



SYLLABUS FOR PH.D. ENTRANCE EXAMINATION 2026

Faculty of Science & Technology

Research Methodology (Common to all Science & Technology Departments)

(Weightage 50%)

Unit: 1 Research: Definition, Characteristics, Objectives, Research and Scientific method. History of Research: Egyptian, Greek ideas methodologies and research in agriculture, chemistry, metallurgy, physics, life science. Ancient Indian research methodology applications. Types of Research: Descriptive vs. Analytical Research, Applied vs. Fundamental Research, Quantitative vs. Qualitative Research, Conceptual vs. Empirical Research. Research Methodology: An Introduction. Research Process: Basic Overview, Formulating the Research Problem, Defining the Research Problem, Research Questions and Research Methods vs. Research Methodology.

Unit: 2 Research Measurement: Concept of measurement- what is measured? Problems in measurement in research- Validity and Reliability. Levels of measurement – Nominal, Ordinal, Interval and Ratio. Sampling: Concepts of Statistical Population, Sample, Sampling Frame, Sampling Error, Sample Size, Non Response. Characteristics of a good sample. Probability Sample- Simple Random Sample, Systematic Sample, Stratified Random Sample & Multi-stage sampling. Determining size of the sample- Practical considerations in sampling and sample size.

Unit: 3 Literature Review: Review Concepts and Theories, Formulation of Hypothesis: Sources of Hypothesis, Characteristics of Hypothesis, Role of Hypothesis, Tests of Hypothesis. Research Design, Sampling design, data Collection: Observation Method, Interview Method, Questionnaires, field data collection, safety in field, Case Study Method. Processing and Analysis of Data: Processing Operations, Statistics in Research, Descriptive Statistics, Inferential Statistics, Elements / Types of Analysis. Interpretation of data.

Unit: 4 Legal Research: Medical Research & Dental Research (Clinical Trials), Design Research, Market Research, Technical Research, Social Research, Models of Research. Evolutive and Evaluative, Identificatory and Impact studies, Projective and Predictive, Collative, Historical, Comparative. Current trends in Research: Mono-disciplinary Research, Trans-disciplinary Research, Inter-disciplinary Research. Computer & Internet: It's Role in Research and Threats and Challenges to Good Research.

Unit: 5 Writing a/an: Article, Essay, Research Paper, Research Project Legislation Drafting, Judgment Writing, Thesis, Dissertation, Book, Reviews - Book Review; Case Review. Making a presentation, writing a research proposal in science. Project management tools (MS project, MS One Note, Asana). Criteria of Good Research, Research Ethics. Citation Methods: Foot Note, Text Note, EndNote, BiBTeX, RefMan. Bibliography, Citation Rules: Blue Book, OSCOLA, MLA, APA, Chicago, Harvard.

Unit: 6 Data Analysis: Data Preparation – Univariate analysis (frequency tables, bar charts, pie charts, percentages), Bivariate analysis – Cross tabulations and Chi-square test including testing hypothesis of association. Statistical analysis and its significance. Descriptive Statistics: Measurement Scales, Sources of error in measurement. Measures of central Tendency (Mean, medium, Mode), Measures of dispersion (range, mean deviation, standard deviation), standard error. Testing the Significance of difference between means (z and 't' test).

Unit: 7 Exploratory and confirmatory research, Planned and ad-hoc methods of data collection, Non-response and methods of recovering the missing response, various software like SPSS, Graph Pad, Origin, Daniel soper, MS Excel, Mini Tab or MATLAB Software in Data Analysis. Different case studies of the research performed in various (FST) subjects using statistical methods. Error and noise analysis, curve fitting. Maintaining laboratory records (case study based). Safety in Laboratories, Ethical considerations, copy rights and patents in Science, technology. Use of Encyclopaedias, Research Guides, Handbook etc., Academic Databases for Science Discipline.

Unit: 8 Understanding and Overview of the IPR Regime: introduction, types of intellectual property. Need for intellectual property rights. Rationale and Protection of IPR. Impact of IPR on development, health, agriculture and genetic resources. IPR in India- Genesis and development. IPR in abroad- Some important examples of IPR. International organisations and agency. Trademark: Rights of trademark, kind of signs used for trademarks- types, purpose and functions of a trademark, trademark processing, registration and protection. Copyrights- Rights of protection covered by copy right- law of copy right, fundamentals of copyrights law, originality of material, copyright ownership issues, obtaining copyright registration, international copy right law. Difference between copy right and related right.

Unit: 9 Ethics with respect to science and research. Intellectual honest and research integrity Publication ethics: Definition, introduction and importance. Best practices/ standard setting initiatives and guidelines: COPE, WAME etc., Conflict of interest. Scientific misconducts: falsification, fabrications and plagiarism. Publication misconduct: Definition, concept, problems that lead to unethical behaviour and types. Violation of publication ethics, authorship and contributor ship. Identification of publication misconduct: complaints and appeal. Redundant publications: duplicate and overlapping publications, salami silencing.

Unit: 10 Open access publishing: Open access publications and initiatives, SHERPA/ RoMEO online resources to check publisher copyright and self-archiving policies. Predatory publishers and journals, software tools to identify predatory publications by SPPU. Journal finder/ suggester like, JANE, Elsevier Journal finder, Springer Journal suggester, Wiley online suggester etc. Use of plagiarism softwares viz., Turnitin, URKUND and other open source tools. Database: Indexing databases, citation databases- Web of Sciences, Scopus, Google scholar, Researchgate etc. Research Metrics: Impact factor: Authentic (Thomson Reuter's JCR impact factor). Impact factor of journals as per JCR, SNIP, SJR, IPP and cite score. Metrics: h- index, g- index, i10 index.

Reference books/ articles

1. Best, J.W. and Kahn, J.V., 2009. *Research in Education*, PHI Learning Pvt. Ltd., New Delhi, pp.24-36.
2. Ganguli, P., 2001. *Intellectual Property Rights: Unleashing the Knowledge Economy*. Tata McGraw-Hill Publishing Company.
3. George, D., 2011. *SPSS for windows step by step: A simple study guide and reference, 17.0 update, 10/e*. Pearson Education India.
4. Gopalakrishnan, N.S. and Agitha, T.G., 2009. *Principles of Intellectual Property*, Eastern Book Co.
5. Gurumani, N., 2019. *Research Methodology: For Biological Sciences*. MJP Publisher.
6. Jacob, R., 1970. *Patents, trademarks, copyright and industrial designs*. London: Sweet & Maxwell.
7. Kothari, C.R., 2004. *Research methodology: Methods and techniques*. New Age International.
8. Kuehl, R.O. and Kuehl, R.O., 2000. *Design of experiments: statistical principles of research design and analysis*.
9. Levin, R.I., 2011. *Statistics for management*. Pearson Education India.
10. Mittal, D.P., 1997. *Taxmann's new law of arbitration ADR & contract in India*. Kluwer Law Intl.
11. Singh, A. and Sadhu, A.N., 1985. *Research Methodology in Social Sciences*. Himalaya Publishing House.
12. Wadehra, B.L., 2007. *Law Relating to Intellectual Property: Patents, Trade Marks, Copyright, Designs, Geographical Indications, Semiconductors Integrated Circuits Layout-design, Protection of Plant Varieties and Farmers' Rights, Trips*. Universal Law Publishing Company.
13. Wilcox, R.R., 2010. *Fundamentals of modern statistical methods: Substantially improving power and accuracy*. Springer.

Botany (Weightage 50%)

UNIT 1: Cyanobacteria-Classification, Thallus organization, Phylogeny and affinities and Economic importance of cyanobacteria. **Algae**-General characteristics, Classification (Fritsch, Smith and Chapman), Thallus organization, Algal pigments, Effects of algal blooms, Bloom control, Carbon sequestration, Algae as bioindicator and algal metabolites. **Bryophytes**-Distribution and classification systems (Eichler, Smith and Wardlaw), Affinities with Algae and Pteridophytes, Succession and role of bryophytes in ecosystem. **Pteridophytes**- Evolution, Characteristics and classification system (Arthur J Eames, Tippo and Bierhorst), Stellar evolution, Heterospory, Seed habit and cryptogams as bio indicator.

UNIT 2: Gymnosperms- General characteristics, Affinities, Classification (Sahni, Bierhorst and Christenhusz), Phylogeny and morphological variation, Economic importance. **Paleobotany**- Geological time scale, Paleoclimatic and evolution of plants. Fossilization- Fossil types, Techniques in paleobotany. **Angiosperms**-Concepts of species and hierarchical taxa, Biological nomenclature, Principles and priorities, Natural, artificial and phylogenetic system of classification and APG III, Evolutionary among taxa, Herbarium, Botanical gardens, Botanical Survey of India(BSI), International code of nomenclature of algae, fungi and plants. IUCN, Red data book, Rare endangered species and conservation strategies. Characteristics and interrelationships of ANA Grade, Magnollids, monocots, eudicots, core eudicots, superrosids and rosids.

UNIT 3: Viruses- Classification, Nomenclature, Properties, Structure and Replication of DNA and RNA Viruses. Mycoplasma, characteristics and its diseases (Sandal spike, little leaf of Brinjal and Witches broom). **Bacteria**- General characteristics, Classification based on shape, flagellation and mode of nutrition, Ultra structure of bacteria and reproduction, Symbiotic and asymbiotic bacteria (*Rhizobium* and *Azotobacter*). **Fungi**- General characteristics, Classification (Alexopolous), Modification in mycelium, Mode of nutrition and Heterothalism and Parasexuality in fungi. Mushroom cultivation and its nutritional value.

UNIT 4: Ecology-Ecosystem (Aquatic and Terrestrial), Energy flow, Community ecology, Population ecology-methods of estimating population density of plants ranging patterns through direct, indirect and remote observations. Plant succession- views and types, Concept of climax, Habitat and Niche. Soil formation, Soil erosion and conservation, Global environmental change, Environmental pollution. **Biodiversity**-Concept and importance of biodiversity, Biodiversity-status, Biodiversity conservation (*In situ* and *Ex situ*). Rio de Janeiro Earth Summit 1992. Hotspots of world and India. Loss of bio diversity. Organizations associated with bio diversity management (IUCN, UNEP, UNESCO & WWF). Biodiversity conservation legal aspects.

Phytogeographical regions of world and India, Plant migration and its barriers, Native taxa, Naturalization of exotic taxa.

UNIT 5: Plant Anatomy-Meristem- Organization of shoot and root apical meristem, Leaf development and phyllotaxy, Floral meristem and floral development in *Arabidopsis*. Phylogeny and ultra structure of xylem and phloem. Anatomical peculiarities of dicot stem(*Aristolochia*, *Nyctanthus*, *Boerhaavia* and *Bougainvillae*) and Monocot stem (*Dracena*). **Embryology**- Male gametophyte- Microsporogenesis, Female gametophyte-Megasporogenesis. Pollination, fertilization. **Endosperm**- Development and types of endosperm, embryogenesis- Monocot and dicot embryo development. **Physiology- Photosynthesis**-Photosynthetic apparatus, Photosynthetic pigments, PS-I and PS-II, Photo protective mechanism, Photophosphorylation, C3, C4 and CAM Pathway. Photorespiration. **Respiration**- Glycolysis and TCA cycle, Electron transport and ATP synthesis, Oxidative phosphorylation. Biological nitrogen fixation, Stress physiology (salinity and drought), Photoperiodism and Biological Clock.

UNIT 6: Biopesticide-Types, Uses and limitations of Biopesticide, Advantages and role of Biofertilizer in modern agriculture (*Azolla* and BGA). Dietary plants of Kalaburagi region- Cereals and Millets(Sorghum and Bajra), Pulses(Red gram and Bengal gram), Oil yielding Plants(Sunflower and Groundnut), Vegetables(Spinach, Fenugreek leaves). **Commercial Food Plants**-Distribution and commercial importance of sugar yielding plants (Sugarcane and Sweet potato), Spices (Clove and Pepper). **Diseases concept in plants**-Disease classification, Causal factors (Biotic and Abiotic), Koch's rule. Defence mechanism in plants (Structural and Biochemical), Disease cycle (Triangle and Tetrangle). New tools in plant pathology-GIS and remote sensing. Seed borne diseases management (Red gram, Jowar, Cotton, Bajra and Sugarcane), Post-harvest diseases and management. Sulphur fungicide and Copper fungicide, Use of antagonistic microorganisms and VAM fungi in disease control.

UNIT 7: Medicinal Plants-Different system of medicine- Ayurveda, Siddha, Unani, Homeopathy and Naturopathy. Plant drugs from underground parts, bark, stem, woods, leaves, flower, fruits and seeds and lower plants. Plants with Anti-cancer, Anti-jaundice, Anti-aging and CNS effectors, Medicinal food plants-Spices and Condiments (*Piper nigrum*, *Syzygium aromaticum* and *Zingiber officinale*), Wild food medicinal plants (*Murrayya koenigii* and *Mimordica cymbalaria*). **Pharmacognosy**- Scope and principle of Pharmacognosy. Raw drug analysis- Microscopic, Macroscopic characteristics, Preliminary and chemical analysis of (*Emblica*, *Rauwolfia*, *Curcuma*), Primary metabolites in plants (Carbohydrates, Proteins, Lipids). Classification and properties of Alkaloids, Terpenoids, and Phenols. **Ethnobotany**- Concept, scope and principles, application and objectives of Ethnobotany. Quantitative ethnobotany, Ethnic group of India, Importance in modern health care system.

UNIT 8: Cell Biology-Structure and function of cells and intracellular organelles (of both prokaryotes and eukaryotes), Cell division- mitosis and meiosis, and cell differentiation. Cell-cell interaction, Immune response, Dosage compensation and mechanism of sex determination in plants. **Genetics**-Principles of Mendelian inheritance, Regulation of gene expression and gene silencing, Linkage and genetic mapping, Extra-chromosomal inheritance (mitochondria and chloroplasts). DNA damage-causes and factors, DNA repair, Chromosome aberrations. Genome organisation (in both prokaryotes and eukaryotes). DNA replication, Replication fork, Extra chromosomal replicons. Central Dogma-Transcription, transcription activators and repressors, RNA polymerases, RNA processing. **Translation**-Mechanism, Factors responsible for translation, RNA export receptors, aminoacylation of tRNA, Translational proof-reading, Translational inhibitors, and Post- translational modification of proteins.

UNIT 9: Plant Breeding and Biotechnology-Conventional breeding methods in self and cross pollinated and vegetatively propagated crops, Polyploidy, organizations role viz., NBPGR and IBPGR. Male sterility and heterosis breeding. Inbreeding depression. Vegetative propagation techniques and its applications and limitations. Plant tissue culture- role of auxins and cytokinins, Cellular totipotency- Totipotency of cell differentiation, de-differentiation, callogenesis and organogenesis. Embryo culture, Haploid culture. Somatic embryogenesis, factors affecting somatic embryogenesis. Protoplast isolation and somatic hybridization, Cybrids, Gene transfer methods in plants (*Agrobacterium* and PEG). Enzymes of rDNA technology- DNA ligases, Topoisomerases/gyrases, Methylases, Nucleases, Kinase, Restriction endonucleases, Plasmids and bacteriophage based vectors for genomic libraries and cDNA library construction.

UNIT 10: Methods in Biology- Molecular biology and recombinant DNA methods-Isolation and purification of RNA, DNA (genomic and plasmid), Expression of recombinant proteins using bacterial vectors, Large scale expression analysis such as micro array based techniques, Isolation, separation and analysis of carbohydrate and lipid molecules, RFLP, RAPD and AFLP techniques. **Histochemical and immune techniques**-Antibody generation, detection of molecules using ELISA, western blot, detection of molecules in living cells, *in situ* localization by techniques such as FISH and GISH. **Microscopic techniques**: Visualization of cells and sub cellular components by light microscopy, Resolving powers of different microscopes, Scanning and Transmission microscopes. **Biophysical methods**-Analysis of biomolecules using UV/visible, Fluorescence and NMR, Structure determination using X-ray diffraction and NMR, Analysis using light scattering, different types of mass spectrometry and surface plasma resonance methods.

References:

1. A text book of Environmental Studies. DK Asthana & Meera Asthana. S Chand Publication. 2006.
2. An introduction to Embryology of angiosperms. Maheshwari P. McGraw Hill, New York. 1950.
3. Cellular molecular biology. P.K. Gupta. 5th Edition. Rastogi Publication. 2018.
4. College Botany Vol. I Ganguli, Kamkar, Santra. NCBA Publication. 2015.
5. College Botany Vol. I. B.P. Pandey. S Chand publication. 2016.
6. College Botany Vol. I. Ganguli, Kamkar & Datta. NCBA Publication. 2018.
7. College Botany Vol. II. B.P. Pandey. S Chand publication. 2017.
8. College Botany Vol. III. B.P. Pandey. S Chand publication. 2011
9. Economic Botany of Crop Plants. Sambamurthy. A.V.V.S. & Subramanyam. N.S. Asia Tech Publishers Inc. 2000.
10. Genetics. B.D. Singh. 3rd Edition. Kalyani Publishers.2019.
11. Modern Plant Physiology. Sinha R.K. 2nd Edition. Narosa Publication. 2014.
12. Molecular biology of the cell. Alberts, B., Bray, D., Lewis, J, Raff, M., Roberts, K and Watson, J.D. Garland Publishing, Inc. New York. 1999.
13. Molecular Biology of the gene. James D. Watson, Tania, A. Baker, Stephen, P. Bell, Alexander, Gannm, Michael Levine. 5th Edition, Pearson Education. 2004.
14. Plant Anatomy. Roy, K. New Central Book Agency (P) Limited, Calcutta. 2006.
15. Plant Biotechnology. Chawla, H.S. 3rd ed. Oxford & IBH. 2008.
16. Plant Pathology. Agrios G N. 4thEdn, Academic, USA. 1997.
17. Principles of Biochemistry. Nelson D.L. and Cox M.M. Lehninger. 5th Ed, W.H Freeman and Company, New York. 2008.
18. Principles of virology, molecular biology, pathogenesis and control. Flint S.J. Enquist L.W, Krug R.M. 2000,
19. Research methodology for Biological Sciences. Gurumani, N. M. J. P.2006.
20. Text Book of Microbiology. A Ananthnarayana and C K J Paniker. 6 Ed:

Chemistry (weightage 50%)

Inorganic Chemistry:

Unit 1

Atomic structure and periodic properties: Quantum numbers and their significance, radial and angular probability, shapes of orbitals, relative energies of atomic orbitals as a function of atomic number. Electronic configurations of elements; Aufbau principle, Hund's multiplicity rule, Pauli's exclusion principle. Periodic classification of elements, salient characteristics of s,p,d and f block elements. Periodic trends of atomic radii, ionic radii, ionization potential, electron affinity and electronegativity in the periodic table.

Unit 2

Errors: Classification, minimization of determinate errors, accuracy and precision. Significant figures and their computations.

Organic Chemistry:

Unit 3:

Bond cleavage – Homolytic and heterolytic. Types of reagents – electrophilic and nucleophilic reagents. Reactive intermediates - generation and relative stabilities of carbocation, carbanion, carbon free radicals and carbenes – explanation for stability and based on inductive, resonance and hyperconjugation effects.

Unit 4 :

Types of reactions - addition, substitution and elimination. Concept of isomerism – Structural isomerism, stereo isomerism - geometrical and optical isomerism

Chemistry of Aliphatic and aromatic Hydrocarbons Alkanes: Sources, Nomenclature of branched chain alkanes, preparation of symmetrical and Unsymmetrical alkanes- Corey- House reaction and Wurtz reaction - their merits and Demerits.

Cycloalkanes: Nomenclature. Method of formation. Explanation for stability based on Hydrogenation data, Baeyer's strain theory and its limitation, Sachse -Mohr theory of strainless rings; cyclopropane ring - banana bonds.

Alkenes: Preparation of alkenes by Wittig reaction-stereo selectivity. Addition of HX to unsymmetrical alkene - Markownikov's rule and Antimarkownikov's rule with Mechanism. Reactions: Hydroboration- oxidation, reduction.

Alkynes: Methods of preparation - Dehydrohalogenation of vicinal and geminal dihalides; and higher alkynes from terminal alkynes. Reactions - metal ammonia reduction – significance. Oxidation with KMnO_4 , acidic nature of terminal synthesis and reactions of alcohols, phenols Amines & Aldehydes & ketones.

Aromaticity ;Huckel's rule; electrophilic aromatic substitution-nitration, sulphonation, halogenation (nuclear and side chain), Friedel-Crafts alkylation and acylation, substituents effect.

Physical Chemistry :

Unit 5:

Thermodynamics : Deviation of real gases from the equation of state for an ideal gas, van der Waals and Virial equation of state, critical phenomena, principle of corresponding states, equation for reduced state. Liquification of gases, distribution of molecular speed, collisions between molecules in a gas; mean free path, specific heat of gases. Spontaneity of a process, entropy and entropy changes in various processes, free energy functions, criteria for equilibrium, relation between equilibrium constant and thermodynamic quantities.

Unit 6:

Phase rule and its applications : Equilibrium between liquid, solid and vapours of a pure substance, Clausius-Clapeyron equation and its applications. Number of components, phases and degrees of freedom; phase rule and its applications; simple systems with one (water) and two components (lead-silver). Distribution law, its modifications, limitations and applications.

Unit 7 :

Solutions : Solubility and its temperature dependence, partially miscible liquids, upper and lower critical solution temperatures, vapour pressures of liquids over their mixtures, Raoult's and Henry's laws, fractional and steam distillations.

Applied Chemistry:

Unit 8 :

Instrumental Methods of Analysis: UV-visible spectrophotometry, NMR and ESR spectroscopy, mass spectrometry. Chromatography including GC and HPLC. Electroanalytical methods- polarography, cyclic voltammetry, ion-selective electrodes. Thermoanalytical methods.

Unit 9:

Organic and Inorganic Polymers: Differences between inorganic and organic polymers. Polymerisation: types: addition and condensation polymerization, Molecular weight of Polymers:

Expression for Weight average and Number average (experimental determination is not required)
Preparation and applications of the following types of polymers 1. Plastics: i) Thermosetting plastics (Phenol-formaldehyde) ii) Thermo softening plastics (PVC) 2. Fibers: Acrylic, polyamide, polyester types: one example for each 3. Rubber: Neoprene, 4. Fluoro Carbons: Teflon 5. Silicones.

Unit 10:

Environmental Chemistry: Air pollution, types of air pollutants; control of air and water pollution Depletion of ozone in the stratosphere. Causes and remedial measures. The greenhouse effect and its consequences. Acid rain, photochemical smog. Treatment of sewage and industrial effluents. Disposal of radioactive wastes.

Reference Books:

1. Concise Inorganic Chemistry, J.D. Lee, Fifth Edition, John Wiley and Sons Ltd.
2. Advanced Inorganic Chemistry - Vol. 1 & Vol. 2, Satya Prakash et al, S. Chand Publication.
3. Organic Chemistry, Morrison and Boyd, Sixth Edition, Pearson Publication.
4. Physical Chemistry, Peter Atkins and Julio de Paula, 10th Edition, Oxford Publication.
5. Fundamentals of Analytical Chemistry, Skoog et al, 8th Edition, Thomson Publishers.
6. Polymer Science, V. R. Gowariker et al, Third Edition, New Age International Publishers.
7. Environmental Chemistry, Anil K. De, 9th Edition, New Age International Publishers.

Mathematics (Weightage 50%)

MODULE I:

Motion of In-viscous fluids: Introduction, Basic Definitions and types of flows, Lagrange's and Euler's equation of motion, Equation of continuity, conservation of mass, momentum and energy equations. Applications of Fluid Mechanics, mode of heat transfer, definition of convection, conduction and radiation, Fourier law of heat cooling.

MODULE II: Groups, Rings, fields: Basic properties, its related problems, Automorphisms, Inner automorphisms, groups of automorphisms and inner automorphisms and their relation with centre of a group. Some special classes of rings (Integral domain, division ring, field). Homomorphisms of rings, Kernel and image of Homomorphisms of rings, Isomorphism of rings, Ideals and Quotient rings.

Algebra: Systems of linear equations, matrices, determinat, elementary row operations, rank, Vector spaces, subspaces, bases and dimension, coordinates. Linear transformations and its algebra and representation by matrices, algebra of polynomials, determinant functions, additional properties. Elementary canonical forms, characteristic values and vectors, Cayley Hamilton's theorem, adjoints, Hermitian, self-adjoint, Bilinear forms, symmetric and skewsymmetric bilinear forms.

MODULE III: Numerical Solution of Ordinary Differential Equation IVP Taylor's Series method, Euler's Method, Modified Euler's method, Explicit Runge-Kutta Methods, I and II order Runge-Kutta methods, Runge-Kutta IV order method.

Numerical Solution of Partial Differential Equation: Parabolic PDE: Crank-Nicholson method, Gauss Seidal iterative scheme for Crank-Nicholson method, Successive Over Relaxation (SOR).

MODULE IV: Differential Equations: Linear differential equations of nth order, degree of DE, fundamental sets of solutions, Wronskian –Abel's identity, theorems on linear dependence of solutions, adjoint – self - adjoint linear operator, Green's formula, Adjoint equations, the nth order non-homogeneous linear equations- Fundamental existence and uniqueness theorem. Dependence of solutions on initial conditions, existence and uniqueness theorem for higher order and system of differential equations – method of solving initial value problem (only formulas).

MODULE V: Graphs and planar graphs : Basic terminologies, multigraphs and weighted graphs, paths and circuits, shortest paths in weighted graphs, Eulerian paths and circuits, Hamiltonian paths and circuits. Colourable graphs, Chromatic numbers, Five colour theorem and Four color problem. Trees and cut-sets : trees, rooted trees, path lengths in rooted trees, spanning trees and BFS & DFS algorithms, minimum spanning trees and Prims & Kruskal's algorithms.

Reference Books

- F. Charlton, Fluid Dynamics, C. B. S Publisher Delhi (1985).
- Er. R. K. Rajput, A text Book of fluid Mechanics, S. Chand. (2008).
- I. N. Herstein, Topics in Algebra, 2nd Edition, John Wiley and Sons, 2007.

- Hoffman and Kunze, Linear Algebra, Prentice Hall of India, New Delhi, 2003
- P.G. Bhattacharya, S.K. Jain and S.R. Nagpaul, First course in Linear Algebra, Wiley Eastern Ltd., New Delhi, 1991.
- G.F. Simmons : Differential Equations, TMH Edition, New Delhi, 1974.
- J. P. Tremblay and R. P. Manohar, Discrete Mathematical Structures with applications to Computer Science, McGraw Hill, 2004.
- F. Harary: Graph theory, Addition Wesley, 1969.
- S.S. Sastry: Introductory methods of Numerical analysis, Prentice- Hall of India, New Delhi (1998).
- D.V. Griffiths and I.M. Smith, Numerical Methods for Engineers, Blackwell Scientific Publications (1991).

Physics (Weightage 50%)

Module – 1

Mechanics and Properties of Matter: - Frames of Reference, Rigid body dynamics, Moment of Inertia, Laws of Conservation, Gravitation, Elasticity, Viscosity, Surface Tension.

Module – 2

Heat and Thermodynamics: – Kinetic Theory, Laws of Radiation, Thermodynamics, Liquefaction of Gases, Entropy, Heat engines and Refrigeration, Thermal Conductivity.

Module – 3

Waves and Oscillations: – Progressive waves, Superposition, Doppler effect, Acoustics of Buildings, Fourier transforms, Ultrasonic.

Module – 4

Optics: - Theories of Light, Interference, Diffraction, Polarisation, Optical Instruments, Resolving Power, Laser, Production, Properties and Applications, Holography, Optical Fibers.

Module – 5

Electricity and Magnetism: – Electrostatics-magnetostatic, Alternating and Direct current, Thermoelectricity, Electromagnetism, Maxwell's equations.

Module – 6

Atomic and Molecular Physics: – The electron, Atomic Models, Atomic spectra, Molecular spectra, Related measurements, Zeeman Effect, Raman effect, X-rays, Crystallography.

Module – 7

Nuclear Physics: – Nuclear models, Properties of nucleus, Nuclear reactions, Accelerator, Nuclear detectors Mass spectrograph, Radioactivity, Cosmic ray, Mossbauer effect, Magnetic Resonance, Applications, Elementary Particles, Nuclear Energy.

Module – 8

Solid State Physics: - Relativity, Special and General Theories of relativity, Statistical Physics, Specific Heats of Solids , Band Theory of solids, Classification of solids, Electrical and thermal properties, Dielectric and Magnetic Properties, Specific Heats of Solids, Superconductivity.

Module – 9

Classical Mechanics and Quantum Physics: – constraints of motion, D'alembert's Principle, Lagrange's equation, Failure of Classical Physics, Duality, Wave function, Uncertainty Principle, Schrodinger wave equations and its applications, Eigen function and Eigen values.

Module – 10

Semiconductors: - Electronics and Semiconductor devices-Digital Electronics-Transistors, Amplifiers, Logic Gates & Circuits.

Reference Books:

1. Classical Mechanics by H. Goldstien (2nd Edition) (Addison-Wesley) 1980.
2. Concepts of Modern Physics by Arthur Beiser, (McGraw-Hill) 2002.
3. Elements of properties of matter by D S Mathur (S. Chand publication) 2010.
4. Heat and Thermal Physics by Brijlal & Subramaiam (S. Chand Publication) 2014.
5. Elements of Electronics by V. K. Mehta, (S. Chand and Co) 2013.
6. A text book of Optics by by Subrahmaniyam N, Brij Lal and M N Avadhanalu,(S. Chamd) 2006.
7. Introduction to Atomic and Molecular Spectroscopy by V. K. Jain, Vimal Kumar Jain (Alpha Science International Limited) 2007.

8. Introductory Nuclear Physics by Kenneth Crane (Wiley Indai Pvt Ltd) 2008.
9. Engineering physics by R. K. Gaur and S. L. Gupta Dhanpathrai Publications.

Zoology (Weightage 50%)

UNIT -1 : Taxonomy and Non-chordates.

Species concept. Mechanism of speciation. Taxonomic procedures. General characters and classification of major invertebrate phyla. Theories on the origin of metazoa and coelom. Canal system in porifera. Primitive and advanced nervous system in invertebrates. Larval forms in arthropoda and echinodermata. Patterns of reproduction : Asexual, sexual and Parthenogenesis.

UNIT -2 : Molecular Cell Biology.

Levels of organization. Central dogma of molecular biology. Classification and biological significance of carbohydrates, proteins and lipids. Nucleic acids : Structure of DNA and RNA and types of RNA. Structure, composition and functions of biomembrane. Cell organelles. Cancer cell. Cell cycle. Cell division.

UNIT -3 : Chordates and Economic Zoology.

General characters and classification of chordates. Theories on origin of chordates. Retrogressive metamorphosis. Lateral line system. Migration in fishes and birds. Aerial adaptation and mechanism of flight. Neotony. Poison apparatus in snakes. Adoptive radiation in marsupials. Sericulture : Silkworm rearing methods. Apiculture : Different species of honey bees. Management of bee keeping. Importance of vermiculture and vermiwash. Dairy breeds and their management and diseases. Poultry breeds and their diseases .

UNIT -4 : Molecular Genetics and Evolution.

DNA as genetic material. Regulation of gene expression in prokaryotes and eukaryotes. Interaction of genes : Epistasis, polygenic inheritance. Mechanism of replication. Mechanism of transcription. Mechanism of translation. Linkage and crossing over. Gene mutation, chromosomal aberrations. Darwinism, Neo Darwinism, Lamarckism, Neo lamarckisim. Isolating mechanism. Evolution of man.

UNIT -5 : Endocrinology and Animal Behavior.

Classification of hormones. Structure and functions of hypothalamus, pituitary, thyroid, parathyroid, adrenal, pancreas, liver, hypothalamus, testis and ovary. Mechanism and biosynthesis of hormones : peptide and steroid hormone. Growth factors: Neurotropic, haemopiotic and epidermal growth factors. Types of behavior : innate and acquired. Social organization in insects and primates. Optimal foraging theory. Parental care. Courtship behavior. Types of Mimicry. Pheromones. Types of communication. Chronobiology.

UNIT -6 : Developmental Biology.

Theories of developmental biology. Stages of animal development. Gametogenesis: spermatogenesis and oogenesis, structure of gametes. Fertilization : Types, mechanism and

significance. Parthenogenesis: Definition, types and significance. Implantation: Types, mechanism and hormonal regulation. Fetal membrane : Types, structure and functions. Placenta : Types, structure and functions.

UNIT -7 : Animal Physiology.

Digestion and absorption of carbohydrates proteins and lipids. Mechanical and chemical digestion. Mechanism of respiration. Neural and chemical regulation of respiration. Composition of blood. Structure, functions and regulation of heart beat. Structure and functions of different types of muscles. Mechanism of muscle contraction and relaxation. Contractile proteins. Physiology of urine formation. Neurotransmitters, neuromuscular junction, conduction of nerve impulse.

UNIT -8 : Environmental Biology.

Pollution : Types, sources, effects and control measures. Abiotic and biotic interactions, energy flow, food chain and food web. Types of ecosystem : Aquatic and terrestrial. Biogeochemical cycles. Disaster management. Global warming. Ozone layer depletion. Acid rain. Solid waste management. Sewage and waste water treatment. Biomedical waste management. Levels of biodiversity. Biodiversity hot spots. Environmental awareness. Environmental education and NGO's.

UNIT -9 : Animal Biotechnology.

Cell culture. Stem cell technology. Gene cloning. Restriction enzymes. Cloning Vectors. Generation of genomic and cDNA libraries. Transgenic animals. Animal cloning. Gene knock out and Gene knock in technology. Gene therapy. Recombinant DNA technology. Hybridoma Technology. Recombinant vaccines. Blotting techniques. Polymerase Chain Reaction. Nanobiotechnology.

UNIT – 10 : Methods in Biology and Histology.

Centrifugation. Electrophoresis. Chromatography. Spectrophotometer. Light, phase contrast, fluorescence and confocal microscope. Microtome. Care and handling of laboratory animals. Radioisotopes and autoradiography. Histological structure and functions of ovary, uterus, oviduct, mammary gland, testis, epididymis, vas deference, prostate gland, Cowper's gland and seminal vesicles. Endocrine glands – pituitary, pineal, adrenal, thyroid, parathyroid, pancreas. Immune system – Innate and acquired. Structure and functions of lymph node, tonsil, thymus, spleen.

Reference Books:

- ❖ Principles of Animal taxonomy, Ashok Verma.
- ❖ Principles of Systematic Zoology, Mayr, E. & P.D. Ashlock (1991) 2nd Edition, McGraw-Hill, Inc.

- ❖ Modern Textbook of Zoology-Invertebrates Animal Diversity-1, R. L. Kotpal.
- ❖ Invertebrate Structure and Function, E J W Barrington ELBS 1971.
- ❖ Cell & Molecular Biology, Roberts De EDP. 7th Edition.
- ❖ Introduction to Cell Biology, S Sundara Rajan.
- ❖ Cytology, Genetics, Evolution and Ecology, P K Gupta.
- ❖ Molecular Biology, David Frie feloder.
- ❖ Textbook of Zoology Vertebrates, Jeffery Parker T, Vol-2.
- ❖ Chordate Zoology, E. L Jordan.
- ❖ Fish and Fisheries of India. Jhingran, V.G. 1977, Hindustan Publication., New Delhi.
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- ❖ The Science of Genetics, Atherly. A.G., Girten, J. R. and Mcdonald, J.F., Saunders College, 1999.
- ❖ Genetics, P K Gupta.
- ❖ Evolution by Dobzhansky, Ayala, Stebbins, Valentine.
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- ❖ A Textbook of Comparative Endocrinology, Gorbman and Beru. 1962.
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- ❖ Introduction to Embryology, BI Balinsky.
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- ❖ Textbook of Medical Physiology, Guyton & Hall, John E Hall.
- ❖ A Textbook of Physiology, Vol- 1 & 2, A. K. Jain.
- ❖ Animal physiology ,P S Verma.
- ❖ Fundamentals of Ecology, E.P.Odum, G W Barrett.
- ❖ Environmental biology and Toxicology, P D Sharma.
- ❖ Environmental biology – principles of ecology, P S Verma.
- ❖ Environmental studies, Dr. Nandini.
- ❖ Biotechnology, Satyanarayana. U.
- ❖ Molecular Biotechnology: Principles and Application of recombinant DNA, Bernard R. and Jack, ASM Press, Herndon, U.
- ❖ Elements of biotechnology, P K Gupta.
- ❖ Modern Experimental Biochemistry, Benjamin, Boyer. 1982.
- ❖ Locquin and Langeron. Handbook of Microscopy. Butterwaths, 1983.
- ❖ Bloom and Fawcett.D.1972 Text book of histology 10th ed.