

# L\_5\_General\_Ed\_Science\_Stream

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## I MATHEMATICS

### Paper-I : GEOMETRY : PLANE AND SOLID

#### SECTION-A

##### Pair of Straight Lines :

Joint equation of pair of straight lines and angle between them, Condition of parallelism and perpendicularity, Joint equation of the angle bisectors, Joint equation of lines joining origin to the intersection of a line and a curve.

##### Circle :

General equation of circle, Circle through intersection of two lines, Tangents, normals, chord of contact, pole and polar, pair of tangents from a point, equation of chord in terms of mid-point, angle of intersection and orthogonality, power of a point w.r.t. circle, radical axis, coaxial family of circles, limiting points.

##### Conic :

General equation of a conic, tangents, normals, chord of contact, pole and polar, pair of tangents from a point, equation of chord in terms of mid-point, diameter. Conjugate diameters of ellipse and hyperbola, special properties of parabola, ellipse and hyperbola, conjugate hyperbola, asymptotes of hyperbola, rectangular hyperbola.

#### SECTION-B

##### Transformation of Axes in two Dimensions :

Shifting of origin, rotation of axes, invariants, reduction of general second degree equation into standard forms by transformation, identification of curves and to find other parameters, tracing of conics.

##### Polar Co-ordinates :

Polar equation of a line, circle, conics, equations of chords, tangents and normals only.

##### Transformation of Axes in three Dimensions :

Shifting of origin, rotation of axes.

##### Sphere :

Section of a sphere and a plane, spheres through a given circle, intersection of a line and a sphere, tangent line, tangent plane, angle of intersection of two spheres and condition of orthogonality, power of a point w.r.t. a sphere, radical planes, radical axis, radical center, coaxial family of spheres, limiting points.

Cylinder :

Cylinder as a surface generated by a line moving parallel to a fixed line and through a fixed curve, different kinds of cylinders such as right circular, elliptic, parabolic and hyperbolic cylinders in standard forms, enveloping cylinders.

Cone :

Cone with a vertex at the origin as the graph of a homogeneous equation of second degree in  $x, y, z$ , cone as a surface generated by a line passing through a fixed curve and a fixed point outside the plane of the curve, reciprocal cones, right circular and elliptic cones, right circular cone as a surface of revolution obtained by rotating the curve in a plane about an axis, enveloping cones.

Equations of ellipsoid, hyperboloid and paraboloid in standard form, tangent planes and normals.

## Paper-II : CALCULUS

### SECTION-A

Properties of Real Numbers :

Order property of real numbers, bounds, l.u.b. and g.l.b. order completeness property of real numbers, archimedian property of real numbers.

Limits :definition of the limit of a function, basic properties of limits, infinite limits.

Continuity :Continuous functions, types of discontinuities, continuity of composite functions, continuity of  $|f(x)|$ , sign of a function in a neighborhood of a point of continuity, intermediate value theorem, maximum and minimum value theorem.

Hyperbolic, inverse hyperbolic functions of a real variable and their derivatives, successive differentiation, Leibnitz's theorem.

Mean Value Theorems :Rolle's Theorem, Lagrange's mean value theorem, Cauchy's mean value theorem, their geometric interpretation and applications, Taylor's theorem, Maclaurin's theorem with various forms of remainders and their applications.

Curvature :Curvature of a curve at a point, radius of curvature of Cartesian, parametric, polar curves and for implicit equations, evolute and involute, chord of curvature.

### SECTION-B

Indeterminate forms, Asymptotes, Concavity, Convexity and points of inflexion, Multiple points, Tracing of curves (Cartesian and parametric co-ordinates only).

Integral Calculus :

Integration of hyperbolic and inverse hyperbolic functions, Reduction formulae, Application of definite integral, Quadrature, Rectification, Volumes and Surfaces of solids of revolution (Cartesian co-ordinates only).

## Paper- III : ALGEBRA AND TRIGONOMETRY

### SECTION-A

Relation between sides and trigonometric ratios of the angles of a triangle, Circum-circle, in-circle, ex-circles of a triangle and their radii, Orthocentre, and centroid.

De'Moivre's theorem, application of De'Moivre's theorem including primitive  $n^{\text{th}}$  root of unity. Expansions of  $\sin n \theta$ ,  $\cos n \theta$ ,  $\sin^n \theta$ ,  $\cos^n \theta$  ( $n \in \mathbb{N}$ ). The exponential, logarithmic, direct and inverse circular and hyperbolic functions of a complex variable.

Euclid's algorithm, synthetic division, roots and their multiplicity. Complex roots of real polynomials occur in conjugate pairs with same multiplicity. Relation between roots and coefficients. Transformation of equations. Descartes' Rule of Signs.

### SECTION-B

Solution of cubic and bi-quadratic equations, Cardan's method of solving a cubic, discriminant and nature of roots of real cubic, trigonometric solutions of a real cubic with real roots. Descartes' and Ferrari's method for a bi-quadratic.

Hermitian and Skew-Hermitian matrices, linear dependence of row and column vectors, row rank, column rank and rank of a matrix and their equivalence. Theorems on consistency of a system of linear equations (both homogeneous and non-homogeneous). Eigen-values, eigen-vectors and characteristic equation of a matrix, Cayley-Hamilton theorem and its use in finding inverse of a matrix.

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## II PHYSICS

Course 1: Mechanics, Oscillations and Properties of Matter

Course 2: Electricity, Magnetism and Electromagnetic Theory.

Course 3: Laboratory I

Course 1: MECHANICS, OSCILLATIONS AND PROPERTIES OF MATTER

1.1 Mechanics :

- Uniformly rotating frame; centripetal acceleration, Coriolis force and its applications.
- Center of mass, equation of motion, conservation of linear and angular momenta, conservation of energy, elastic and inelastic collisions.
- Rigid body motion, rotational motion, moments of inertia and their products, principal moments and axes. Euler's equations.

1.2 Oscillations :

- Harmonic oscillations, differential equation and its solution, kinetic and potential energy, Compound pendulum, Oscillations of two masses connected by a spring.
- Superposition of two simple harmonic motions of the same and different frequencies along the same line, Lissajous figures.

- Damped harmonic oscillators, power dissipation, quality factor, examples, driven harmonic oscillator, transient and steady states, power absorption, resonance in systems.

### 1.3 Motion of charged particles in electric and magnetic fields

- E as accelerating and deflecting field-CRO, sensitivity, fast CRO, Linear accelerator.
- Transverse B field; 180° deflection, mass spectrograph or velocity selector.
- Mutually perpendicular E and B fields-velocity selector, its resolution.
- Parallel E and B fields; positive ray parabolas, discovery of isotopes, elements of mass spectrography, principle of magnetic focusing (lens).

### 1.4 Properties of matter

- Elasticity, Hooke's law, bending moments and shearing forces.
- Equations of continuity for fluids, Euler's equation, Bernoulli's theorem, viscous fluids, streamline and turbulent flow. Poiseuille's law. Capillary tube flow.
- Surface tension and surface energy, wetting.

## Course 2: ELECTRICITY, MAGNETISM AND ELECTROMAGNETIC THEORY

### 2.1 Mathematical Background

- Functions of two and three variables, partial derivatives, geometrical interpretation of partial derivatives of functions of two variables. Total differential of a function of two and three variables, higher order derivatives, applications.
- Repeated integrals of a function of more than one variables, definition of a double and a triple integral, evaluation of double and triple integrals as repeated integrals, change of variables of integration, Jacobian applications.

### 2.2 Electrostatics

- Coulomb's law in vacuum expressed in vector forms, dipole and quadrupole fields.
- Work done on a charge in an electrostatic field expressed as a line integral, conservative nature of the electrostatic field. Electric potential  $\phi$ ,  $E = -\nabla\phi$ , torque on a dipole in a uniform electric field and its energy, flux of the electric field, Gauss's law and its application for finding E for symmetric charge distributions,. Screening of E field by a conductor, capacitors, electrostatic field energy.
- Dielectrics, parallel plate capacitor with a dielectric, dielectric constant, polarization and polarization vector, displacement vector D.

### 2.3 Electric Currents (steady and alternating)

- Steady current, current density J, Kirchoff's law and analysis of multiloop circuits, rise and decay of current in LR and CR circuits, decay constants, transients in LCR circuits, AC circuits, complex numbers and their applications in solving AC circuit problems, complex impedance and reactance, series and parallel resonance, Q factor

### 2.4 Magnetostatics

- Force on a moving charge; Lorentz force equation and definition of  $\mu_0$ , force on a straight conductor carrying current in a uniform magnetic field, torque on a current loop, magnetic dipole moment, angular momentum and gyromagnetic ratio. Biot and Savart's Law, calculation of H order in simple geometrical situations, Ampere's Law  
 $\nabla \cdot \mathbf{B} = 0$ ,  $\nabla \times \mathbf{B} = \mu_0 \mathbf{J}$ , field due to a magnetic dipole.

## 2.5 Time Varying Fields and Electromagnetic Waves

- Electromagnetic induction, Faraday's law, electromotive force,  $\epsilon = \int \mathbf{E} \cdot d\mathbf{r}$ , integral and differential forms of Faraday's law, mutual and self inductance, transformers, energy in a static magnetic field.
- The wave equation satisfied by E and B, plane electromagnetic waves in vacuum, Poynting's vector, Faraday effect.

## Course 3: LABORATORY I

(Any 15 experiments with at least 1 from each group from the lists of 7 groups given below.)

### 3.1 Mechanics, Oscillations and Properties of Matter

#### 3.1.1 Mechanics

1. Study of laws of parallel and perpendicular axes for moment of inertia.
2. Study of conservation of momentum in two dimensional oscillations.

#### 3.1.2 Oscillations

1. Study of a compound pendulum
2. Study of damping of a bar pendulum under various mechanics
3. Study of oscillations under a bifilar suspension
4. Potential energy curves of a 1-Double system and oscillations in it for various amplitudes
5. Study of oscillations of a mass under different combinations of springs

#### 3.1.3 Properties of Matter

1. Study of bending of a cantilever or a beam
2. Study of torsion of a wire (static and dynamic methods)
3. Study of flow of liquids through capillaries
4. Determination of surface tension of a liquid by different methods
5. Study of viscosity of a fluid by different methods

### 3.2 Electricity, Magnetism and Electromagnetic Theory

#### 3.2.1 Electrostatics

1. Characteristics of a ballistic galvanometer
2. Setting up and using an electroscope or electrometer

#### 3.2.2 Moving Charges and Magnetostatics

1. Use of a vibration magnetometer to study a field
2. Study of B field due to a current
3. Measurement of low resistance by Carey-Foster bridge or otherwise
4. Measurement of inductance using impedance at different frequencies

5. Measurement of capacitance using impedance at different frequencies
6. Study of decay of currents in LR and RC circuits
7. Response curve for LCR circuit and resonance frequency and quality factor

### 3.2.3 Varying Fields and Electromagnetic Theory

1. Sensitivity of a cathode-ray oscilloscope
2. Characteristics of a choke
3. Measurement of inductance
4. Study of Lorentz force
5. Study of discrete and continuous LC transmission lines

### 3.3 Computer Programming I

1. Elementary Fortran programs, flowcharts and their interpretation
  2. To print out all natural even/odd numbers between given limits
  3. To find maximum, minimum and range of a given set of numbers
  4. To compile a frequency distribution and evaluate moments such as mean; standard deviation etc.
  5. To evaluate sum of finite series and the area under a curve
  6. To find the product of two matrices
  7. To find a set of prime numbers and Fibonacci series
  8. Motion of a projectile using computer simulation
  9. Numerical solution of equation of motion
  10. Motion of particle in a central force field
  11. To find the roots of a quadratic equation
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## III CHEMISTRY

### Paper I Inorganic Chemistry – I

#### I Atomic Structure

Idea of de Broglie matter waves, Heisenberg uncertainty principle, atomic orbitals, Schrodinger wave equation, significance of  $\psi$  and  $\psi^2$ , quantum numbers, radial and angular wave functions and probability distribution curves, shapes of s, p, d orbitals.

#### II Periodic Properties

Atomic and ionic radii, ionization energy, electron affinity and electronegativity - definition, methods of determination or evaluation, trends in periodic table.

#### III Chemical Bonding

- A. Covalent Bond - Valence bond theory and its limitations, directional characteristics of covalent bond, various types of hybridization and shapes of simple inorganic molecules and ions. Valence shell electron pair repulsion (VSEPR) theory to  $\text{NH}_3$ ,  $\text{H}_3\text{O}^+$ ,  $\text{SF}_4$ ,  $\text{ClF}_3$ ,  $\text{ICl}_2^-$  and  $\text{H}_2\text{O}$ . MO theory, homonuclear and heteronuclear (CO and NO) diatomic molecules, multiple (center bonding in electron deficient molecules, bond strength and bond energy, percentage ionic character from dipole moment and electronegativity difference.
- B. Ionic Solids - ionic structures, radius ratio effect and coordination number, limitation of

radius ratio rule, lattice defects, semiconductors, lattice energy and Born-Haber cycle, solvation energy and solubility of ionic solids.

C. Weak Interactions - Hydrogen bonding, van der Waals forces

IV p-Block Elements

Comparative study (including diagonal relationship) of groups 13-17 elements, hydrides of boron-diborane and higher boranes, borazine, fullerenes, carbides, fluorocarbons, silicates (structural principle).

VI Chemistry of Noble Gases

Chemical properties of the noble gases, chemistry of xenon, structure and bonding in xenon compounds.

## PAPER II Organic Chemistry – I

I Structure and Bonding

Hybridization, bond lengths and bond angles, bond energy, localized and delocalized chemical bond, van der Waals interactions, inclusion compounds, clathrates, charge transfer complexes, resonance, hyperconjugation, aromaticity, inductive and field effects, hydrogen bonding.

II Mechanism of Organic Reactions

Curved arrow notation, drawing electron movements with arrows, half-headed and double-headed arrows, homolytic and heterolytic bond breaking. Types of reagents-electrophiles and nucleophiles. Types of organic reactions. Energy considerations. Reactive intermediates - carbocations, carbanions, free radicals, Carbenes, arynes and nitrenes (with examples).

III Stereochemistry of Organic Compounds

Concept of isomerism. Types of isomerism.

Optical isomerism - elements of symmetry, molecular chirality, enantiomers, stereogenic centre, optical activity, properties of enantiomers, chiral and achiral molecules with two stereogenic centres, diastereomers, threo and erythrodiastereomers, meso compounds, resolution of enantiomers, inversion, retention and racemization.

Relative and absolute configuration, sequence rules, D&L and R&S systems of nomenclature.

Geometric isomerism – Basic Concept

IV Alkanes and Cycloalkanes

IUPAC nomenclature of branched and unbranched alkanes, methods of formation (with special reference to Wurtz reaction, Kolbe reaction, Corey-House reaction and decarboxylation of carboxylic acids), physical properties and chemical reactions of alkanes.

Mechanism of free radical halogenation of alkanes: orientation, reactivity and selectivity. Cycloalkanes - nomenclature, methods of formation, chemical reactions.

V Alkenes, Cycloalkenes, Dienes and Alkynes

Nomenclature of alkenes, methods of formation, mechanisms of dehydration of alcohols and dehydrohalogenation of alkyl halides, regioselectivity in alcohol dehydration. The Saytzeff rule, Hofmann elimination, physical properties and relative stabilities of alkenes. Chemical reactions of alkenes - mechanisms involved in hydrogenation, electrophilic and free radical additions, Markownikoff's rule, hydroboration-oxidation, oxymercuration-reduction. Epoxidation, ozonolysis, hydration, hydroxylation and oxidation with  $\text{KMnO}_4$ . Polymerization of alkenes.

Methods of formation, conformation and chemical reactions of cycloalkenes. Nomenclature and classification of dienes: isolated, conjugated and cumulated dienes. Diels-Alder reaction.

Nomenclature, structure and bonding in alkynes. Methods of formation. Chemical reactions of alkynes, acidity of alkynes. Mechanism of electrophilic and nucleophilic addition reactions.

## VI Arenes and Aromaticity

Nomenclature of benzene derivatives. The aryl group. Aromatic nucleus and side chain. Structure of benzene: molecular formula and Kekule structure. Stability and carbon-carbon bond lengths of benzene, resonance structure, MO picture.

Aromaticity: the Huckel rule, aromatic ions.

Aromatic electrophilic substitution - general pattern of the mechanism, role of s- and p-complexes. Friedel-Crafts reaction. Activating and deactivating substituents, orientation and ortho/para ratio. Birch reduction.

Methods of formation and chemical reactions of alkylbenzenes

## VII Alkyl and Aryl Halides

Nomenclature and classes of alkyl halides, methods of formation, chemical reactions. Mechanisms of nucleophilic substitution reactions of alkyl halides,  $\text{S}_{\text{N}}2$  and  $\text{S}_{\text{N}}1$  reactions with energy profile diagrams.

Polyhalogen compounds: chloroform, carbon tetrachloride.

Methods of formation of aryl halides, nuclear and side chain reactions.

## PAPER III-Physical Chemistry – I

### I Mathematical Concepts and Computers

#### (A) Mathematical Concepts

Logarithmic relations, curve sketching, linear graphs and calculation of slopes, differentiation of functions like  $k_x$ ,  $e^x$ ,  $x^n$ ,  $\sin x$ ,  $\log x$ ; maxima and minima, partial differentiation and reciprocity relations. Integration of some useful/relevant functions; permutations and combinations. Factorials. Probability.

### II Gaseous States

Postulates of kinetic theory of gases, deviation from ideal behavior, van der Waals equation of state.

Critical Phenomena : PV isotherms of real gases, continuity of states, the isotherms of van der Waals equation, relationship between critical constants and van der Waals constants, the law of corresponding states, reduced equation of state.

- Molecular velocities: Root mean square, average and most probable velocities. Qualitative discussion of the Maxwell's distribution of molecular velocities, collision number, mean free path and collision diameter. Liquification of gases (based on Joule-Thomson effect).
- III Liquid State  
Intermolecular forces, structure of liquids (a qualitative description). Structural differences between solids, liquids and gases. Liquid crystals: Introduction.
- IV Solid State  
Definition of space lattice, unit cell. Laws of crystallography - (i) Law of constancy of interfacial angles (ii) Law of rationality of indices (iii) Law of symmetry. Symmetry elements in crystals. X-ray diffraction by crystals. Derivation of Bragg equation. Determination of crystal structure of NaCl and CsCl (Laue's method and Powder method).
- V Colloidal State  
Definition of colloids, classification of colloids. Solids in liquids (sols): properties - kinetic, optical and electrical; stability of colloids, protective action, Hardy-Schulze law, gold number. Liquids in liquids (emulsions): types of emulsions, preparation. Emulsifier. Liquids in solids (gels): classification, preparation and properties, inhibition, general
- VI Chemical Kinetics and Catalysis  
Chemical kinetics and its scope, rate of a reaction, factors influencing the rate of a reaction - concentration, temperature, pressure, solvent, light, catalyst. Concentration dependence of rates, mathematical characteristics of simple chemical reactions - zero order, first order, second order, pseudo order, half life and mean life. Determination of the order of reaction - differential method, method of integration, method of half life period and isolation method.  
Effect of temperature on rate of reaction, Arrhenius equation, concept of activation energy.  
Simple collision theory based on hard sphere model, transition state theory (equilibrium hypothesis).  
Catalysis, characteristics of catalysed reactions, classification of catalysis, miscellaneous examples.

#### PAPER IV Laboratory Course I

##### Inorganic Chemistry

Semimicro Analysis - cation analysis, separation and identification of ions from Groups I, II, III, IV, V and VI. Anion analysis.

##### Organic Chemistry

###### Determination of melting point

Naphthalene 80 – 82°, Benzoic acid 121.6 -122°

Urea 152.5 – 133°, Succinic acid 184.5-185°

Determination of boiling points (any two)

Ethanol 78°, Cyclohexane 81.4°, Toluene 110.6°, Benzene 80°

###### Mixed melting point determination

Urea-Cinnamic acid mixture of various compositions (1:4, 1:1, 4:1)

#### Distillation

Simple distillation of ethanol-water mixture using water condenser  
Distillation of nitrobenzene and aniline using air condenser

#### Crystallization (any two)

Concept of induction of crystallization

Phthalic acid from hot water (using fluted filter paper and stemless funnel)

Acetanilide from boiling water

Naphthalene from ethanol

Benzoic acid from water

#### Decolourisation and crystallization using charcoal

Decolorisation of brown sugar (sucrose) with animal charcoal using gravity filtration.

Crystallization and decolorisation of impure naphthalene (100 g of naphthalene mixed with 0.3 g of Congo Red using 19 decolorising carbon) from ethanol.

#### Qualitative Analysis

Detection of extra elements (N, S and halogens) and functional groups (phenolic, carboxylic, carbonyl, esters, carbohydrates, amines, amides, nitro and anilide) in simple organic compounds.

### PHYSICAL CHEMISTRY

#### Chemical Kinetics

1. To determine the specific reaction rate of the hydrolysis of methyl acetate/ethyl acetate catalyzed by hydrogen ions at room temperature.
2. To study the effect of acid strength on the hydrolysis of an ester.

#### Distribution Law

To study the distribution of iodine between water and  $\text{CCl}_4$ .

#### Viscosity, Surface Tension

1. To determine the percentage composition of a given mixture (non interacting systems) by viscosity method.
2. To determine the percentage composition of a given binary mixture by surface tension method (acetone & ethyl methyl ketone).

OR

Simultaneous measurements of surface tension and viscosity with Survisometer.

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## V COMPUTER SCIENCE

Paper A Theory Computer Fundamentals & C Programming

Paper B Theory PC Software under Windows

Paper C Practical Practicals based on Paper-A and Paper-B

### I Paper-A : COMPUTER FUNDAMENTALS AND C PROGRAMMING

#### 1.1 SECTION-A

- Information Concepts and Processing :
- Evolution of information processing, Data, Information language and communication. Elements of a computer processing system : Hardware-CPU, storage devices and media.
- VDU, Input-output devices, data communication equipment. Software — System software, Application software.
- Programming Languages : Classification, machine code, assembly language, higher level languages.
- Fourth generation languages.

## 1.2 SECTION-B

- Operating Systems : Concept as resource manager and coordinator of processor, devices and memory.
- Concept of priorities, protection and parallelism. Command interpreter, typical commands of DOS/ UNIX/ Netware, GUI-Windows.
- Computers and Communication : Single user, multi-user, workstation, and client server systems. Computer networks, Network protocols. LAN, WAN, Services offered by Internet.

## 1.3 SECTION-C

- Information Integrity Definition, Ensuring Integrity, Computer Security : Perverse software, concepts and components of security, preventive measures and treatment.
- Range of Applications : Scientific, word processing, spread sheets, e-commerce, business, educational, industrial, national level weather forecasting, remote sensing, planning multilingual applications.

## 1.4 SECTION-D

- Problem analysis, flow charts, decision tables, pseudo codes and algorithms.
- Algorithmic Programming Language : Representation of integers, characters, constants and variables, arithmetic expressions and their evaluation using rules of hierarchy. Assignment statements, logical constants, variables and expression, control structures—sequencing, alteration, iteration, arrays, manipulating vector and matrix. Subroutines and linkage. Data management. Sample I/O statements, Documentation, Debugging. Examples illustrating structured program development methodology. C should be used as the teaching language.

## II Paper-B : PC SOFTWARE UNDER WINDOWS

### II.1 SECTION-A

- Concept of files and directories. Basic DOS commands for handling files and directories, use of wildcards, batch files, autoexec bat file creation of batch files, replaceable parameters, and MS- DOS editing and function keys, Line editor, configuring DOS, role of config.sys file, FDISK commands.

### II.2 SECTION-B

- Introduction to graphical user interface, window operating system, Anatomy of

windows, organising folders and files, multitasking, recycle bin, my computer, windows explorer, control panel.

### **II.3 SECTION-C**

- Word Processing : Creation, editing, formatting of documents, global search and replacement of text, special print features, mailmerge, spelling checker, MS-Word should be used as teaching tool.

### **II.4 SECTION-D**

- Spread Sheet : Getting started with EXCEL, EXCEL worksheet, entering data into worksheet, editing, cell addressing, ranges and range names, commands, menus, copying and moving cell contents, inserting and deleting rows and columns, column—width control, cell protection, printing reports, creating and displaying graphs, printing graphs, statistical functions.
- MS-Power Point software for presentation.

## **III Paper C : PRACTICAL : PRACTICALS BASED ON PAPERS A & B.**

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## **V APPLIED STATISTICS**

### **Paper-A : MATHEMATICAL METHODS-I**

#### **SECTION-I (CALCULUS AND TRIGONOMETRY)**

- Limits and continuity of functions, derivatives and their geometrical interpretations. Applications of derivatives to maxima and minima, exponential and logarithmic functions, integrals of functions of one variable, geometrical interpretation of integral as area, integration of standard functions, integration by substitution and parts.
- Trigonometry : Definition of an angle, its various measures and relations between them, graphs, circular functions.

#### **SECTION-II (ALGEBRA AND GEOMETRY)**

- The solution of linear and quadratic equations in one variable, arithmetic, geometric and harmonic progressions, permutations and combinations, principle of induction, binomial theorem for positive integral index.
- Elementary Analytical Geometry : Equations of straight line, parabola, and hyperbola.

### **Paper-B : PROBABILITY**

#### **SECTION-I**

Random experiments, sample space, events, probability-Finite sample spaces, equally likely outcomes, conditional probability, Bayes theorem; independent events, random variables, discrete and continuous probability density functions.

## SECTION-II

Expectation and variance of random variable.

Binomial, Poisson, geometric, hypergeometric, uniform, exponential and normal distributions.

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## VI BOTANY

- Theory Paper-A Diversity of Microbes &
- Theory Paper-B Cell Biology & Genetics

One practical pertaining to entire syllabus included in both theory papers

Paper A : DIVERSITY OF MICROBES &  
CRYPTOGAMS

### UNIT-I

Algae : General characters, classification and economic importance; structure and life history of Volvox, Oedogonium (Chlorophyceae); Vaucheria (Xanthophyceae); Ectocarpus (Phaeophyceae); Batrachospermum (Rhodophyceae).

### UNIT-II

Fungi : General characters, classification and economic importance; structure and life history of Cystopus (Albugo) (white rust of crucifers) Rhizopus; Saccharomyces, Peziza; Ustilago (loose smut of wheat), Puccinia (black rust of wheat), Agaricus, Colletotrichum (Red rot of sugarcane); general account of Lichens.

### UNIT-III

Bryophyta : General characters, classification; structure, reproduction and life cycle of Marchantia (Hepaticopsida); Anthoceros (Anthocerotopsida); Funaria (Bryopsida) (excluding developmental stages).

### UNIT-IV

Pteridophyta : General characters, classification; structure, reproduction and life cycle of Rhynia (Psilophytopsida); Selaginella (Lycopsida); Equisetum (Sphenopsida); Pteris (Pteropsida) (excluding developmental stages).

Paper-B : CELL BIOLOGY & GENETICS

### UNIT-I

Ultra structure and functions of a typical plant cell and its organelles. Presence and function of mitochondrial and plastid DNA; Plasmids.

Structure of chromosome; nucleosome model; chromosomal alterations (deletions,

duplications, translocations, inversions); variations in chromosome number (aneuploidy, polyploidy) a brief account.

## UNIT-II

Cell divisions (Mitosis and Meiosis) in plants and their significance. Structure and Replication of DNA. Mendelism (Laws of segregation dominance and independent assortment); Incomplete dominance and linkage (complete and incomplete); Chromosome mapping; cytological interpretation of Mendelism.

## UNIT-III

Chromosome theory of heredity; Gene interactions (Dominant and recessive epistasis, supplementary genes, complementary genes, quantitative or polygenic inheritance, duplicate genes, multiple alleles, pleiotropic genes, sex-linked inheritance (Morgan's experiments on *Drosophila*; haemophilia and colour blindness).

## UNIT-IV

Structure and concept of gene, one gene one enzyme hypothesis; Genetic code; Protein synthesis (transcription, translation). Regulation of gene expression in prokaryotes and eukaryotes (Lac and tryptophan operon model).

Mutations : Types, characteristics, importance, a brief account of mutagens, mechanism of gene mutations; DNA damage and repair. Extra nuclear inheritance with reference to *Mirabilis jalapa* and *Zea mays*.

### Suggested Laboratory Exercises :

1. Study of morphology of various genera included in algae and fungi.
  2. Study of Crustose, Foliose and Fructicose types of Lichen thalli.
  3. Histopathological study of white rust of crucifers, loose smut of wheat, black rust of wheat and red rot of sugarcane.
  4. Study of morphology of various genera mentioned in Bryophyta and Pteridophyta.
  5. I Preparation of permanent stained slides of :  
Marchantia (V.S. Thallus) , Selaginella (T.S. Stem), Anthoceros (V.S. Thallus)  
Equisetum, (T.S. Aerial stem passing through internode) Funaria, (T.S. Stem) Pteris (T.S. Petiole and leaflet)
- II Study through permanent slides :
- Marchantia : (i) L.S. Antheridiophore.  
(ii) L.S. Archegoniophore.  
(iii) L.S. Mature Sporogonium.
- Anthoceros : (i) T.S. Thallus passing through antheridia.  
(ii) T.S. Thallus passing through archegonia.  
(iii) L.S. Mature sporogonium.

Funaria : (i) L.S. Male receptacle.  
(ii) L.S. Female receptacle.  
(iii) L.S. Capsule.  
(iv) Primary protonema

Selaginella : L.S. Sporangiferous spike.

Equisetum : (i) L.S. Strobilus.  
(ii) T.S. Strobilus.

Pteris :Mature prothallus.

6. To study cell structure from onion leaf peels; demonstration of staining and mounting method.
7. Preparation of temporary slides to show different stages of mitosis from root tips of *Allium cepa*, and *A. sativum*.
8. Preparation of temporary slides to show different stages of meiosis from floral buds of *Allium/Brassica*.

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## VII ZOOLOGY

- Paper-A : Cell Biology & Biodiversity-I
- Paper-B : Biodiversity-II & Ecology
- Practical : One paper covering entire syllabus of

### PAPER–A : CELL BIOLOGY & BIODIVERSITY–I

#### UNIT-I

Methods in Cell Biology : Principles of light and electron microscopes, fixation & fixatives, staining techniques.

Organisation of Cell : Extra nuclear and nuclear.

Plasma : Structure, Osmosis, active and passive transport, endocytosis and exocytosis.

Endoplasmic reticulum: Structure, types and associated enzymes.

Mitochondria : Structure, mitochondrial enzymes and the role of mitochondria in respiration and mitochondrial DNA.

Golgi complex : Structure and functions.

Ribosomes : Types of ribosomes, their structure and functions.

Lysosomes : Polymorphism and their function.

#### UNIT-II

Centrosome : Structure and functions.

Nucleus : Structure and functions of nuclear membrane, nucleolus and chromosomes.

An elementary idea of cell transformation in Cancer.

An elementary idea of cellular basis of immunity.

UNIT-III Detailed study of the following animal types

Protozoa : Amoeba, Paramecium and Plasmodium.  
Parazoa (Porifera) : Sycon  
Cnidaria (Coelenterata): Obelia

Classification upto orders with brief ecological note and economic importance (if any) of the following:

Protozoa : Entamoeba, Trypanosoma, Giardia, Noctiluca, Eimeria, Opalina Vorticella, Balantidium and Nyctotherus.  
Parazoa (Porifera) : Grantia, Euplectella, Hyalonema and Spongilla.  
Cnidaria (Coelenterata) : Hydra, Sertularia, Plumularia, Obelia, Tubularia, Bougainvillea, Porpita, Velella, Physalia, Rhizostoma Millipora, Aurelia, Alcyonium, Tubipora, Zoanthus, Metridium, Madrepora, Favia, Fungia and Astrangia.

UNIT-IV Detailed study of the following animal types

Platyhelminthes : Fasciola, Taenia  
Aschelminthes : Ascaris, Parasitic adaptations in Helminths.  
Annelida : Pheretima

Classification upto orders with brief ecological note and economic importance (if any) of the following:

Platyhelminthes : Dugesia, Schistosoma and Echinococcus.  
Aschelminthes : Ascaris, Oxyuris, Wuchereria.  
Annelida : Nereis, Polynoe, Eunice, Arenicola, Aphrodite, Amphitrite, Chaetopterus, Tubifex and Pontobdella.

PAPER-B : BIODIVERSITY-II & ECOLOGY (ZOO 102)

UNIT-I Detailed study of the following animal types

Arthropoda : Periplanata, Prawn, Social organizations in insects (honey bee and termite), life cycle of Anopheles and Culex.

Classification up to orders with ecological notes and economic importance (if any)

Arthropoda : Peripatus, Prawn, Lobster, Cancer, (Crab) Sacculina, Eupagurus (Hermit crab), Lepas, Balanus, Apis, Lepisma (Silver Fish), Schistocerca (Locust), Poeciloceris, (AkGrasshopper), Gryllus (Cricket), Mantis (Preying Mantis) Cicada, Forficula (Earwig) Scarabaeus (Dung beetle), Agrian (Dragon fly), Odontotermes, (Termite queen), Cimex (Bed bug), Cicindela (Tiger beetle), Polistes (Wasp), Bombyx (Silk moth), Julus (Millipede), Scolopendra (Centipede) Palamnaeus (Scorpion) Aranea (Spider) and Limulus (King crab).

UNIT-II

Mollusca : Pila  
Echinodermata : Asterias, Echinoderm larvae.  
Hemichordata : Balanoglossus, External characters and affinities.

Classification up to orders with ecological notes and economic importance (if any)

Mollusca : Chiton, Anodonta, Mytilus, Ostrea, Cardium, Pholas, Solen (Razor Fish), Pecten, Haliotis, Patella, Aplysia, Doris, Limax, Loligo, Sepia, Octopus, Nautilus shell and Dentalium.

Echinodermata : Echinus, Cucumaria, Ophiothrix and Antedon.

Hemichordata : Balanoglossus.

### UNIT-III ECOLOGY :

Ecology - Scope of ecology and subdivisions.

Ecosystem - Components, ecological energetics, food web, introduction to major ecosystems of the world.

Ecological factors - Temperature, light and soil as ecological factors.

Nutrients - Biogeochemical cycles & concept of limiting factors.

Ecological - Morphological, physiological and behavioural adaptations in animals in different habitats.

Population - Characteristics and regulation of population.

### UNIT-IV

Inter and intra - Competition, predation, parasitism, commensalisms & specific relationships & mutualism.

Biotic community - Characteristics, ecological succession, ecological niche.

Natural resources - Renewable and nonrenewable natural resources and their conservations.

Environmental Degradation. - Causes, impact and control of environmental pollution.

### PRACTICALS : Practical based on Theory Papers ZOO 101 & 102 (ZOO 151)

1. Classification upto orders with ecological notes and economic importance, if any, of the following animals :

Protozoa	(a) Examination of cultures of Euglena and Paramecium. (b) Slides : Amoeba, Euglena, Trypanosoma, Monocystis, Paramecium (Binary fission and conjugation),
Parazoa (Porifera)	: Specimens : Sycon, Grantia, Euplectella, Hyalonema, Spongilla, Euspongia.
Cnidaria (Coelenterata)	(a) Specimens : Porpita, Velella, Physalia, Aurelia, Rhizostoma Metridium, Millipora, Alcyonium, Tubinora, Zoanthus, Madrenora, Favia, Fungia and (b) Slides : Hydra (W.M.) Hydra with buds. Obelia (colony and medusa). Sertularia, Plumularia, Tubularia, Bougainvillea and Aurelia Larva.
Platyhelminthes	(a) Specimens : Dugesia, Fasciola, Taenia,

	(b) Slides : Miracidium, Sporocyst, Redia, Cercaria of Fasciola, Scolex and Proglottids of Taenia (mature
Aschelminthes	: Ascaris (male and female), Trichinella, Ancylostoma.
Annelida	: Pheretima, Nereis, Heteronereis, Polynoe, Eunice,
Arthropoda	: Peripatus, Prawn, Lobster, Cancer (Crab), Sacculina, Eupagurus (Hermit crab), Lepas, Balanus, Apis, Lepisma (Silver Fish), Schistocerca (Locust), Poecilocerus, (Ak Grasshopper), Gryllus (Cricket), Mantis (Preying Mantis) Cicada, Forficula (Earwig) Cimex, Scarabaeus (Dung beetle), Agrian (Dragon fly), Odontotermes,
Mollusca	: Anodonta, Mytilus, Ostrea, Cardium, Pholas, Solen (Razorfish) Pecten, Haliotis, Patella, Aplysia, Doris, Limax, Loligo, Sepia, Octopus, Nautilus shell
Echinodermata	: Asterias, Echinus, Ophiothrix and Antedon.
Hemichordata	Balanoglossus

- Study of the following permanent stained preparations :  
L.S. and T.S. Sycon, gemmules, spicules and spongin fibres of a sponge. T.S. Hydra (Testis and ovary region).  
T.S. Fasciola (Different regions). T.S. Ascaris (Male & female).  
T.S. Pheretima (Pharyngeal and typhlosolar regions); setae, septal nephridia, spermathecae and ovary of Pheretima  
Trachea, mouth parts of Periplanata  
Radula and osphradium of Pila. T.S. Star fish (Arm).
- Preparation of the following slides :  
Temporary preparation of Paramecium, mouth parts of Periplaneta (cockroach), radula of Pila & appendages of Prawn.  
Preparation of permanent whole mount stained in borax carmine of Hydra, Obelia. Sertularia, Plumularia and Bougainvillea.
- Dissections of the following animals :  
Pheretima : Digestive, reproductive and nervous systems.  
Periplanata : Digestive and nervous systems; mouth parts and trachea.  
Pila : Pallial complex, digestive and nervous systems.
- ECOLOGY :Study of animal adaptations with the help of specimens, charts and models.  
Study of Zoogeographical regions and their fauna. Study of biotic components of an ecosystem. Study of different types of nests in birds.  
Study & preparation of zoogeographical charts.
- CELL BIOLOGY Paper  
chromatography.  
Gel electrophoresis through photographs or through research laboratories. Familiarity with TEM & SEM.  
Study of different ultrastructures of cell organelles through photographs.

### Guidelines for the conduct of Practical Examination

1. Dissect the animal provided so as to expose its system. Draw its labelled sketch and demonstrate it to the Examiner.
  2. Make a temporary mount of the material "A". Identify and draw its labelled sketch and show it to the examiner.
  3. Make permanent stained preparation of the material "B". Identify and make its labelled diagram and show it to the examiner.
  4. Identify the slides (C-F) and give two important reasons for each identification.
  5. Identify and classify the specimens (G-J) up to orders. Write a short note on the habitat, special features, feeding habit and economic importance.
  6. Identify the type of adaptation/type of nest with a short note.
  7. Mark Zoogeographical region on the given map along with endemic fauna and climate.
  8. Viva voce
  9. Practical records and chart.
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## VIII BIOCHEMISTRY

### Paper- A : BIOMOLECULES

#### SECTION-I

#### Amino Acids & Proteins :

- I Introduction to Bio-chemistry. Water as a biological solvent. Dissociation of water. Buffer solution. Henderson Hasselbalch equation.
- II Amino Acids : Common structural features. Stereoisomerism and RS system of designating optical isomers. Classification based on the nature of "R" groups. Amino acids present in proteins and non-protein amino acids. Specialized role of amino acids. Physical and Chemical properties of amino acids. Titration of amino acids.
- III Peptide Bonds : Rigid and planar nature of a peptide bond. Folding of peptide chains into regular repeating structures (□ helix, □ pleated sheets). □ turn in polypeptides. Chemical synthesis of polypeptides. Biologically active peptides.
- IV Proteins : Levels of protein structure. Determination of primary structure of proteins. Forces stabilising structure and shape of proteins. Native proteins and their conformations. Behaviour of proteins in solutions. Salting in & salting out of proteins. Denaturation of proteins.
- V Structural and functional diversity of proteins, fibrous proteins (keratins, collagen & elastin), globular proteins (hemoglobin, myoglobin) and conjugated proteins.

#### SECTION-II

#### Carbohydrates :

- I Definition and classification of carbohydrates.

- II Fischer and Haworth structures of carbohydrates. Stereoisomerism, and mutarotation. Anomeric forms of monosaccharides. Derivatives of monosaccharides (glycosides, deoxysugars, amino sugars and other derivatives of biological importance). Oligosaccharides (structure of maltose, lactose, sucrose, cellobiose, trehalose, raffinose).
- III Characteristic reactions of monosaccharides : Reactions with hydrazine, hydrogen cyanide, hydroxylamine; reduction and oxidation of sugars; periodic acid oxidation; action of alkali upon sugars; acylation and methylation of sugars.
- IV Homo-and hetero-polysaccharides (structures of amylose, amylopectin, starch, inulin, pectins, dextrans, glycogen, cellulose, chitin). (GAGs) as components of connective tissue. Polysaccharides of bacterial cell wall.

### SECTION-III

#### Lipids :

- I Definition and classification of fatty acids (saturated and unsaturated). Essential fatty acids.  
Important reactions of functional groups present in fatty acids. Characteristics of fatty acids and fats (saponification, iodine, acid, acetyl and peroxide values). Refractive index, m. p., b. p. and their relation to molecular size. Properties of glycerol. Fats as source of energy. Waxes.
- II Structures, characteristics and functions of lipids : Triacylglycerols, phospholipids : lecithins (Phosphotidyl Cholines), lysolecithins, cephalins (Phosphotidyl ethanolamines), Phosphatidyl serines, phosphatidyl inositol, sphingomyelins, plasmalogens), cerebroside, gangliosides, sulfatides.
- III Lipoproteins—Composition, classification and biological functions. Liposomes.
- IV Terpenes and Steroids—Terpenes of biological significance e.g. carotenes, phytol. Cholesterol and other animal sterols. Colour reactions of sterols. Sterols of yeast and fungi (Mycosterols). Phytosterols. Steroidal hormones. Bile acids.
- V Structure and properties of Eicosanoids - Prostaglandins, Leukotrienes, Thromboxanes, Prostacyclins.
- VI Structure, sources and biochemical functions of fat soluble vitamins.

### SECTION-IV

#### Nucleic Acid and Porphyrins :

- I Nucleic Acids : Structure and properties of purine and pyrimidine bases. Nucleosides and nucleotides. Biologically important nucleotides. Double helical model of DNA and forces responsible for it. Shorthand representation of polynucleotides.

Denaturation of DNA. Physical and chemical properties of nucleic acids. Methods for isolation, purification and characterization of nucleic acids. Chemical and enzymatic hydrolysis of nucleic acids. Sequencing of polynucleotides.

- II Porphyrins : Porphyrin nucleus and classification of porphyrins. Heme and other metalloporphyrins occurring in nature. Detection of Porphyrins spectrophotometrically and by fluorescence. Chemical nature and physiological significance of bile pigments.

## Paper-B : ENZYMOLOGY AND BIOENERGETICS

### SECTION-I

General Characteristics :

Introduction to enzymes. General characteristics of enzymes. Prosthetic group. Holoenzymes, apoenzyme and cofactors. Coenzymes and their biochemical functions, assay of enzyme activity, units of enzyme activity. Active sites(s) of enzymes. IUB system of nomenclature and classification of enzymes.

Enzymes as catalysts. Theories of enzymes catalysis : Proximity and orientation effects, acid base catalysis, covalent catalysis. Role of metals in enzyme catalysis.

### SECTION-II

Enzyme Purification :

- Need for purification. Preliminary fractionation procedures and precipitation techniques, Chromatography methods : Gel filtration—, adsorption—, ion exchange— and affinity chromatography. Types of support materials. Selection of appropriate conditions and elution procedures. Criteria of enzyme purity.

### SECTION-III

Enzyme Kinetics :

- Factors affecting velocity of enzyme catalysed reactions : Enzyme concentration, pH and temperature. Michaelis –Menten equation. Determination of  $K_m$  and its significance.
- Enzyme inhibition. Various types of enzyme inhibitions. Determination of  $K_i$  value. Enzyme inhibitors and their importance. Introduction to multisubstrate enzymes. Allosteric enzymes and enzyme regulation. Isoenzymes and their clinical significance.

Bioenergetics :

### SECTION-IV

Biological systems and concept of free energy, Endergonic processes and role of ATP & other high energy compounds. Biological oxidations. Redox potential. Enzymes and co-enzymes involved in oxidations and reductions. Mitochondrial electron transport chain and oxidative phosphorylation. Mechanism of oxidative phosphorylation.

### PRACTICALS :

- I Qualitative tests for : (a) Carbohydrates. (b) Amino acids and proteins.

- (c) Cholesterol and lipids.
- II Determination of saponification value of fats.
- III Determination of Iodine value of fats.
- IV Estimation of ascorbic acid by dye method.
- V Titration curve for amino acids and determination of pKa value.
- VI Verification of Beer-Lambert Law for nitrophenol or cobalt chloride.
- VII Estimation of :
- (a) Amino acids by ninhydrin method.
  - (b) Protein by biuret method.
  - (c) Carbohydrate by anthrone method.
- VIII (a) Assay of serum alkaline phosphatase activity.
- (b) Effect of pH on enzyme activity.
  - (c) Effect of temperature on enzyme activity and determination of Energy
  - (d) Effect of substrate concentration on enzyme activity and determination
- IX Inhibition of alkaline phosphatase by EDTA.
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## **IX MICROBIOLOGY**

### **FUNDAMENTALS OF MICROBIOLOGY**

#### **SECTION-A**

1. History, development, scope and applications of Microbiology.
2. Methods of Microbiology isolation of pure cultures, theory and practice of sterilization.
3. Microscopic examination of micro-organism, bright field microscopy, dark field microscopy, phase contrast microscopy, electron microscopy.
4. Staining of microbes, theory of Gram staining.
5. Nature of Microbial World : Prokaryotes and eucaryotes, growth pattern in microbes.

#### **SECTION-B**

1. Morphology & fine structure of bacteria, fungi, actinomycete and algae.
2. Organization of cell wall, cell membrane, flagella and capsules in bacteria.
3. Morphogenesis in bacteria, formation of spores and cysts.
4. Animal Viruses : Morphology, cultivation and viral disease cycle.
5. Bacteriophages : Morphology, multiplication, detection and enumeration.
6. Biotransformation of
  - (a) D-Sorbitol to L-Sorbose.
  - (b) Antibiotics.
  - (c) Steroids.

#### **SECTION-C**

1. Recombinant DNA technology, genetic engineering and gene cloning in micro-organisms.
2. Strategies of genetic engineering. Restriction enzymes, vectors, plasmids.

### 3. Genetic engineering for human welfare.

- (a) Production of pharmaceuticals.
- (b) Insect pest control.
- (c) Use of Genetically Engineered Micro-organisms (GEMs) for control of pollution.

#### SECTION-D

1. Rhizosphere & Rhizoplane micro-organisms, reasons for increased microbial activity in rhizosphere.
2. Biogeochemical Cycling—Carbon cycle, Nitrogen cycle, Phosphorus & Sulphur cycle.
3. Symbiotic & non-symbiotic Nitrogen fixation biofertilisers & biopesticides.
4. Sewage (waste-water) treatment, chemical characteristics, microbiological characteristics, waste water treatment processes.

#### MICROBIAL PHYSIOLOGY—METABOLISM

##### SECTION-A

1. Microbial Nutrition : Requirements for Growth. Physical requirement (temperature, pH, osmotic pressure), chemical requirements (C, N, S, P, O).
2. Culture Media : Chemically defined media, complex media, anaerobic growth media, selective & differential media, and enrichment culture. Cultivation of Aerobes and Anaerobes.
3. Microbial Growth : Growth in population, bacterial growth curve, mathematical nature and expression, measurement of growth in bacteria, Factors affecting growth in microorganisms, continuous cultures and synchronous cultures.

##### SECTION-B

1. Enzymes and their Regulation : Chemical and physical properties of enzymes.
2. Nomenclature of Enzymes.
3. Mechanism of enzymes action.
4. Inhibition of enzyme action.
5. Regulation of enzymes.

##### SECTION-C

###### Microbial Metabolism :

1. Respiration and fermentation.
2. Glycolysis, Pentose Phosphate pathway, The Entner Doudoroff pathway, Fermentation.
3. Tricarboxylic acid cycle.
  
4. Catabolism of lipid, proteins.
5. Glyoxylate cycle.
6. Beta oxidation.

##### SECTION-D

###### Microbial Utilization of Energy & Biosynthesis :

1. Transport of nutrient by bacteria. Biochemical mechanisms of generation of ATP.
2. Synthesis of Amino Acids : Glutamate, lysine, glutamine, serine, arginine family.
3. Structures and biosynthesis of cell wall peptidoglycan.

4. Biosynthesis of Carbohydrates (gluconeogenesis) & Phospholipids.
5. Replication of DNA molecules, Transcription & Translation (process of protein synthesis).

**Bacterial Genetics :**

1. Conjugation.
2. Transformation.
3. Transduction (generalized transduction, specialized transduction).
4. The Regulation of Gene Expression : Lac operon, tryptophan operon.

**PRACTICALS**

1. Use of microscope in examination of unstained bacteria, fungi, algae, parasites and stained cell preparations including simple staining, Gram's staining, acid fast staining, capsule staining, spore staining using prokaryotic and eukaryotic cells, hanging drop preparation.
  2. Preparation of culture media, spread plates, pour plates, selective media, differential media.
  3. Separation of pure cultures and study the effect of selective nutrients on prokaryotes.
  4. Isolation of Soil Bacteria, Soil Fungi, Soil Actinomycetes.
  5. Selective media for Soil microflora and use of growth factors, Study of Rhizosphere interactions, Quantitative measurements of Soil nutrients and Rhizosphere microflora and preparation of starter cultures of Rhizobia, Azotobacter.
  6. Measurement of Soil Enzymes.
  7. Use of ultraviolet light for its germicidal effect.
  8. The replica plating technique.
  9. Presumptive, confirmed and completed tests for safety of water supplies.
  10. Effect of temperature, Osmotic pressure, energy source etc. on growth of prokaryotes.
  11. Relation of free oxygen to microbial growth, monitoring of dissolved oxygen in various effluents.
  12. Determination of COD in Industrial effluents.
  13. Effects of antimetabolites on Microbial culture (Inhibition by Sulfanilamide).
  14. Determination of Water Activity of various substrates and assay of surface active agents.
  15. Turbidimetric/spectrophotometric monitoring of growth using liquid cultures.
  16. Efficiency of photosynthesis in photoautotrophs.
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## **X ELECTRONICS**

### **Paper A : ANALOG ELECTRONICS**

#### **UNIT-I**

##### **Junction Diodes :**

Review of p and n type semiconductors, qualitative treatment of rectifying diodes, forward and reverse bias characteristics, switching diodes, photo diode, LED, optical isolators. Zener diodes. Rectifiers (half and full wave), capacitor and inductor filters.

#### **UNIT-II**

- **Bipolar Junction Transistor :**

Basic working principle (qualitative), characteristics, basic configurations and biasing, operating point. Loadline (a.c. and d.c.) biasing and stabilization of operating point (Qualitative).

- JFET AND MOSFET :

Basic working principles (qualitative), characteristics. Pinch off voltage and biasing (qualitative).

- Amplifiers :

Different terms used in amplifiers such as signal source voltage gain, current gain, power gain and Decibel, input and output impedance, class A, B, C and AB operation. Distortion in amplifiers (non-linear, frequency and phase).

#### UNIT-III

- Feedback in Amplifiers :

Concept of feedback, types of feedback, effect of negative feedback in amplifier performance (Qualitative).

- Power Amplifiers :

Input and output considerations, push –pull amplifiers, complementary symmetry and transformer types, idea of thermal run away and heat sink, concept of amplifier efficiency.

- Oscillators :

Positive feedback, Barkhausen criteria. Hartley oscillator, Wein Bridge oscillator (no derivation of formulae).

#### UNIT-IV

- Operational Amplifiers :

Operational amplifiers with black box concept, inverting and non-inverting inputs, virtual ground, parameters such as input impedance, output impedance, open loop gain and band width, specifications of an OP –AMP, qualitative description of OP –AMP as inverting and non-inverting amplifiers summing and difference amplifiers, comparator, differentiator, integrator and instrumentation amplifiers.

- Power Supplies :

Concept of regulation, regulated power supply, three terminals IC based voltage regulation. Study of power supply regulation with respect to variation in load current and line voltage, switched mode power supply (SMPS) –working principle and applications, brief idea of C.V.T. and U.P.S.

#### Paper B : DIGITAL AND NON-LINEAR ELECTRONICS UNIT-I

- Number Systems :

Introduction to decimal, binary and hexadecimal number systems. BCD code, interconversion of decimal, binary and hex numbers, concept of parity, error detection and correction.

- Binary Arithmetic and Boolean Algebra :

Boolean Axioms, D. Morgan's theorem – verification and applications, simplification of logic expressions using theorems and Karnaugh Map (upto four variables), concept of signed and unsigned numbers, fixed and floating point representation, concept of 1's and 2's compliment, addition and subtraction of integer values, half and full adder, half and full subtract.

## UNIT-II

- Logic Gates :

Logic values and variables, positive and negative logic, different logic gates as AND, OR, NOT, NAND, NOR, AND, XOR, definition of universal gates, symbols and truth tables, inverting and non- inverting buffers, tristate buffers, Boolean expressions for truth tables and vice versa.

- Sequential Circuits :

Flip flops (RS, JK, D, T), shift registers, ripple counters, Modulo –N counters, need for DAC (weighed resistance type), ADC (counter ramp type).

## UNIT-III

- Logic Families (Qualitative Treatment Only) :

TTL, CMOS familiar characteristics, parameters like power dissipation, speed, supply requirements logic level, in Fan out, noise immunity.

Combinational Circuits :

Encoders, decoders, symbols and truth tables of multiplexer demultiplexer.

## UNIT-IV

- Wave Shaping Circuits :

Concept of multivibrators (bistable, mono and astable) and Schmidt Trigger, integration, differentiation using RC circuits, and operational amplifiers, clipping, clamping, operation and application of 555 timer and VCO 565, generation of pulse, square and saw tooth wave.

- Semiconductor Memories :

Idea of different types of SC memories (RAM, ROM, PROM, EPROM, EEPROM), process of data storage and retrieval, organization of memory, concept of PLA and PAL.

## ELECTRONICS (Practicals)

Guidelines for Electronics Practical Examination :

I The distribution of marks is as following :

- (i) One full experiment requiring the student to take data, analyse it and draw conclusions.
- (ii) Brief Theory.
- (iii) One exercise based on experiment (to be allotted by the examiner)
- (iv) Viva-Voce
- (v) Record (Practical file)

II There will be one session of 4 hours duration. The paper will consist of 8 experiments, out of which an examinee will mark 6 and one of them will be allotted by the examiner.

III Number of candidates in a group for practical examination should not exceed 12.

IV In a single group, same experiment will not be allotted to more than three examinees in any group.

List of Experiments :

1. (i) To familiarize the multimeter
    - (a) To measure AC/DC voltage. (b) To measure resistance. (c) To measure AC/DC current. (d) To test diode, transistor (BJT, FET)
  - (ii) To measure capacitance of a capacitor using capacitance meter.
  2. (i) To familiarize with various functional controls of CRO.
    - (ii) To use the CRO for the measurement of frequency, voltage and phase shift.
  3. To draw forward and reverse bias characteristics for a PN junction and draw load line.
  4. To observe the forms of half wave and full wave rectification using diode.
  5. To draw  $V - I$  characteristics of Zener diode and to study Zener diode as a voltage regulator w.r.t. input voltage and load resistance.
  6. To draw  $C - B$  characteristics of BJT.
  7. To draw  $C - E$  characteristics of BJT.
  8. To find the voltage gain at different frequencies and to find the band width and gain band width product of CE transistor amplifiers.
  9. To set up a Hartley Oscillation and calculate the capacitance using CRO.
  10. To study the output of regulated power supply (using 3 pin voltage regulator), w.r.t. input voltage and load.
  11. Verification of truth table of OR, AND, NOT, NAND, NOR, XOR gates.
  12. To implement the following arithmetic operations by using gates ICs.
    - (i) Half Adder (ii) Half Subtractor (iii) Full Adder (iv) Full Subtractor
  13. To verify truth tables of JK, D.T. Master –Slave Flip Flop.
  14. Use of 7 – segment LED's and use of 7447 BCD to 7 – segment decoder.
  15. To plot output and mutual characteristics of FET.
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