Chhatrapati Shivaji Maharaj University
PANVEL, NAVI MUMBAI
Private University Estab. under act XXXII- 2018 of Govt. of Mah.

Syllabus and Question Pattern for PET for admission in the Academic year 2024-25 (Even Semester)

PET will be an online examination consist of a100 marks- multiple-choice-type (**MCQ**) question paper with the following pattern

1. Section A: 50 questions - 50 Marks
2. Section B: 50 questions - 50 Marks

Minimum Qualifying Marks: 40.

No Negative marking

Section A

1. **General Knowledge:** Current affairs, General information about India and World, Fundamentals of Computer Applications.
2. **Research Methodology:** Methods of data collection, Data types and analysis techniques, Statistical Methods (Central Tendency and variance), Theory and Hypotheses, Editing tools, Computer based tools, Literature survey.
3. **Aptitude:** Quantitative Aptitude, Logical Reasoning, Comprehension and Composition of sentence fragments.

Section B

This section is subject based as follow:

1. **Physical Sciences:**
    a. **Classical Mechanics:** General concepts of statics and dynamics, constraints, equation of motion, generalized coordinates, Lagrangian and Hamiltonian Formalisms.
    b. **Quantum Mechanics:** Wave-particle duality, uncertainty, wavefunction, Schrodinger Equation, Energy and momentum quantization, hydrogen-like atom.
    c. **Thermodynamics and Statistical Mechanics**: Laws of thermodynamics, thermodynamic cycle, ensemble, specific heats, entropy and probability, kinetic theory of gas, real gas, Bose-Einstein and Fermi-Dirac distributions.
    d. **Electronics:** Analog and digital systems, diode and transistors, op-amp, oscillators, RF transmission, Boolean algebra and logic gates, adders, register, flip flops, RAM & ROM, basics of microprocessors.

e. **Solid State Physics:** Crystal structure, Vibration and phonons, magnetic properties of matter, superconductivity.

f. **Nuclear and Particle Physics:** Nuclear models, spin, NMR, subatomic particles, quark and leptons, accelerators, latest discoveries of heavy bosons.

2. Chemical Sciences

a. Inorganic Chemistry

- Chemical periodicity
- Structure and bonding in homo- and heteronuclear molecules, including shapes of molecules (VSEPR Theory).
- Concepts of acids and bases, Hard-Soft acid base concept, Non-aqueous solvents.
- Main group elements and their compounds: Allotropy, synthesis, structure and bonding, industrial importance of the compounds.
- Transition elements and coordination compounds: structure, bonding theories, spectral and magnetic properties, reaction mechanisms.
- Inner transition elements: spectral and magnetic properties, redox chemistry, analytical applications.
- Organometallic compounds: synthesis, bonding and structure, and reactivity. Organometallics in homogeneous catalysis.
- Cages and metal clusters.
- Analytical chemistry- separation, spectroscopic, electro- and thermos analytical methods.
- Bioinorganic chemistry: photosystems, porphyrins, metalloenzymes, oxygen transport, electron- transfer reactions; nitrogen fixation, metal complexes in medicine.
- Characterisation of inorganic compounds by IR, Raman, NMR, EPR, Mössbauer, UV-vis, NQR, MS, electron spectroscopy and microscopic techniques.
- Nuclear chemistry: nuclear reactions, fission and fusion, radio-analytical techniques and activation analysis.

b. Physical Chemistry:

- Basic principles of quantum mechanics: Postulates; operator algebra; exactly-solvable systems: particle-in-a-box, harmonic oscillator and the hydrogen atom, including shapes of atomic orbitals; orbital and spin angular momenta; tunneling.
- Approximate methods of quantum mechanics: Variational principle; perturbation theory up to second order in energy; applications.

- Atomic structure and spectroscopy; term symbols; many-electron systems and antisymmetry principle.
- Chemical bonding in diatomics; elementary concepts of MO and VB theories; Huckel theory for conjugated π-electron systems.
- Chemical applications of group theory; symmetry elements; point groups; character tables; selection rules.
- Molecular spectroscopy: Rotational and vibrational spectra of diatomic molecules; electronic spectra; IR and Raman activities – selection rules; basic principles of magnetic resonance.
- Chemical thermodynamics: Laws, state and path functions and their applications; thermodynamic description of various types of processes; Maxwell's relations; spontaneity and equilibria; temperature and pressure dependence of thermodynamic quantities; Le Chatelier principle; elementary description of phase transitions; phase equilibria and phase rule; thermodynamics of ideal and non-ideal gases, and solutions.
- Statistical thermodynamics: Boltzmann distribution; kinetic theory of gases; partition functions and their relation to thermodynamic quantities – calculations for model systems.
- Electrochemistry: Nernst equation, redox systems, electrochemical cells; Debye-Huckel theory; electrolytic conductance – Kohlrausch's law and its applications; ionic equilibria; conductometric and potentiometric titrations.
- Chemical kinetics: Empirical rate laws and temperature dependence; complex reactions; steady state approximation; determination of reaction mechanisms; collision and transition state theories of rate constants; unimolecular reactions; enzyme kinetics; salt effects; homogeneous catalysis; photochemical reactions.
- Colloids and surfaces: Stability and properties of colloids; isotherms and surface area; heterogeneous catalysis.
- Solid state: Crystal structures; Bragg's law and applications; band structure of solids.
- Polymer chemistry: Molar masses; kinetics of polymerization.
- Data analysis: Mean and standard deviation; absolute and relative errors; linear regression; covariance and correlation coefficient.

c. Organic Chemistry

- IUPAC nomenclature of organic molecules including regio- and stereoisomers.
- Principles of stereochemistry: Configurational and conformational isomerism in acyclic and cyclic compounds; stereogenicity, stereoselectivity, enantioselectivity, diastereoselectivity and asymmetric induction.

- Aromaticity: Benzenoid and non-benzenoid compounds – generation and reactions.
- Organic reactive intermediates: Generation, stability and reactivity of carbocations, carbanions, free radicals, carbenes, benzynes and nitrenes.
- Organic reaction mechanisms involving addition, elimination and substitution reactions with electrophilic, nucleophilic or radical species. Determination of reaction pathways.
- Common named reactions and rearrangements – applications in organic synthesis.
- Organic transformations and reagents: Functional group interconversion including oxidations and reductions; common catalysts and reagents (organic, inorganic, organometallic and enzymatic). Chemo, regio and stereoselective transformations.
- Concepts in organic synthesis: Retrosynthesis, disconnection, synthons, linear and convergent synthesis, umpolung of reactivity and protecting groups.
- Asymmetric synthesis: Chiral auxiliaries, methods of asymmetric induction – substrate, reagent and catalyst-controlled reactions; determination of enantiomeric and diastereomeric excess; enantio-discrimination. Resolution – optical and kinetic.
- Pericyclic reactions–electrocyclisation, cycloaddition, sigmatropic rearrangements and other related concerted reactions. Principles and applications of photochemical reactions in organic chemistry.
- Synthesis and reactivity of common heterocyclic compounds containing one or two heteroatoms (O, N, S).
- Chemistry of natural products: Carbohydrates, proteins and peptides, fatty acids, nucleic acids, terpenes, steroids and alkaloids. Biogenesis of terpenoids and alkaloids.
- Structure determination of organic compounds by IR, UV-Vis, 1H & 13C NMR and Mass spectroscopic techniques.

d. Interdisciplinary topics

- Chemistry in nanoscience and technology.
- Catalysis and green chemistry.
- Medicinal chemistry.
- Supramolecular chemistry.
- Environmental chemistry.

3. Environment Science

a. Fundamentals of Environmental Sciences

- Definition, Principles and Scope of Environmental Science.
- Structure and composition of atmosphere, hydrosphere, lithosphere and biosphere.
- Environmental education and awareness. Environmental ethics
- Meteorological parameters

b. Environmental Chemistry

- Fundamentals of Environmental Chemistry
- Composition of air
- Inorganic and organic components of soils
- Hydrological cycle

c. Environmental Biology

- Ecology as an interdisciplinary science
- Ecosystem Structure and functions
- Basis of Ecosystem classification
- Population & Community ecology
- Environmental Biotechnology

d. Environmental Geosciences

- Origin of earth
- Weathering including weathering reactions, erosion, transportation and deposition of sediments
- Natural Hazards
- Natural resource exploration and exploitation and related environmental
- concerns
- Geochemical classification of elements

e. Energy and Environment

- Nuclear energy
- Sun as source of energy
- Bioenergy
- Environmental implications of energy use

f. Environmental Pollution and Control

- Types of Pollution – Air, Noise, Water, Soil
- Thermal, Marine Pollution and Radioactive
- Sources and Types of Pollutants

g. Solid and Hazardous Waste Management

- Solid Waste
- Solid waste collection and transportation
- Solid waste processing and recovery
- Hazardous waste
- E-waste, Plastic waste.
- Fly ash

h. Environmental Assessment, Management and Legislation

- Environmental Impact Assessment (EIA), Environmental Impact Statement (EIS) and Environmental Management Plan (EMP).
- Overview of Environmental Laws in India

- Risk Assessment
- Environmental Conventions and Agreements
- National Forest Policy, 1988, National Water Policy, 2002, National Environmental Policy, 2006.

i. Statistical Approaches and Modelling in Environmental Sciences

- Attributes and Variables
- Scales of measurement
- Approaches to development of environmental models

j. Contemporary Environmental Issues

- Global Environmental Issues
- Current Environmental Issues in India
- National Action Plan on Climate Change
- National river conservation plan
- Climate change

4. Life Sciences/Biotechnology

a. Molecules and Their Interaction Relevant to Biology

- Structure of atoms, molecules, and chemical bonds
- Composition, structure, and function of biomolecules (carbohydrates, lipids, proteins, nucleic acids, and vitamins)
- Stabilizing interactions (Van der Waals forces, electrostatic interactions, hydrogen bonding, hydrophobic interactions, etc.)
- Principles of biophysical chemistry (pH, buffer systems, reaction kinetics, thermodynamics, colligative properties)
- Bioenergetics: glycolysis, oxidative phosphorylation, coupled reactions, group transfer, and biological energy transducers
- Principles of catalysis: enzymes and enzyme kinetics, enzyme regulation, mechanisms of enzyme catalysis, isozymes
- Conformation of proteins (Ramachandran plot, secondary structure, domains, and folds)
- Conformation of nucleic acids (helical forms A, B, Z; t-RNA, micro-RNA)
- Stability of proteins and nucleic acids
- Metabolism of carbohydrates, lipids, amino acids, nucleotides, and vitamins

b. Cellular Organization

- Membrane structure and function
  - ✓ Structure of model membranes: lipid bilayer and membrane proteins
  - ✓ Diffusion, osmosis, ion channels, active transport, membrane pumps
  - ✓ Mechanism of sorting and regulation of intracellular transport
  - ✓ Electrical properties of membranes
- Structural organization and function of intracellular organelles

- ✓ Cell wall, nucleus, mitochondria, Golgi bodies, lysosomes, endoplasmic reticulum, peroxisomes, plastids, vacuoles, and chloroplasts
- ✓ Cytoskeleton structure, function, and its role in motility

- Organization of genes and chromosomes
  - ✓ Operons, unique and repetitive DNA, interrupted genes, gene families
  - ✓ Chromatin structure, euchromatin, heterochromatin, and transposons
- Cell division and cell cycle
  - ✓ Mitosis and meiosis: regulation and control
  - ✓ Steps of the cell cycle and regulatory mechanisms
- Microbial physiology
  - ✓ Growth yield and characteristics
  - ✓ Strategies of cell division and stress response

c. Fundamental Processes

- DNA replication, repair, and recombination
  - ✓ Unit of replication, replication enzymes, replication origin, and fork
  - ✓ Fidelity of replication, extrachromosomal replicons
  - ✓ DNA damage and repair mechanisms • Homologous and site-specific recombination
- **RNA synthesis and processing**
  - ✓ Transcription factors, initiation complex formation
  - ✓ Activators, repressors, RNA polymerases
  - ✓ Capping, elongation, termination
  - ✓ RNA processing, editing, splicing, and polyadenylation
  - ✓ Structure and function of different types of RNA
  - ✓ RNA transport
- **Protein synthesis and processing**
  - ✓ Ribosome structure, initiation complex formation
  - ✓ Initiation factors and regulation, elongation factors, and termination
  - ✓ Genetic code, aminoacylation of tRNA, tRNA identity
  - ✓ Aminoacyl tRNA synthetase and translational proofreading
  - ✓ Post-translational modifications and inhibitors of translation
- **Control of gene expression at transcription and translation levels**
  - ✓ Regulation of phages, viruses, prokaryotic and eukaryotic genes
  - ✓ Role of chromatin in gene expression and silencing

d. Cell Communication and Cell Signalling

- **Host-Parasite Interaction**
  - ✓ Recognition and entry of pathogens (bacteria, viruses) into animal and plant host cells
  - ✓ Alteration of host cell behaviour by pathogens
  - ✓ Virus-induced cell transformation

- ✓ Pathogen-induced diseases in animals and plants • Cell-cell fusion in normal and abnormal cells

- **Cell Signalling**
  - ✓ Hormones and their receptors
  - ✓ Cell surface receptors and signalling through G-protein-coupled receptors
  - ✓ Signal transduction pathways and second messengers
  - ✓ Regulation of signalling pathways
  - ✓ Bacterial and plant two-component systems
  - ✓ Light signalling in plants, bacterial chemotaxis, and quorum sensing

- **Cellular Communication**
  - ✓ General principles of cell communication
  - ✓ Regulation of hematopoiesis
  - ✓ Cell adhesion and roles of adhesion molecules
  - ✓ Gap junctions, extracellular matrix, integrins
  - ✓ Neurotransmission and its regulation

- **Cancer Biology**
  - ✓ Genetic rearrangements in progenitor cells
  - ✓ Oncogenes and tumour suppressor genes
  - ✓ Cancer and the cell cycle
  - ✓ Virus-induced cancer and metastasis
  - ✓ Interaction of cancer cells with normal cells
  - ✓ Apoptosis and therapeutic interventions for uncontrolled cell growth

- **E. Innate and Adaptive Immune Systems**
  - ✓ Cells and molecules 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 and 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
  - ✓ Complement system and Toll-like receptors
  - ✓ Cell-mediated effector functions, inflammation, hypersensitivity, and autoimmunity
  - ✓ Immune responses to bacterial (e.g., tuberculosis), parasitic (e.g., malaria), and viral (e.g., HIV) infections
  - ✓ Congenital and acquired immunodeficiencies
  - ✓ Vaccines

e. Developmental Biology

- **Basic Concepts of Development**

- ✓ Potency, commitment, specification, induction, competence, determination, and differentiation
- ✓ Morphogenetic gradients, cell fate, and lineages
- ✓ Stem cells and genomic equivalence
- ✓ Cytoplasmic determinants, imprinting
- ✓ Use of mutants and transgenics in developmental analysis

- **Gametogenesis, Fertilization, and Early Development**
  - ✓ Gamete production and sperm-egg recognition in animals
  - ✓ Embryo sac development and double fertilization in plants
  - ✓ Zygote formation, cleavage, blastula formation
  - ✓ Embryonic fields, gastrulation, and germ layer formation in animals
  - ✓ Embryogenesis and establishment of symmetry in plants
  - ✓ Seed formation and germination

- **Morphogenesis and Organogenesis in Animals**
  - ✓ Cell aggregation and differentiation in Dictyostelium
  - ✓ Axes and pattern formation in Drosophila, amphibians, and chicks
  - ✓ Organogenesis: vulva formation in Caenorhabditis elegans, eye lens induction, limb development, and regeneration in vertebrates
  - ✓ Neuronal differentiation and post-embryonic development (larval formation, metamorphosis)
  - ✓ Environmental regulation of normal development and sex determination

- **Morphogenesis and Organogenesis in Plants**
  - ✓ Organization of shoot and root apical meristems
  - ✓ Development of shoots, roots, and leaves; phyllotaxy
  - ✓ Transition to flowering; floral meristems and floral development in Arabidopsis and Antirrhinum

- **Programmed Cell Death, Aging, and Senescence**

f. System Physiology – Plant

- **Photosynthesis:**
  - ✓ Light-harvesting complexes, electron transport mechanisms, and photoprotective mechanisms.
  - ✓ CO_2 fixation pathways: C3, C4, and CAM.

- **Respiration and Photorespiration:**
  - ✓ Citric acid cycle, mitochondrial electron transport, and ATP synthesis in plants.
  - ✓ Role of alternate oxidase and photorespiratory pathways.

- **Nitrogen Metabolism:**
  - ✓ Assimilation of nitrate and ammonium.
  - ✓ Biosynthesis of amino acids.

- **Plant Hormones:**
  - ✓ Biosynthesis, storage, breakdown, and transport mechanisms.
  - ✓ Physiological effects and mechanisms of action.

- **Sensory Photobiology:**
  - ✓ Structure, function, and action mechanisms of phytochromes, cryptochromes, and phototropins.
  - ✓ Stomatal movement, photoperiodism, and biological clocks.
- **Solute Transport and Photoassimilate Translocation:**
  - ✓ Uptake, transport, and translocation of water, ions, solutes, and macromolecules.
  - ✓ Processes through soil, cells, xylem, and phloem, including transpiration.
  - ✓ Mechanisms of photoassimilate loading and unloading.
- **Secondary Metabolites:**
  - ✓ Biosynthesis of terpenes, phenols, and nitrogenous compounds.
  - ✓ Functional roles of these metabolites.
- **Stress Physiolo**gy:
  - ✓ Plant responses to biotic stresses (pathogens, insects) and abiotic stresses (water, temperature, salt).

g. System Physiology – Animal

- **Blood and Circulation:**
  - ✓ Blood corpuscles, hemopoiesis, formed elements, and plasma function.
  - ✓ Blood volume regulation, blood groups, haemoglobin, immunity, and haemostasis.
- **Cardiovascular System:**
  - ✓ Comparative anatomy of heart structures, myogenic heart, and specialized tissues.
  - ✓ ECG principles and significance, cardiac cycle, blood pressure regulation, and heart function.
- **Respiratory System:**
  - ✓ Comparative respiration, gas exchange, transport, and waste elimination across species.
  - ✓ Neural and chemical regulation of respiration. Nervous System:
  - ✓ Neurons, action potentials, and gross neuroanatomy of the brain and spinal cord.
  - ✓ Central and peripheral nervous systems and neural control of muscle tone and posture.
- **Sense Organs:** Mechanisms of vision, hearing, and tactile responses.
- **Excretory System:**
  - ✓ Comparative physiology of excretion and kidney function.
  - ✓ Processes of urine formation, concentration, micturition, and waste elimination.
  - ✓ Regulation of water, blood volume, electrolyte balance, and acid-base homeostasis.
- **Thermoregulation:**
  - ✓ Body temperature regulation (physical, chemical, and neural).
  - ✓ Acclimatization and stress adaptation.

- **Digestive System:** Digestion, absorption, energy balance, and basal metabolic rate (BMR).
- **Endocrinology and Reproduction:**
  - ✓ Endocrine glands, hormone mechanisms, and diseases.
  - ✓ Reproductive processes, including gametogenesis, ovulation, and neuroendocrine regulation.

h. Inheritance Biology

- **Mendelian Principles:** Dominance, segregation, and independent assortment.
- **Concept of Gene:** Alleles, multiple alleles, pseudo alleles, and complementation tests.
- **Extensions of Mendelian Principles:**
  - ✓ Codominance, incomplete dominance, gene interactions, pleiotropy, genomic imprinting.
  - ✓ Penetrance, expressivity, phenocopy, linkage, sex linkage, and sex-influenced characters.
- **Gene Mapping Methods:**
  - ✓ Linkage maps, tetrad analysis, molecular markers, and somatic cell hybrids.
  - ✓ Mapping population development in plants.
- **Extrachromosomal Inheritance:**
  - ✓ Mitochondrial and chloroplast gene inheritance.
  - ✓ Maternal inheritance patterns.
- **Microbial Genetics:**
  - ✓ Genetic transfer methods: transformation, conjugation, transduction, and sex-duction.
  - ✓ Gene mapping through interrupted mating and fine-structure gene analysis.
- **Human Genetics:** Pedigree analysis, linkage testing (lod scores), karyotypes, and genetic disorders.
- **Quantitative Genetics:** Polygenic inheritance, heritability measures, and QTL mapping.
- **Mutation:**
  - ✓ Mutation types, causes, and detection methods.
  - ✓ Mutant classifications: lethal, conditional, biochemical, loss of function, gain of function, and germinal vs. somatic mutations.
- **Chromosomal Alterations:**
  - ✓ Structural changes: deletion, duplication, inversion, translocation.
  - ✓ Numerical changes: ploidy and their genetic consequences.
- **Recombination:** Homologous and non-homologous recombination, including transposition.

i. Diversity of Life Forms

- **Principles and Methods of Taxonomy:**

- ✓ Concepts of species and hierarchical taxa.
- ✓ Biological nomenclature.
- ✓ Classical and quantitative methods of taxonomy for plants, animals, and microorganisms.

- **Levels of Structural Organization:**
  - ✓ Unicellular, colonial, and multicellular forms.
  - ✓ Organization of tissues, organs, and systems.
  - ✓ Comparative anatomy, adaptive radiation, and modifications.
- **Outline Classification of Plants, Animals, and Microorganisms:**
  - ✓ Criteria for classification in each taxon.
  - ✓ Classification schemes and evolutionary relationships among taxa.
- **Natural History of the Indian Subcontinent:**
  - ✓ Major habitat types of the subcontinent.
  - ✓ Geographic origins and species migrations.
  - ✓ Common Indian mammals and birds. • Seasonality and phenology.
- **Organisms of Health and Agricultural Importance:** Common parasites and pathogens affecting humans, domestic animals, and crops.
- **Organisms of Conservation Concern:**
  - ✓ Rare and endangered species.
  - ✓ Conservation strategies.

j. Ecological Principles

- **The Environment:**
  - ✓ Physical and biotic environments.
  - ✓ Interactions between biotic and abiotic factors.
- **Habitat and Niche:**
  - ✓ Concept of habitat and niche.
  - ✓ Niche width and overlap, fundamental vs. realized niche.
  - ✓ Resource partitioning and character displacement.
- **Population Ecology:**
  - ✓ Population characteristics and growth curves.
  - ✓ Population regulation mechanisms.
  - ✓ Life history strategies (r and K selection).
  - ✓ Concept of metapopulations, including demes, dispersal, and age-structured populations.
- **Species Interactions:** Interspecific competition, herbivory, carnivory, pollination, and symbiosis.
- **Community Ecology:**
  - ✓ Community structure, attributes, and species diversity measurement.
  - ✓ Concepts of edges and ecotones.
- **Ecological Succession:**
  - ✓ Types and mechanisms.

- ✓ Changes during succession and climax concepts.

- **Ecosystem Ecology:**
  - ✓ Ecosystem structure and function.
  - ✓ Energy flow, mineral cycling (C, N, P).
  - ✓ Primary production, decomposition.
  - ✓ Examples of Indian ecosystems: terrestrial (forest, grassland) and aquatic (freshwater, marine, estuarine).

- **Biogeography:**
  - ✓ Major terrestrial biomes.
  - ✓ Theory of island biogeography.
  - ✓ Biogeographical zones of India.

- **Applied Ecology:**
  - ✓ Environmental pollution and global environmental changes.
  - ✓ Biodiversity status, monitoring, and documentation.
  - ✓ Drivers of biodiversity change and management strategies.

- **Conservation Biology:**
  - ✓ Principles and approaches to conservation.
  - ✓ Indian case studies, including Project Tiger and biosphere reserves.

k. Evolution and Behaviour

- **Emergence of Evolutionary Thoughts:**
  - ✓ Concepts from Lamarck and Darwin: variation, adaptation, struggle, fitness, and natural selection.
  - ✓ Mendelism and spontaneous mutations.
  - ✓ Evolutionary synthesis.

- **Origin of Cells and Unicellular Evolution:**
  - ✓ Abiotic synthesis of biological molecules, monomers, and polymers.
  - ✓ Concepts of Oparin and Haldane; Miller's experiment (1953).
  - ✓ Evolution of prokaryotic and eukaryotic cells.
  - ✓ Metabolic shifts: anaerobic metabolism, photosynthesis, and aerobic pathways.

- **Palaeontology and Evolutionary History:**
  - ✓ Evolutionary timescale: eras, periods, and epochs.
  - ✓ Origins of unicellular and multicellular organisms.
  - ✓ Evolution of major plant and animal groups.
  - ✓ Stages in primate evolution, including Homo.

- **Molecular Evolution:**
  - ✓ Neutral evolution, molecular divergence, and molecular clocks.
  - ✓ Phylogeny tools: protein and nucleotide sequence analysis.
  - ✓ Gene duplication, divergence, and origin of new genes/proteins.

- **Evolutionary Mechanisms:**
  - ✓ Population genetics: gene pool, gene frequency, Hardy-Weinberg equilibrium.
  - ✓ Changes in gene frequency: natural selection, migration, genetic drift.

- ✓ Adaptive radiation, isolating mechanisms, and speciation.
- ✓ Concepts of allopatry, sympatry, convergent evolution, and co-evolution.

- **Brain, Behaviour, and Evolution:**
  - ✓ Sexual selection and altruism: group and kin selection, reciprocal altruism.
  - ✓ Neural basis of learning, memory, cognition, sleep, and biological clocks.
  - ✓ Development of behaviour, social communication, dominance, and space use.
  - ✓ Mating systems, parental care, aggressive behaviour, foraging optimality, migration, and domestication.

i. Applied Biology

- **Microbial Fermentation:** Production of small and macromolecules through microbial fermentation processes.
- **Immunological Applications:** Utilization of immunological principles in developing vaccines and diagnostics.
- **Tissue and Cell Culture:** Methods for culturing plant and animal tissues and cells.
- **Transgenic Technology:** Development of transgenic plants and animals with molecular approaches for diagnosis and strain identification.
- **Genomics Applications:** Genomics for health and agriculture, including advancements in gene therapy.
- **Biodiversity and Bioresources:** Exploration and sustainable use of bioresources and biodiversity.
- **Breeding Techniques:** Plant and animal breeding with a focus on marker-assisted selection.
- **Environmental Biotechnology:** Techniques in bioremediation, phytoremediation, and biosensors for environmental management.

j. Methods in Biology

- **Molecular Biology and Recombinant DNA Techniques**
  - ✓ Isolation and purification of RNA, DNA (genomic and plasmid), and proteins using various separation methods.
  - ✓ Analysis of RNA, DNA, and proteins via one- and two-dimensional gel electrophoresis, including isoelectric focusing.
  - ✓ Molecular cloning of DNA/RNA fragments in bacterial and eukaryotic systems.
  - ✓ Expression of recombinant proteins in bacterial, animal, and plant vectors.
  - ✓ Isolation of specific nucleic acid sequences.
  - ✓ Generation of genomic and cDNA libraries using plasmid, phage, cosmid, BAC, and YAC vectors.
  - ✓ In vitro mutagenesis, deletion techniques, and gene knockout methods in bacteria and eukaryotes.
  - ✓ Protein sequencing and detection of post-translational modifications.
  - ✓ DNA sequencing methods and genome sequencing strategies.
  - ✓ Analysis of gene expression at RNA and protein levels using large-scale techniques like microarrays.
  - ✓ Isolation and analysis of carbohydrates and lipid molecules.
  - ✓ Genetic fingerprinting techniques: RFLP, RAPD, and AFLP.

- **Histochemical and Immunological Techniques**
  - ✓ Antibody generation.
  - ✓ Detection using ELISA, RIA, western blot, immunoprecipitation, flow cytometry, and immunofluorescence microscopy.
  - ✓ In situ localization using FISH and GISH techniques.
- **Biophysical Methods**
  - ✓ Molecular analysis using spectroscopy (UV/Visible, fluorescence, circular dichroism, NMR, ESR).
  - ✓ Molecular structure determination through X-ray diffraction and NMR.
  - ✓ Advanced techniques such as light scattering, mass spectrometry, and surface plasma resonance.
- **Statistical Methods**
  - ✓ Measures of central tendency and dispersion.
  - ✓ Probability distributions: Binomial, Poisson, and normal.
  - ✓ Sampling distributions and parametric vs. non-parametric statistics.
  - ✓ Confidence intervals, errors, and significance levels.
  - ✓ Regression, correlation, t-tests, ANOVA, and Chi-square tests.
  - ✓ Introduction to multivariate statistics.
- **Radiolabelling Techniques**
  - ✓ Detection and measurement of biological radioisotopes.
  - ✓ Incorporation of radioisotopes in tissues and cells.
  - ✓ Molecular imaging and safety protocols for handling radioactive materials.
- **Microscopic Techniques**
  - ✓ Visualization of cells and subcellular components using light microscopy.
  - ✓ Techniques for microscopy of living cells and resolving power across types.
  - ✓ Scanning and transmission electron microscopy (SEM/TEM).
  - ✓ Fixation and staining methods for EM, freeze-etch, and freeze-fracture techniques.
  - ✓ Image processing in microscopy.
- **Electrophysiological Techniques**
  - ✓ Single-neuron and patch-clamp recording.
  - ✓ Electrocardiography (ECG) and brain activity recording.
  - ✓ Brain lesioning, stimulation, and pharmacological testing.
  - ✓ Imaging methods such as PET, MRI, fMRI, and CT scans.
- **Field Biology Methods**
  - ✓ Estimation of plant and animal population densities.
  - ✓ Observation of ranging patterns through direct, indirect, and remote methods.
  - ✓ Sampling methods for behavioural studies.
  - ✓ Habitat characterization using ground-based and remote sensing methods.

5. Mathematical Sciences

a. **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. Riemann sums and Riemann 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, inverse and implicit function theorems. Metric spaces, compactness, connectedness. Normed linear Spaces. Spaces of continuous functions as examples.

b. **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, Cayley-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.

c. **Complex Analysis:** Algebra of complex numbers, the complex plane, polynomials, power series, transcendental functions such as exponential, trigonometric and hyperbolic functions. Analytic functions, Cauchy-Riemann 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.

d. **Algebra:** Permutations, combinations, pigeon-hole principle, inclusion-exclusion principle, derangements. Fundamental theorem of arithmetic, divisibility in Z, congruences, Chinese Remainder Theorem, Euler's Ø- function, primitive roots. 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, Galois Theory.

e. **Topology:** basis, dense sets, subspace and product topology, separation axioms, connectedness and compactness.

f. **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 homogenous and non-homogeneous linear ODEs, variation of parameters, Sturm-Liouville boundary value problem, Green's function.

g. **Partial Differential Equations (PDEs):** Lagrange 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.

h. **Numerical Analysis:** Numerical solutions of algebraic equations, Method of iteration and Newton-Raphson method, Rate of convergence, Solution of systems of linear algebraic equations using Gauss elimination and Gauss-Seidel methods, Finite differences, Lagrange, Hermite and spline interpolation, Numerical differentiation and integration, Numerical solutions of ODEs using Picard, Euler, modified Euler and Runge-Kutta methods.

i. Descriptive statistics, exploratory data analysis.
   - Sample space, discrete probability, independent events, Bayes theorem. Random variables and distribution functions (univariate and multivariate); expectation and moments. Independent random variables, marginal and conditional distributions. Characteristic functions. Probability inequalities (Tchebyshef, Markov, Jensen). Modes of convergence, weak and strong laws of large numbers, Central Limit theorems (i.i.d. case).
   - Markov chains with finite and countable state space, classification of states, limiting behaviour of n-step transition probabilities, stationary distribution, Poisson and birth-and-death processes.
   - Standard discrete and continuous univariate distributions. sampling distributions, standard errors and asymptotic distributions, distribution of order statistics and range.
   - Methods 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 chi-square test of goodness of fit. Large sample tests.
   - Simple nonparametric tests for one and two sample problems, rank correlation and test for independence. Elementary Bayesian inference.
   - Gauss-Markov models, estimability of parameters, best linear unbiased estimators, confidence intervals, tests for linear hypotheses. Analysis of variance and covariance. Fixed, random and mixed effects models. Simple and multiple linear regression. Elementary regression diagnostics. Logistic regression.
   - Multivariate normal distribution, Wishart distribution and their properties. Distribution of quadratic forms. Inference 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.
   - Completely randomized designs, randomized block designs and Latin-square designs. Connectedness and orthogonality of block designs, BIBD. 2K factorial experiments: confounding and construction.
   - Hazard function and failure rates, censoring and life testing, series and parallel systems.
   - Linear programming problem, simplex methods, duality. Elementary queuing and inventory models. Steady-state solutions of Markovian queuing models: M/M/1, M/M/1 with limited waiting space, M/M/C, M/M/C with limited waiting space, M/G/1.

4. Civil Engineering

a. Structural Engineering

- **Engineering Mechanics:** System of forces, free-body diagrams, equilibrium equations; Internal forces in structures; Frictions and its applications; Centre of mass; Free Vibrations of undamped SDOF system.
- **Solid Mechanics:** Bending moment and shear force in statically determinate beams; Simple stress and strain relationships; Simple bending theory, flexural and shear stresses, shear centre; Uniform torsion, Transformation of stress; buckling of column, combined and direct bending stresses.
- **Structural Analysis:** Statically determinate and indeterminate structures by force/ energy methods; Method of superposition; Analysis of trusses, arches, beams, cables and frames; Displacement methods: Slope deflection and moment distribution methods; Influence lines; Stiffness and flexibility methods of structural analysis.
- **Construction Materials and Management:** Construction Materials: Structural Steel – Composition, material properties and behaviour; Concrete - Constituents, mix design, short-term and long-term properties. Construction Management: Types of construction projects; Project planning and network analysis - PERT and CPM; Cost estimation.
- **Concrete Structures:** Working stress and Limit state design concepts; Design of beams, slabs, columns; Bond and development length; Prestressed concrete beams**.**
- **Steel Structures:** Working stress and Limit state design concepts; Design of tension and compression members, beams and beam- columns, column bases; Connections - simple and eccentric, beam-column connections, plate girders and trusses; Concept of plastic analysis -beams and frames.

b. Geotechnical Engineering

- **Soil Mechanics:** Three-phase system and phase relationships, index properties; Unified and Indian standard soil classification system; Permeability - one dimensional flow, Seepage through soils – two - dimensional flow, flow nets, uplift pressure, piping, capillarity, seepage force; Principle of effective stress and quicksand condition; Compaction of soils; One- dimensional consolidation, time rate of consolidation; Shear Strength, Mohr's circle, effective and total shear strength parameters, Stress-Strain characteristics of clays and sand; Stress paths.
- **Foundation Engineering:** Sub-surface investigations - Drilling bore holes, sampling, plate load test, standard penetration and cone penetration tests; Earth pressure theories - Rankine and Coulomb; Stability of slopes – Finite and infinite slopes, Bishop's method; Stress distribution in soils – Boussinesq's theory; Pressure bulbs, Shallow foundations – Terzaghi's and Meyerhoff's bearing capacity theories, effect of water table; Combined footing and raft foundation; Contact pressure; Settlement analysis in sands and clays; Deep foundations – dynamic and static

formulae, Axial load capacity of piles in sands and clays, pile load test, pile under lateral loading, pile group efficiency, negative skin friction.

c. Water Resources Engineering

- **Fluid Mechanics:** Properties of fluids, fluid statics; Continuity, momentum and energy equations and their applications; Potential flow, Laminar and turbulent flow; Flow in pipes, pipe networks; Concept of boundary layer and its growth; Concept of lift and drag.
- **Hydraulics:** Forces on immersed bodies; Flow measurement in channels and pipes; Dimensional analysis and hydraulic similitude; Channel Hydraulics - Energy-depth relationships, specific energy, critical flow, hydraulic jump, uniform flow, gradually varied flow and water surface profiles.
- **Hydrology:** Hydrologic cycle, precipitation, evaporation, evapo-transpiration, watershed, infiltration, unit hydrographs, hydrograph analysis, reservoir capacity, flood estimation and routing, surface run-off models, ground water hydrology - steady state well hydraulics and aquifers; Application of Darcy's Law.
- **Irrigation:** Types of irrigation systems and methods; Crop water requirements - Duty, delta, evapo transpiration; Gravity Dams and Spillways; Lined and unlined canals, Design of weirs on permeable foundation; cross drainage structures.

d. Environmental Engineering

- **Water and Waste Water Quality and Treatment:** Basics of water quality standards – Physical, chemical and biological parameters; Water quality index; Unit processes and operations; Water requirement; Water distribution system; Drinking water treatment.
- Sewerage system design, quantity of domestic wastewater, primary and secondary treatment. Effluent discharge standards; Sludge disposal; Reuse of treated sewage for different applications.
- **Air Pollution:** Types of pollutants, their sources and impacts, air pollution control, air quality standards, Air quality Index and limits.
- **Municipal Solid Wastes:** Characteristics, generation, collection and transportation of solid wastes, engineered systems for solid waste management (reuse/ recycle, energy recovery, treatment and disposal).

e. Transportation Engineering

- **Transportation Infrastructure:** Geometric design of highways - cross-sectional elements, sight distances, horizontal and vertical alignments.
- Geometric design of railway Track – Speed and Cant.
- Concept of airport runway length, calculations and corrections; taxiway and exit taxiway design.
- **Highway Pavements:** Highway materials - desirable properties and tests; Desirable properties of bituminous paving mixes; Design factors for flexible and rigid pavements; Design of flexible and rigid pavement using IRC codes.

- **Traffic Engineering:** Traffic studies on flow and speed, peak hour factor, accident study, statistical analysis of traffic data; Microscopic and macroscopic parameters of traffic flow, fundamental relationships; Traffic signs; Signal design by Webster's method; Types of intersections; Highway capacity.

f. Geomatics Engineering: Principles of surveying; Errors and their adjustment; Maps - scale, coordinate system; Distance and angle measurement - Levelling and trigonometric levelling; Traversing and triangulation survey; Total station; Horizontal and vertical curves. Photogrammetry and Remote Sensing - Scale, flying height; Basics of remote sensing and GIS.

5. Computer Science and Engineering

k. Digital Logic: Boolean algebra. Combinational and sequential circuits. Minimization. Number representations and computer arithmetic (fixed and floating point).

l. Computer Organization and Architecture: Machine instructions and addressing modes. ALU, data-path and control unit. Instruction pipelining, pipeline hazards. Memory hierarchy: cache, main memory and secondary storage; I/O interface (interrupt and DMA mode).

m. Programming and Data Structures: Programming in C. Recursion. Arrays, stacks, queues, linked lists, trees, binary search trees, binary heaps, graphs.

n. Algorithms: Searching, sorting, hashing. Asymptotic worst-case time and space complexity. Algorithm design techniques: greedy, dynamic programming and divide-and-conquer. Graph traversals, minimum spanning trees, shortest paths.

o. Theory of Computation: Regular expressions and finite automata. Context-free grammars and push-down automata. Regular and context-free languages, pumping lemma. Turing machines and undecidability.

p. Compiler Design: Lexical analysis, parsing, syntax-directed translation. Runtime environments. Intermediate code generation. Local optimisation, Data flow analyses: constant propagation, liveness analysis, common sub expression elimination.

q. Operating System: System calls, processes, threads, inter-process communication, concurrency and synchronization. Deadlock. CPU and I/O scheduling. Memory management and virtual memory. File systems.

r. Databases: ER-model. Relational model: relational algebra, tuple calculus, SQL. Integrity constraints, normal forms. File organization, indexing (e.g., B and B+ trees). Transactions and concurrency control.

s. Computer Networks: Concept of layering: OSI and TCP/IP Protocol Stacks; Basics of packet, circuit and virtual circuit switching; Data link layer: framing, error detection, Medium Access Control, Ethernet bridging; Routing protocols: shortest path, flooding, distance vector and link state routing; Fragmentation and IP addressing, IPv4, CIDR notation, Basics of IP support protocols (ARP, DHCP, ICMP), Network Address Translation (NAT); Transport layer: flow control and congestion control, UDP, TCP, sockets; Application layer protocols: DNS, SMTP, HTTP, FTP, Email.

6. Electrical Engineering

a. Network Elements: Ideal voltage and current sources, dependent sources, R, L, C, M elements; Network solution methods: KCL, KVL, Node and Mesh analysis; Network Theorems: Thevenin's, Norton's, Superposition and Maximum Power Transfer theorem; Transient response of DC and AC networks, sinusoidal steady-state analysis, resonance, two port networks, balanced three phase circuits, star-delta transformation, complex power and power factor in AC circuits.

b. Electromagnetic Fields: Coulomb's Law, Electric Field Intensity, Electric Flux Density, Gauss's Law, Divergence, Electric field and potential due to point, line, plane and spherical charge distributions, Effect of dielectric medium, Capacitance of simple configurations, Biot-Savart's law, Ampere's law, Curl, Faraday's law, Lorentz force, Inductance, Magnetomotive force, Reluctance, Magnetic circuits, Self and Mutual inductance of simple configurations.

c. Signals and Systems: Representation of continuous and discrete time signals, shifting and scaling properties, linear time invariant and causal systems, Fourier series representation of continuous and discrete time periodic signals, sampling theorem, Applications of Fourier Transform for continuous and discrete time signals, Laplace Transform and Z transform. R.M.S. value, average value calculation for any general periodic waveform.

d. Electrical Machines: Single phase transformer: equivalent circuit, phasor diagram, open circuit and short circuit tests, regulation and efficiency; Three-phase transformers: connections, vector groups, parallel operation; Auto-transformer, Electromechanical energy conversion principles; DC machines: separately excited, series and shunt, motoring and generating mode of operation and their characteristics, speed control of dc motors; Three-phase induction machines: principle of operation, types, performance, torque-speed characteristics, no-load and blocked-rotor tests, equivalent circuit, starting and speed control; Operating principle of single-phase induction motors; Synchronous machines: cylindrical and salient pole machines, performance and characteristics, regulation and parallel operation of generators, starting of synchronous motors; Types of losses and efficiency calculations of electric machines.

e. Power Systems: Basic concepts of electrical power generation, AC and DC transmission concepts, Models and performance of transmission lines and cables, Economic Load Dispatch (with and without considering transmission losses), Series and shunt compensation, Electric field distribution and insulators, Distribution systems, Per-unit quantities, Bus admittance matrix, Gauss- Seidel and Newton-Raphson load flow methods, Voltage and Frequency control, Power factor correction, Symmetrical components, Symmetrical and unsymmetrical fault analysis, Principles of over current, differential, directional and distance protection; Circuit breakers, System stability concepts, Equal area criterion.

f. Control Systems: Mathematical modelling and representation of systems, Feedback principle, transfer function, Block diagrams and Signal flow graphs, Transient and

Steady-state analysis of linear time invariant systems, Stability analysis using Routh-Hurwitz and Nyquist criteria, Bode plots, Root loci, Lag, Lead and Lead-Lag compensators; P, PI and PID controllers; State space model, Solution of state equations of LTI systems.

g. **Electrical and Electronic Measurements:** Bridges and Potentiometers, Measurement of voltage, current, power, energy and power factor; Instrument transformers, Digital voltmeters and multi-meters, Phase, Time and Frequency measurement; Oscilloscopes, Error analysis.

h. **Analog and Digital Electronics:** Simple diode circuits: clipping, clamping, rectifiers; Amplifiers: biasing, equivalent circuit and frequency response; oscillators and feedback amplifiers; operational amplifiers: characteristics and applications; single stage active filters, Active Filters: Sallen Key, Butterwoth, VCOs and timers, combinatorial and sequential logic circuits, multiplexers, demultiplexers, Schmitt triggers, sample and hold circuits, A/D and D/A converters.

g. **Power Electronics:** Static V-I characteristics and firing/gating circuits for Thyristor, MOSFET, IGBT; DC to DC conversion: Buck, Boost and Buck-Boost Converters; Single and three-phase configuration of uncontrolled rectifiers; Voltage and Current commutated Thyristor based converters; Bidirectional ac to dc voltage source converters; Magnitude and Phase of line current harmonics for uncontrolled and thyristor based converters; Power factor and Distortion Factor of AC to DC converters; Single phase and three-phase voltage and current source inverters, sinusoidal pulse width modulation.

7. Electronics and Communication Engineering

a. Networks, Signals and Systems

- **Circuit Analysis:** Node and mesh analysis, superposition, Thevenin's theorem, Norton's theorem, reciprocity. Sinusoidal steady state analysis: phasors, complex power, maximum power transfer. Time and frequency domain analysis of linear circuits: RL, RC and RLC circuits, solution of network equations using Laplace transform. Linear 2-port network parameters, wye-delta transformation.
- **Continuous-time Signals:** Fourier series and Fourier transform, sampling theorem and applications.
- **Discrete-time Signals:** DTFT, DFT, z-transform, discrete-time processing of continuous-time signals. LTI systems: definition and properties, causality, stability, impulse response, convolution, poles and zeroes, frequency response, group delay, phase delay.

b. Electronic Devices: Energy bands in intrinsic and extrinsic semiconductors, equilibrium carrier concentration, direct and indirect band-gap semiconductors.

Carrier Transport: Diffusion current, drift current, mobility and resistivity, generation and recombination of carriers, Poisson and continuity equations.

P-N junction, Zener diode, BJT, MOS capacitor, MOSFET, LED, photo diode and solar cell.

c. Analog Circuits:

- **Diode Circuits:** Clipping, clamping and rectifiers. BJT and MOSFET Amplifiers: Biasing, AC coupling, small signal analysis, frequency response. Current mirrors and differential amplifiers.
- **Op-amp Circuits:** Amplifiers, summers, differentiators, integrators, active filters, Schmitt triggers and oscillators.

d. Digital Circuits:

- **Number Representations:** Binary, integer and floating-point- numbers. Combinatorial circuits: Boolean algebra, minimization of functions using Boolean identities and Karnaugh map, logic gates and their static CMOS implementations, arithmetic circuits, code converters, multiplexers, decoders.
- **Sequential Circuits:** Latches and flip-flops, counters, shift-registers, finite state machines, propagation delay, setup and hold time, critical path delay.
- **Data Converters:** Sample and hold circuits, ADCs and DACs.
- **Semiconductor Memories:** ROM, SRAM, DRAM.
- **Computer Organization:** Machine instructions and addressing modes, ALU, data-path and control unit, instruction pipelining.

e. Control Systems: Basic control system components; Feedback principle; Transfer function; Block diagram representation; Signal flow graph; Transient and steady-state analysis of LTI systems; Frequency response; Routh-Hurwitz and Nyquist stability criteria; Bode and root-locus plots; Lag, lead and lag-lead compensation; State variable model and solution of state equation of LTI systems.

f. Communications:

- **Random Processes:** Auto correlation and power spectral density, properties of white noise, filtering of random signals through LTI systems.
- **Analog Communications:** Amplitude modulation and demodulation, angle modulation and demodulation, spectra of AM and FM, super heterodyne receivers.
- **Information Theory:** Entropy, mutual information and channel capacity theorem.
- **Digital Communications:** PCM, DPCM, digital modulation schemes (ASK, PSK, FSK, QAM), bandwidth, inter-symbol interference, MAP, ML detection, matched filter receiver, SNR and BER. Fundamentals of error correction, Hamming codes, CRC.

g. Electromagnetics:

- **Maxwell's Equations:** Differential and integral forms and their interpretation, boundary conditions, wave equation, Poynting vector.
- **Plane Waves and Properties:** Reflection and refraction, polarization, phase and group velocity, propagation through various media, skin depth.

- **Transmission Lines:** Equations, characteristic impedance, impedance matching, impedance transformation, S-parameters, Smith chart. Rectangular and circular waveguides, light propagation in optical fibers, dipole and monopole antennas, linear antenna arrays.

8. Mechanical Engineering

a. Applied Mechanics and Design

- **Engineering Mechanics:** Free-body diagrams and equilibrium; friction and its applications including rolling friction, belt-pulley, brakes, clutches, screw jack, wedge, vehicles, etc.; trusses and frames; virtual work; kinematics and dynamics of rigid bodies in plane motion; impulse and momentum (linear and angular) and energy formulations; Lagrange's equation.
- **Mechanics of Materials:** Stress and strain, elastic constants, Poisson's ratio; Mohr's circle for plane stress and plane strain; thin cylinders; shear force and bending moment diagrams; bending and shear stresses; concept of shear centre; deflection of beams; torsion of circular shafts; Euler's theory of columns; energy methods; thermal stresses; strain gauges and rosettes; testing of materials with universal testing machine; testing of hardness and impact strength.
- **Theory of Machines:** Displacement, velocity and acceleration analysis of plane mechanisms; dynamic analysis of linkages; cams; gears and gear trains; flywheels and governors; balancing of reciprocating and rotating masses; gyroscope.
- **Vibrations:** Free and forced vibration of single degree of freedom systems, effect of damping; vibration isolation; resonance; critical speeds of shafts.
- **Machine Design:** Design for static and dynamic loading; failure theories; fatigue strength and the S-N diagram; principles of the design of machine elements such as bolted, riveted and welded joints; shafts, gears, rolling and sliding contact bearings, brakes and clutches, springs.

b. Fluid Mechanics and Thermal Sciences

- **Fluid Mechanics:** Fluid properties; fluid statics, forces on submerged bodies, stability of floating bodies; control-volume analysis of mass, momentum and energy; fluid acceleration; differential equations of continuity and momentum; Bernoulli's equation; dimensional analysis; viscous flow of incompressible fluids, boundary layer, elementary turbulent flow, flow through pipes, head losses in pipes, bends and fittings; basics of compressible fluid flow.
- **Heat Transfer:** Modes of heat transfer; one dimensional heat conduction, resistance concept and electrical analogy, heat transfer through fins; unsteady heat conduction, lumped parameter system, Heisler's charts; thermal boundary layer, dimensionless parameters in free and forced convective heat transfer, heat transfer correlations for flow over flat plates and through pipes, effect of turbulence; heat exchanger performance, LMTD and NTU methods; radiative heat transfer, Stefan Boltzmann law, Wien's displacement law, black and grey surfaces, view factors, radiation network analysis.

- **Thermodynamics:** Thermodynamic systems and processes; properties of pure substances, behavior of ideal and real gases; zeroth and first laws of thermodynamics, calculation of work and heat in various processes; second law of thermodynamics; thermodynamic property charts and tables, availability and irreversibility; thermodynamic relations.
- **Applications:** Power Engineering: Air and gas compressors; vapour and gas power cycles, concepts of regeneration and reheat. I.C. Engines: Air-standard Otto, Diesel and dual cycles. Refrigeration and air-conditioning: Vapour and gas refrigeration and heat pump cycles; properties of moist air, psychrometric chart, basic psychrometric processes. Turbomachinery: Impulse and reaction principles, velocity diagrams, Pelton-wheel, Francis and Kaplan turbines; steam and gas turbines.

c. Materials, Manufacturing and Industrial Engineering

- **Engineering Materials:** Structure and properties of engineering materials, phase diagrams, heat treatment, stress-strain diagrams for engineering materials.
- **Casting, Forming and Joining Processes:** Different types of castings, design of patterns, moulds and cores; solidification and cooling; riser and gating design. Plastic deformation and yield criteria; fundamentals of hot and cold working processes; load estimation for bulk (forging, rolling, extrusion, drawing) and sheet (shearing, deep drawing, bending) metal forming processes; principles of powder metallurgy. Principles of welding, brazing, soldering and adhesive bonding.
- **Machining and Machine Tool Operations:** Mechanics of machining; basic machine tools; single and multi-point cutting tools, tool geometry and materials, tool life and wear; economics of machining; principles of non-traditional machining processes; principles of work holding, jigs and fixtures; abrasive machining processes; NC/CNC machines and CNC programming.
- **Metrology and Inspection:** Limits, fits and tolerances; linear and angular measurements; comparators; interferometry; form and finish measurement; alignment and testing methods; tolerance analysis in manufacturing and assembly; concepts of coordinate-measuring machine (CMM).
- **Computer Integrated Manufacturing:** Basic concepts of CAD/CAM and their integration tools; additive manufacturing.
- **Production Planning and Control:** Forecasting models, aggregate production planning, scheduling, materials requirement planning; lean manufacturing.
- **Inventory Control:** Deterministic models; safety stock inventory control systems.
- **Operations Research:** Linear programming, simplex method, transportation, assignment, network flow models, simple queuing models, PERT and CPM.

9. Computer Science and Information Technology

a. Discrete Structures and Optimization

- **Mathematical Logic:** Propositional and Predicate Logic, Propositional Equivalences, Normal Forms, Predicates and Quantifiers, Nested Quantifiers, Rules of Inference.
- **Sets and Relations:** Set Operations, Representation and Properties of Relations, Equivalence Relations, Partially Ordering.
- **Counting, Mathematical Induction and Discrete Probability:** Basics of Counting, Pigeonhole Principle, Permutations and Combinations, Inclusion-Exclusion Principle, Mathematical Induction, Probability, Bayes' Theorem.
- **Group Theory:** Groups, Subgroups, Semi Groups, Product and Quotients of Algebraic Structures, Isomorphism, Homomorphism, Automorphism, Rings, Integral Domains, Fields, Applications of Group Theory.
- **Graph Theory:** Simple Graph, Multigraph, Weighted Graph, Paths and Circuits, Shortest Paths in Weighted Graphs, Eulerian Paths and Circuits, Hamiltonian Paths and Circuits, Planner graph, Graph Coloring, Bipartite Graphs, Trees and Rooted Trees, Prefix Codes, Tree Traversals, Spanning Trees and Cut-Sets.
- **Boolean Algebra:** Boolean Functions and its Representation, Simplifications of Boolean Functions.
- **Optimization:** Linear Programming - Mathematical Model, Graphical Solution, Simplex and Dual Simplex Method, Sensitive Analysis; Integer Programming, Transportation and Assignment Models, PERT-CPM: Diagram Representation, Critical Path Calculations, Resource Levelling, Cost Consideration in Project Scheduling.

b. Computer System Architecture

- **Digital Logic Circuits and Components:** Digital Computers, Logic Gates, Boolean Algebra, Map Simplifications, Combinational Circuits, Flip-Flops, Sequential Circuits, Integrated Circuits, Decoders, Multiplexers, Registers and Counters, Memory Unit.
- **Data Representation:** Data Types, Number Systems and Conversion, Complements, Fixed Point Representation, Floating Point Representation, Error Detection Codes, Computer Arithmetic - Addition, Subtraction, Multiplication and Division Algorithms.
- **Register Transfer and Microoperations:** Register Transfer Language, Bus and Memory Transfers, Arithmetic, Logic and Shift Microoperations.
- **Basic Computer Organization and Design:** Stored Program Organization and Instruction Codes, Computer Registers, Computer Instructions, Timing and Control, Instruction Cycle, Memory-Reference Instructions, Input-Output, Interrupt.
- **Programming the Basic Computer:** Machine Language, Assembly Language, Assembler, Program Loops, Subroutines, Input-Output Programming.

- **Microprogrammed Control:** Control Memory, Address Sequencing, Design of Control Unit.
- **Central Processing Unit:** General Register Organization, Stack Organization, Instruction Formats, Addressing Modes, RISC Computer, CISC Computer.
- **Pipeline and Vector Processing:** Parallel Processing, Pipelining, Arithmetic Pipeline, Instruction Pipeline, Vector Processing Array Processors.
- **Input-Output Organization:** Peripheral Devices, Input-Output Interface, Asynchronous Data Transfer, Modes of Transfer, Priority Interrupt, DMA, Serial Communication.
- **Memory Hierarchy:** Main Memory, Auxillary Memory, Associative Memory, Cache Memory, Virtual Memory, Memory Management Hardware.
- **Multiprocessors:** Characteristics of Multiprocessors, Interconnection Structures, Interprocessor Arbitration, Interprocessor Communication and Synchronization, Cache Coherence, Multicore Processors.

c. Programming Languages and Computer Graphics

- **Language Design and Translation Issues:** Programming Language Concepts, Paradigms and Models, Programming Environments, Virtual Computers and Binding Times, Programming Language Syntax, Stages in Translation, Formal Transition Models.
- **Elementary Data Types:** Properties of Types and Objects; Scalar and Composite Data Types.
- **Programming in C:** Tokens, Identifiers, Data Types, Sequence Control, Subprogram Control, Arrays, Structures, Union, String, Pointers, Functions, File Handling, Command Line Arguments, Preprocessors.
- **Object Oriented Programming:** Class, Object, Instantiation, Inheritance, Encapsulation, Abstract Class, Polymorphism.
- **Programming in C++:** Tokens, Identifiers, Variables and Constants; Data types, Operators, Control statements, Functions Parameter Passing, Virtual Functions, Class and Objects; Constructors and Destructors; Overloading, Inheritance, Templates, Exception and Event Handling; Streams and Files; Multifile Programs.
- **Web Programming:** HTML, DHTML, XML, Scripting, Java, Servlets, Applets.
- **Computer Graphics:** Video-Display Devices, Raster-Scan and Random-Scan Systems; Graphics Monitors, Input Devices, Points and Lines; Line Drawing Algorithms, Mid-Point Circle and Ellipse Algorithms; Scan Line Polygon Fill Algorithm, Boundary-Fill and Flood- Fill.
- **2-D Geometrical Transforms and Viewing:** Translation, Scaling, Rotation, Reflection and Shear Transformations; Matrix Representations and Homogeneous Coordinates; Composite Transforms, Transformations Between Coordinate Systems, Viewing Pipeline, Viewing Coordinate Reference Frame, Window to View-Port Coordinate Transformation, Viewing Functions, Line and Polygon Clipping Algorithms.

- **3-D Object Representation, Geometric Transformations and Viewing:** Polygon Surfaces, Quadric Surfaces, Spline Representation, Bezier and B-Spline Curves; Bezier and B-Spline Surfaces; Illumination Models, Polygon Rendering Methods, Viewing Pipeline and Coordinates; General Projection Transforms and Cipping.

d. Database Management Systems

- **Database System Concepts and Architecture:** Data Models, Schemas, and Instances; Three-Schema Architecture and Data Independence; Database Languages and Interfaces; Centralized and Client/Server Architectures for DBMS.
- **Data Modeling:** Entity-Relationship Diagram, Relational Model - Constraints, Languages, Design, and Programming, Relational Database Schemas, Update Operations and Dealing with Constraint Violations; Relational Algebra and Relational Calculus; Codd Rules.
- **SQL:** Data Definition and Data Types; Constraints, Queries, Insert, Delete, and Update Statements; Views, Stored Procedures and Functions; Database Triggers, SQL Injection.
- **Normalization for Relational Databases:** Functional Dependencies and Normalization; Algorithms for Query Processing and Optimization; Transaction Processing, Concurrency Control Techniques, Database Recovery Techniques, Object and Object-Relational Databases; Database Security and Authorization.
- **Enhanced Data Models:** Temporal Database Concepts, Multimedia Databases, Deductive
- Databases, XML and Internet Databases; Mobile Databases, Geographic Information Systems, Genome Data Management, Distributed Databases and Client-Server Architectures.
- **Data Warehousing and Data Mining:** Data Modeling for Data Warehouses, Concept Hierarchy, OLAP and OLTP; Association Rules, Classification, Clustering, Regression,
- Support Vector Machine, K-Nearest Neighbour, Hidden Markov Model, Summarization, Dependency Modeling, Link Analysis, Sequencing Analysis, Social Network Analysis.
- **Big Data Systems:** Big Data Characteristics, Types of Big Data, Big Data Architecture, Introduction to Map-Reduce and Hadoop; Distributed File System, HDFS.
- **NOSQL:** NOSQL and Query Optimization; Different NOSQL Products, Querying and Managing NOSQL; Indexing and Ordering Data Sets; NOSQL in Cloud.

e. System Software and Operating System

- **System Software:** Machine, Assembly and High-Level Languages; Compilers and Interpreters; Loading, Linking and Relocation; Macros, Debuggers.
- **Basics of Operating Systems:** Operating System Structure, Operations and Services; System Calls, Operating-System Design and Implementation; System Boot.
- **Process Management:** Process Scheduling and Operations; Interprocess

Communication, Communication in Client–Server Systems, Process Synchronization, Critical-Section Problem, Peterson's Solution, Semaphores, Synchronization.

- **Threads:** Multicore Programming, Multithreading Models, Thread Libraries, Implicit Threading, Threading Issues.
- **CPU Scheduling:** Scheduling Criteria and Algorithms; Thread Scheduling, Multiple- Processor Scheduling, Real-Time CPU Scheduling.
- **Deadlocks:** Deadlock Characterization, Methods for Handling Deadlocks, Deadlock Prevention, Avoidance and Detection; Recovery from Deadlock.
- **Memory Management:** Contiguous Memory Allocation, Swapping, Paging, Segmentation, Demand Paging, Page Replacement, Allocation of Frames, Thrashing, Memory-Mapped Files.
- **Storage Management:** Mass-Storage Structure, Disk Structure, Scheduling and Management, RAID Structure.
- **File and Input/Output Systems:** Access Methods, Directory and Disk Structure; File- System Mounting, File Sharing, File-System Structure and Implementation; Directory Implementation, Allocation Methods, Free-Space Management, Efficiency and Performance; Recovery, I/O Hardware, Application I/O Interface, Kernel I/O Subsystem, Transforming I/O Requests to Hardware Operations.
- **Security:** Protection, Access Matrix, Access Control, Revocation of Access Rights, Program Threats, System and Network Threats; Cryptography as a Security Tool, User Authentication, Implementing Security Defenses.
- **Virtual Machines:** Types of Virtual Machines and Implementations; Virtualization.
- **Linux Operating Systems:** Design Principles, Kernel Modules, Process Management, Scheduling, Memory Management, File Systems, Input and Output; Interprocess Communication, Network Structure.
- **Windows Operating Systems:** Design Principles, System Components, Terminal Services and Fast User Switching; File System, Networking.
- **Distributed Systems:** Types of Network based Operating Systems, Network Structure, Communication Structure and Protocols; Robustness, Design Issues, Distributed File Systems.

f. Software Engineering

- **Software Process Models**: Software Process, Generic Process Model – Framework Activity, Task Set and Process Patterns; Process Lifecycle, Prescriptive Process Models, Project Management, Component Based Development, Aspect-Oriented Software Development, Formal Methods, Agile Process Models – Extreme Programming (XP), Adptive Software Development, Scrum, Dynamic System Development Model, Feature Driven Development, Crystal, Web Engineering**.**
- **Software Requirements**: Functional and Non-Functional Requirements; Eliciting Requirements, Developing Use Cases, Requirement Analysis and Modelling; Requirements Review, Software Requirment and Specification (SRS) Document.

- **Software Design**: Abstraction, Architecture, Patterns, Separation of Concerns, Modularity, Information Hiding, Functional Independence, Cohesion and Coupling; Object-Oriented Design, Data Design, Architectural Design, User Interface Design, Component Level Design.
- **Software Quality:** McCall's Quality Factors, ISO 9126 Quality Factors, Quality Control, Quality Assurance, Risk Management, Risk Mitigation, Monitoring and Management (RMMM); Software Reliability.
- **Estimation and Scheduling of Software Projects**: Software Sizing, LOC and FP based Estimations; Estimating Cost and Effort; Estimation Models, Constructive Cost Model (COCOMO), Project Scheduling and Staffing; Time-line Charts.
- **Software Testing**: Verification and Validation; Error, Fault, Bug and Failure; Unit and Integration Tesing; White-box and Black-box Testing; Basis Path Testing, Control Structure Testing, Deriving Test Cases, Alpha and Beta Testing; Regression Testing, Performance Testing, Stress Testing.
- **Software Configuration Management**: Change Control and Version Control; Software Reuse, Software Re-engineering, Reverse Engineering.

g. Data Structures and Algorithms

- **Data Structures:** Arrays and their Applications; Sparse Matrix, Stacks, Queues, Priority Queues, Linked Lists, Trees, Forest, Binary Tree, Threaded Binary Tree, Binary Search Tree, AVL Tree, B Tree, B+ Tree, B* Tree, Data Structure for Sets, Graphs, Sorting and Searching Algorithms; Hashing.
- **Performance Analysis of Algorithms and Recurrences:**Time and Space Complexities; Asymptotic Notation, Recurrence Relations.
- **Design Techniques:** Divide and Conquer; Dynamic Programming, Greedy Algorithms, Backtracking, Branch and Bound.
- **Lower Bound Theory:** Comparison Trees, Lower Bounds through Reductions.
- **Graph Algorithms:** Breadth-First Search, Depth-First Search, Shortest Paths, Maximum Flow, Minimum Spanning Trees.
- **Complexity Theory:** P and NP Class Problems; NP-completeness and Reducibility.
- **Selected Topics:** Number Theoretic Algorithms, Polynomial Arithmetic, Fast Fourier Transform, String Matching Algorithms.
- **Advanced Algorithms:** Parallel Algorithms for Sorting, Searching and Merging, Approximation Algorithms, Randomized Algorithms.

h. Theory of Computation and Compilers

- **Theory of Computation:** Formal Language, Non-Computational Problems, Diagonal Argument, Russels's Paradox.
- **Regular Language Models:** Deterministic Finite Automaton (DFA), Non-Deterministic Finite Automaton (NDFA), Equivalence of DFA and NDFA, Regular Languages, Regular Grammars, Regular Expressions, Properties of Regular Language, Pumping Lemma, Non-
- Regular Languages, Lexical Analysis.

- **Context Free Language:** Pushdown Automaton (PDA), Non-Deterministic Pushdown Automaton (NPDA), Context Free Grammar, Chomsky Normal Form, Greibach Normal Form, Ambiguity, Parse Tree Representation of Derivation Trees, Equivalence of PDA's and Context Free Grammars; Properties of Context Free Language.
- **Turing Machines (TM):** Standard Turing Machine and its Variations; Universal Turing Machines, Models of Computation and Church-Turing Thesis; Recursive and Recursively- Enumerable Languages; Context-Sensitive Languages, Unrestricted Grammars, Chomsky Hierarchy of Languages, Construction of TM for Simple Problems.
- **Unsolvable Problems and Computational Complexity:** Unsolvable Problem, Halting Problem, Post Correspondence Problem, Unsolvable Problems for Context-Free Languages, Measuring and Classifying Complexity, Tractable and Intractable Problems.
- **Syntax Analysis:** Associativity, Precedence, Grammar Transformations, Top Down Parsing, Recursive Descent Predictive Parsing, LL(1) Parsing, Bottom up Parsing, LR Parser, LALR(1) Parser.
- **Semantic Analysis:** Attribute Grammar, Syntax Directed Definitions, Inherited and Synthesized Attributes; Dependency Graph, Evaluation Order, S-attributed and L-attributed Definitions; Type-Checking.
- **Run Time System:** Storage Organization, Activation Tree, Activation Record, Stack Allocation of Activation Records, Parameter Passing Mechanisms, Symbol Table.
- **Intermediate Code Generation:** Intermediate Representations, Translation of Declarations, Assignments, Control Flow, Boolean Expressions and Procedure Calls.
- **Code Generation and Code Optimization:** Control-flow, Data-flow Analysis, Local Optimization, Global Optimization, Loop Optimization, Peep-Hole Optimization, Instruction Scheduling.

i. Data Communication and Computer Networks

- **Data Communication**: Components of a Data Communication System, Simplex, Half- Duplex and Duplex Modes of Communication; Analog and Digital Signals; Noiseless and Noisy Channels; Bandwidth, Throughput and Latency; Digital and Analog Transmission;
- Data Encoding and Modulation Techniques; Broadband and Baseband Transmission;
- Multiplexing, Transmission Media, Transmission Errors, Error Handling Mechanisms.
- **Computer Networks**: Network Topologies, Local Area Networks, Metropolitan Area Networks, Wide Area Network, Wireless Networks, Internet.
- **Network Models**: Layered Architecture, OSI Reference Model and its Protocols; TCP/IP Protocol Suite, Physical, Logical, Port and Specific Addresses; Switching Techniques.

- **Functions of OSI and TCP/IP Layers**: Framing, Error Detection and Correction; Flow and Error Control; Sliding Window Protocol, HDLC, Multiple Access – CSMA/CD, CSMA/CA, Reservation, Polling, Token Passing, FDMA, CDMA, TDMA, Network Devices, Backbone Networks, Virtual LANs.
- IPv4 Structure and Address Space; Classful and Classless Addressing; Datagram, Fragmentation and Checksum; IPv6 Packet Format, Mapping Logical to Physical Address (ARP), Direct and Indirect Network Layer Delivery; Routing Algorithms, TCP, UDP and SCTP Protocols; Flow Control, Error Control and Congestion Control in TCP and SCTP.
- **World Wide Web (WWW):** Uniform Resource Locator (URL), Domain Name Service (DNS), Resolution - Mapping Names to Addresses and Addresses to Names; Electronic Mail Architecture, SMTP, POP and IMAP; TELNET and FTP.
- **Network Security**: Malwares, Cryptography and Steganography; Secret-Key Algorithms, Public-Key Algorithms, Digital Signature, Virtual Private Networks, Firewalls.
- **Mobile Technology**: GSM and CDMA; Services and Architecture of GSM and Mobile Computing; Middleware and Gateway for Mobile Computing; Mobile IP and Mobile Communication Protocol; Communication Satellites, Wireless Networks and Topologies; Cellular Topology, Mobile Adhoc Networks, Wireless Transmission and Wireless LANs; Wireless Geolocation Systems, GPRS and SMS.
- **Cloud Computing and IoT:** SaaS, PaaS, IaaS, Public and Private Cloud; Virtualization, Virtual Server, Cloud Storage, Database Storage, Resource Management, Service Level Agreement, Basics of IoT.

j. Artificial Intelligence (AI)

- **Approaches to AI:** Turing Test and Rational Agent Approaches; State Space Representation of Problems, Heuristic Search Techniques, Game Playing, Min-Max Search, Alpha Beta Cutoff Procedures.
- **Knowledge Representation**: Logic, Semantic Networks, Frames, Rules, Scripts, Conceptual Dependency and Ontologies; Expert Systems, Handling Uncertainty in Knowledge.
- **Planning:** Components of a Planning System, Linear and Non-Linear Planning; Goal Stack Planning, Hierarchical Planning, STRIPS, Partial Order Planning.
- **Natural Language Processing**: Grammar and Language; Parsing Techniques, Semantic Analysis and Pragmatics.
- **Multi Agent Systems**: Agents and Objects; Agents and Expert Systems; Generic Structure of Multiagent System, Semantic Web, Agent Communication, Knowledge Sharing using Ontologies, Agent Development Tools.
- **Fuzzy Sets**: Notion of Fuzziness, Membership Functions, Fuzzification and Defuzzification; Operations on Fuzzy Sets, Fuzzy Functions and Linguistic Variables; Fuzzy Relations, Fuzzy Rules and Fuzzy Inference; Fuzzy Control System and Fuzzy Rule Based Systems.
- **Genetic Algorithms (GA)**: Encoding Strategies, Genetic Operators, Fitness Functions and GA Cycle; Problem Solving using GA.

- **Artificial Neural Networks (ANN):** Supervised, Unsupervised and Reinforcement Learning; Single Perceptron, Multi-Layer Perceptron, Self Organizing Maps, Hopfield Network.

10.Commerce and Management

a. Accounting: Basic accounting standard and principles, Journal & Ledger entries, Final A/c (Trading, P.&. L. & Balance Sheet), Partnership Accounts, Ratio Analysis, Cash Flow Analysis.

b. Cost & Management Accounting: Concept of Different Costs, Elements of Costs, Break- Even - Point Analysis, Marginal Costing, Standard Costing, Budgetary Control.

c. Financial Management: Basic Concept of Financial Management, Time Value of Money, Capital Structure, Capital Budgeting, Cost of Capital, Working Capital Management.

d. Economics, Banking and International Business: Demand and Supply, Indifference Curve Analysis, Production Theory, Cost & Revenue, Various Markets and Pricing Strategies, National Income, Inflation, Business Cycle, Foreign Trade, Business Environment and Policy Framework in India, International Business, Balance of Payment, International Banking, Foreign Exchanges And Foreign Trade Policy. Banking Structure, Types of Banks & Their Functions, Role Of RBI, SEBI, NABARD & Rural Banking, E- Banking, Financial Institutions, Financial Regulators, Banking Sector Reforms.

e. Taxation: Basic Concepts, Residential Status, Incidence of Tax for Different Tax Payers, Exempted Incomes, Heads of Income, Deductions and Rebates.

f. General Management: Marketing Mix, Product Decisions, Pricing Decisions, Promotion Decisions, Distribution Decisions, Market Segmentation, Targeting & Positioning, Product LifeCycle, And Consumer Behavior. Planning, Decision Making, Organization, Motivation, Leadership, Organization Structure, Organizational Culture.

HR Planning, Recruitment, Selection, Job Description, Job Analysis, Job Specification, Training & Development, Performance Appraisal Indian Contract Act, 1872, Sale of Goods Act, 1930, RTI Act, Negotiable Instruments Act, 1881, Goods and Services Tax (GST), The Companies Act, 2013.

11.Law

a. JURISPRUDENCE

- Nature and sources of law
- Schools of jurisprudence
- Law and morality
- Concept of rights and duties
- Legal personality
- Concepts of property, ownership and possession
- Concept of liability
- Law, poverty and development

- Global justice
- Modernism and post-modernism

b. CONSTITUTIONAL AND ADMINISTRATIVE LAW

- Preamble, fundamental rights and duties, directive principles of state policy.
- Union and State executive and their interrelationship
- Union and State legislature and distribution of legislative powers
- Judiciary
- Emergency provisions
- Temporary, transitional and special provisions in respect of certain states
- Election Commission of India
- Nature, scope and importance of administrative law
- Principle of natural justice
- Judicial review of administrative actions – Grounds.

c. PUBLIC INTERNATIONAL LAW AND IHL

- International law – Definition, nature and basis
- Sources of International law
- Recognition of states and governments
- Nationality, immigrants, refugees and internally displaced persons (IDPs)
- Extradition and asylum
- United Nations and its organs
- Settlement of international disputes
- World Trade Organization (WTO)
- International humanitarian law (IHL) - Conventions and protocols
- Implementation of IHL – Challenges

d. LAW OF CRIMES

- General principles of criminal liability – Actus reus and mens rea, individual and group liability and constructive liability
- Stages of crime and inchoate crimes - Abetment, criminal conspiracy and attempt
- General exceptions
- Offences against human body
- Offences against state and terrorism
- Offences against property
- Offences against women and children
- Drug trafficking and counterfeiting

- Offences against public tranquility
- Theories and kinds of punishments, compensation to the victims of crime

e. LAW OF TORTS AND CONSUMER PROTECTION

- Nature and definition of tort
- General principles of tortious liability
- General defenses
- Specific torts – Negligence, nuisance, trespass and defamation
- Remoteness of damages
- Strict and absolute liability
- Tortious liability of the State
- The Consumer Protection Act 1986 - Definitions, consumer rights and redressal mechanism
- The Motor Vehicles Act, 1988 - No fault liability, third party insurance and claims tribunal
- The Competition Act, 2002 - Prohibition of certain agreements, abuse of dominant position and regulation of combinations

f. COMMERCIAL LAW

- Essential elements of contract and e-contract
- Breach of contract, frustration of contract, void and voidable agreements
- Standard form of contract and quasi-contract
- Specific contracts - Bailment, pledge, indemnity, guarantee and agency
- Sale of Goods Act, 1930
- Partnership and limited liability partnership
- Negotiable Instruments Act, 1881
- Company law – Incorporation of a company, prospectus, shares and debentures
- Company law – Directors and meetings
- Corporate social responsibility

g. FAMILY LAW

- Sources and schools
- Marriage and dissolution of marriage
- Matrimonial remedies - Divorce and theories of divorce
- Changing dimensions of institution of marriage – Live-in relationship
- Recognition of foreign decrees in India on marriage and divorce
- Maintenance, dower and stridhan

- Adoption, guardianship and acknowledgement
- Succession and inheritance
- Will, gift and wakf
- Uniform Civil Code

h. ENVIRONMENT AND HUMAN RIGHTS LAW

- Meaning and concept of 'environment' and 'environmental pollution'
- International environmental law and UN Conferences
- Constitutional and legal framework for protection of environment in India
- Environmental Impact Assessment and control of hazardous waste in India
- National Green Tribunal
- Concept and development of human rights
- Universalism and cultural relativism
- International Bill of Rights
- Group rights – Women, children, persons with disabilities, elderly persons, minorities and weaker sections
- Protection and enforcement of human rights in India – National Human Rights Commission, National Commission for Minorities, National Commission for Women, National Commission for Scheduled Castes, National Commission for Schedule Tribes and National Commission for Backward Classes

12. Journalism and Mass Communication

a. Introduction to Journalism and Mass Communication

- Concept of Journalism and mass communication, mass communication in India.
- History, growth and development of print and electronic media. Major landmarks in print and electronic media in Indian languages. Media's role in formulation of states of India.
- Media criticism and media literacy, Press Council and Press Commissions of India, status of journalism and media education in India. Media policies of the Government of India since Independence.
- Models and theories of mass communication, normative theories, administrative and critical traditions in communication, media and journalism studies, communication and theories of socio-cultural, educational and agricultural change. Technological determinism, critique of Marshall McLuhan's views on media and communication and Marxist approaches. Information and knowledge societies.
- Indian traditions and approaches to communication from the Vedic era to the 21st century. Western and Eastern philosophical, ethical and aesthetic perceptions of communication - Aristotle and Plato, Hindu, Buddhist, and Islamic traditions.

- Media and culture - framework for understanding culture in a globalised world. Globalisation with respect to politico-economic & socio-cultural developments in India.

b. Communication for Development and Social Change

- Concept and definition of development communication, role of media and journalism in society, characteristics of Indian society – demographic and sociological impact of communication, media and journalism. Media and specific audiences.
- Development and social change. Issues and post-colonial conceptions.
- Deconstruction of dominant paradigm of communication and development. Responses and critique of dominant models.
- Corporatisation of development - Corporate Social Responsibility, non-state actors in development, mass campaigns by NGOs, Government of India, international agencies and corporates. Paradigms and discourse of development communication.
- Emergence of global civil societies, public sphere, global communication system - nation state-universal, national communication policies.
- Leading influencers of social reform in India - Raja Rammohan Roy, Pandit Madanmohan Malviya, Bal Gangadhar Tilak, Mahatma Jyotiba Phule, Mahatma Gandhi, Acharya Vinoba Bhave, Dr B. R. Ambedkar, Deendayal Upadhyay, Dr Ram Manohar Lohia etc.

c. Reporting and Editing

- News-concepts, determinants (values), structure and perspectives. Reporting for print, radio, television and digital media. Types of reporting. National and international news agencies and feature syndicates, functions and role.
- Writing for print, electronic and digital news media. Translation and transcreation.
- Editing and presentation techniques for print, television and digital media.
- Journalism as profession, reportage of contemporary issues, ethics of reporting.
- Critique of western news values, effect of new technology on global communication flows.
- Niche Reporting.

d. Advertising and Marketing Communication

- Definition, concept, functions, types, evolution of advertising, standards and ethics in advertising. Theories and models of communication in advertising.
- Brand management.
- Advertising management - agency-role, structure and function, client-agency relationship, media planning and budgeting.
- Advertising and creativity, language and translation.
- Advertising campaign and marketing. f. Advertising and marketing research.

e. Public Relations and Corporate Communication

- Public Relations and Corporate Communication - definition, concept and scope.
- Structure of PR in State, Public, Private and non-government sectors.
- Tools and techniques of PR and Corporate Communication.
- Crisis communication and crisis communication management.
- Ethics of Public Relations.
- International Public Relations, communication audit.

f. Media Laws and Ethics

- Concept of law and ethics in India and rest of the world.
- The Constitution of India, historical evolution, relevance.
- Concept of freedom of speech and expression in Indian Constitution.
- Defamation, Libel, Slander-IPC 499-502, Sedition IPC 124(A), Contempt of Courts Act 1971, Official Secrets Act 1923, Press and Registration of Books Act 1867, Working Journalists and other Newspaper Employees (Conditions of Service) and Miscellaneous Provisions Act 1955, Wage Boards, Law of Obscenity (Section 292-294 of IPC); the Miller test, the Hicklin test, Indecent Representation of Women (Prohibition) Act 1986, Scheduled Castes and Tribes (Prevention of Atrocities) Act, 1989, Parliamentary Privileges. Famous cases involving journalists and news media organisations.
- Right to Information Act 2005, Copyright Act 1957, Intellectual Property Rights, Cable Television Network (Regulation) Act 1995, Information Technology Act (relevant) 2000 and cyber laws, Cinematograph Act 1952, Film Censorship, Press Council Act as amended from time to time, IPR, ASCI, Drugs and Magic Remedies (Objectionable Advertisements) Act, 1954, Various regulatory bodies for print, TV, Advertising, PR, and Internet.
- Rules, regulations and guidelines for the media as recommended by Press Council of India, Information and Broadcasting ministry and other professional organisations, adversarial role of the media, human rights and media.

g. Media Management and Production

- Definition, concept of media management. Grammar of electronic media.
- Communication design theories and practice.
- Media production techniques – print and electronic.
- Digital media production techniques.
- Economics and commerce of mass media in India.
- Principles and management in media industry post liberalisation.

h. ICT and Media

- ICT and media - definition, characteristics and role. Effect of computer mediated communication. Impact of ICT on mass media. Digitisation.
- Social networking.
- Economics and commerce of web enabled media.
- Mobile adaption and new generation telephony by media, ethics and new media.
- ICT in education and development in India, online media and e-governance.
- Animation - concepts and techniques.

i. Film and Visual Communication

- Film and television theory.
- Film and identity in Indian film studies, leading film directors of India before and after Independence. Indian cinema in the 21st century.
- Approaches to analysis of Indian television.
- Visual Communication. Visual analysis.
- Basics of film language and aesthetics, the dominant film paradigm, evolution of Indian cinema-commercial and 'non-commercial' genres, the Hindi film song, Indian aesthetics and poetics (the theory of Rasa and Dhvani).
- National cinema movements: Soviet Montage cinema, German Expressionistic cinema, Italian Neo-Realistic cinema, French New Wave cinema, British New Wave cinema, Indian New Wave cinema, Period cinema. Cinema in the new millennium.

j. Communication Research

a. Definition, concept, constructs and approaches to communication research process.

b. Research Designs - types, structure, components, classical, experimental and quasi experimental, variables and hypotheses; types and methods of research; basic, applied, descriptive, analytical, historical, case study, longitudinal studies.

c. Research in journalism, Public Relations, advertising, cinema, animation and graphics, television, Internet, social media practices, magazines, children's media. Communication, journalism and media research in India.

d. Levels of measurement: sampling-probability and non-probability, tests of validity and reliability, scaling techniques. Methods and tools of data collection-interviews, surveys, case studies, obtrusive and non-obtrusive techniques, ethnography, schedule, questionnaire, dairy, and internet-based tools, media specific methods such as exit.

e. polls, opinion polls, telephone, SMS surveys and voting with regard to GEC (general entertainment content).

f. Data analysis, testing, interpretation, application of statistical tests-parametric and non-parametric, tests of variance-univariate, bivariate and multivariate, tests of significance, computer mediated research.

g. Ethical considerations in communication, media and journalism research, writing research reports, plagiarism.

13. Library and Information Science

- Data, Information, Knowledge and Wisdom.
- Information Life Cycle - Generation, Collection, Storage and Dissemination.
- Role of Information in Planning, Management, Socio-economic, Cultural, Educational and Technological Development.
- Information Science - Relationship with other subjects, Information Society and Knowledge Society.
- Communication – Concept, Types, Theories, Models, Channels and Barriers; Trends in Scholarly Communication.
- Information Industry - Generators, Providers and Intermediaries.
- IPR and Legal Issues - Categories, Conventions, Treaties, Laws.
- Plagiarism: Concept and Types.
- Right to Information Act (RTI); Information Technology Act.
- National Knowledge Commission; National Mission on Libraries.

- Historical Development of Libraries in India; Committees and Commissions on Libraries in India.
- Types of Libraries – Academic, Public, Special and National.
- Library Legislation and Library Acts in Indian States; The Press and Registration of Books Act; The Delivery of Books and Newspapers (Public Libraries) Act.
- Laws of Library Science.
- Library and Information Science Profession - Librarianship as a Profession, Professional Skills and Competences; Professional Ethics.
- Professional Associations - National – ILA, IASLIC, IATLIS; International – IFLA, ALA, CILIP, ASLIB, SLA; Role of UGC, RRRLF and UNESCO in Promotion and Development of Libraries.
- Library and Information Science Education in India.
- Library Public Relations and Extension Activities.
- Type of Users - User Studies, User Education.
- Information Literacy - Areas, Standards, Types and Models; Trends in Information Literacy.

- Information Sources - Nature, Characteristics, Types and Formats.
- Sources of Information - Primary, Secondary and Tertiary; Documentary and Non-Documentary.
- Primary Information Sources (Print and Electronic) - Journals, Conference Proceedings, Patents, Standards, Theses & Dissertations, Trade Literature.
- Secondary Information Sources (Print and Electronic) - Dictionaries, Encyclopedias, Bibliographies, Indexing & Abstracting, Statistical sources, Handbooks and Manuals.

- Tertiary Information Sources (Print and Electronic)- Directories, Year Books, Almanacs.
- Reference Sources - Bibliographical, Biographical, Educational, Language and Geographical.
- Electronic Information Resources - Subject Gateways, Web Portals, Bulletin Boards, Discussion Forums /Groups.
- Databases: Bibliographic, Numeric, Full text, Multimedia; Open Access Databases.
- Institutional and Human Resources.
- Evaluation of Reference Sources and Web Resources.

- Community Information Services.
- Reference Service – Concept and Types; Referral Services
- Alerting Services - CAS, SDI, Inter Library Loan and Document Delivery.
- Mobile based Library Services and Tools – Mobile OPAC, Mobile Databases, Mobile Library Website, Library Apps, Mobile Library Instructions, Augmented Reality, SMS Alerts, Geo-Location, Reference Enquiry.
- Web 2.0 and 3.0 - Library 2.0- Concept, Characteristics, Components; Instant Messaging, RSS Feeds, Podcasts, Vodcasts, Ask a Librarian
- Collaborative Services- Social Networks, Academics Social Networks, Social Tagging, Social Bookmarking.
- Web – Scale Discovery Services
- National Information Systems and Networks: NISCAIR, DESIDOC, SENDOC, ENVIS, INFLIBNET, DELNET, NICNET, ERNET, National Knowledge Network (NKN), Biotechnology Information System Network
- International Information Systems and Networks: INIS, AGRIS, INSPEC, MEDLARS, BIOSIS, ERIC, Patent Information System (PIS), Biotechnology Information System (BIS).
- Library Resource Sharing and Library Consortia – National and International.

- Universe of Knowledge - Nature and Attributes; Modes of Formation of Subjects.
- Knowledge Organisation - Classification – Theories, Cannons, and Principles; Simple Knowledge Organisation System (SKOS), Taxonomies, Folksonomy, Trends in Classification.
- Mapping of Subjects in Library Classification Schemes – DDC, UDC and CC.
- Knowledge Organisation: Cataloguing - Cannons and Principles; Centralized and Co-operative Catalogue; Library Cataloguing Codes: CCC and AACR - II.
- Standards of Bibliographic Record Formats and Description – ISBD, MARC 21, CCF, RDA, FRBR, Bibframe.
- Standards for Bibliographic Information Interchange & Communication – ISO 2709, Z39.50, Z39.71.
- Metadata Standards: Dublin Core; MARC21, METS, MODES, EAD.
- Indexing Systems and Techniques: Assigned - Pre-coordinate; Post-Coordinate; Derived- Title-based; Vocabulary Control.

- Abstracting – Types and Guidelines.
- Information Retrieval System – Features, Components, Models and Evaluation.

- Management - Principles, Functions and Schools of thought.
- Library and Information Centers Management - Book Selection Tools and Principles; Library Acquisition, Technical Processing, Circulation, Serial Control, Maintenance and Stock Verification; Preservation and Conservation; Hazards and Control Measures of Library Materials.
- Human Resource Management – Planning, Job Analysis, Job Description, Job Evaluation, Selection, Recruitment, Motivation, Training and Development, Performance Appraisal; Staff Manual.
- Financial Management in Libraries - Sources of Finance, Resource Mobilisation, Budgeting Methods; Cost Effective and Cost Benefit Analysis, Annual Reports & Statistics; Library Authority and Committee.
- Project Management - SWOT, PEST, PERT / CPM.
- Total Quality Management (TQM) - Concepts, Principles and Techniques, Six Sigma; Evaluation of Services of Libraries and Information Centers.
- Library Building, Furniture and Equipments; Green Library Building; Information Commons; Makers Space; Security and Safety.
- Management Information System (MIS), MBO, Change Management, Disaster Management, Crisis Management.
- Knowledge Management – Principles, Tools, Components and Architecture.
- Marketing of Library Products and Services – Plan, Research, Strategies, Mix, Segmentation, Pricing and Advertising; Management Consultancy.

- Computer Technology - Character Representation (ASCII, ISCII, Unicode); Computer Hardware, Software; Storage Devices; Input and Output Devices.
- Types of Software - System Software, Application Software.
- Programming Languages – Object Oriented, Procedural, High Level, Scripting; Web Languages.
- Telecommunication - Transmission Channels, Mode, and Media, ISDN, PSDN, Multiplexing, Modulation, Standards and Protocols.
- Wireless Communication – Media, Wi-fi, Li-fi, Satellite Communication, Mobile Communication.
- Computer Networks - Topologies, Types of Networks – LAN, MAN, WAN.
- Internet - Web browsers, WWW, E-mail; Search Engines, Meta and Entity Search engines.
- Internet Protocols and Standards – HTTP, SHTTP, FTP, SMTP, TCP/IP, URI, URL.
- Hypertext, Hypermedia, Multimedia, Video conferencing, Virtual Reality, Augmented Technologies.
- Data Security, Network Security, Firewalls, Cryptographic Techniques, Anti-virus software, Anti-spyware, Intrusion Detection System.

- Library Automation – Areas, Planning, Selection of Hardware and Software, Implementation and Evaluation; Standards for Library Automation.
- Barcode, RFID, QR Code, Biometric, Smartcard: Features and Applications.

- Digitization – Planning, Selection of Materials, Hardware, Software, Process, Issues.
- Digital Library: Genesis, Characteristics, Types, Architecture; Standards, Formats and Protocols, DOI.
- Digital Preservation - Need, Purpose, Standards, Methods, Techniques, Projects (National and International).
- Digital Library Initiatives – National and International.
- Institutional Repositories - Need, Purpose, Types and Tools; Institutional Repositories in India; ROAR, DOAR, SHARPA-ROMIO.
- Content Management Systems – Architecture, Data Integration, CMS Software – Selection, Implementation and Evaluation.
- Application of Artificial Intelligence, Expert Systems and Robotics in Libraries; Social Mobile Analytics Cloud (SMAC); Cloud Computing.
- Ontology – Tools (RDF, RDFS, Potege); Semantic Web, Linked Data, Big Data, Data Mining, Data Harvesting.

- Research - Concept, Purpose, Functions, Scope and Ethics; Types of Research – Basic and Applied, Interdisciplinary and Multidisciplinary.
- Research Methods: Historical, Descriptive, Experimental and Delphi.
- Research Design - Selection of Research Problem, Review of Literature; Formulation of Research Problem; Hypothesis – Formulation, Types and Testing; Sampling Techniques.
- Methods of Data Collection: Questionnaire, Interview, Observation, Library Records, Scales and Checklist.
- Data Analysis and Interpretation - Presentation of Data; Statistical Methods/ Techniques.
- Statistical Packages – Spreadsheet, SPSS, Bibexcel, 'R' Statistics.
- Research Report Writing and Citation Tools – Structure, Style, Contents, Guidelines; Style Manuals; Online Citation Tools; Reference Style Management Tools; Anti plagiarism Tools; Evaluation of Research Report.
- Metric Studies in LIS - Bibliometrics, Scientometric, Webometrics, Altmetrics;
- Impact Factors – Journal, Institutional and Authors; h-Index, g-Index, i10 Index.
- Trends in Library and Information Science Research.

- Academic Library and Information System.
- Public Library and Information System.
- Special Library and Information System.
- Health Science Library and Information System.
- Corporate Library and Information System.
- Agricultural Library and Information System.
- Engineering and Technological Library and Information System.
- Archive, Museums and Oriental Libraries.
- Community Information System.
- Information Services and System for Persons with Disability, Children and Women.

14. Economics

a. Micro Economics

- Theory of Consumer Behaviour
- Theory of Production and Costs
- Decision making under uncertainty Attitude towards Risk
- Game Theory – Non Cooperative games
- Market Structures, competitive and non-competitive equilibria and their efficiency properties
- Factor Pricing
- General Equilibrium Analysis
- Efficiency Criteria: Pareto-Optimality, Kaldor – Hicks and Wealth Maximization
- Welfare Economics: Fundamental Theorems, Social Welfare Function
- Asymmetric Information: Adverse Selection and Moral Hazard

b. Macro Economics

- National Income: Concepts and Measurement
- Determination of output and employment: Classical & Keynesian Approach
- Consumption Function
- Investment Function
- Multiplier and Accelerator
- Demand for Money
- Supply of Money
- IS – LM Model Approach
- Inflation and Phillips Curve Analysis
- Business Cycles • Monetary and Fiscal Policy
- Rational Expectation Hypothesis and its critique

c. Statistics and Econometrics

- Probability Theory: Concepts of probability, Distributions, Moments, Central Limit theorem
- Descriptive Statistics – Measures of Central tendency & dispersions, Correlation, Index Numbers
- Sampling methods & Sampling Distribution
- Statistical Inferences, Hypothesis testing
- Linear Regression Models and their properties – BLUE
- Identification Problem
- Simultaneous Equation Models – recursive and non-recursive

- Discrete choice models
- Time Series Analysis

d. Mathematical Economics

- Sets, functions and continuity, sequence, series
- Differential Calculus and its Applications
- Linear Algebra – Matrices, Vector Spaces
- Static Optimization Problems and their applications
- Input-Output Model, Linear Programming
- Difference and Differential equations with applications

e. International Economics

- International Trade: Basic concepts and analytical tools
- Theories of International Trade
- International Trade under imperfect competition
- Balance of Payments: Composition, Equilibrium and Disequilibrium and Adjustment Mechanisms
- Exchange Rate: Concepts and Theories
- Foreign Exchange Market and Arbitrage
- Gains from Trade, Terms of Trade, Trade Multiplier
- Tariff and Non-Tariff barriers to trade; Dumping
- GATT, WTO and Regional Trade Blocks; Trade Policy Issues
- IMF & World Bank

f. Public Economics

- Market Failure and Remedial Measures: Asymmetric Information, Public Goods, Externality
- Regulation of Market – Collusion and Consumers' Welfare
- Public Revenue: Tax & Non-Tax Revenue, Direct & Indirect Taxes, Progressive and non-Progressive Taxation, Incidence and Effects of Taxation
- Public expenditure
- Public Debt and its management
- Public Budget and Budget Multiplier
- Fiscal Policy and its implications

g. Money and Banking

- Components of Money Supply
- Central Bank
- Commercial Banking

- Instruments and Working of Monetary Policy
- Non-banking Financial Institutions
- Capital Market and its Regulation

h. Growth and Development Economics

- Economic Growth and Economic Development
- Theories of Economic Development: Adam Smith, Ricardo, Marx, Schumpeter, Rostow, Balanced & Unbalanced growth, Big Push approach.
- Models of Economic Growth: Harrod-Domar, Solow, Robinson, Kaldor
- Technical progress – Disembodied & embodied; endogenous growth
- Indicators of Economic Development: PQLI, HDI, SDGs
- Poverty and Inequalities – Concepts and Measurement
- Social Sector Development: Health, Education, Gender

i. Environmental Economics and Demography

- Environment as a Public Good
- Market Failure
- Coase Theorem
- Cost-Benefit Analysis and Compensation Criteria
- Valuation of Environmental Goods
- Theories of Population
- Concepts and Measures: Fertility, Morbidity, Mortality
- Age Structure, Demographic Dividend
- Life Table
- Migration

j. Indian Economy

- Economic Growth in India: Pattern and Structure
- Agriculture: Pattern & Structure of Growth, Major Challenges, Policy Responses
- Industry: Pattern & Structure of Growth, Major Challenges, Policy Responses
- Services: Pattern & Structure of Growth, Major Challenges, Policy Responses
- Rural Development – Issues, Challenges & Policy Responses
- Urban Development – Issues, Challenges and Policy Responses.
- Foreign Trade: Structure and Direction, BOP, Flow of Foreign Capital, Trade Policies
- Infrastructure Development: Physical and Social; Public-Private Partnerships
- Reforms in Land, Labour and Capital Markets

- Centre-State Financial Relations and Finance Commissions of India; FRBM
- Poverty, Inequality & Unemployment

15. Psychology

a. Emergence of Psychology: Psychological thought in some major Eastern Systems: Bhagavad Gita, Buddhism, Sufism and Integral Yoga. Academic psychology in India: Pre independence era; post-independence era; 1970s: The move to addressing social issues; 1980s: Indigenization; 1990s: Paradigmatic concerns, disciplinary identity crisis; 2000s: Emergence of Indian psychology in academia. Issues: The colonial encounter; Post colonialism and psychology; Lack of distinct disciplinary identity.

Western: Greek heritage, medieval period and modern period. Structuralism, Functionalism, Psychoanalytical, Gestalt, Behaviorism, Humanistic Existential, Transpersonal, Cognitive revolution, Multiculturalism. Four founding paths of academic psychology - Wundt, Freud, James, Dilthey. Issues: Crisis in psychology due to strict adherence to experimental analytical paradigm (logical empiricism). Indic influences on modern psychology.

Essential aspects of knowledge paradigms: Ontology, epistemology, and methodology. Paradigms of Western Psychology: Positivism, Post-Positivism, Critical perspective, Social Constructionism, Existential Phenomenology, and Co-operative Enquiry. Paradigmatic Controversies. Significant Indian paradigms on psychological knowledge: Yoga, Bhagavad Gita, Buddhism, Sufism, and Integral Yoga. Science and spirituality (avidya and vidya). The primacy of self-knowledge in Indian psychology.

b. Research Methodology and Statistics: Research: Meaning, Purpose, and Dimensions. Research problems, Variables and Operational Definitions, Hypothesis, Sampling. Ethics in conducting and reporting research

Paradigms of research: Quantitative, Qualitative, Mixed methods approach Methods of research: Observation, Survey [Interview, Questionnaires], Experimental, Quasi-experimental, Field studies, Cross-Cultural Studies, Phenomenology, Grounded theory, Focus groups, Narratives, Case studies, Ethnography

Statistics in Psychology: Measures of Central Tendency and Dispersion. Normal Probability Curve. Parametric [t-test] and Non-parametric tests [Sign Test, Wilcoxon Signed rank test, Mann-Whitney test, Kruskal-Wallis test, Friedman]. Power analysis. Effect size.

Correlational Analysis: Correlation [Product Moment, Rank Order], Partial correlation, multiple correlation. Special Correlation Methods: Biserial, Point biserial, tetrachoric, phi coefficient. Regression: Simple linear regression, Multiple regression. Factor analysis: Assumptions, Methods, Rotation and Interpretation.

Experimental Designs: ANOVA [One-way, Factorial], Randomized Block Designs, Repeated Measures Design, Latin Square, Cohort studies, Time series, MANOVA, ANCOVA. Single-subject designs.

c. Psychological testing: Types of tests Test construction: Item writing, item analysis. Test standardization: Reliability, validity and Norms.

Areas of testing: Intelligence, creativity, neuropsychological tests, aptitude, Personality assessment, interest inventories.

Attitude scales – Semantic differential, Staples, Likert scale. Computer-based psychological testing.

Applications of psychological testing in various settings: Clinical, Organizational and business, Education, Counseling, Military. Career guidance.

d. Biological basis of behavior: Sensory systems: General and specific sensations, receptors and processes

Neurons: Structure, functions, types, neural impulse, synaptic transmission. Neurotransmitters.

The Central and Peripheral Nervous Systems – Structure and functions. Neuroplasticity.

Methods of Physiological Psychology: Invasive methods – Anatomical methods, degeneration techniques, lesion techniques, chemical methods, microelectrode studies. Non-invasive methods – EEG, Scanning methods.

Muscular and Glandular system: Types and functions Biological basis of Motivation: Hunger, Thirst, Sleep and Sex. Biological basis of emotion: The Limbic system, Hormonal regulation of behavior. Genetics and behavior: Chromosomal anomalies; Nature-Nurture controversy [Twin studies and adoption studies]

e. Attention, Perception, Learning, Memory and Forgetting: Attention: Forms of attention, Models of attention

Perception: Approaches to the Study of Perception: Gestalt and physiological approaches Perceptual Organization: Gestalt, Figure and Ground, Law of Organization Perceptual Constancy: Size, Shape, and Color; Illusions Perception of Form, Depth and Movement Role of motivation and learning in perception.

Signal detection theory: Assumptions and applications Subliminal perception and related factors, information processing approach to perception, culture and perception, perceptual styles, Pattern recognition, Ecological perspective on perception.

Learning Process: Fundamental theories: Thorndike, Guthrie, Hull Classical Conditioning: Procedure, phenomena and related issues Instrumental learning: Phenomena, Paradigms and theoretical issues; Reinforcement: Basic variables and schedules; Behaviour modification and its applications Cognitive approaches in learning: Latent learning, observational learning. Verbal learning and Discrimination learning Recent trends in learning: Neurophysiology of learning.

Memory and Forgetting Memory processes: Encoding, Storage, Retrieval Stages of memory: Sensory memory, Short-term memory (Working memory), Long-term Memory (Declarative – Episodic and Semantic; Procedural)

Theories of Forgetting: Interference, Retrieval Failure, Decay, Motivated forgetting.

f. Thinking, Intelligence and Creativity: Theoretical perspectives on thought processes: Associationism, Gestalt, Information processing, Feature integration model Concept formation: Rules, Types, and Strategies; Role of concepts in thinking Types of Reasoning Language and thought.

Problem solving: Type, Strategies, and Obstacles Decision-making: Types and models

Metacognition: Metacognitive knowledge and Metacognitive regulation

Intelligence: Spearman; Thurstone; Jensen; Cattell; Gardner; Stenberg; Goleman; Das, Kar & Parrila

Creativity: Torrance, Getzels & Jackson, Guilford, Wallach & Kogan Relationship between Intelligence and Creativity

g. **Personality, Motivation, emotion, stress and coping:** Determinants of personality: Biological and socio-cultural Approaches to the study of personality: Psychoanalytical, Neo-Freudian, Social learning, Trait and Type, Cognitive, Humanistic, Existential, Transpersonal psychology. Other theories: Rotter's Locus of Control, Seligman's Explanatory styles, Kohlberg's theory of Moral development.

   Basic motivational concepts: Instincts, Needs, Drives, Arousal, Incentives, Motivational Cycle. Approaches to the study of motivation: Psychoanalytical, Ethological, S-R Cognitive, Humanistic.

   Exploratory behavior and curiosity Zuckerman's Sensation seeking Achievement, Affiliation and Power Motivational Competence Self-regulation Flow.

   Emotions: Physiological correlates Theories of emotions: James-Lange, Canon-Bard, Schachter and Singer, Lazarus, Lindsley. Emotion regulation

   Conflicts: Sources and types Stress and Coping: Concept, Models, Type A, B, C, D behaviors, Stress management strategies [Biofeedback, Music therapy, Breathing exercises, Progressive Muscular Relaxation, Guided Imagery, Mindfulness, Meditation, Yogasana, Stress Inoculation Training].

h. **Social Psychology:** Nature, scope and history of social psychology

   Traditional theoretical perspectives: Field theory, Cognitive Dissonance, Sociobiology, Psychodynamic Approaches, Social Cognition.

   Social perception [Communication, Attributions]; attitude and its change within cultural context; prosocial behavior

   Group and Social influence [Social Facilitation; Social loafing]; Social influence [Conformity, Peer Pressure, Persuasion, Compliance, Obedience, Social Power, Reactance]. Aggression. Group dynamics, leadership style and effectiveness. Theories of intergroup relations [Minimal Group Experiment and Social Identity Theory, Relative Deprivation Theory, Realistic Conflict Theory, Balance Theories, Equity Theory, Social Exchange Theory]

   Applied social psychology: Health, Environment and Law; Personal space, crowding, and territoriality.

i. **Human Development and Interventions:** Developmental processes: Nature, Principles, Factors in development, Stages of Development. Successful aging. Theories of development: Psychoanalytical, Behavioristic, and Cognitive Various aspects of development: Sensory-motor, cognitive, language, emotional, social and moral.

   Psychopathology: Concept, Mental Status Examination, Classification, Causes

Psychotherapies: Psychoanalysis, Person-centered, Gestalt, Existential, Acceptance Commitment Therapy, Behavior therapy, REBT, CBT, MBCT, Play therapy, Positive psychotherapy, Transactional Analysis, Dialectic behavior therapy, Art therapy, Performing Art Therapy, Family therapy.

Applications of theories of motivation and learning in School Factors in educational achievement Teacher effectiveness Guidance in schools: Needs, organizational set up and techniques.

Counselling: Process, skills, and techniques

j. Emerging Areas: Issues of Gender, Poverty, Disability, and Migration: Cultural bias and discrimination. Stigma, Marginalization, and Social Suffering; Child Abuse and Domestic violence.

Peace psychology: Violence, non-violence, conflict resolution at macro level, role of media in conflict resolution.

Wellbeing and self-growth: Types of wellbeing [Hedonic and Eudemonic], Character strengths, Resilience and Post-Traumatic Growth.

Health: Health promoting and health compromising behaviors, Life style and Chronic diseases [Diabetes, Hypertension, Coronary Heart Disease], Psychoneuroimmunology [Cancer, HIV/AIDS]

Psychology and technology interface: Digital learning; Digital etiquette: Cyber bullying; Cyber pornography: Consumption, implications; Parental mediation of Digital Usage.

16. English

- Drama
- Poetry
- Fiction, short story
- Non-Fictional Prose
- Language: Basic concepts, theories and pedagogy. English in Use.
- English in India: history, evolution and futures
- Cultural Studies
- Literary Criticism
- Literary Theory post World War II
- Research Methods and Materials in English

17.Geology

a. **The Earth and the Solar System:** Milky Way and the solar system. Modern theories on the origin of the Earth and other planetary bodies. Earth‟s orbital parameters, Kepler‟s laws of planetary motion, Geological Time Scale; Space and time scales of processes in the solid Earth, atmosphere and oceans. Radioactive isotopes and their applications. Meteorites Chemical composition and the Primary differentiation of the earth. Basic principles of stratigraphy. Theories about the origin of life and the nature of fossil record. Earth‟s gravity and magnetic fields and its thermal structure: Concept of Geoid and, spheroid; Isostasy.

b. **Earth Materials, Surface Features and Processes:** Gross composition and physical properties of important minerals and rocks; properties and processes responsible for mineral concentrations; nature and distribution of rocks and minerals in different units of the earth and different parts of India. Physiography of the Earth; weathering, erosion, transportation and deposition of Earth's material; formation of soil, sediments and sedimentary rocks; energy balance of the Earth‟s surface processes; physiographic features and river basins in India.

c. **MINERALOGY AND PETROLOGY:** Concept of point group, space group, reciprocal lattice, diffraction and imaging. Concepts of crystal field theory and mineralogical spectroscopy. 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, alkaline rocks, Kimberlites, ophiolites and granitoids.

d. **STRUCTURAL GEOLOGY AND GEOTECTONICS:** Theory of stress and strain. Behaviour 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. 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. Introduction to 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 of superposed fold. Fault-related folding. Gravity induced structures. Tectonic features of extensional-, compressional-, and strike-slip-terrains and relevance to plate boundaries. mantle plumes. Himalayan Orogeny; concept of super continent, their assembly and breakup.

e. **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 tectonism. 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.

f. **SEDIMENTOLOGY AND STRATIGRAPHY:** Classification of sediments and sedimentary rocks; elastic, volcanoclastic and chemical. Classification of elastic 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. Proterozoic sedimentary basins of India. Life in Precambrian. Precambrian – Cambrian boundary with special reference to India**.**

g. **GEOCHEMISTRY:** Atomic Structure and 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; geochemical differentiation of the earth; geochemical cycles.

h. **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. Concepts of petrophysics, 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.

i. **Remote Sensing and GIS:** Elements of photogrammetry, elements of photo-interpretation, electromagnetic spectrum, emission range, film and imagery, sensors, geological interpretations of air photos and imageries. Global positioning systems. GIS- data structure, attribute data, thematic layers and query analysis.

j. **Engineering Geology:** Engineering properties of rocks and physical characteristics of building stones, concretes and other aggregates. Geological investigations for construction of dams, bridges, highways and tunnels. Remedial measures. Mass movements with special emphasis on landslides and causes of hillslope instability. Seismic design of buildings.

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

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