical motion. Isobaric coordinate System - Transformation of momentum & continuity equations. Circulation & Vorticity – Bjerknes circulation theorem. Application to Land & Sea breeze. Vorticity equation. Potential vorticity - Application to Lee of the mountain trough, CAV Trajectories, Scale analysis of vorticity equation.

Atmospheric boundary layer: Atmospheric turbulence; Boussinesq approximation, Reynolds equations; Turbulent kinetic energy; Momentum equations for PBL- well mixed boundary layer, the Flux-gradient theory, Mixing length theory, Ekman layer, Surface layer, Modified Ekman layer; Secondary circulations; Prandtl Layer – Logarithmic Profile Properties of Prandtl Layer

3. Synoptic Meteorology:

Synoptic data and collection: Surface and upper air weather data transmission- Code for inland, coastal and ship stations. Upper air data – PILOT and TEMP codes. Station models, Weather charts and analysis.

Air masses and fronts: Air mass production – Classification – Sources of air masses in winter and summer and their modification. Fronts and frontal surfaces – Principal frontal zones – frontogenesis and frontolysis. Extra-tropical cyclones- formation – Life cycle – Structure and movement. Anticyclones and blocking. Heat and cold waves.

Kinematics of the pressure field: Characteristic curves – General expressions for their velocity and acceleration – Movement of troughs, ridges and pressure centres, Intensification and Weakening, deepening and Filling of surface pressure systems.

Kinematics of the wind field: Relation between streamlines and trajectories. Trajectories in moving cyclones and anticyclones. Differential properties of the wind field. Application of geostrophic, gradient, thermal winds, divergence and vertical velocity computations.

Indian monsoons: Land and sea breezes – Definition of monsoon – Synoptic features associated with onset, withdrawal, active and break situations of southwest monsoon. Rainfall distribution and rain bearing systems during summer monsoon season - monsoon depression, Mid-tropospheric cyclones and Onset vortex. Northeast monsoon onset phenomenon and rainfall distribution.

Prediction of weather elements: Seasonal prediction of monsoon rainfall and date of onset. Maximum and minimum temperatures – Fog. Aviation Meteorology: SEGMET and Meteorological hazards to aviation – Take-off, landing, in-flight, - Icing, turbulence, CAT, visibility and fog.

4. Advanced Dynamical Meteorology:

Atmospheric energetics – Energy equation. Kinetic energy. Internal energy, Potential energy, Morgules theory of conversion of Potential & Internal energies to Kinetic energy. Available potential energy, CAPE, CINE. Expression for APE . General circulation of atmosphere – Maintenance of the mean circulation of kinetic energy balance of the atmosphere, Angular momentum consideration. Absolute vorticity consideration.

Linear perturbation theory – Perturbation method. Properties of waves Sound waves, Gravity waves – External and Internal gravity waves, Rossby waves, Inertial waves, Geostropic adjustment process.

Dynamics of tropical atmosphere: scale analysis of tropical motions, cumulus convection and convective heating, equatorial wave theory, Scale interaction in the tropics- wave number domain, frequency domain, Adiabatic potential vorticity.

5. Numerical weather Prediction:

Numerical models - Filtered models : Filtering of sound and gravity wave models: Barotropic model ; Equivalent barotropic model ; Barotropic instability.

Numerical methods - Computation of Jacobian and Laplacian ; solution of Helmholtz and Poisson equations using relaxation method; Finite difference methods - Forward and centered finite difference methods, semi-implicit method - computational instability.

Baroclinic Models - Two level model; Quasi-geostrophic multi-level models; Omega equation; Liner balanced model; Nonlinear balanced model, Baroclinic instability.

Primitive equation models - Sigma coordinate system; Two level primitive equation model; Multilevel primitive equation models.

Introduction to mesoscale models: Nonhydrostatic assumption, basic structure of MM5 and WRF models and their applications.

Objective analysis - Cressman method, Method of Optimum Interpolation.

Initialisation ; Static initialisation; Dynamic initialisation- Normal mode initialisation, Newtonian relaxation or Nudging .

Nonlinear instability, Aliasing. Arakawa Jacobian. Staggered grid systems

6. Satellite Meteorology:

Physical basis of remote sensing - Remote sensing of the environment with Electromagnetic energy - Atmospheric transmission, atmospheric window regions and absorption bands. Remote sensing of atmospheric variables: Schwarzchild's Equation and its solution, Vertical sounding, Limb sounding, No emission equation, Detection of Aerosols.

Kepler's laws of universal planetary motion, Meteorological satellites and their orbital characteristics, Geostationary, Sun-synchronous, Polar and special purpose orbits, Different meteorological satellite systems- INSAT series, Meteosat series, NOAA series, TRMM and SSMI series, QUICKSCAT etc and future ISRO programmes **-** MEGHATROPIQUES satellite. Global weather satellite system.

Satellite analogue data: Satellite image interpretation and enhancement techniques, cloud type identification and Neph analysis, Synoptic scale weather systems, Mesoscale weather systems, Tropical cyclones, Tropical cyclone categorization of different stages, Estimation of central pressure by using Dvorak's technique and extra tropical cyclones.

Satellite digital data: Retrieval techniques, SST, Cloud top temperature, methods of retrieval algorithms for temperature and humidity profiles, Cloud motion wind vectors, Quantitative precipitation estimation. Radiation budget.

Tropical phenomena, Method of analysis of tropical disturbances, Mesoscale circulation patterns, Sea and land breeze circulations, orographic pattern; Application of satellite data for the study of southwest monsoon namely-onset of monsoon, active, break cycle, seasonal monsoon rainfall, low frequency oscillations.

Rainfall monitoring by VIS and IR data, Cloud Indexing Method, Bispectral techniques, Life History Techniques, Cloud Model Techniques, Active and passive microwave sensors and their application for Ocean surface winds, sea surface temperature, soil moisture and NDVI. GPS sounding, receiver and data analysis.

7. Physical Oceanography:

Physical properties of seawater: Temperature, Salinity and Conductivity, Density, Sound in the sea, Light in the sea, Colour of seawater. Temperature, Salinity and density distributions. Transparency of seawater.

Heat budget of the oceans: Heat budget terms, Short and Long wave radiation, Evaporation, Heat conduction.

Oceanographic Instruments: Temperature measurements; Protected and unprotected reversing thermometers, MBT, XBT, XCTD, ARGOS, Drifters, Sea Gliders, CTD. Current measurements: Lagrangian and Eulerian methods with examples, Aandhera current meter, ADCP, Position fixing at sea, GPS. Wave and Tide measurements.

Marine Geology: Continental shelf; Slope, Shelf sediments, mineral resources of the world ocean, submarine topography, mid oceanic ridge system. Manganese and other deposits and the factors control their distribution. Beach material, Shape and size. Beach terminology.

Marine chemistry: Composition of seawater, constancy of composition, dissolved gases, oxygen in the ocean, transfer of particle-aerosols, plankton and climate, bio-geo chemical cycles, marine environment and their characteristics, Marine Eco - system, Rocky shore, Sandy shore, Mangroves and Seaweed.

8. Dynamical Oceanography:

The Geopotential structure of the sea – Concept of Geopotential, field of mass, field of pressure, determination of Geopotential anomaly, isobaric and level surfaces.

Stability of fluid column: vertical acceleration in fluids and criteria for static stability. Geostrophic currents: Barotropic and baroclinic fields, relative and slope currents, level of no motion, computation of relative currents in a two layer ocean and in stratified ocean, Bjerknes' circulation theorem and application to relative currents.

Ocean circulation: wind induced currents, Ekman spiral, Up welling, sinking; equatorial current system, west ward intensification of currents, warm and cold currents of major world ocean, seasonal currents in North Indian Ocean, thermohaline circulation, T-S diagram and water masses.

Fundamentals of waves and tides: wave characteristics, wave generation, sea and swell, deep and shallow water waves. Tide producing forces, equilibrium theory and tidal currents. Coastal Hazards- Storm surges and Tsunamis.

9. Air Sea Interaction:

The significance of Air-Sea Interaction; Atmospheric and Oceanic Interaction at various scales; Concept of Boundary Layer, Barrier Layer, Thermal inversion; Atmospheric Heat Budget; Variations of wind, temperature and moisture over the sea surface. Air sea temperature differences; Wind stress and resultant drag coefficient with variation to wind speed; Upper ocean boundary layer. Oceanic heat budget.

Physical interaction between the ocean and atmosphere; Radiation, Heat exchange through latent and sensible heat; Oceanic forcing by air-sea exchange of moisture and heat; Momentum transfer and drag; Oceanic impact on the marine atmospheric circulation.

Large Scale Air-Sea Interaction: Ocean – Atmosphere interaction in tropics

Characteristics of ENSO; ENSO and Air – Sea coupling; ENSO and the Indian Monsoon

Warm Pool in Indian and Pacific Oceans

10. Waves and tides:

Wave hydrodynamics: wave characteristics, simple harmonic wave, Laplace equation, potential flows, Small amplitude wave theory - Airy's solution, Finite amplitude waves - -Stokes solution.

Deep water waves and shallow water waves. Wave transformation. Wave celerity and particle orbits

Wave generation: Jeffrey's theory, Sverdrup and Munk theory, wave growth and propagation. Group velocity.

Ocean tides: Tide producing forces, tide characteristics. Theories of tide generation: equilibrium theory, Dynamical theory. Prediction of tides by harmonic analysis. Renewable energy sources from Ocean – Wave energy, tidal energy and thermal energy OTEC.

Wave forecasting: Sea and swell, significant wave height, wave spectrum. SMB method of wave forecasting, PNJ method of wave forecasting, Co-cumulative spectrum method, fetch limited and duration limited cases, swell forecasting, dispersion, angular spreading and the concept of wave forecasting filter.

11. Satellite Oceanography:

Physical Principles of remote Sensing: Electromagnetic Spectrum, Wavelength regions, atmospheric window regions, black body radiation laws, Radiative transfer equation, Gaseous absorption and Scattering. Satellite Orbits: Newton's laws, Kepler's laws, Orientation in space, Orbital elements, Orbit perturbation, Sun synchronous orbits, Geostationary Orbits, other Orbits.

Sensors for forecasting the Ocean: using the EM spectrum, ocean properties measurable from above, classes of sensors, seeing through the atmosphere. Indian Remote Sensing Program with special reference to satellite Meteorology and Oceanography INSAT and OCEANSAT. Other satellites – NOAA, SEASAT. Principles of Image Processing: Basics of image processing and Enhancement Presentation of Multi channel image data.

Passive sensors: Visible wave band, thermal IR and microwave; Ocean colors and Remote Sensing: The coastal zone color scanner, Atmospheric correction of visible wave length data, Oceanographic interpretation of ocean colors and its applications in oceanography, Sea surface Temperature from infrared scanning radiometers, Characteristics of AVHRR, Atmospheric correction, cloud removal techniques. Retrieval of SST from AVHRR data, Potential uses of SST data.

Passive microwave radiometers: Physical principles, microwave emissivity of the sea surface, skin depth, effects of the atmosphere, and the geophysical model of the microwave radiation, salinity, and surface wind and SST retrieval. Comparison between infrared and microwave radiometers for SST measurement. Air – Sea Interaction studies using satellite data:

Active Sensors: Altimeter, Scatterometer and Synthetic Aperture Radar; Radars, sea surface roughness and Scatterometry: Measuring the radars energy reflected from the sea, microwave interaction with the sea surface, relationship between wind and radar back scatter, retrieving wind vectors from Scatterometer measurements, QUIKSCAT Scatterometer. Radar Altimeters from the Ocean: Principles of Radar altimetry, distance measurement with a satellite altimeter, orbit determination, ocean currents from altimetry, estimating of wave height from the altimeter pulse shape, retrieving wind speed from return pulse amplitude, Application of altimetry. Synthetic Aperture Radar imaging of Ocean: Principles of SAR operation, Ocean information from σo images, SAR imaging of ocean waves, shallow water bathymetry measured from SAR images.

12. Electronics:

Operational Amplifier Fundamentals**:** The operational Amplifier - Ideal OP Amp - Non inverting amplifier, Inverting amplifier, Summing amplifier, differentiator and integrator, Feed back in OP Amp circuits-- The non-inverting configuration, Inverting configuration. Current to voltage converter, photo detector amplifiers, transducer bridge amplifiers. Digital Electronics: Binary number system, invertors, OR gate, AND gate, Boolean algebra, Nor gate, Nand gate, De Morgan's theorems, Boolean laws and theorem, exclusive - OR gates, Arithmetic circuits, 2 complement Arithmetic, Half adder, Full Adder, Adder subtractor.

Amplitude Modulation: Amplitude modulation theory, frequency spectrum of AM wave, representation of AM, power relations in AM wave. Frequency Modulation: Theory of frequency modulation, Mathematical representation of FM, Frequency spectrum of FM wave, Comparison between frequency and amplitude modulation. Propagation of radio waves - ground waves, sky wave propagation, space waves, Tropospheric scatter propagation. Antennas: Antenna gain and effective radiated power, Antenna resistance,

Bandwidth, Beam width and polarization. Microwave antennas - antennas with parabolic reflectors, properties of paraboloid reflectors, feed mechanisms.

Radar System: Basic radar system, Radar range equation, effect of noise, Basic pulsed radar system - block diagram and description. Moving target indication radar-- Doppler effect, fundamentals of moving target indication radar, Synthetic Aperture Radar. General characteristics of a satellite communication systems, Advantages of Satellite communication, Digital signal communication- Elements of Digital Communication system, Digital Modulation Techniques, Satellite Digital Link design, Time Division Multiplexing. Satellite Transponders, Earth stations.

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AURCET - 2013 SYLLABUS

TEST NO. – 14: MICROBIOLOGY

PAPER - II

Discovery, Evolution and development of Microbiology**.** Contributions of Van Leeuwenhock, Joseph Lister, Pasteur, Koch, Jenner, Winogradsky, Beijerinck. Recent trends and development in modern in microbiology.

Identification, characterization and classification of microorganisms- Principles of bacterial taxonomy and classification: - Bergy's manual and its importance, Hackel's three kingdom concept-Whittaker's five kingdom concept-three domain concept of Carl Woese.Basis of microbial classification.

Concepts, nomenclature and taxonomic ranks: general properties of bacterial groups. Major characteristics used in Taxonomy-morphological, physiological and metabolic, ecological, numerical taxonomy, genetic and molecular classification systems; the kingdoms of organisms and phylogenetic trees. Distinguishing characteristics between prokaryotic and eukaryotic cells Structure and function of Cell wall of bacteria, cell membranes, flagella, pili, capsule, gas vesicles, carboxysomes, magnetosomes and phycobolisomes.

METHODS OF STERILIZATION: Physical methods – Dry heat, moist heat, radiation methods, filtration methods, chemical methods and their application. Concept of containment facility, sterilization at industrial level.

Microbial cultures: Concept of pure culture, Methods of pure culture isolation, Enrichment culturing techniques, single cell isolation, and pure culture development.

Chemical structure of peptidoglycon, protoplasts, spheroplasts, microsomes and ribosomal RNAs, Nuclear material/nucleus.

Microscopic identification characteristics, staining methods – simple staining, differential staining, structural staining and special staining methods

Microbiological media-Natural and synthetic; autotrophic, heterotrophic and phototropic media: basal, defined, complex, enrichment, selective, differential, maintenance and transport media

Preservation and Maintenance of Microbial cultures: Repeated sub culturing, preservation at low temperature, sterile soil preservation, mineral oil preservation, deep freezing and liquid nitrogen preservation, drying, glycerol cultures, freeze-drying (lyophilization). Advantages and disadvantages of each method.

Ecological identification methods, Nutritional (cultural) identification characters, chemical identification characters, biochemical identification methods, immunological characteristics, pathogenic properties identification, genetic characteristics identification.

Bacterial nutrition and growth kinetics- synchronous, stock, batch and continuous cultures. Growth measurement methods –Metabolic diversity, measurements of NAD, ATP, DNA, and Protein, CO_2 liberated O_2 consumed, extra cellular enzymes. Cultivation of aerobes and anaerobes. Reproduction in bacteria & spore formation.

Morphology, Ultra structure and chemical composition of bacteria, actinomycetes, spirochetes, rickettsiae, mycoplasma, Chlamydiae – TRIC agents and LGV Archaebacteria

Eukaryotic microorganisms: General characteristics, reproduction and economic importance of fungi. Classification, structure, composition, reproduction and other characteristics of fungal divisions-Zygomycota, Ascomycota, Basidomycota, Deuteromycota and slime & water molds

Classification, structure, reproduction and other characteristics of algal divisions,

Distribution of algae. Biochemical classification of algae.

Characteristics of- blue green algae, dinoflagellates, Microalgae, thallus organization, products of algae and their economic importance. Biochemical classification of algae.

Characteristics of Various protozoa-Morphology, nutritional requirements, reproduction.

VIROLOGY

History and Discovery of Viruses, Nature origin and evolution of viruses, New emerging viruses, viruses in human welfare.

Nomenclature, classification and structure of viruses – criteria used for naming, classification of viruses, recent ICTV classification of viruses infecting animals, humans, plants, bacteria, algae, fungi. Major characteristics of different virus families/genera/groups- Poxviridae, Hepadnaviridae, Baculoviridae, Adenoviridae, Herpesviridae, Ortho and Paramyxoviridae, Retroviridae, Reoviridae, Parvoviridae, Rhadboviridae, Picornaviridae, Flaviviridae, Potyviridae, Tobamoviridae, Bromoviridae, Bunyaviridae, Geminiviridae, Caulimoviridae.

Algal, Fungal viruses- Phycodnaviridae, Cyanophages, Partitiviridae and Totiviridae. Subviral agents-sat viruses, Sat nucleic acids, Viroids, Prions.

Properties of Viruses- Biological properties of viruses – host range, transmission-vector, non-vector, Physical properties of viruses – morphology, structure, sedimentation, electrophoretic mobility, buoyant density; Biochemical characteristics – chemical composition of viruses, proteins, nucleic acids, envelope, enzymes, carbohydrates, polyamines, cations, Antigenic nature of viruses.

Isolation, cultivation, assay and maintenances of viruses – Animal, Plant and Bacterial Viruses: Experimental animals, apparatus& equipment, media tissue culture – organs cultures, primary and secondary cell cultures, suspension and monolayer cell cultures, cell strains, cell lines, embryonated eggs, experimental plant tissue cultures.

Viral replication and genome expression – viral genomes- structure and complexity of viral genomes, diversity among viral genomes – DNA and RNA genomes- linear, circular, double and single stranded, positive and negative sense of RNA genomes, mono, bi tri and multipartite of genome. Replication of viruses – an overview of viral replication cycles, replication strategies of DNA, RNA viruses and regulation of viral genome expression-Baltimore strategies.

Virus – host interactions – Influence of virus on host organism-latent infection, cytopathic effects of viral infections, inclusion bodies, chromosomal aberrations; Response of host cells to viral infection – Host specificity, resistance, interference, immunological responses of the host, host induced modification, patterns of host response-biological gradient, systemic and general syndromes – interactions.

Virus offense meets host defense – Host defense against viral infections, innate and adaptive immune response to viruses. Molecular mechanisms of viral pathogenesis with respect to Poliovirus, Rotavirus, Herpesvirus (CMV). Molecular parasitism concepts.

Transmission of viruses – Vertical (Direct) transmission – contact, mechanical, transplacental, transovarial, sexual, fecal, oral, respiratory, seed and pollen. Horizontal (Indirect) transmission- aerosols, fomites, water, food, graft, dodder. Vector-arthropod, non-arthopods, virus and vector relationship. Multiple host infections – viral zoonosis.

Persistence of viruses – Pattern of viral infection, mechanism of viral persistence. Mechanism of infection and viral spread in the body: Routes of entry – skin, respiratory tract, oropharynx and intestinal tract, conjunctiva, gential; Host specificity and tissue tropism – receptors, viral enchancers; Mechanism of virus spread in the body – spread in epithelia, subepithelial invasion and lymphatic spread, spread by the blood stream, invasion of the skin, central nervous system, respiratory and intestinal tracts, other organs.

Virus ecology and epidemiology – Epidemiological concepts. Scope of epidemiology – epidemiological investigation of virus diseases, qualitative and quantitative investigations. Definition of terms, types of epidemiological investigations, components of epidemiology, biological and physical factors influencing the survival and spread of virus diseases. Disease gradients and forecasting of diseases. Virus disease surveillance, strategies of virus maintenance in communities- wild and domestic animals, wild plants and weeds.

BIOMOLECULES

Major Biomolecules: Carbohydrates – Classification, chemistry, properties, and function – mono, di, oligo and polysaccharides.bacterial cell wall polysaccharides. Conjugated polysaccharides– glycoproteins, muriens and lipopolysaccharides.

Lipids – classification, chemistry, properties and function – free fatty acids, triglycerides, phospholipids, glycolipids & waxes. Conjugated lipids – lipoproteins. Major steroids of biological importance – prostaglandins.

Amino acids and proteins – classification, structure and function. Essential amino acids & amphoteric nature of amino acids and reactions and functions of carboxyl and amino groups and side chains. Peptide structure. Ramachandran's plot. Methods for isolation and characterization of proteins. Structural levels of proteins – primary, secondary, tertiary and quaternary, denaturation of proteins. Hydrolysis of proteins. Protein sequencing using various methods.

Nucleic acids **–** structure**,** function and their properties. Structural polymorphism of DNA, RNA. Structural characteristics of RNA.
Sources, Chemistry and biochemical functions of water-soluble vitamins. Chemistry of Porphyrins – Heme, Cytochromes, Chlorophylls, xanthophylls, Bacteriochlorophylls & algal pigments. Carotenoides.

Biological oxidation, Biological redox carriers, biological membranes, electron transport, oxidative phosphorylation and mechanism. Bacterial photosynthesis, photosynthetic electron transport

Mineral metabolism – phosphorus, potassium, calcium and Trace elements –molybdenum, zinc, manganese, cobalt and copper. Influence of minerals on the production of toxins. Role of trace elements on microbial enzymes**.**

ANALYTICAL TECHNIQUES

Microscopy – Principles of light, phase, fluorescent & electron microscopes; Microtomy – sectioning. Microscopic techniques: Basic principles and applications of phase – contrast microscopy (phase annulus, phase plate, specimen preparations), fluorescent microscopy (filters, dark field condensor, complex optical system, sample preparations) and electron microscopy (Magnetic lenses, electron beams, condensors, types of electron microscopy – scanning and transmission, sample preparations - fixing of specimens, preparation of blocks, microtomy and staining, negative staining techniques of biological samples), cytometry and flow cytometry.

Principles of Centrifugation – Centrifugation techniques-preparative and analytical methods, density gradient centrifugation.

General principles and applications of chromatography – Paper, Column, Thin layer, Gas, Ion exchange, Affinity chromatography, HPLC, FPLC and Gel filtration.

Electrophoresis – moving boundary, zone (Paper Gel) electrophoresis. Immunoelectrophoresis. Immunoblotting. Isoelectric focusing, 2-D electrophoresis

Principles, Laws of absorption and radiation. Visible, ultraviolet, infrared and mass spectrophotometry. Absorption spectra, fluorescence flame photometry, NMR, ESR, Principles of colorimetry, Turbidometry, Viscometry. Determination of size, shape and molecular weight of macromolecules – osmotic pressure, flow birefringence, optical rotatory dispersion. light scattering, diffusion, sedimentation and X-ray diffraction.

Radio isotopic tracers – methodology, problems of experimental design, radiometric analysis, stable and radioactive isotopes, preparation, labeling, detection and measurement of isotopes. RIA. Kinetics of radioactive disintegration.

Manometric techniques. Freeze drying and its application in biological systems.

MICROBIAL PHYSIOLOGY & METABOLISM

Nutritional types – autotrophic bacteria, chemosynthetic and photo synthetic microorganisms. Heterotrophic bacteria – saprophytes, parasites and mixotrophs. Respiration in bacteria – aerobic and anaerobic types of respiration, obligate aerobes, facultative anaerobes and obligate anaerobes. Toxic effect of oxygen on anaerobes. Bioluminescence in microorganisms. Energy yields. Microbial growth: The concept of growth and definition, Cell cycle in microbes and generation time

Growth phases of bacteria –survival of microbial cells. Importance of each growth phase. Synchronous cultures – methods of synchronous culturing

Continuous culturing methods, factors effecting growth. Methods of growth measurement. Physiology and biochemistry of sporulation and germination of spores

Carbohydrate metabolism in microbes – synthesis of carbohydrates in photosynthetic, chemosynthetic and heterotrophic microbes. Fermentation of carbohydrates by microorganisms – Embden-Meyerhof-Parnas pathway, Entner-Doudoroff (ED) pathway, C2-C4 split pathway. Kreb's cycle, glyoxylate cycle, hexose monophosphate shunt (HMP), gluconeogenesis, anaplerotic reactions, synthesis of peptidoglycans and glycoproteins. Anaerobic respiration - Fermentation, Biochemical mechanisms of lactic acid, ethanol, butanol and citric acid fermentations. Nitrate and sulphate respiration.

Metabolism of amino acids –Biosynthesis of amino acids and their regulation with emphasis on tryptophan and histidine by microorganisms

Protein metabolism - Assimilation of inorganic nitrogen and sulphur, Biochemistry of nitrogen fixation. Urea cycle . Signal transduction with reference to nitrogen metabolism. Catabolism of amino acids, transamination, decarboxylation and oxidative deamination. Porphyrin biosynthesis and catabolism.

Lipid metabolism - Biosynthesis of triacyl glycerols, phospholipids and sphingolipids. Oxidation of saturated and unsaturated fatty acids. Microbial metabolism of aromatic and aliphatic hydrocarbons (camphor, 2,4-D and toluene) with emphasis on the role of monooxygenase and dioxygenase in the ring cleavage (*ortho*, *meta* and gentsiate cleavage) and reductive catabolism.

Nucleotide metabolism - Biosynthesis of purnine and pyrimidine nucleotides, biosynthesis of deoxyribonucleotides. Regulation of nucleotide synthesis, catabolism of purine and pyrimidines.

Secondary metabolism - Utilization of secondary metabolites for production of vitamins, toxins (aflatoxin and corynebacterial), hormones (GA), and antibiotics (penicillin and streptomycin).

CELL BIOLOGY & ENZYMOLOGY

ORGANELLAR BIOLOGY: Structure, function & biogenesis of chloroplast and mitochondria, mesosomes, lysosomes and cytoskeletal system. Photosynthesis in bacteria and plants: Organization, apparatus, electron donors & acceptors, energetics. Physico-chemical properties of bacteria – intracellular osmotic pressure, permeability of the bacterial cell. Nutrient transport – simple diffusion, active, passive and facilitated diffusion. Purple green photosynthetic bacteria Photosynthesis - Oxygenic and anoxygenic photosynthesis, structure of synthetic pigments, primary photochemistry of PS I and PS II, and photosynthetic electron transport, CO_2 fixation, halo bacterial photosynthesis.

SIGNAL TRANSDUCTION IN EUKARYOTES: Protein kinases, phosphorylation cascades, Ras pathway, MAP kinase pathway, etc. Cyclic nucleotides, G proteins. Mechanisms of protein translocation across membranes in prokaryotes and eukaryotes, coated vesicles, membrane receptors.

Outlines of enzyme classification, nomenclature, assay of enzymes and kinetics of enzyme catalyzed reactions – Michaelis – Menton equation, determination of K_m, V_{max} and k_{cat} values. Factors affecting enzyme reaction – pH, temperature, radiation, enzyme and substrate concentrations, activators, coenzymes and metalloenzymes. Ribozymes and abzymes

Enzyme inhibitors, competitive and noncompetitive inhibition. Active site determination. Mechanism of action of ribonuclease, lysozyme and chymotrypsin. Isoenzymes, Regulatory enzymes – covalent modification, zymogen activation, Allosteric enzymes – ATCase, Glutamine synthetase. Hemoglobin & Myoglobin.

Enzyme purification - Methods of isolation, purification. Recovery and yield of enzymes. Criteria for testing purity of enzyme preparations. Immobilised enzymes - Methods of immobilisation. Comparison of kinetics of immobilised and free enzymes. Application of immobilized enzymes.

MOLECULAR & MICROBIAL GENETICS

Molecular organization of chromosomes in Prokaryotes and Eukaryotes. Centromeres and telomeres. Recombination at molecular level, heteroduplex analysis. Fine Structure analysis.

Organisation of genomes – Repeated sequences - C value – cot curves" Multigene families; Molecular markers(RFLP and RAPD)

Polymorphisms. Yeast & Drosophila as model organisms. Complementation and functional allelism.

Plasmids – types, plasmid DNA properties. Sex plasmid F and its derivatives, drug resistance (R) plasmids. The Ti plasmid of *Agrobacterium*.

Hybridization in yeast, control of mating type loci in yeast. Transposable elements – transposition. Types of bacterial transposons, duplication of target sequence at an insertion site. Deletion and inversion caused by transposons. Transposable elements in yeast and drosophila. Retroposons.

Mutations – Terminology, types of mutations, Molecular basis of mutations, isolation & analysis of mutants. Mutagenesis – base analogue mutagens, chemical mutagens, intercalating substances, mutator genes. Site directed mutagenesis, mutational hot spots, Reversion, second site revertants, frame shift mutations, carcinogens, screening of mutants. UV damage of DNA and repair.

Bacterial genetics – Inheritance of characteristics and variability. Phenotypic changes due to environmental alterations. Genotypic changes. Bacterial recombination. Bacterial conjugation. Transduction – Generalized and specialized transductions. Bacterial transformation. Tetrad analysis in eukaryotic microbes – Neurospora and yeast.

Mapping of bacterial chromosome by interrupted mating and transduction. Recombination in bacteriophages. Benzer's studies on r-II locus of T4 bacteriophage. Complementation test.

IMMUNOLOGY

Adaptive immunity, innate immunity, cells involved in immune system – T-lymphocytes, B-lymphocytes, monocytes, macrophages, APC, Neutrophils, mast cells, lymphoid system, Thymus, bone marrow, spleen, lymph nodes, generation of lymphocyte specificity and diversity, processing and presentation of antigens, clonal selection of lymphocytes, immunological memory.

Antigen-Antibody reactions; Ag-Ab binding, agglutination, blood groups, immunoflourescence, and important immunological diagnostic tests - ELISA, RIA, immune blot, Immunodiffusion, Immunoelectrophoresis, Complement fixation test (CFT).

Nature of antigens; antibody structure, classification of antibodies, functions of IgG, IgA, IgM, IgD and IgE; primary and secondary immune response; serological analysis of antibodies – isotypes, allotypes and idiotypes. Antibody diversity, antigen receptors on B and T lymphocytes. Opsonins and opsonocytophagic reaction.

Hybridoma techniques (monoclonal antibody production) – Myeloma cell lines, fusion methods. Selection and screening methods for positive hybrids. Production, purification and characterization of monoclonal antibodies. Applications of monoclonal antibodies in biomedical research, clinical diagnosis and treatment.

The complement system. components of classical and alternative complement pathways, complement receptors, biological, consequences of complement activation.

Humoral and cell-mediated immunity**,** ontogeny of B and T lymphocytes, generation of memory B cells and affinity maturation. T and B cell interactions, cytokines, lymphocyte-mediated cytotoxicity (CTL). Antibody-dependent cell-mediated cytotoxicity. Transmembrane signaling, antigen receptor and signal pathways. Reactions of immunity – antitoxins, neutralization of toxin with antitoxin Immune response to infectious diseases: viral infections, bacterial infections, and protozoan diseases.

Vaccines – development and production, vaccine expression system. Production of rabies vaccine, foot & mouth disease vaccine and hepatitis-B vaccine. DNA vaccines.

Major Histocompatibility Complex (MHC). Human leucocyte antigen (HLA) restriction, Hypersensitive reactions – Auto immunity, transplantation immunity, Tumor immunology, immunological tolerance and immunosuppression. Immunodeficiency diseases - Primary immunodeficiency (genetic) diseases due to B-cell and T-cell and combined defects (hypogammaglobulinemia, thymic aplasia, SCID). Secondary immunodeficiency (acquired). Immunotherapy of infectious diseases; Types and principles of immunization; vaccinoprophylaxis, vaccinotherapy, serotherapy. Development of immuno diagnostic kits.

MOLECULAR BIOLOGY

Proof of DNA & RNA as genetic material; Transformation experiments, Blenders experiments, properties of genetic material. Modern concept of gene structure. Overlapping genes, split genes, constitutive genes, jumping genes, Oncogenes.

Types of tumors, physical, chemical and biological Carcinogens, chromosomal changes induced by Carcinogens.

DNA replication –various modes of replication, Meselson-Stahl's studies on replication. Enzymes and Proteins involved in replication Mechanism of replication – Initiation, polymerization and temination. Topoisomerases, DNA ligases. Procaryotic and Eucaryotic promoters. Mechanism of transcription and transcriptional activators. Posttranscriptional modifications.

The genetic code: Deciphering the genetic code; theory of triplet code, elucidation of base composition of codons. Identification of stop and start codons, universality of the code, redundancy of the code, the decoding system.

PROTEIN SYNTHESIS: Mechanism and role of various factors involved in Initiation, elongation and termination of Protein Synthesis Inhibitors of protein synthesis. Post translational processing of proteins, protein channeling, role of RNA in protein synthesis.

Regulation of gene expression at the levels of transcription and translation. Operon concept; Regulatory genes, structural genes and repressors. Negative and Positive regulation. Regulation of lac, ara and trp operons. Catabolite repression. Regulation of gene expression in lambda and nif operon. Regulation of gene expression in eucaryotes.

MEDICAL MICROBIOLOGY

Normal microbial flora of human body, host microbe interactions. Infection and infections process- routes of transmission of microbes in the body. Description and pathology of diseases caused by bacteria; Streptococcus, Pneumococcus, Gonococcus, Enterobacteriaceae, E. coli, Salmonella, Shigella, Pseudomonas, Klebsiella, Proteus, Vibrio cholera. Brucella, Haemophilus, influenzae; pathogenic anaerobes, Tetanus, Clostridia, Conynebacteria, Mycobacteria, Spirochaetes.

Description and pathology of diseases caused by Aspergillus, Penicillium, Mucomycosis, Blastomycosis, Microsporosis, Rhinosporidium, Epidermophyscosis. Description and pathology of diseases caused by hemoflagellates; Leishmania donavani, L.tropica, Trypanosoma gambiense; intestinal flagellates; Trichomonas, Giardia, Entamoeba histolytica, malarial parasites, Helminthes; Ascaris lumbricoides, Hook worm, pinworm, Filarial parasites.

Laboratory diagnosis of Common infective syndromes and parasitic manifestations; Methods of transmission & role of vectors- biology of vectors. (1) House fly (2) Mosquitoes (3) sand fly. Need and significance of epidemiological studies. Epidemiological investigations to identify a disease, Principles of chemotherapy, Mode of antibiotics. Penicillin, streptomycin, sulfonamides and Polymyxins. Antifungal drugs (Nystatin), Antiviral agents. Problems of drug resistance and drug sensitivity. Drug resistance in bacteria.

Viral diseases: Description, pathology and lab diagnosis of diseases caused by pox viruses; herpes virus (chicken pox- zoster); orthomyxo and paramyxo viruses; adenovirus, other respiratory viruses, viruses affecting nervous system (ex: Polio virus, Rabies virus), enterovirus, reovirus, viral hepatitis, HIV Virus, rickettsiae. Interferon – Nomenclature, types & classification, Induction of interferon, types of inducers.

BIOSTATISTICS & BIOINFORMATICS

Biostatistics: Measures of Central tendency and distribution – mean, median, mode, range, standard deviation, variance. Basic principles of probability theory, Bayes theorem, Normal distribution, statistical inference – Types of errors and levels of significance. Comparison of variance (F-test), small sample test, t-test for comparison of means chi square test. Correlation and Linear regression. Introduction to hidden Markov models.

Sequence Analysis: Introduction to biological databases: NCBI, EMBL, EXPASY, PIR, Pfam. Concept of World Wide Web: HTML, HTPP. Similarity measures - Euclidean, Mahalanobis distance, Edit distance, similarity matrices (PAM, BLOSUM) Searching sequence databases using BLAST. Pairwise sequence alignment using dynamic

programming (Needleman – Wunsch & Smith – Waterman algorithms.) Multiple sequence alignment – progressive alignment – profiles – multidimensional dynamic programming.

Genomics and proteomics: Molecular phylogenetics: Construction of of phytogenetic trees using parsimony method and branch & bound method. Clustering methods – UPGMA & neighbor- joining, Analysis of gene expression data by clustering.Gene prediction – Statistical approaches – Similarity based approaches gene annotation. Fragment assembly, peptide sequencing using mass and spectroscopy data. Comparative genomics.

Modeling: Protein secondary structure prediction – Chou Fasman rules – neural networks – discriminant analysis. Prediction of transmembrane segments in membrane proteins. Protein 3D structure prediction – homology – threading – potential energy functions – energy minimization – molecular dynamics – simulated annealing.

MOLECULAR BIOTECHNOLOGY

R-DNA technology- Isolation of nucleic acids, DNA sequencing, maxam-Gilbert and Di-deoxy methods. Restriction endonucleases, restriction maps, Southern, Northern blotting and western blotting. DNA finger printing, PCR- principle, types, application.

Cloning vectors- Plasmids, Cosmids and bacteriophages. Ligases- DNA ligases, ligation of fragments with cohesive ends & blunt ends; homopolymer tailing, Cloning strategies – shot gun experiments, gene libraries. Isolation of poly mRNA, synthesis of c-DNA, cloning of c-DNA in bacteria. Isolation of cloned genes, identification of recombinants, structural and functional analysis of recombinants.

Gene expression- expression of cloned genes in bacteria, yeast, plant and animal cells. Application of recombinant DNA technology in biology, plant, medicine, genetic diseases, gene therapy. Genetically engineered microorganisms and intellectual property rights.

Nucleic acid probe technology, DNA micro array – printing of oligonucleotides and PCR products on glass slides, nitrocellulose paper. Whole genome analysis for global patterns of gene expression using fluorescent-labelled c-DNA or end labeled RNA probes. Analysis of single nucleotide polymorphisms using DNA chips. Protein micro array, advantages and disadvantages of DNA and protein micro arrays.

FERMENTATION TECHNOLOGY & INDUSTRIAL MICROBIOLOGY

An introduction to fermentation processes – the range of fermentation processes. Microorganisms used in industrial microbiological processes – the isolation, preservation and strain improvement of industrially important microorganisms, screening methods, isolation of autotrophic mutants. Media and materials required for industrial microbiological processes – Antifoams.

Microbial growth kinetics, batch culture, continuous culture, fed batch culture and Dual or multiple fermentations. Inoculum development for large-scale processes. Design of fermentor: Construction and maintenance of aseptic conditions. Control of various parameters. Sterilization of media. Types of fermentors. Computer application in fermentation technology. Recovery and purification of fermentation products. Fermentation Economics.

Production of ethyl alcohol, beer & wine. Enzyme probe biosensors, biochips, biofilms, biosurfactants, Biotransformation, Petroleum Microbiology. Microbial leaching- role of microorganisms in the recovery of minerals (uranium, copper) from ores.

Microbial products from genetically modified (cloned) organisms ex: insulin. Microbial groups involved in biogas production, design of digester.

PATENTING: Concept and its composition & protection of right and their limitation, intellectual property rights (IPR); patenting biotechnology inventions.

ENVIRONMENTAL MICROBIOLOGY

Basic concepts of Ecology and Environment – Biological spectrum at levels of organization & realm of ecology. Ecosystem – Concept, components, food chains, food webs and tropic levels. Energy transfer efficiencies between tropic levels. Biological factors influencing the growth and survival of microorganisms- inter reactions of microbial population and community dynamics – Growth in closed environments and in open environments. The kinetic

properties of competition between microbial populations. Kinetic principles of prey-predator relationship.

AQUATIC ENVIRONMENT: Fresh water microorganisms, their zonation and characteristics. Salt water, oceans, estuaries, microorganism their zonation and characteristics. Faecal pollution of waters – water borne diseases, indicator organisms. IMVIC test, sanitary examination of water.

ATMOSPHERIC ENVIRONMENT: Dispersal of airborne microorganisms. Air Sampling principles and techniques. Air spora: Concepts and components, indoor and outdoor air spora. Diurnal periodicity patterns. Seasonal periodicity patterns. Vertical profiles.

Microorganisms and pollution: Microbial production of methyl mercury, trimethyl arsine, hydrogen sulphide, acid rain water, carbon monoxide, ammonia, nitrate, nitrogen oxides, nitrosamines, Eutrophication, algal toxins.

MICROORGANISMS AND SEWAGE TREATMENT: COD, BOD & DO, trickling filters, activated sludge process, oxidation ponds; sludge treatment (anaerobic digestion).

Bioremediation Technology – Microbial degradation of oil spills, pesticides and detergents, Biofouling; Fate of genetically engineered microorganisms in the environment. Environmental impact assessment studies.

Deterioration of materials – paper, textiles, painted surfaces, prevention of microbial deterioration.

FOOD MICROBIOLOGY & AGRICULTURAL MICROBIOLOGY

Microbiology of foods – Microbial flora of fresh foods, grains, fruits, vegetables, milk, meat, eggs and fish and their infestation by bacteria, fungi and viruses. Microbiological examination of foods- microscopic techniques and cultural techniques. Direct microscopic examination, total colony counts and differential enumeration. Identification of specific groups – Bacteria, Viruses, Fungi and Protozoa. Microbial spoilage of milk, food, types of spoilage organisms, food poisoning, mycotoxins and bacterial toxins.

Food processing & preservation: Methods of food preservation, Aseptic handling, pasteurization of milk, refrigeration and freezing, dehydration, osmotic pressure, chemicals – organic acids, nitrates, nitrites and cresols; Radiation – UV light, Y-irradiation.

Fermented foods – preparation of Yogurt, streptococcus species, Lactobacillus bulgaricus; Manufacture of cheese; Pencillium roqueforti. Fermented soybean products. Microorganisms as food – single cell protein, yeast, algae and fungal biomass production.

Soil Environment- Microorganisms, soil structure, soil profile, Physico-chemical conditions, Microbial composition, sampling techniques, role of Microorganisms in organic matter decomposition (cellulose, Hemicellulose, Lignins)

Bio-geo chemical cycles – Carbon cycle, Nitrogen cycle – Nitrogen fixation, nitrification, de-nitrification, sulpher, iron and phosphorus cycles. Rhizosphere – Rhizoshere Microorganisms, Biochelators (Siderophores).

Biofertilizers – Introduction, biofertilizers using nitrogen fixing microbes – phosphate solubilization- Rhizobium, Azatobacter, Azospirillum, Azolla; Anabaena Symbiosis, blue green algae, Mycorrihiza, Biopesticides – toxins from Bacillus thuringiensis, Psuedomonas syringae, Biological Control – Use of Baculovirus, NPV virus, protozoa & fungi in biological control.

PHARMACEUTICAL MICROBIOLOGY

Chemical disinfectants, antiseptics and preservatives. Types of Antibiotics-B-lactam antibiotics, tetracycline group Rifamycin, aminoglycoside antibiotics, macrolides, polypeptide antibiotics, glycopeptide antibiotics, miscellaneous antibacterial antibiotics and antifungal antibiotics. Production of antibiotics – Penicillin, Streptomycin, Erythromycin, bacitracin and tetracycline.

Mechanism of action of antibiotics – the bacterial cell wall, protein synthesis, chromosome function & replication, folate antagonis, the cytoplasmic membrane. Bacterial resistance to antibiotics - Intrinsic & acquired resistance, biochemical mechanism of resistance. Assay of antibiotics – Penicillin, Streptomycin.

Industrial Production of Enzymes – amylases, Proteases, organic acids- lactic acid, citric acid, vinegar, aminoacids – L-lysine, L-glutamic acid; Food supplements and hormones. Production of Vitamin B_{12}; Microbial transformation of sterioids and nonsteroids. Analytical Microbiology – microbiological assays of Vitamins (Riboflavin, B_{12}), amino acids (lysine, tryptophan).

Ecology of Microorganisms as it effects the pharmaceutical industry; Microbial spoilage & preservation of medicines using antimicrobial agents; quality assurance and the control of microbial risk in medicines. Contamination of non-sterile pharmaceuticals in hospital & community environments.

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AURCET - 2013 SYLLABUS
TEST NO. – 15: NUCLEAR PHYSICS

PAPER - II

NETWORK THEOREMS: Thevenin theorem, Norton's theorem and maximum power transfer theorem.Semiconductor **DEVICES:** Tunnel diode, LDR, Photo diode, Solar cell, LED.

UJT- characteristics and relaxation oscillator. JFET and MOSFET – construction and characteristics – and their applications. JFET as common source amplifier.

BJT – CE amplifier – voltage gain, input and output resistance, graphical analysis and analysis using h-parameter equivalent circuit.

Feedback Amplifiers : Feedback concept, types of feed back, general characteristics of negative feedback in amplifiers, voltage series feedback, current series feed back and voltage shunt feedback.

Digital Electronics: (Combinational Logic)The transistor as a switch, OR, AND and NOT gates – NOR and NAND gates – Ex OR gate. Boolean algebra and Logic implementation. Decoders and Encoders, Multiplexers and De multiplexers**.**

Digital Electronics: (Sequential Logic) Flip-Flops, one bit memory – RS flip-flop, JK flip-flop, JK – master slave flip-flop, T flip-flop. Modulo N counters.

Operational Amplifiers: Ideal Operational amplifier. Op. Amp. architecture- differential stage, gain stage, dc level shifting and output stage. Practical inverting and Non inverting Op. Amp configurations, voltage follower.

Op. Amp parameters – input offset voltage (Vio) input bias current (Iio),Output offset voltage, Common Mode Rejection Ratio(CMRR), Slew rate, Op. Amp. Open loop gain

OP. AMPLIFIER APPLICATIONS: Summing, scaling and difference of input voltages, Integrator and Differentiator. RC phase shift Oscillator. Comparators. Window -comparator, Schmitt trigger, Astable and monostable multivibrators. Voltage regulators – fixed regulators and adjustable voltage regulators.

Spectra of alkali elements- Different series in alkali spectra, Ritz combination principle, Spin-orbit interaction, Doublet structure in alkali spectra, transition rules, intensity rules.

Spectra of alkaline earths, Coupling schemes, interaction energy levels in L-S coupling and j-j coupling, singlet and triplet series in two valance electron systems. Spectrum of helium atom.

Fine and hyperfine structure of spectral lines—fine structure of hydrogen lines, Lamb shift, experimental determination of Lamb shift, hyperfine structure—experimental study and interpretation, measurement of nuclear spin.

Effect of electric and magnetic fields on the spectrum of an atom—Zeeman effect—classical interpretation of Normal Zeeman effect, Vector atom model and Zeeman effect, Vector atom model anomalous Zeeman effect, Paschen – Back effect, quantam mechanical treatment of Zeeman and Paschen-Back effect, Lande's g-factor for two valance electron system—L-S coupling and j-j coupling, Stark effect of one electron atom.

Molecular spectra of diatomic molecules-regions of the spectrum, Pure rotational spectra—salient features of rotational spectra, the molecule as a rigid rotator, diatomic molecule as a non rigid rotator, determination of bond length and moment of inertia, isotopic effect in rotational spectra, Vibrational spectra-- diatomic molecule as a harmonic oscillator, fine structure of rotation-vibration bands, Electronic transitions and Frank-Condon principle.

Raman spectra—classical and quantum theory of Raman effect, vibrational Raman spectra, pure rotational Raman spectra, vibrational-rotational Raman spectra, structure determination from Raman & infra red spectroscopy.

a. Maxwell's equations: Maxwell's Equations in Free Space and Linear isotropic media. Boundary conditions on the fields at interfaces.

b. Potential formulation of electrodynamics**:** Scalar and Vector potentials, Gauge transformations - Coulomb gauge, Lorentz gauge, Gauge invariance, Lorentz force law in

potential form. Poynting's theorem, Maxwell's Stress Tensor, Conservation of Energy and Momentum.

c. Electromagnetic waves: The Wave Equation, Electromagnetic waves in non-conducting media-Plane waves in Vacuum - Energy and Momentum of electromagnetic waves - Propagation through Linear media – Polarization Reflection and Transmission at a Conducting surface/thin layer. Dispersion - The frequency dependence of Permittivity, Permeability and Conductivity - Dispersion in non-conducting media-Cauchy's Equation.

a. Fields and Radiation by Moving Charges: Retarded Potentials - 'Lienard-Wiechert Potentials' – Electric and Magnetic fields due to a uniformly moving point charge and an accelerated charge. Power radiated by accelerated charge - Larmour's formula and its relativistic generalisation - Radiation losses in charged particle accelerators. Electric and Magnetic dipole radiation. Linear and Circular acceleration and angular distribution of power radiated, Bremsstrahlung, Synchrotron radiation and Cerenkov radiation, Radiation reaction force.

Shell Model: Evidence for shell structure in nuclei –square well potential – energy level scheme – spin orbit potential, reproducibility of magic numbers with the spin orbit splitting of energy levels – Extreme Single Particle Model, explanations of spins, parities and magnetic dipole moments of the ground and low lying excited states of nuclei, nuclear isomerism in terms of shell model.

Collective Model: Elementary considerations, evidence for the collective motions within the nuclei, pure vibrational states, deformed nuclei, pure rotational states - motions of nucleons in a deformed or non-spherical potential - exited states of deformed nuclei – Nilsson's Model - beta and gamma vibrational bands – particle-rotational coupling.

RAL Model: High spin states – back bending – rotational alignment.

Characteristics of nuclear energy levels and nature of the connecting transitions – radioactive decay and heavy ion induced nuclear reactions.

Energies and intensities of gamma rays and conversion electrons – construction of the level scheme using coincident methods – energy matrix.

Life times of nuclear excited states – delayed coincidence with gamma rays and pulsed beam – Doppler shift attenuation, recoil distance and Coulomb excitation methods – transition probabilities – single particle estimates.

Spins and parities of nuclear excited states and the nature of the connecting transitions:

a) Angular distributions in stripping and pickup reactions – angular momentum transfer – spectroscopic factors.
b) Internal conversion coefficients – XPG, NPG, summing and coincident methods – sub-shell ratios – mixing ratios - dynamic nuclear structure effects – penetration parameters.
c) Electron-gamma and gamma-gamma directional correlations – spin and parities – particle parameters - mixing ratios.
d) Directional correlation of gamma rays from nuclear excited levels populated in heavy ion induced nuclear reactions – multi-polarities from DCO ratios – linear polarization.

Static magnetic dipole and electric quadrupole moments of nuclear excited states – magnetic fields and electric field gradients at the nucleus:

a) Perturbed angular correlations – integral and differential correlations – experimental arrangement.

b) Mossbauer spectroscopy – principle of the method - experimental arrangement.

GENERAL PROPERTIES OF NUCLEI:

Size of the nuclei, nuclear binding energy, nuclear angular momentum, parity and statistics, nuclear magnetic dipole moments, Schmidt limits, nuclear quadrupole moments.

Energy release in beta decay, Fermi theory of beta decay, shape of the beta spectra, angular momentum and parity selection rules, comparative half lives, non conservation of parity, beta spectroscopy.

Energetics of gamma decay, angular momentum and parity selection rules, internal conversion, lifetimes for gamma emission, gamma ray spectroscopy.

General Characterstics of Nuclear forces, The nuclear 2-body problem--- deuteron and its simple theory—range and depth of the potential, excited states of deuteron.

n-p scattering at low energies—phase shift analysis, scattering length, spin dependence of the nuclear forces, shape independent approximation/effective range theory, coherent scattering of slow neutrons.

p-p scattering at low energies--- equivalence of p-p and n-p singlet forces, equivalence of n-n and p-p forces, exchange forces, evidence for the existence of non central forces.

Particle interactions and families, symmetries and conservation laws--- energy and momentum, angular momentum, parity, Baryon number, lepton number, isospin, strangeness and charm, the quark model, colored quarks and gluons, Grand unified theories (preliminaries only)

Introduction: Principle of detection of photons, charged particles and neutrons. (Interaction of light and heavy charged particles with matter, photoelectric, Compton and pair production)

Gas counters: Ionisation chambers, Proportional counters, Neutron detectors and G.M. counters.

Scintillation detectors: Organic and inorganic Scintillators – theory, characteristics and detection efficiency. BGO detectors – advantages of BGO over Scintillation detectors.

Solid State Detectors: Silicon Surface Barrier detectors, E - ΔE detection for charged particles, Si(Li) detectors for X-rays and electrons, HPGe detectors for photon detection. Energy resolution, efficiency and timing considerations. Introduction to Cluster and Clove detectors.

Pulse Processing and shaping:- Preamplifiers - Voltage, Current and Charge sensitive types. Resistive and Optical feed back. Main amplifiers- pulse shaping, pole-zero compensation, base line restoration and pile up rejection.

PULSE HEIGHT ANALYSIS: Single Channel analyser – integral and differential modes of operation. Simple spectrometer assembly.

MULTI CHANNEL ANALYSER: A/D converters (Wilkinson and Flash types). D/A converters (R-2R ladder type). Principle of operation and performance indices. Multi channel analyser in PHA and MCS modes.

Coincidence measurements: Slow - fast coincidence arrangement for measurement of coincidence between radiation. Prompt and chance coincidences. Experimental arrangement for energy and time coincidence measurements. Compton suppression spectrometer (Ge(Li) detectors with anti Compton BGO shield).

COUNTING STATISTICS: Statistical errors and their propagation in experimental measurements, χ^2 - test.

Liquid Drop Model: Analogy between the atomic nucleus and a drop of liquid, Weizsaekar's semi empirical mass formula, Stability considerations of nuclei – Mass parabola – discovery of nuclear fission, energy release in symmetric fission – conditions for spontaneous fission – neutron induced fission of both slow and fast neutrons.

Nuclear Reactions: Types of reactions and Conservation laws – Energetics of Nuclear Reactions – Cross sections – Neutron induced reactions – Slow neutron resonance – the two step view or the compound nucleus picture due to Bohr – Entrance and Exit channels – Level width and Level Spacing – Resonance reactions – Briet-Wigner single level formulation – Statistical model, Average level spacing and reduced width – Direct interaction Mechanisms – Angular distribution in stripping, pick up and inelastic scattering reactions – Spin, parity assignments – Total neutron cross sections. Gross structure problem – Optical model and its explanation of gross structure problem.

Cyclotron –FM Cyclotron (Synchro-Cyclotron), Microtron – Alternate gradient (strong) focussing – Variable energy cyclotron (AVF Cyclotron).

Linear Accelerator –– modern linear accelerator for electrons and charged particles.

Cockcroft Walton Accelerator – Production of 14MeV neutrons.

Van de Graaf Accelerator - Tandem Van de Graaf Accelerator – Pelletron.

Betatron – Electron Synchrotron and Proton synchrotron –– Beam transport.

Production of Neutrons: Classification of Neutrons – Slow, Intermediate and Fast Neutrons – Radioactive Sources – Photo neutron sources – Particle accelerators as sources of neutrons – Mono energetic neutrons – Reactors as source of thermal neutrons – Distribution of energy of neutrons in a thermal reactor – Thermal column – The cadmium ratio – Measurement of thermal neutron flux using foil activation method.

Interaction of neutrons with matter in bulk – Moderation of neutrons – The elastic collision – Average logarithmic energy decrement – Slowing down density and slowing down flux – Space distribution of slowing down density – Transport mean free path – Fremi Age – Point source consideration – Experimental determination of Fermi Age – Diffusion of neutrons – The basic diffusion equation – Diffusion of thermal neutrons from a infinite plane source – Point source considerations – Diffusion length and its experimental determination.

Nuclear Fission – Characteristics of Fission reaction – Fission chain reaction – Neutron Balance in chain reaction.

Reactor types – Multiplication factor for thermal reactors – Four-factor formula – Bare homogeneous thermal reactor – Critical equation – Geometrical and Material Buckling – Neutron balance in a thermal reactor – Calculation of critical size and composition in simple cases.

Heterogeneous reactors – Properties of Heterogeneous systems – Resonance capture – Volume and surface absorption – Resonance escape probability – Advantages and Disadvantages of Heterogeneous systems. The Behavior of a Bare thermal reactor with prompt and delayed neutrons – The inhour formula – Temperature effects – Fission product poisoning – Use of Coolants and Control rods.Breeder and Power reactors – Elementary considerations.

CONDENSED MATTER PHYSICS:

CRYSTAL STRUCTURE: Crystalline solids, periodic arrays of atoms – Fundamental types of lattices – index systems for crystal planes – Simple crystal structures (NaCl, CaCl and diamond)

RECIPROCAL LATTICE: Reciprocal Lattice – Derivation of Scattered wave amplitude - Reciprocal Lattice vectors – Diffraction conditions

Crystal Diffraction: Introduction – Bragg's law – Diffraction by X-rays, electrons and neutrons – Experimental methods for Crystal structure determination – The Laue, powder and rotating crystal methods

DEFECTS IN CRYSTALS: *Point defects:-* impurities – Vacancies – Schottky and Frenkel vacancies – Extrinsic vacancies – Diffusion-Color centers – F-centers , other centers in Alkali halides

LINE DEFECTS: -Edge dislocation – Screw dislocations – Burgers vectors – Slip – Plastic deformation – Crystal growth

PLANER DEFECTS:- Stacking faults – Grain boundaries – Low angle Grain boundaries Ionic Crystals: Electrostatic or Madelung energy – Evaluation of the madelung constant – Ionic crystal radii

BAND THEORY OF SOLIDS: Energy spectra in atoms, molecules and solids – Bloch theorem – acceleration of the moving electron in the periodic lattice and effective mass of the electron – The tight binding approximation – Construction of Fermi surfaces – Experimental methods in

Fermi surface studies: Cyclotron resonance, De Hass Von Alphen effect, Magneto-resistance and the anomalous skin effect

SEMICONDUCTORS: Physical significance of Fermi function and Fermi energy – Photons, Phonons, electrons and holes – Intrinsic carrier density – Intrinsic conductivity as a function of temperature and band gap – extrinsic semiconductors – semiconductor energy band structure with acceptor type and donor type impurities - extrinsic conductivity – position of Fermi level

MAGNETISM: Introduction - review of basic concepts – Wiess theory of ferromagnetism – Heisenerg model and molecular field theory. Spin waves and magnons – Curie Weiss law for susceptibility. Ferri – and antiferro-magnetic order. Domains and Bloch – wall energy.

SUPERCONDUCTIVITY: Occurrence of superconductivity – Effect of magnetic fields – Flux exclusion and Meissner effect – Heat capacity – Energy gap – Microwave and infrared properties – Isotope effect – The London equations – Meissner effect and flux penetration – High frequency effects – The BCS theory – BCS ground state

Trace elemental analysis – X-ray fluorescence technique – particle induced x-ray emission technique – neutron activation analysis technique – experimental arrangement – applications in environmental pollution studies, medicine, geology.

Rutherford back scattering spectroscopy – basic principle – experimental arrangement – applications in surface physics.

Auger electron spectroscopy – basic principle – experimental arrangement – applications in surface physics

Nuclear Magnetic Resonance – Nature of the phenomenon – Analysis – Experimental method – Determination of nuclear magnetic moments – structural studies.

Positron annihilation technique – basic principle – experimental arrangement for positron life time measurement – Doppler broadening and angular correlation studies – applications

Ion beam channeling – basic principle – experimental arrangement – applications

Neutron logging - Bulk density – applications in Geophysics.

Units of radio activity and radiation exposure – Curie, Roentgen, Becquerel – RAD – REP-REM – Gray – Sievert - RBE, AD and DE and their relations.

Protection of personnel against nuclear radiations – Radiation monitoring – film badge technique - Radioactive waste management – planning and use of radio isotopes and chemical laboratories

Structure of the living cell – cell division – direct and indirect action of ionizing radiation – Biological effects of radiations – somatic and genetic effects

Applications of radio isotopes in medicine – use of ^{131}I for the study of the thyroid – use of radioisotopes in the diagnosis and treatment of cancer – radiation therapy

Applications of radio isotopes in industry – principle of industrial radiology – non destructive testing of materials

Applications of radio isotopes in agriculture – detection of plant diseases by tracer methods – study of photo synthesis – uptake of nutrients – radiation induced genetic changes and crop improvement – preservation and sterilization of foods and drugs.

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AURCET - 2013 SYLLABUS

TEST NO. – 17 & 85: PHYSICS AND ENGINEERING PHYSICS

PAPER - II

MATHEMATICAL METHODS OF PHYSICS

Beta, Gamma & Special functions (Hermite, Laguerre and Legendre); Fourier series, Fourier and Laplace transforms; Elements of complex analysis: Laurent series-poles, residues and evaluation of integrals; Elements of computational techniques: roots of functions, interpolation, extrapolation, integration by trapezoid and Simpson's rule; Finite difference methods.

CLASSICAL MECHANICS

Newton's laws; Phase space dynamics, stability analysis; Central-force motion; Two-body collisions, scattering in laboratory and centre-of-mass frames; Rigid body dynamics, moment of inertia tensor, non-inertial frames and pseudoforces; Variational principle, Lagrangian and Hamiltonian formalisms and equations of motion; Poisson brackets and canonical transformations; Symmetry, invariance and conservation laws, cyclic coordinates; Periodic motion, small oscillations and normal modes, relativistic kinematics and mass–energy equivalence.

ELECTROMAGNETIC THEORY

Electrostatics: Gauss' Law and its applications; Laplace and Poisson equations, boundary value problems; Magnetostatics: Biot-Savart law, Ampere's theorem, electromagnetic induction; Maxwell's equations in free space and linear isotropic media; boundary conditions on fields at interfaces; Scalar and vector potentials; Gauge invariance; Electromagnetic waves in free space, dielectrics, and conductors; Reflection and refraction, polarization, Fresnel's Law, interference, coherence, and diffraction; Dispersion relations in plasma; Lorentz invariance of Maxwell's equations; Dynamics of charged particles in static and uniform electromagnetic fields; Radiation from moving charges, dipoles and retarded potentials.

QUANTUM MECHANICS

Wave-particle duality; Wave functions in coordinate and momentum representations; Commutators and Heisenberg's uncertainty principle; Matrix representation; Dirac's bra and ket notation; Schroedinger equation (time-dependent and time-independent); Eigenvalue problems such as particle-in-a-box, harmonic oscillator, etc.; Tunneling through a barrier; Motion in a central potential; Orbital angular momentum, Angular momentum algebra, spin; Addition of angular momenta; Hydrogen atom, spin-orbit coupling, fine structure; Time-independent perturbation theory and applications; Variational method; Time dependent perturbation theory and Fermi's Golden Rule; Selection rules; Semi-classical theory of radiation; Elementary theory of scattering, phase shifts, partial waves, Born approximation; Identical particles, Pauli's exclusion principle, spin-statistics connection; Relativistic quantum mechanics: Klein Gordon and Dirac equations.

THERMODYNAMIC AND STATISTICAL PHYSICS

Laws of thermodynamics and their consequences; Thermodynamic potentials, Chemical potential, phase equilibria; Phase space, micro- and macrostates; Microcanonical, canonical and grand-canonical ensembles and partition functions; Free Energy and connection with thermodynamic quantities; First- and second-order phase transitions; Classical and quantum statistics, ideal Fermi and Bose gases; Principle of detailed balance; Blackbody radiation and Planck's distribution law; Bose-Einstein condensation; Random walk and Brownian motion.

ELECTRONICS

Semiconductor device physics, diodes, junction transistors, field effect devices, UJT, SCR devices structure, device characteristics and applications; Feedback concept in amplifiers, tuned amplifiers, oscillators, multivibrators, operational amplifiers and their applications; Digital circuits – number systems, logic gates and Boolean algebra, De-Morgan laws, flip-flops, counters, shift registers, A/D and D/A converters; Microprocessor basics.

ATOMIC & MOLECULAR PHYSICS

Quantum states of an electron in an atom; Electron spin; Stern-Gerlach experiment; Spectrum of Hydrogen, helium and alkali atoms; Relativistic corrections for energy levels of hydrogen; Hyperfine structure and isotopic shift; width of spectral lines; LS & JJ coupling; Zeeman, Paschen Back & Stark effect; X-ray spectroscopy; Electron spin resonance, Nuclear magnetic resonance, chemical shift; Rotational, vibrational, electronic, and Raman spectra of diatomic molecules; Frank – Condon principle and selection rules; Spontaneous and stimulated emission, Einstein A & B coefficients; Lasers, optical pumping, population inversion, rate equation; Modes of resonators and coherence length.

CONDENSED MATTER PHYSICS

Bravais lattices; Reciprocal lattice, diffraction and the structure factor; Bonding of solids; Elastic properties, phonons, lattice specific heat; Free electron theory and electronic specific heat; Response and relaxation phenomena; Drude model of electrical and thermal conductivity; Hall effect and thermoelectric power; Diamagnetism, paramagnetism, and ferromagnetism; Electron motion in a periodic potential, band theory of metals, insulators and semiconductors; Superconductivity, type – I and type - II superconductors, Josephson junctions; Defects and dislocations; Ordered phases of matter, translational and orientational order, kinds of liquid crystalline order; Conducting polymers; Quasicrystals.

NUCLEAR AND PARTICLE PHYSICS

Basic nuclear properties: size, shape, charge distribution, spin and parity; Binding energy, semi-empirical mass formula; Liquid drop model; Fission and fusion; Nature of the nuclear force, form of nucleon-nucleon potential; Charge-independence and charge-symmetry of nuclear forces; Isospin; Deuteron problem; Evidence of shell structure, single- particle shell model, its validity and limitations; Rotational spectra; Elementary ideas of alpha, beta and gamma decays and their selection rules; Nuclear reactions, reaction mechanisms, compound nuclei and direct reactions; Classification of fundamental forces; Elementary particles (quarks, baryons, mesons, leptons); Spin and parity assignments, isospin, strangeness; Gell-Mann-Nishijima formula; C, P, and T invariance and applications of symmetry arguments to particle reactions, parity non-conservation in weak interaction.

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AURCET - 2013 SYLLABUS
TEST NO. – 19: STATISTICS
PAPER - II

Sample Space, Discrete Probability, independent events, Bayes theorem. Random Variables and distribution functions (univariate and multivariate); expectation and moments. Independent random variables, marginal and conditiomnal distributions, characterisric functions, probability inequalities(Tchebyshev, markov, Jensen), modes of convergence, weak and strong laws of large numbers, central limit theorem(i.i.d case), Markov chains with finite and countable statespace, Classification of states, limiting behaviour of n-step transition probabilities, stationary distribution.

Standard discrete and contiunuous univariate distributions. Sampling distributions. Standard errors and asymptotic distributions, distribution of ordered statistics and range. Method of estimation. Properties of estimators. Confidence intervals. Tests of Hypotheses. Most powerful and uniformly most powerful tests, Likelihood ratio tests. Analysis of discrete data and chisquare test of goodness of fit. Large sample tests.

Sample non-parametric tests for one and two sample problems, rank correlation and test for independence.

Gauss-Markov models, estimability of parameters, Best Linear Unbiased estimators, tests for Linear hypotheses and confidence intervals. Analysis of variance and covariance. Fixed, random and mixed effects models. Simple and multiple linear regression. Elementary regression diagnostics. Logistic Regression.
Multi-Variate Normal Distribution, Wishart distribution and their properties. Distribution of quadratic forms. Inferences for parameters, partial and multiple correlation coefficients and related tests. Data reduction techniques: Principle Component Analysis, Discriminant Analysis, Cluster Analysis, Canonical Correlation.

Simple random sampling, Stratified sampling and systematic sampling. Probability proportional to size sampling. Ratio and Regression Methods, Cluster sampling, two stage and multi stage sampling.

Completely randomized, randomized block and Latin square Designs. Connected, complete and orthogonal block designs, BIBD. 2k factorial experiments: Confounding and construction.

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AURCET - 2013 SYLLABUS
TEST NO. – 20: SYSTEM DESIGN
PAPER - II

DIGITAL SYSTEMS

Number system and codes: Binary, Octal, Hexadecimal number systems – Conversions – BCD Codes.

Digital logic circuits: Logic gates – Boolean algebra – Map simplification – Combinational logic circuit design – Arithmetic circuits – Flip flops – Excitation tables – Design of Register and counters

Digital components: Decodes – Encoders – Multiplexer – Demultiplexer.

COMPUTER ORGANIZATION

General register organization – Instruction formats – Addressing modes – Data transfer – Data manipulation – Program control types – Reduced instruction set computer.

I/O & Memory Organization: Peripheral deices – I/O Interface – Asynchronous data transfer – Modes of transfer – interrupts – DMA – Memory hierarchy – Main memory – AUX memory – Associate memory – Cache memory – Virtual memory.

PROGRAMMING IN C

Introduction – Character – Constants – Variables – Keywords arithmetic instruction – Assignment statements – I/O Function – Conditional statement – Expressions in C-Logical expressions and control statements – Decision control, loop control and case control structures, function arrays, syntax rules, global, local & static variables data types.

DIGITAL SIGNAL PROCESSING

Discrete time systems – Classification of discrete time systems – LTI systems and time domain characterization – Linear and circular convolution – Auto and cross Correlations – Different structures of discrete time systems – Basics of statistics – Probability and noise – Linear constant coefficient difference equations – Frequency domain representation of discrete time systems and signals – Frequency response of LTI systems – Discrete Fourier transform – DFT properties – Computation of DFT – Fast Fourier transform (DIT and DIF) – Computational considerations of FFT – Linear convolution using DFT (Overlap-add, Overlap-save methods) – Z-transform – Region of convergence of Z-transform – Inverse Z-transform –Z-transform properties – FIR filters – IIR filters – FIR design methods (Fourier, windowed and frequency sampling methods) – IIR filter design methods (Impulse invariant, bilinear transformation and other methods) – Concept of circular buffering – Finite word length effects in digital filters.

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AURCET - 2013 SYLLABUS
TEST NO. – 21: ZOOLOGY
PAPER - II

1. Biosystematics and Taxonomy

Definition and basic concepts of biosystematics and taxonomy, Importance and applications of biosystematics in biology, Material basis of biosystematics. Trends in biosystematics–concepts of different conventional and newer aspects, Chemotaxonomy, Cytotaxonomy, Molecular taxonomy, Molecular perspective on the conservation of diversity, Diversity and ecosystem process: Dimensions of speciation and taxonomy characters, Mechanisms of speciation in panmictic and apomictic species, Species concepts–species category. Theories of biological classification, hierarchy of categories, Taxonomic characters – biological mechanism of genetic incompatibility, Procedure keys in taxonomy,-taxonomic collections, preservation, curetting process of identification, International Code of Zoological Nomenclature (ICZN)–its operative principles, Zoological nomenclature, formation of scientific names of various taxa

2. Chordates and Invertebrates:

Origin of Chordata, Concepts of Protochordata, The nature of Vertebrate morphology
Origin and classification of vertebrates, Common Indian vertebrates : Fishes, amphibians, reptiles, birds & mammals, Vertebrate integument and its derivatives, Development, general structure and function of skin and its derivatives, Glands, scales, horns, claws, nails, hoofs, feathers and hairs, General plan of circulation in various groups, Evolution of heart, Evolution of aortic arches and portal systems, Respiratory system, Characters of respiratory tissue, Evolution of urinogenital system in vertebrate series, Sense organs, Simple receptors, Organs of Olfaction and taste, Lateral line system, Electroreception, Nervous system, Comparative anatomy of the brain in relation to its functions, Nerves-cranial, peripheral and autonomous nervous systems, Origin of coelom, Locomotion, Flagella and ciliary movement in Protozoa, Hydrostatic movement in Coelenterata, Annelida and Echinodermata, Nutrition andDigestion, Patterns of feeding and digestion in lower metazoa, Filter feeding in Polychaeta, Mollusca and Echinodermata, Respiration, Organs of respiration: Respiratory pigments, Mechanism of respiration, Excretion, Organs of excretion: Nephridia and Malphigian tubules, Mechanisms of excretion , Nervous system, Primitive nervous system: Coelenterata and Echinodermata, Trends in neural evolution, Invertebrate larva.

3. General Physiology:

Types of muscles and classification, Light and Electron microscopic structure of skeletal muscle, Molecular basis of muscle contraction, Sliding filament theory, Twitch, Summation, Tetanus and Fatigue, Nerve Structure of the nerve, Excitability, conductivity, Nerve Impulse, Ionic basis of resting and action potentials, Synaptic transmission, Neurotransmitters, Blood : Structure and properties of Blood, Blood coagulation – Defense mechanism , Reticulo Endothelial system : Macro phages, Immunoglobulins, Humoral Immunity and Cell- Mediated Immunity, . Blood groups and tissue antigens, Physiological adaptation of animals to different environments, Marine environment, Shores and Estuaries, Freshwater environment Terrestrial life, Extreme terrestrial environment, Parasitic habitats, Stress Physiology, Basic concept of environmental stress and strain, concepts of elastic and plastic strain; Acclimation and Acclimatization, Concept of homeostatis and homeostatic mechanisms of the body, . Thermoregulation, Exothermic and Endothermic organisms, physiological mechanism of body temperature regulation, Physiological adaptation to osmotic and ionic stress; Osmoregulation in aqueous and terrestrial environments, Physiological response to oxygen deficient stress, Physiological response to body exercise.

4. Endocrinology

Hormones as messengers, Hormones and eukaryotic metabolic regulation, Classification of hormones, Discovery of hormones, Phylogeny of endocrine glands (Pituitary, pancreas, adrenals, thyroid, Ontogeny of endocrine glands, Concept of Neurosecretion and Neuro-endocrine system in invertebrate groups, Neuro-endocrine mechanisms of moulting and growth in crustaceans, insects, Mollusca and Echinodermata, General principles of hormone action, Concept of hormone receptors, Hormonal control of homeostasis, Hormonal regulation of

carbohydrate metabolism, nitrogen and lipid metabolism, Hormone structure and Biosynthesis of hormones, Biosynthesis of steroid hormones *de novo,* Biosynthesis and amino acid derives small size hormones (Biosynthesis and simple peptide hormones, Pre- and Pro-hormones, Co-translational and post-translational modifications of hormone structure, Hormones and behaviour, Neuro-endocrine integration in vertebrate.

5. Biostatistics :

Concept of sample and Population Sampling methods - Frequency distribution - Classification and tabulation of data - Diagrammatic and graphical presentation. Measures of central tendency: Mean, Median and Mode., Measures of Dispersion - Coefficient of Variation - Standard Deviation – Variance - Standard Error., Analysis of variance – One way ANOVA Correlation and Regression, Probability – Concept and types of probabilities, Distribution– Binomial, Poisson, Normal distribution, Tests of significance–Chi-square test and Student's 't' test, Population attributes-population dispersion- population density-Natality-Mortality-Age structure-Age pyramids- Survivorship curves Remote sensing- applications in fish

6. General Ecology and Adaptation :

Origin of groups – Reproduction- passive transport - Active Locomotion - Common orientation - Mutual Attraction, Population Regulation – Effects of increased numbers – Division of labour, Population growth – Natality and Mortality Biotic Potential and Environmental resistance – Form of population growth – Logistic Curve – Stochastic and time lag models of population growth – Optimal yield, Population–Inter-specific relationships – Positive interactions – Commensalism – Mutualism – Negative interactions – Predation – Parasitism – Antibiosis, Community concept – Community dominance – Ecotone – Community composition – Stratification of community, Habitat and Ecological Niche Sympatry and Allopatry – Spatial relations of populations Home range and Territory – Homing and return migration – Emigration, Demography – Life Tables – Net Reproductive rate – Longevity and theories of ageing – Reproductive strategies, Fish population – Population density – Population structure : Year classes – Estimation of population – Population dynamics – Abundance in population and fishery – Population dynamics and fishery catches.

7. CELL AND MOLECULAR BIOLOGY :

Biomembranes, Molecular composition and arrangement, Transport across cell membrane: diffusion, active transport and pumps, uniports, symports and antiports, Membrane potential, Transport of macromolecules, Cytoskeleton, Microfilaments and microtubules, Microtubules and mitosis, Cilia and flagella, Cell movements – intracellular transport, signal transduction mechanisms Cell surface receptors, Second messenger system, MAP kinase pathways, Apoptosis Cell-Cell adhesion and communication, Ca^{++} dependent homophillic cell-cell adhesion, Ca^{++} independent homophillic adhesion, Gap junctions and connections, Integrins, Collagen, Cell cycle, Cyclines and cyclin dependent kinases, Regulation of CDK-cycline activity, Genome organization Mobile DNA, Morphological and functional elements of eukaryotic chromosomes, Protein synthesis on free and bound polysomes, Biogenesis of mitochondria and nuclei, Trafficking mechanisms,

8. GENETICS:

Concepts of evolution and theories of organic evolution with emphasis on Darwinism, Neo-Darwinism, Hardy Weinberg law of genetic equilibrium, natural selection Mutation Migration, Genetic drift, Genetic structure of natural populations, Phenotypic variation, Factors affecting human diseases frequency, Genetics of quantitative traits in populations, Analysis of quantitative traits. Estimation or habitability, Genotype – environment interactions, Inbreeding, depression and Heterosis, Genetics of speciation, Phylogenetic and biological concept of species, Patterns and mechanisms of reproductive isolation, Molecular evolution, Gene evolution, Phylogenetic gradualism and punctuated equilibrium, Micro- and macro-evolution, Molecular Phylogenetics, Phylogenetic trees?, Immunological techniques, Restriction Enzyme sites, Amino acid phylogeny-DNA-DNA hybridizations, Nucleotide sequence comparisons and homologies

9. INSTRUMENTATION:

Chemical assay, Biological assay, Principles and uses of analytical instruments, pH meter, Spectrophotometer, Ultra-centrifuge, Radio activity counter, N.M.R. Spectrophotometer, Microscopy, Principles of light, dark field, phase contrast, fluorescence, transmission electron, scanning EM, Micro-biological Techniques, Media Use of fermentors, Microbial assays, Cell culture techniques, Culture Media, Separation Techniques in biology,
chromatography and electrophoresis, Organelle separation by centrifugation, density gradient separation, Radio Isotopes.

10. Fisheries and Aquaculture :

Fish catch statistics of the world, A general survey of inland and marine fish catches of India and the world, Estimation of Inland fish, Estimation of marine fish landings and Fisheries of different Marine States., Craft and Gear used in Inland and Marine Fisheries, Freshwater Fisheries, Riverine Fisheries : River systems in India, their ecology and fisheries (Ganga, Brahmaputra, East Coast River system and West Coast river system),
Reservoir Fisheries Estuarine Fisheries, Major Estuaries of India and their fisheries (Hooghly – Matlah, Mahanadi, Godavari, Krishna, Cauvery and West Coast estuaries), Brackishwater Fisheries Chilka lake, Pulicat lake and Kerala back waters, Hilsa fishery – causes of decline and efforts for revival, Fisheries of Indian Sea, Fish populations and factors affecting the population structures, Estimation of fish yield and control of over-fishing, Fish products and By-products, EEZ and its strategy, Fish transport and marketing including fishery co-operatives, Fishery education, training and extension Freshwater Aquaculture, Selection of species for culture–Biological principles, Procurement and transportation of seed from natural resources, Transportation of brood stock and induced breeding, Construction of hatcheries and their management, Freshwater fish culture Freshwater prawn culture, Integrated Fish Farming – Paddy cum Fish Culture and Fish cum Livestock Culture, Fish nutrition, Nutritional requirements, energy metabolism, formulation and preparation of fish feeds, Brackish water aquaculture, culture of shrimps and their management and economics, Crab culture – Pond design, management of crab farm, fattening process of crab, Finfish culture – Mullets (Mugil), Milk fish (Chanos) and sea bass (Lates), Principles of establishment of crab and lobster hatcheries; Water quality management – pH, turbidity, dissolved oxygen, BOD, COD, Nitrates, Phosphates, Ammonia etc., Feed management Mariculture , Lobster culture, Mussel culture, Pearl oyster culture, Edible oyster culture, and, Sea weed culture.

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AURCET - 2013 SYLLABUS
TEST NO. – 22: FOODS, NUTRITION AND DIETETICS
PAPER - II

FOOD CHEMISTRY

STARCH CHEMISTRY: Classification of carbohydrates, types of starches, examples physical and chemical properties of starches, structure, enzymes and starch, technology of starch, Modified starches, methods of identification and extraction, browning reactions, flours and flour mixes.
PROTEIN CHEMISTRY: Chemical and physical properties, structure, denatured proteins, gel formation, theories, collagen and gelatine, determination of proteins in foods, heat treatment, pure proteins of from foods, and amino acid composition of some proteins.
LIPID CHEMISTRY: Fatty acids, types of fats, physical and chemical properties of fats, flavour changes in fats and oils, Rancidity, methods of evaluation of rancidity, methods of determination, shortening value of fats
ENZYMES: Types of enzymes in foods, function and their importance to Food Industry

ADVANCED FOOD SCIENCE

Different methods of sensory evaluation. Chemical and physico chemical methods of food evaluation.
Methods of cooking- dry and moist heat methods.
Cereals & Cereal products, Pulses, Milk & milk products, Flesh Foods: Meat, Fish and Eggs, Composition, Nutritive value Fats and Oils, Nuts and Oil seeds: Composition & Nutritive value Fruits and Vegetables. Types, composition, nutritive value, effect of cooking on plant pigments and Sources, Physical and chemical changes during ripening, cooking methods, browning reactions.
Beverages: Tea, Coffee, & Cocoa, Composition & Nutritive value.

FOOD PROCESSING AND PRESERVATION TECHNOLOGY

PHYSICAL PRINCIPLES OF FOOD PROCESSING AND PRESERVATION- Thermal processing methods, application of cold conditions, Refrigeration, Freezing etc., Irradiation, canning.
CHEMICAL PRINCIPLES OF FOOD PROCESSING – Processing by salt, sugar, curing, smoke, acids and chemicals. Additives and Preservatives- Cereal and pulse processing, Cereal and pulse based products,
FERMENTATION TECHNOLOGY: Fermentation technology of various fermented products, Milk products, beverages, vegetables, fermented soya products
OIL SEEDS PROCESSING TECHNOLOGY: Oil seed pressing, solvent extraction, purification (degumming, bleaching, refining, deodorization), hydrogenation, plasticizing, tempering, products- butter, margarine, shortening, mayonnaise, salad dressing, winterisation, inter esterification and production of MCT
MILK AND MILK PRODUCTS processing Meat, Fish and Eggs: Preservation, processing and storage of meat, fish eggs, Products.
FRUIT AND VEGETABLE PROCESSING TECHNOLOGY FOOD FORTIFICATION AND ENRICHMENT TECHNOLOGY-current trends, application, fortified foods and their production technology
FOOD SAFETY AND QUALITY CONTROL- Food adulteration, Food laws and regulations, Hygiene Methods of quality control in food industries, Shelf life testing, GMP, GHP,HACCP, Food labelling
FOOD PACKAGING: Packaging – Concepts, definition, significance, classification,.

FOOD ANALYSIS

CARBOHYDRATES: Methods and principles of starch determination, sugar determination and polarimetry, refraction index, gel strength, brix, densitometry, refractometry.
CRUDE FIBRE AND FIBRE FRACTIONS: Soluble and insoluble, neutral, detergent fibre and methods of determining fibre fractions.
TOTAL PROTEINS: Protein nitrogen and non-protein nitrogen, methods and principles in Micro and Macro determination of nitrogen, solubility separation of protein fractions electrophoresis (paper and boundary zone), ultra centrifugation and ultra filtration techniques with examples.

TOTAL FAT: Macro method and principles, method of separation of lipid fraction, neutral glycerol, fatty acids, phospholipids and cholesterol.
ASH as an indicator of total mineral content. Estimation of different minerals in foods
INSTRUMENTATION: Application of spectroscopy, flame photometry, atomic absorptiometry, colorimetry procedures and principles in food analysis with suitable examples. Principles and Application of Chromatographic procedures in food analysis: Ion exchange, thin layer, solid, liquid, gas, column, paper and gas and high performance liquid chromatography with suitable examples.

FOOD MICRO BIOLOGY

Brief history of Micro biology, General classification of Micro organisms- Family-genus-species, study of their morphology, cultural characteristics and biochemical activities-Micro organisms of importance to foods. Growth curve of a typical bacterial cell, Factors affecting the growth of micro organisms. Beneficial and harmful activities of micro organisms. Beneficial micro organisms- role in oriental and traditional foods, Probiotics and prebiotics. Brief account of fermentation technology. Role of micro organisms in antibiotics. Food poisoning and food infections- causative agents, symptoms and foods involved their prevention.. Bacterial &viral diseases of man. Pathogenic yeasts and Moulds
Methods of detection and isolation of micro organisms in foods: conventional methods, newer techniques viz. radio immuno assays and immuno diffusion. Culture media-solid and liquid media, isolating pure cultures and culturing techniques. Micro biological analysis of water-test for coli forms-most probable no, differential test.

HUMAN NUTRITION

ENERGY- Energy content of foods**,** physiological fuel value, TEE, Energy balance, Basal metabolic rate, total energy requirements, BMR & RMR, Factors affecting BMR, Body composition, methods of assessment, Changes in body weight and body composition with the changing energy balance, Thermic effect of food, Associated nutritional problems - PEM, Obesity
CARBOHYDRATES, PROTEINS& LIPIDS Functions, sources, Dietary requirements and recommended allowances with respect to various stages of life and for different activity. Hormonal control of carbohydrate homeostasis, Fructo Oligo saccharides, Dietary Fibre and its role in health and disease. Evaluation of protein quality . Role of n3 & n6 in health and disease, Trans fatty acids, Prostaglandins, Cholesterol
VITAMINS AND MINERALS - sources, functions, deficiency, and toxicity, dietary requirements and the recommended allowances with respect to various stages of life and for different activities.

NUTRIENT INTERACTIONS- vitamin and mineral, macro and micro nutrients
INTERACTIONS BETWEEN DRUGS,NUTRIENTS- Effect of drugs on Nutrient intake, absorption, Metabolism and requirements, Drugs affecting the intake of food and nutrients and their absorption

NUTRITIONAL BIOCHEMISTRY

CARBOHYDRATE METABOLISM- Classification of carbohydrates, biochemical functions, Glycolysis, TCA cycle, oxidative phosphorylation; HMP Shunt, energetics of aerobic and anaerobic Breakdown, Glycogenesis, Glcogenolysis, Gluconeogenesis and Regulation, Regulation of blood glucose, Altered metabolism in Diabetic Mellitus
ENZYMES- Classification, biochemical functions, intracellular distribution of enzymes, Enzymes in clinical diagnosis (SGPT, SGOT, alkaline phosphatase).
PROTEIN METABOLISM- Classification of proteins; Amino acids and its classification , Pathway of entry of amino acids into TCA cycle; Transamination, deamination (oxidative and non-oxidative pathway); Decarboxylation for amino acids, Detoxification of ammonia, Urea cycle, biosynthesis of amino acids, Protein biosynthesis (Transcription and Translation) , Creatine and creatine synthesis,- Changes in serum protein levels in PEM, pregnancy and liver disorders.
LIPID METABOLISM- Classification, functions, Biosynthesis and oxidation of fatty acids, Ketosis and control mechanisms and steps of ketone bodies formation, cholesterol synthesis; bile acids metabolism, triglycerides , Lipoproteins, prostaglandins in health and disease

BIOLOGICAL OXIDATION: Concept of enzyme system and carriers in oxidation chain reactions, respiratory chain components, functions, redox potentials, energy carriers and oxidative phosphorylation

METABOLISM OF NUCLEIC ACIDS- Biosynthesis and degradation of purine and pyrimidine ring nucleotides, regulation of bio-synthesis, and conversion to bio nucleotides

INBORN ERRORS OF METABOLISM- Alcaptoneria; Phenylketonuria, Albinism; Homocystinuria; Cystinuria, Maple Syrup Urine Disease; Galactosemia; Glycogen storage disease; Fructosuria; Pentosuria; Wilson's disease.

DIET THERAPY

INTRODUCTION to diet therapy, **MENU PLANNING-** principles, factors to be considered, food guide pyramid and food exchange lists. Standardization of recipes and portions.

NUTRITIONAL NEEDS AND DIET MANAGEMENT THROUGHOUT LIFE CYCLE

THERAPEUTIC DIETS- MODIFICATION of normal diet to suit special needs. Routine hospital diets, regular diet, light diet, soft diet, liquid diet, tube-feeding, parenteral feeding, commercial formula feeds.

Nutritional care for weight management- Overweight, obesity, underweight.

Dietary management in Gastro intestinal diseases

Dietary management in liver and gall bladder disorders

Dietary management in Diabetes mellitus

Dietary management in renal disorders

Dietary management in Cardio vascular disorders

Dietary management in respiratory disorders

Dietary management in cancers

COMMUNITY NUTRITION

CONCEPT OF COMMUNITY NUTRITION AND MALNUTRITION- Indicators of mal nutrition, IMR, MMR,CMR, birth Rate, Death Rate, Total fertility rate, Identification of vulnerable groups- pregnant women, nursing mothers, infants and children. Impact of malnutrition on National Development. Nutritional problems in India- Xeropthalmia, Anemia, Ricketts, Iron deficiency disorders etc. Nutrition Intervention Schemes and programmes operating in India- ICDS, Mid day Meals, Vitamin A Prophylaxis, anemia control, Goiter control, role of various National and International agencies in promoting nutrition and health status of the vulnerable sections of the society. Ex. FAO, WHO, UNICEF, CARE, NIN, CFTRI.

ASSESSMENT OF NUTRITIONAL STATUS OF COMMUNITY- Clinical, Bio-chemical and Anthropometric Measurements.Comparison with standards of ICMR and NCHS, classification according to grades of malnutrition, Clinical signs and symptoms for PEM, and deficiencies of vitamins and minerals. Biochemical parameters for assessing the nutritional status, Diet surveys.

Role of Communication and Mass media in Nutrition and Health education, Channels of communication, Impact of Mass media communication on modification of food and nutrition behaviour.

Nutrition education- planning, conducting and evaluating nutrition education programmes.

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