



Syllabus for the Ph.D. Entrance Examination for Admission- 2026

Research Methodology (common to all discipline)

1. Introduction to Research:

Basics of Research and Methodds, importance of scientific research, classificattions of research, essential qualities of a researcher, Types of research – Quantitative vs. Qualitaative, Descriptive vs. Analytical, Use of tools/techhniques for research

2. Experimental Research and Data Collection methods:

Data classification, Data Processing, Hypothesis-formulation, sampling tecchniques, Survey methods, Methods for standarrd classification of crops in India, Aspects of Experimental Research including purpose of the report, abstracts, introduction and resultss and discussion. Structure and components of sccientific reports, types of report, developing successful research proposals.

3. Research Design:

Problem Identification & Formmulation – Questions for investigation – Dataa, Measurements, Hypothesis – Qualities of a good Hypothesis –Null Hypothesis & Alternaative Hypothesis. Hypothesis Testing – Logic & Importance.

4. Research ethics, IPR and schoolarly publishing:

Environmental impacts, Ethical issues, ethical committees, Commercializatioon – Copy right, royalty - Intellectual property rights and patent law, Reproduction of published material, Plagiarism - Citation and ackno wledgement, Reproducibility and accountabilityy. Use of Internet in Research – E Journal, E Libr ary, INFLIBNET.

Aero Engineering

1. **Aerodynamics:** Subsonic, Transonic, Supersonic, Hypersonic, Rarefied Gas flows (Theoretical and Experimental), Boundary Layers and Stability of Flows, Turbulent Flows, Shock Tubes and Related Problems, Development of Algorithms and Code for Numerical Methods in Gas Dynamics and Computational Fluid Dynamics, Vortex Dynamics, Supersonic Mixing and Combustion, Optical Flow Diagnostics.
2. **Aircraft Structures:** Finite Element Methods, Numerical Methods, Photo Elasticity, Moire and Holographic Methods of Structural Analysis. Composite Structures, Fatigue and Fracture Mechanics, Contact Mechanics, Vibrations and Impact Mechanics.
3. **Aerospace Propulsion:** Rocket Propulsion and Solid Propellant Combustion, Air breathing Propulsion and Combustion, Cascade Flows, Multiphase Flow Simulation, Combustion Instability, Optical Flow/Combustion Diagnostics.
4. **Dynamics and Control:** Nonlinear Dynamics in Aerospace Applications, Computational Methods in Nonlinear Dynamics, Nonlinear Control Theory and Applications, Flight Simulations and Controller Development, Design Development of Autonomous Flying Vehicles. Laplace transform, response of LTI, transfer functions, feedback systems, open loop and closed loop gains, types of systems, poles and zeros, state space form, stability, controllability, observability. Free body diagram, point mass model, Airplane performance, rigid body dynamics, trim and stability, static margin, longitudinal and lateral-directional dynamics, longitudinal and lateral modes.

CIVIL ENGINEERING

1. Structural Engineering :

Engineering Mechanics: System of forces, free-body diagrams, equilibrium equations; Internal forces in structures; Friction and its applications; Kinematics of point mass and rigid body; Centre of mass; Euler's equations of motion; Impulse-momentum; Energy methods; Principles of virtual work. **Solid Mechanics:** Bending moment and shear force in statically determinate beams; Simple stress and strain relationships; Theories of failures; Simple bending theory, flexural and shear stresses, shear centre; Uniform torsion, 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. **Concrete Structures:** Working stress, Limit state and Ultimate load design concepts; Design of beams, slabs, columns; Bond and development length; Prestressed concrete; Analysis of beam sections at transfer and service loads. **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; Plastic analysis of beams and frames.

2. Geotechnical Engineering

Soil Mechanics: Origin of soils, soil structure and fabric; Three-phase system and phase relationships, index properties; Soil classification system; Permeability – one and two dimensional flow; flow nets; Principle of effective stress, capillarity, seepage force and quicksand condition; Compaction in laboratory and field conditions; One dimensional consolidation, time rate of consolidation; Shear strength; Mohr's circle, effective and total shear strength parameters, Dynamic properties of soil and their measurement. **Foundation Engineering:** Sub-surface investigations; Earth pressure theories - Rankine and Coulomb; Stability of slopes - finite and infinite slopes; Stress distribution in soils - Boussinesq's and Westergaard's theories, 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 - types of piles, dynamic and static formulae, load capacity of piles in sands and clays, pile load test, negative skin friction.

3. Environmental Engineering:

Water and Waste Water: Quality standards, basic unit processes and operations for water treatment. Drinking water standards, water requirements, basic unit operations and unit processes for surface water treatment, distribution of water. Sewage and sewerage treatment, quantity and characteristics of wastewater. Primary, secondary and tertiary treatment of wastewater, effluent discharge standards. Domestic wastewater treatment, quantity and characteristics of domestic wastewater, primary and secondary treatment. Unit operations and unit processes of domestic wastewater, sludge disposal. **Air Pollution:** Types of pollutants, their sources and impacts, air pollution meteorology, air pollution control, air quality standards 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). **Noise Pollution:** Impacts of noise, permissible limits of noise pollution, measurement of noise and control of noise pollution.

4. Transportation Engineering:

Transportation Infrastructure: Highway alignment and engineering surveys;

Geometric design of highways – cross-sectional elements, sight distances, horizontal and vertical alignments; Geometric design of railway track; Airport runway length, taxiway and exit taxiway design. **Highway Pavements:** Highway materials – desirable properties and quality control tests; Design of bituminous paving mixes; Design factors for flexible and rigid pavements; Design of flexible pavement using IRC: 37-2012; Design of rigid pavements using IRC: 58- 2011; Distresses in concrete pavements. **Traffic Engineering:** Traffic studies on flow, speed, travel time – delay and O-D study, PCU, peak hour factor, parking study, accident study and analysis, statistical analysis of traffic data; Microscopic and macroscopic parameters of traffic flow, fundamental relationships; Control devices, signal design by Webster's method; Types of intersections and channelization; Highway capacity and level of service of rural highways and urban roads.

ELECTRICAL & ELECTRONICS ENGINEERING

1. Engineering Mathematics: Linear Algebra, Calculus, Differential equations. Probability, Linear Algebra, Differential equations, Numerical Methods, Transform Theory.

2. 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 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.

3. 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.

4. 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

5. 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.

6. 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.

7. 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. 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.

8. 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, and linear antenna arrays.

MECHANICAL ENGINEERING

1: Materials Science& Metallurgy:

Classification of engineering materials, crystallography, solid solutions, eutectic, eutectoid, peritectic and peritectoid transformations, iron carbon diagrams, TTT diagrams, alloys and composite materials.

2: Manufacturing Processes and Machine Tools:

Manufacturing Processes: Casting, forging, sheet metal working, rolling, extrusion, metal joining processes (welding, soldering, and brazing).

Machine Tools: Lathe machine, drilling machine and grinding machine (basic elements, working and types of operations). Non-conventional machining methods, Introduction to NC, CNC, and DNC.

3: Introduction to Thermodynamics:

System, process, properties, specific properties, concept of mechanical work & heat, heat engine, heat pump and refrigerator, efficiency and COP terms, Laws of Thermodynamics (Zeroth, First and Second laws), various power cycles, refrigeration and air-conditioning.

4: Energy Producing Devices/Thermal Engineering Devices:

Boilers, working principle of two stroke and four stroke IC engines (diesel and petrol).

Power absorbing devices: pumps (reciprocating and centrifugal, rotary pumps), compressors (reciprocating and centrifugal compressors), fans, blowers.

5: Design of Machine Elements:

Design Fundamentals: Design concept, need, design considerations, design of machine elements.

Mechanisms: Kinematic link, kinematic pair, kinematic chain, mechanisms (four bar and slider crank). Machine Elements: Shaft, axle, keys, coupling (rigid & flexible), drives (belt, chain & gear), brakes.

6: Fluid Mechanics and Machinery:

Fluid statics, dynamics and kinematics, dimensional analysis and model testing, water turbines, pumps, and hydraulic couplings, computational fluid dynamics.

7: Industrial Engineering:

Productivity, method study and work measurements, types of production systems, plant layouts, aggregate planning, master production scheduling, materials requirement planning, facility layouts, sequencing and scheduling, CPM and PERT, inventory management and quality control.

COMPUTER SCIENCE & APPLICATIONS

1. **Discrete Structures:** Sets, Relations, Functions, Pigeonhole Principle, Inclusion-Exclusion Principle, Equivalence and Partial Orderings, Counting Techniques. Probability, Measure(s) for information and Mutual information. *Computability:* Finite Automata, NFA, DPDA and PDAs and Languages accepted by these structures, Grammars. *Graph Theory:* Tree and rooted tree. Hamiltonian and Eulerian graphs, Planar graphs. Groups: Finite fields and Error correcting/detecting codes.
2. **Computer Arithmetic:** Propositional (Boolean) Logic, Predicate Logic, Well-formed formulae (WFF), Satisfiability and Tautology. Logic Families : TTL, ECL and C-MOS gates. Boolean Algebra, Flip-flops-types, race condition and comparison, Design of combinational and sequential circuits. Representation of Integers
3. **Programming in C and C++ :** *Programming in C:* Data types in C. Control structures in C. Sequence, selection and iteration(s), Structured data types in C arrays, struct, union, string and pointers. *O-O Programming Concepts:* Class, object, instantiation, Inheritance, polymorphism and overloading. Constructors and destructors, Overloading, Inheritance, Templates, Exception handling.
4. **Relational Database Design and SQL:** E R diagrams and their transformation to relational design, normalization and its forms. SQL : Data Definition language (DDL), Data Manipulation Language (DML), Data Control language (DCL) commands. Database objects like-Views, indexes, sequences, synonyms, data dictionary.
5. **Data and File structures** Data, Information, Definition of data structure, Arrays, stacks, queues, linked lists, trees, graphs, priority queues and heaps. File Structures : Fields, records and files, Sequential, direct, index-sequential and relative files, Hashing, inverted lists and multi-lists B trees and B+ trees.
6. **Computer Networks** Network fundamentals: LAN, WAN, MAN. The OSI model, TCP/IP model, Data Communication, Internetworking, Routing, Network Security, Cryptography, Electronic Mail and Worldwide Web (WWW), E-mail architecture and Services.
7. **System Software and Compilers:** Assembly language fundamentals (8085 based assembly language programming). Loading, linking, relocation, Compilation and Interpretation, Phases of compilation process, Lexical analysis, Context free grammars, Intermediate code generation, Code generation, Code optimization.
8. **Operating Systems (with Case Study of Unix):** Main functions of operating systems, Types of Operating Systems, Memory Management, Concurrent Processing, Scheduling. **The Unix System :** Introduction. Working on various commands, Shell Scripting.
9. **Software Engineering:** System Development Life Cycle (SDLC), Software Metrics, Software Design Coding and testing.
10. **Current Trends and Technologies:**
 - a) *Parallel Computing,*
 - b) *Mobile Computing*
 - c) **E-Technologies:** Electronic Commerce, Digital Libraries and Data Warehousing, Software Agents, Broadband Telecommunications, Main concepts in Geographical Information System (GIS), E-cash, E-Business, ERP packages. Data Mining
 - d) *Windows Programming,*
 - e) *Advanced Windows Programming*

MANAGEMENT STUDIES

1. Organisational Behavior

The concept and significance of organisational behaviour – Skills and Roles in an organisation

– Classical, Neo – Classical and Modern Theories of Organisational Structure – Organisational Design – Understanding and Managing individual behaviour personality – Perception – Values – Attitudes – Learning – Motivation.

2: Human Resource Management

Concepts and perspectives in HRM; HRM in changing environment, Human Resource Planning

– Objectives, Process and Techniques, Job analysis – Job Description, Selecting Human Resources. Induction, Training and Development. Exit policy and Implications. Performance Appraisal and Evaluation, Potential Assessment,

3: Financial Management

Nature and Scope, Valuation Concepts and Valuation of Securities, Capital Budgeting Decisions – Risk Analysis, Capital Structure and Cost of Capital, Dividend Policy – Determinants, Long – Term and Short – Term Financing Instruments, Mergers and Acquisitions.

4: Marketing Management

Marketing Environment and Environment Scanning; Marketing Information Systems and Marketing Research; Understanding Consumer and Industrial Markets; Demand Measurement and Forecasting; Market Segmentation – Targeting and Positioning; Product Decisions, Product mix, Product Life Cycle; New Product Development; Branding and Packaging; Pricing Methods and Strategies. Promotion Decisions – Promotion mix; Advertising; Personal Selling; Channel Management. Customer Relation Management; Uses of Internet as a Marketing Medium – Other related issues like branding, market development, Advertising and retailing on the net. New issues in Marketing.

5: Quantitative methods & Techniques

Overview of Statistics, Classifying Data to convey meaning, Measures of Central Tendency – Mean, Median & Mode, Measures of Variation – Range, Average Deviation, Standard Deviation, Probability Theory; Probability distributions – Binomial, Poisson, Normal and Exponential; Correlation and Regression analysis; Sampling theory; Sampling distributions; Tests of Hypothesis; Large and small samples; t z, F, Chi – square tests.

1. CHEMISTRY

1: Inorganic Chemistry

- a) Chemical periodicity
- b) Structure and bonding in homo- and heteronuclear molecules (VSEPR)
- c) Concepts of acids and bases,
- d) Main group elements and their compounds.
- e) Transition elements and coordination compounds.
- f) Organometallic compounds: synthesis, bonding and structure, and reactivity. applications.
- g) Analytical chemistry- Chromatography, Spectroscopic, Electro-analytical techniques
- h) Bioinorganic chemistry
- i) Nuclear chemistry

2: Physical Chemistry:

- a) Atomic Structure
- b) Basic principles of quantum mechanics: Postulates; operators
- c) Chemical bonding in diatomics;
- d) Chemical applications of group theory
- e) Molecular spectroscopy: IR and Raman and its application.
- f) Chemical thermodynamics
- g) Physical Photochemistry
- h) Electrochemistry
- i) Chemical kinetics
- j) Colloids and surfaces.
- k) Solid state: Crystal structures; Bragg's law and applications; band structure of solids.

3: Organic Chemistry

- a) IUPAC nomenclature of organic molecules.
- b) Stereochemistry: Nomenclature
- c) Aromaticity: Aromatic, Non-aromatic, Antiaromatic.
- d) Organic reactive intermediates.
- e) Organic reaction mechanisms: addition, elimination and substitution reactions with electrophilic, nucleophilic or radical species.
- f) Common named reactions and rearrangements.
- g) Organic transformations and reagents: oxidizing and reducing agents.
- h) Pericyclic reactions – electrocycloisatation, cycloaddition, sigmatropic rearrangements.
- i) Chemistry of Biomacromolecules: Carbohydrates, proteins, fatty acids, nucleic acids,

- j) Organic Spectroscopy: IR, UV-Vis, ^1H & ^{13}C NMR and Mass spectroscopic techniques.

4: Interdisciplinary topics

- a) Chemistry in nanoscience
- b) Green chemistry and Environmental chemistry
- c) Medicinal chemistry.

2. PHYSICS

1. Mathematical Physics and Numerical Analysis: Curve fitting, data analysis, Probability theory. Vector algebra and vector calculus. Linear algebra, Matrices. Linear differential equations. Fourier series, Fourier transforms Elementary complex analysis.

2. Classical Mechanics: Newton's laws, Lagrangian and Hamiltonian formalisms. Symmetries and conservation laws, Motion in the central field of force. Collision and scattering, Mechanics of system of particles. Rigid body dynamics. Non-inertial frames and pseudo forces. Small oscillations and normal modes. Wave equation, phase velocity, group velocity, dispersion.

3. Electromagnetics: Laplace and Poisson equations, Ampere's theorem, Biot-Savart Law, electromagnetic induction. Maxwell's equation Scalar and vector potentials. Reflection and refraction, dispersion, Rectangular wave guides.

4. Quantum Mechanics: Wave-particle duality. Heisenberg's Uncertainty Principle. Schrodinger equation. Particle moving in a one-dimensional potential. Orbital angular momentum. Motion in a central potential symmetry conservation laws and degeneracy. Operator formalism of quantum mechanics. Angular momenta algebra, spin. Addition of angular momenta.

5. Thermodynamics and Statistical Physics: Chemical potential, phase equilibria. Phase space, Microstates and macrostates. Ensembles. Partition function, Free energy and connection with thermodynamic quantities. Classical and quantum statistics. Degenerate electron gas, Blackbody radiation and Planck's distribution law.

7. Electronics:

Semiconductor devices (diodes, junctions, transistors, field effect devices, homo- and hetero- junction devices), device structure, device characteristics, frequency dependence and applications. Optoelectronic devices (solar cells, photo-detectors, LEDs).

8. Atomic and Molecular Physics:

Quantum states of an electron in an atom. Electron spin. Spectrum of hydrogen, helium and alkali atom. Lasers: spontaneous and stimulated emission, Einstein A & B coefficients. Optical pumping, population inversion, rate equation. Modes of resonators and coherence length.

9. Condensed Matter Physics:

Bravais lattices. Reciprocal lattice. Bonding of solids. Phonons, lattice specific heat. Drude model of electrical and thermal conductivity. Hall Effect. Electron motion in a periodic potential, band theory of solids: metals, insulators and semiconductors.

10. Nuclear and Particle Physics:

Nuclear size, shape and charge distribution, spin and parity. Binding energy, Semiempirical mass formula, liquid drop model. Shell model. Elementary ideas of alpha, beta and gamma decays and their selection rules. Fission and fusion. Nuclear reactions, reaction mechanism.

3. MATHEMATICS

1: Real Analysis: Sequences and series of functions, uniform convergence, power series, functions of several variables, maxima, minima; Riemann integration, multiple integrals, theorems of Green, Stokes and Gauss; metric spaces.

2: Functional Analysis: Banach spaces, Hahn-Banach extension theorem, open mapping and closed graph theorems.

3: Complex Analysis: Contour integral, Cauchy's theorem, Cauchy's integral formula, Liouville's theorem, Maximum modulus principle, Schwarz lemma, Open mapping theorem, Calculus of residues. Conformal mappings, Mobius transformations.

4: Algebra: Groups, subgroups, normal subgroups, quotient groups, homomorphisms, cyclic groups, permutation groups, Sylow theorems.

5: Linear Algebra: Eigenvalues and eigenvectors, Cayley-Hamilton theorem. Matrix representation of linear transformations. Inner product spaces, orthonormal basis. Reduction and classification of quadratic forms.

6: 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. ODEs of higher orders.

7: Partial Differential Equations: 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.

8: Numerical Analysis : Finite differences, Lagrange, Hermite and spline interpolation, Numerical differentiation and integration, Numerical solutions of ODEs using modified Euler and Runge-Kutta methods.

9: Calculus of Variations: Variation of a functional, Euler-Lagrange equation, Necessary and sufficient conditions for extrema. Variational methods for boundary value problems in ordinary and partial differential equations.

10: Linear Integral Equations: Fredholm and Volterra integral equation, Solutions

with separable kernels. Characteristic numbers and Eigenfunctions, resolvent kernel.

11: Differential Geometry: Space curves-their curvature and torsion; Serret-Frenet Formula; Fundamental theorem of space curves; Curves on surfaces; First and second fundamental form; Gaussian curvatures; Principal directions and principal curvatures.

12: Fluid Mechanics: Equation of continuity in fluid motion; Euler's equations of motion for perfect fluids; Two dimensional motion complex potential; vorticity.

13: Linear programming: Infeasible and unbounded LPP's, alternate optima; Dual problem and duality theorems, dual simplex method and its application in post optimality analysis; u -v method for solving transportation problems; Hungarian method for solving assignment problems.

4. MICROBIOLOGY

1. Microbial Diversity, Physiology and Metabolism: Archaea, Bacteria, Fungal Systematic and diversity, fungal endophytes, mycorrhizal fungi, agriculturally important toxigenic fungi, secondary metabolites from fungi, genomics and diversity of yeast, algal diversity. Growth and cell division, solute transport, central metabolic pathways and regulation, metabolism of nitrogen, lipids, hydrocarbons and nucleotides, physiological adaptations and intracellular signaling.

2. Enzymology and Instrumentation: Enzyme assay, enzyme kinetics. Cell disintegration and extraction techniques, separation of proteins by fractionation Ion exchange chromatography, molecular sieve chromatography, affinity chromatography, paper chromatography, thin layer chromatography, ultra filtration, Ultracentrifugation. Electrophoresis and types, Microscopy, HPLC, HPTLC, GC-MS, FTIR, SEM/TEM, NMR, AAS.

3. Virology: Animal Viruses-Classification, properties, cultivation. Viral replication strategies, replication pattern of specific viruses, subviral pathogens, anti-viral strategies – prevention and control of viral diseases. Plant and Microbial Viruses- History and development of plant virology, cryptograms and classification of plant viruses and viroids. Propagation, purification, characterization, isolation and genomics of plant viruses. Symptoms, transmission and control of plant viruses.

4. Immunology and Medical Microbiology: Immunoprophylaxis and Immunotherapy, Immune cell receptors, Genetic organization, Regulation of Immune response, autoimmunity, Immunological disorder and hypersensitivity, transplantation and tumor immunology, immunoassays. Monoclonal antibody technology,

Pathophysiology of Infectious diseases – diseases of respiratory tract, digestive system, skin and soft tissues. Host-pathogen interaction, recent developments in aetiology, pathogenesis, diagnosis and control of AIDS. Emerging and reemerging pathogens, epidemiology, chemotherapy and antimicrobial resistance, newer vaccines, rapid diagnosis of pathogens.

5. **Cell and Molecular Biology:** Cell structure, function and organization, genetic material, DNA replication, Recombination and DNA repair, transcription and post transcriptional process, translation, post-translational process, molecular basis of cell physiology. Microbial genetics- gene transfer and mapping by conjugation, lytic and lysogenic bacteriophages, gene transfer by transformation and transduction, transposons, gene regulation
6. **Recombinant DNA technology:** Basics of DNA cloning, methods of DNA and protein analysis, PCR and types, construction of DNA and genomic DNA libraries, genome sequencing, transcriptional analysis of gene expression and transcriptomics, overexpression of recombinant proteins, analysis of protein DNA and protein – protein interaction, protein engineering and protein analysis, pharmaceutical products of DNA technology, transgenics and animal cloning
7. **Industrial and Food Microbiology:** Introduction to industrial microbiology, downstream processing of microbial products, fermentation economics and production aspects, microbiology of food, microbial spoilage of food, food preservation concepts and techniques, fermentation processes, food borne diseases.
8. **Ecology and Environmental Microbiology:** History and development of environmental microbiology, New Directions and Importance of Microbial Ecology, Microbiology of the normal and extreme environment. Geomicrobiological processes, Lignin degradation, Waste management treatment, bioremediation, microbes and mineral recovery.
9. **Recent Trends in Biological Sciences:** Gene Technology, Application of gene technology, Gene Silencing, Gene knock out and gene therapy, Tissue culture Techniques- Animal Culture, Stem cells, Plant tissue culture, Biosensors, Nanotechnology.

5. LIFE SCIENCE / BOTANY

1. Biomolecules

Structure of atoms, molecules and chemical bonds Classification, Structure, Properties, Functions of Carbohydrates, Proteins and Lipids, Characteristics & Physico - Chemical properties of nucleic acids, Conformation of nucleic acids, vitamins.

2. Plant Physiology

Photochemistry and Photosynthesis, Photosynthetic Pigments, Light harvesting complexes, Photo Oxidation of Water, mechanism of electron & Proton transfer, Carbon assimilation, Calvin cycle, Photorespiration and its significance, C₄ cycle and CAM Pathway, Plant hormones, Phytochromes

3. Animal Physiology and Hormones

Digestion, Excretion, respiration, circulation, sensory physiology, muscle contraction, Thermoregulation, Endocrine & its regulation in man.

4. Biophysics & Biochemical Techniques

Principles and techniques of Chromatography, Electrophoresis, Spectroscopy (Visible, UV, NMR, ESR, IR, Mass Spectroscopy), Centrifugation, Biological Solutions, X-ray Diffraction, Radiation Biology (Radioisotopes detection & measurement).

5. Advanced Cell Biology & Cell Biology Techniques

Origin of Life & evolution of cell, cell cycle & its regulation, ultra structure of eukaryotic chromosome, cell-cell interaction, transport across membranes, cytoskeleton, and microscopy. Mitotic and meiotic chromosome preparations, karyotyping, ideogram, camera Lucida, flow cytometry, FISH, chromosome painting.

6. Genetics

Drosophila & mouse as model organisms, Mendelian principles, deviations from Mendelism, extra nuclear inheritance, Molecular mechanism of Sex determination, Transposable elements, mutations & genotoxicity screening in different organisms, genetic repair mechanisms. Syndromes and genetic diseases of human.

7. Molecular Biology

Central dogma, DNA replication, Transcription, Translation, Post transcription & translation modification, gene regulation, Oncogenes & proto-oncogenes. Cancer therapy.

6. Forensic Science

- 1. General forensic science:** Definition, Fundamental concepts, and Basic principles of forensic science, Frye case and Daubert's standard, Duties and Qualifications of forensic scientists, Historical and Developmental aspects of Forensic Science, Ethics in Forensic Science, Need & Scope of development of forensic science in India. Evidence Applicability in Court, Expert's testimony and admissibility of scientific evidence in court of Law, Code of conduct for forensic scientists
- 2. Criminology: Definition: Criminology:** Criminology as Science, The field and scope of Criminology; Victimology; Organized crime; White – collar crimes/ Occupational crimes; Crime against women and children. Definition, Elements, nature, causes of crime. Classification of crimes; Concept of a criminal and classification of criminals, Miranda rights, FIR, Acceptance of evidence in the Court of Law; McNaughton Rule; child witness in the court, State and central police forces – organizational structure, field establishment; Duties and Responsibilities of the Police, Code of Conduct for the Police; Policing styles and principles. Police's power of investigation. Interrogation of suspects and offenders.
- 3. Forensic physics:** Glass evidence – collection, packaging, analysis. Matching of glass samples by mechanical fit and refractive index measurements. Analysis by spectroscopic methods. Fracture analysis and direction of impact. Paint evidence – collection, packaging and preservation. Analysis by destructive and non-destructive methods. Importance of paint evidence in hit and run cases. Cloth evidence – importance, collection, analysis of adhering material. Matching of pieces. Tool mark evidence. Classification of tool marks. Forensic importance of tool marks. Collection, preservation and matching of tool marks. Restoration of erased serial numbers and engraved marks.
- 4. Forensic chemistry and toxicology:** Poisons--Classification of poisons. Physico-chemical characteristics and mode of action of poisons. Accidental, suicidal and homicidal poisonings. Signs and symptoms of common poisoning and their antidotes. Metabolism and excretion of poisons. Definition, Broad classification – Narcotics, stimulants, depressants and hallucinogens, Collection and preservation Toxicological Samples (viscera, blood and urine) for various poison and drug cases. Introduction to Alcohol and Alcoholic Beverages, Fate of ethyl alcohol in the body, alcohol in the circulatory system, breath test instruments, field sobriety testing, analysis of blood for alcohol Arsenic, Mercury: Nature, administration, symptoms,

postmortem findings, Detection and medico-legal aspects; Barbiturates: Classification, administration, symptoms, post-mortem findings, detection and medico-legal aspects; Corrosive poisons: Acids- HCl, H₂SO₄, HNO₃ and Alkalies- NaOH, KOH. Chemistry of fire. Conditions for fire. Fire scene patterns. Location of point of ignition. Recognition of type of fire. Searching the fire scene. Collection and preservation of arson evidence. Analysis of fire debris. Analysis of ignitable liquid residue. Post-flashover burning. Scientific investigation. Classification of explosives – low explosives and high explosives. Military explosives.

5. Forensic Biology and Anthropology: Forensic Biology-- Introduction, Evidences of Biological Importance, Nature, scope of crime scene presence and characterization (blood, semen, vaginal fluids, saliva, urine, sweat, skin, nails, tissue, tooth, bones, uterine fluid, vomit, vitreous humor, CSF, colostrums). Recognition of Biological evidences encountered in various cases, Search, Collection, protection, documentation and chain of custody of Biological Evidences, Packaging & transportation of Biological Evidences Basics of forensic entomology. Insects of forensic importance. Collection of entomological evidence during death investigations. Significance of Entomological evidence. Determination of race, age, sex, stature from long bones, skull, pelvis and other skeletal material of forensic significance, Somatoscopy – observation of hair on head, forehead, eyes, root of nose, nasal bridge, nasal tip, chin, Darwin's tubercle, ear lobes, supra-orbital, ridges physiognomic ear breadth, circumference of head. Scar marks and occupational marks. Somatometry – measurements of head, face, nose, cheek, ear, hand and foot body weight, height. Indices - cephalic index, nasal index, cranial index, upper facial index.

6. Forensic Ballistics: History and development of firearms. Classification of firearms. Weapon types and their operation. Firing mechanisms of different firearms. Internal ballistics – Definition, ignition of propellants, shape and size of propellants, manner of burning, and various factors affecting the internal ballistics: lock time, ignition time, barrel time, erosion, corrosion and gas cutting. External Ballistics – Vacuum trajectory, effect of air resistance on trajectory, base drag, drop, drift, yaw, shape of projectile and stability, trajectory computation, ballistics coefficient and limiting velocity. Effect of projectile on hitting the target: function of bullet shape, striking velocity, striking angle and nature of target, tumbling of bullets, effect of instability of bullet, effect of intermediate targets, and influence of range. Ricochet and its effects, stopping power. Types of ammunition.

Constructional features and characteristics of different types of cartridges and bullets. Different types of marks produced during firing process on cartridge – firing pin marks, breech face marks, chamber marks, extractor and ejector marks.

7. Questioned Documents and Fingerprint Examination: Definition and types of questioned documents. Preliminary examination of documents. Basic tools needed for forensic documents examination – ultraviolet, visible, infrared and fluorescence spectroscopy, video spectral comparator, electrostatic detection apparatus. Definition, Development of individuality in handwriting. Natural variations and fundamental divergences in handwritings. Class and individual characteristics. Comparison of handwriting. Comparison of paper, ink, printed documents, typed documents, documents. Examination of counterfeit Indian currency notes, passports, visas and stamp papers. Biological basis of fingerprints. Formation of ridges. Types of fingerprints. Fingerprint patterns and Ridge Characteristics. Plain and rolled fingerprints, Ridge counting and ridge tracing. Classification and cataloguing of fingerprint record., Henry's system of classification and Extension, Batley's Single Digit Classification. Analysis and comparison of fingerprints using ridge characteristics. Chance prints and types. Constituents of sweat residue. Latent fingerprints detection by physical and chemical techniques. Mechanism of detection of fingerprints by different developing reagents. Application of light sources in fingerprint detection. Preservation of developed fingerprints.

8. Instrumentation and Analytical Techniques: Fundamental principles of Different types of microscopes: Simple and Compound microscope, Comparison microscope, Phase contrast microscope, Stereoscopic microscope, Polarizing microscope, Fluorescent Microscopy, Electron microscope. Forensic applications of microscopy. Electrophoresis, Sodium dodecyl sulphate (SDS) polyacrylamide gel electrophoresis, Agarose gel electrophoresis, Gel immune- diffusion, Immuno-electrophoresis. Principle, Instrumentation, Working procedure and Forensic Applications of thin layer chromatography, gas chromatography and liquid chromatography. Spectroscopic methods. Fundamental principles and forensic applications of Ultraviolet- visible spectroscopy, infrared spectroscopy. Atomic absorption spectroscopy, atomic emission spectroscopy and mass Spectroscopy, X-ray spectrometry.