SIDDHARTH UNIVERSITY
KAPILVASTU OF SIDDHARTH NAGAR
SIDDHARTH NAGAR

SYLLABUS OF
RESEARCH ELIGIBILITY TEST
(RET)
FOR SEEKING ADMISSION
IN
PH. D.
(SESSION : 2019-2020)

FACULTY OF SCIENCE

DEPARTMENTS

1. MATHEMATICS & STATISTICS
2. ZOOLOGY
3. PHYSICS
4. CHEMISTRY
5. BOTANY

1. MATHEMATICS AND STATISTICS

NOTE: Part - A is compulsory for both Mathematics and Statistics Students in Mathematics have to answer additional questions from Part - B. Students in Statistics have to answer additional questions from Part - C.

PART – A : RESEARCH METHODOLOGY

1 **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

2 **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. Quadratic forms, reduction and classification of quadratic forms.

3 **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

4 **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

5. **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.

PART – B : MATHEMATICS

1. **Complex Analysis:** Liouville's theorem, Maximum modulus principle, Schwarz lemma, Open mapping theorem Taylor series, Laurent series, calculus of residues; Conformal mappings, Mobius transformations

2. **Algebra**: 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

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

4. **Functional Analysis** Normed linear Spaces Spaces of continuous functions as examples. Inner product spaces, orthonormal basis

5. **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

6. **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.
7. **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.
8. **Linear Integral Equations:** Linear integral equation of the first and second kind of Fredholm and Volterra type, Solutions with separable kernels. Characteristic numbers and eigen functions, resolvent kernel.
9. **Classical Mechanics:** Generalized coordinates, Lagrange's equations, Hamilton's canonical equations, Hamilton's principle and principle of least action, Two-dimensional motion of rigid bodies, Euler's dynamical equations for the motion of a rigid body about an axis, theory of small oscillations.
10. **Differential Geometry**: Basics of Curved in spaces, Serret-Frenet Formulas, Curvature, Torsion. Riemannian geometry, Riemannian metric, Riemannian curvature tensor, Ricci tensor, Identities of Bianchi's, Sectional curvature. Definition and examples of differentiable manifolds, Differentiable functions, Differentiable curves, Tangent space, Vector fields, Lie bracket. Basics of connections, covariant differentiation, Parallelism, Difference tensor of two connections, Lie derivative, Exterior Algebra.

2. ZOOLOGY

PART – A : RESEARCH METHODOLOGY

1. Principles and uses of Flame Photometry, Spectrophotometer, Spectroflurophotometer, Atomic absorption, Spectrophotometry, Separation and identification of biomolecules by chromatography - Paper and Thin layer chromatography (TLC), Gas Liquid chromatography (GLC), Column chromatography, Ion exchange chromatography, Gel exclusion chromatography, High Performance Liquid chromatography (HPLC), Affinity chromatography, Principles of differential and density centrifugation, Microbial techniques – Media preparation and sterilization, Inoculation and growth monitoring, Use of fermentations, Microbial assays, Microscopy – Electron microscope. Methods of tissue culture, Chemical basis of fixation, Block formation and Microtomy.
2. Methods used in bio-chemical estimations of Protein, Carbohydrate, Lipid, Amino acids, Nucleic acid, Kinetics of amylase activity, Determination of LC_{50}, UCL, LCL, Slope of toxicants against different pests, Methods used in determination of alkanity, dissolved oxygen, carbon-di-oxide, COD, BOD.
3. Test of significance: t-test, Analysis of variance, Chi square test.

PART – B : ZOOLOGY

1. Nutrition and reproduction in Protozoa; parasitism in helminthes; Adaptive radiation in Polychaeta; Origin of Metazoa; Polymorphism in Coelenterata. Organization and affinities of Onychophora, Parasitism and Larval forms in Crustacea, Adaptive radiation in Mollusca, Torsion in gastropods, Larval forms in Echinodermata. Origin of chordate, General organization and affinities of Holocephali, Crossopterygii and Dipnoi, Origin of Tetrapoda, Neoteny in Amphibia, Adaptive radiation in Eutheria.
2. Law of Mass action, Free energy, Kinetics of enzyme reaction, Enzyme inhibition-Competative and Non-competitive inhibitors of enzymes, Allosteric enzymes, Vitamins and Co-enzymes, Glycolysis, HMP shunt, *B*-Oxidation of Fatty acids, Biosynthesis of Amino acids.
3. Mendalism, Interaction of genes, Cytoplasmic inheritance, Lethal genes, Sex-linked inheritance, Sex-determination, Multiple allelism, Transposible elements in genetic regulation, Molecular Cytogentic Techniques (FISH, GISH, DNA Finger printing, Flow cytometry, Gene therapy, Genetic switches, Regulatory genes.
4. Concept of Ecosystem and their types, Ecological adaptations, Concept of homeostasis, Conservation of Natural Resources, Bio-indicators and prediction of Ecological effects, Ozone depletion, Global warming, Challenges of Climatic Changes, Nuclear Winter.
5. Synaptic transmission and Neurotransmitters, Pattern of Nutrition, Origin of Nutritive types, Poikilothermy, Chemoreceptors, Photoreceptors, Endocrine organs in Chordates and Non-chordates, Mechanism of hormone action : Second messenger system-Cyclic AMP, Cyclic GMP, Calcium. Osmotic Conformity and regulation, Respiratory pigments, Respiratory adaptation to low oxygen tension, Bio-synthesis of Urea, Cellular basis of immunity.
6. Innate behaviour, Stereotype and acquired behaviour, Learning and memory, Pattern of communication, Social behaviour with respect to insects and Primates, Sexual behaviour, Parental care, Migratory behaviour of fishes and birds.
7. Animal development and morphogenetics, Gametes structure and formation, Nature of egg and their cleavage, Induction and organizer concept, Diversification in early embryonic cells, Cell memory, Cell determination and the concept of positional values, Aging and cellular death (Apoptosis), Embryonic stem cell, Induced Pluripotent Stem Cell.

8. ***Trends in Bio-systematics***: Chemotaxonomy, Cytotaxonomy, Molecular taxonomy, Species concepts: Species category, Sub species, Neo-Lamarckism, Neo-Darwinism and Synthetic theory of evolution, Micro/Macro/Mega evolution.

9. Prawn culture, Fish culture, Pearl culture, Apiculture, Sericulture, White revolution, Endangered wild animal species, Project Tiger/Crocodile/Elephant.

3. PHYSICS

PART – A : RESEARCH METHODOLOGY

I. Mathematical Methods: Special functions (Hermite, Bessel, Laguerre and Legendre functions). Fourier series, Fourier and Laplace transforms. Elements of complex analysis, analytic functions; Taylor & Laurent series; poles, residues and evaluation of integrals.

II. Classical Mechanics : Central force motions. Two body Collisions - scattering in laboratory and Centre of mass frames. Rigid body dynamics-moment of inertia tensor. Non-inertial frames and pseudoforces. Principle of least action. Generalized coordinates. Constraints, Lagrangian and Hamiltonian formalism and equations of motion. Conservation laws and cyclic coordinates. Poisson brackets and canonical transformations. Periodic motion: small oscillations, normal modes. Special theory of relativity-Lorentz transformations, relativistic kinematics and mass–energy equivalence.

III. Electromagnetic Theory : Electrostatics: Gauss's law and its applications, Laplace and Poisson equations, boundary value problems. Magnetostatics: Biot-Savart law, Ampere's theorem. Electromagnetic induction. Maxwell's equations in free space and linear isotropic media; boundary conditions on the fields at interfaces. Scalar and vector potentials, gauge invariance. Electromagnetic waves in free space. Dielectrics and conductors. Reflection and refraction, polarization, Fresnel's law, interference, coherence, and diffraction. Dynamics of charged particles in static and uniform electromagnetic fields.

IV. Quantum Mechanics : Wave-particle duality. Schrödinger equation (time-dependent and time-independent). Eigenvalue problems (particle in a box, harmonic oscillator, etc.). Tunneling through a barrier. Wave-function in coordinate and momentum representations. Commutators and Heisenberg uncertainty principle. Dirac notation for state vectors. Motion in a central potential: orbital angular momentum, angular momentum algebra, spin, addition of angular momenta; Hydrogen atom. Stern-Gerlach experiment.

V. Thermodynamic and Statistical Physics : Laws of thermodynamics and their consequences. Thermodynamic potentials, Maxwell relations, chemical potential, phase equilibria. First- and second-order phase transitions. Phase space, micro- and macro-states. Micro-canonical, canonical and grand-canonical ensembles and partition functions. Free energy and its connection with thermodynamic quantities. Classical and quantum statistics. Ideal Bose and Fermi gases. Blackbody radiation and Planck's distribution law.

VI. Electronics : Semiconductor devices (diodes, junctions, transistors, field effect devices, homo- and hetero-junction devices), device structure, device characteristics, frequency dependence and applications, C.R.O. Opto-electronic devices (solar cells, photo-detectors, LEDs). Operational amplifiers and their applications.

PART - B: PHYSICS

I. Mathematical Physics : Green's function. Partial differential equations (Laplace, wave and heat equations in two and three dimensions). Elements of computational techniques: root of functions, interpolation, extrapolation, integration by trapezoid and Simpson's rule, Solution of first order differential equation using Runge-Kutta method. Finite difference methods. Tensors. Symmetry operations and group theory.

II. Electromagnetic Theory : Dispersion relations in plasma. Lorentz invariance of Maxwell's equation. Transmission lines and wave guides. Radiation- from moving charges and dipoles and retarded potentials.

III. Quantum Mechanics : Time-independent perturbation theory and applications. Variational method. Time dependent perturbation theory and Fermi's golden rule, selection rules. Identical particles, Pauli exclusion principle, spin-statistics connection. Spin-orbit coupling, fine structure. WKB approximation. Elementary theory of scattering: phase shifts,

partial waves. Born approximation. Relativistic quantum mechanics: Klein-Gordon and Dirac equations. Semi-classical theory of radiation.

IV. Electronics : Digital Electronics: Universal Gates, XOR gates, half and full adder, parallel adder, encoder and decoder, POS, SOP, K-map, Flip-Flops. Impedance matching, amplification (Op-amp based, instrumentation amp, feedback), High frequency devices (including generators and detectors).

V. Atomic & Molecular Physics : Quantum states of an electron in an atom. Electron spin. Spectra of one and two valance electron atoms. Relativistic corrections for energy levels of hydrogen atom, hyperfine structure and isotopic shift, width of spectrum lines, LS & JJ couplings. Zeeman, Paschen-Bach & Stark effects. Electron spin resonance. Nuclear magnetic resonance, chemical shift. Born-Oppenheimer approximation. Electronic, rotational, vibrational and Raman spectra of diatomic molecules, selection rules, Frank-Condon principle; Lasers: spontaneous and stimulated emission, Einstein A & B coefficients. Optical pumping, population inversion, rate equation. Modes of resonators and coherence length. Simple laser systems.

VI. Condensed Matter Physics : Bravais lattices. Reciprocal lattice. Diffraction and the structure factor. Bonding of solids. Elastic properties, phonons, lattice specific heat. Free electron theory and electronic specific heat. Response and relaxation phenomena. Drude model of electrical and thermal conductivity. Hall effect and thermoelectric power. Electron motion in a periodic potential, band theory of solids: metals, insulators and semiconductors. Superconductivity: type-I and type-II superconductors. Diamagnetism, paramagnetism, and ferromagnetism; Superfluidity. Defects and dislocations. Ordered phases of matter: translational and orientational order. Liquid crystals and its types. Quasi crystals.

VII. Nuclear and Particle Physics : Basic nuclear properties: size, shape and charge distribution, spin and parity. Binding energy, semi-empirical mass formula, liquid drop model. Nature of the nuclear force, form of nucleon-nucleon potential, charge-independence and charge-symmetry of nuclear forces. Deuteron problem. Evidence of shell structure, single-particle shell model, its validity and limitations. Rotational spectra. Elementary ideas of alpha, beta and gamma decays and their selection rules. Fission and fusion. Nuclear reactions, reaction mechanism, compound nuclei and direct reactions; Classification of fundamental forces. Elementary particles and their quantum numbers (charge, spin, parity, isospin, strangeness, etc.). Gellmann-Nishijima formula. Quark model, baryons and mesons. C, P, and T invariance. Application of symmetry arguments to particle reactions. Parity non-conservation in weak interaction. Relativistic kinematics.

4. CHEMISTRY

PART – A : RESEARCH METHODOLOGY

1. **Errors and Evaluation** : Definition of terms in mean and median. Precision-standard deviation, relative standard deviation. Accuracy-absolute error, relative error. Types of error in experimental data determinates (systematic), indeterminate (or random) and gross. Sources of errors and the effects upon the analytical results. Methods for reporting analytical data.

2. **Electroanalytical Methods :** ***Conductometric*** - Discussion of the nature of curves in acid-base (including mixtures of acids), precipitation and complexometric titrations; ***Potentiometric*** - Different types of electrodes, discussion of the nature of curves for oxidation-reduction and acid-base titrations, comparison with the conductometric method; ***Polarographic*** - Poloragraphically active species, concept of residual, diffusion and limiting currents and half wave potential, Ilkovic equation and factors affecting diffusion current.

3. **Thermoanalytical Methods :** ***Thermogravimetric*** - Apparatus, factors affecting TGA, interpretation of TG curves of $CaC_2O_4.H_2O$ and $MgC_2O_4.2H_2O$ and in the analysis of their mixtures; ***Differential Thermal Analysis and Differential Scanning Calorimetry*** - Apparatus, factors affecting DTA/DSC curves with special reference to heating rate, particle size and packing, measurements of heats of transition or heat of reaction and heat of dehydration of metal salt hydrates.

4. **Separation Techniques :** ***Principle, Technique and Analytical Applications of the Following***: Solvent extraction; Chromatography (Paper, Thin Layer and Column); Ion exchange; and Structure elucidation of spectral data (IR and UV).

PART – B : CHEMISTRY

1. **Fundamental Concepts of Quantum Chemistry :** De Broglie hypothesis, the Heisenberg's uncertainty principle, Sinusoidal wave equation, Hamiltonian operator, Schrodinger wave equation and its importance, Physical interpretation of the wave function, postulates of quantum mechanics, Particle in one dimension, particle in a one dimensional box; Schrodinger wave equation for H-atom, separation into three equations (without derivation), hydrogen like wave functions, radial eave functions, angular wave functions.

2. **Quantum Mechanical Treatment of a Harmonic Oscillator :** One dimensional harmonic oscillator (classical and quantum mechanical treatment).

3. **Thermodynamics and Electrochemistry :** The Joule Thomson's effect, The Gibbs Helmholtz equation and its applications, The Maxwell's relations, Thermodynamic equations of state (Relationship between E or H and P, V, T); Chemical potential and variation of chemical potential with temperature and pressure, The Gibbs-Duhem equation, Fugacity and variation of fugacity with temperature and pressure, concept of activity and activity coefficient; Debye-Falkenhagen effects, Wein effect, Ionic association, Basic concept of the electrical double layer and electrokinetic phenomena.

4. **Stereochemistry and Bonding in Main Group Compounds :** VSEPR, Walsh diagram, $d\pi$ - $p\pi$ bonds, Bent's rule, Energetics of hybridization, Some simple reactions of covalently bonded molecules.

5. Preparation, structure, bonding and technical applications of polyether complexes of alkali and alkaline earth metals, polyphosphazenes, thiazyl and its polymers, tetrasulphur dinitride; Structures of silicones and silicates.

6. Preparation properties, structure and applications of alkyls and aryls of lithium, beryllium, magnesium, aluminium.

7. **Structures of 2 to 8 Coordinate Metal Complexes :** Cation-anion ratio in various polyhedra, Hybrid orbitals and preferred conditions of formation of the complexes of following geometries : C.N.2 – Linear; C.N.3 - Trigonal planar, Trigonal pyramidal; C.N.4 - Tetrahedral, Square planar; C.N.5 - Trigonal bipyramidal, square pyramidal, pentagonal; C.N.6 - Octahedral, Trigonal prism; C.N.7 - Pentagonal bipyramidal, Capped octahedral, Capped trigonal prism; C.N.8 - Cubic, Tetragonal antiprismatic, Dodecahedral, Hexagonal bipyramidal, and Bicapped trigonal prism,

8. Stereoisomerism in six coordinate octahedral complexes (Ma_3bcd, Ma_2bcde, Mabcdef and complexes containing bi-and terdentate ligands) Intermolecular and intramolecular (rearrangements Bailar and Ray Dutta Twist only), mechanism of racemisation in tris (chelate) octahedral complexes. Methods of resolution of optical isomers.

9. Kinetics and mechanism of substitution reactions in octahedral Co (III) and square planar Pt (II) Complexes; *Electron transfer reactions* : Mechanism of one electron transfer reactions `(Inner and outer sphere mechanisms), factors affecting the rates of direct electron transfer reactions and the Marcus equation; Two electron transfer reactions.

10. **Metal Ligand Equilibria in Solution :** Step wise and overall formation constants and their relations, Factors affecting the stability of metal complexes with reference to the nature of metal ions and ligands, determination of stability constants by pH-metric and spectrophotometric methods.

11. **Organic Reaction Mechanism : *Substitution Reactions***: Aliphatic nucleophilic, substitution (SN^1, SN^2, SN^i, mixed SN^1 and SN^2, and SET mechanisms). Role of substrate structure, attacking reagents, leaving groups and solvents on SN^1 and SN^2 mechanisms. Neighbouring group participation by α and π bonds, anchimeric assistance. Stereochemistry of SN^1 and SN^2 reactions; Aromatic electrophilic substitution (nitration, halogenation, sulfonation, Friedel-Craft's alkylation and Friedel-Craft's acylation). Reactivity and orientation in electrophilic aromatic substitution. Hammett equation (sigma and rho). The effects of multiple substitutions. Nucleophilic aromatic substitution (The addition- elimination and Elimination - addition mechanisms). ***Elimination Reactions***: Mechanism and orientation of E1, E2, $E1_{CB}$ reactions. The factors affecting E1, E2, $E1_{CB}$ reactions. E1-E2-$E1_{CB}$ spectrum. Factors affecting substitution versus elimination. Hofmann and saytzeff like eliminations. Stereochemistry of elimination reactions. Pyrolytic eliminations; ***Addition Reactions***: (a) Addition of halogens and halogen acids to alkenes. 1,2-Bishydroxylation, epoxidation and hydroboration-oxidation reactions to alkenes. Mechanism and stereochemistry of electrophilic addition reactions. Sharpless asymmetric epoxidation. Nucleophilic addition to alkenes; (b) Addition to carbon-oxygen double (C=O) bonds, Cram's rule, Mechanisms of Aldol, Perkin, Knoevenagel, Claisen and Cannizzaro reactions.

12. Genreal methods for the determination of structures of Alkaloid and Terpenes.

5. BOTANY

PART – A : ELEMENTARY RESEARCH METHODOLOGY

1. Gram staining of bacteria; Micrometry and measurement of the spore size; Preparation of medium, slant preparation, inoculation; Serial dilution technique, measurement of bacterial concentration by plate count method; Isolation of bacteria and fungi from air, water and soil samples.
2. Methods of sectioning, staining, mounting and identification of lower plants; Local collection of different algal forms and their study.
3. Methods of excision of embryo/ovule.
4. ***Herbarium*:** Methods of Collection and mounting of specimens; Methods of analysis of plant resources and bioprospection; ***Sampling methods***: quadrate, transect and point sampling.
5. Methods of determining conservation values of species.
6. Methods of calculation of various phyto-sociological indices.
7. Methods of determining soil texture/organic matter and soil moisture constituents.
8. Methods of determining osmotic pressure and DPD.
9. Methods of determining isoelectric point in plant protein and percentage of total reducing sugar.
10. Methods of determining the rate of photosynthesis.
11. Methods of separating major plant pigments/amino acids/reducing sugars.
12. Methods of determining the activity of enzyme amylase/catalase on the effect of substrate concentration, enzyme concentration, pH and temperature.
13. Methods of colorimetric estimation of RNA/DNA; Methods of isolation of protoplast from plant tissue; Methods of gel electrophoresis; Methods of DNA and plasmid isolation.
14. Physico-chemical analysis of polluted water samples; Eutrophic Index (C.Q.).
15. Methods of statistical application to given data.

PART – B : BOTANY

Section-A

1. Ultra structure, reproduction and classification of bacteria. Soil Microbiology; Bio-fertilizers, Food microbiology, Water microbiology and sewage disposal, Microbial production of ethanol, antibiotics, vaccines etc.
2. Classification, Structure, organization, Method of reproduction and Economic importance of fungi. Heterokaryosis, Parasexuality, Heterothallism, Lichen, Mycorrhiza, Study of general characters of the classes Myxomycetes, Plasmodiophoromycetes, Chytridiomycetes, Oomycetes, Zygomycetes, Ascomycetes, Basidiomycetes and Deuteromycetes. Nomenclature and classification of virus, Ultra structure, replication, Control measures, organic viruses, viroids, virusoides, satellite viruses and Prions.
3. Classification, Structure, organization of thallus, Reproductive diversity and life cycle patterns of algae. Distribution in soil and water, Evolutionary tendencies, parallelism in evolution, Economic Importance, Study of general characters of the divisions Cyanophyta, Chlorophyta, Xanthophyta, Phaeophyta and Rhodophyta, Prochlorophyta, Charophyta, Euglenophyta, Pyrrophyta, Bacillariophyta and Cryptophyta.

4. Classification, Diversity, Origin and evolution of bryophyte, Developmental morphology, Fossils, Ecological significance and Economic importance, Study of general characters of: *Riccia, Targionia, Cyathodium, Plagiochasma, Dumartiera, Asterella (Fimbriaria), Conocephalum, Lunularia, Marchantia, Riccardia (Anura), Pellia, Porella, Anthoceros, Notothylas, Spahagnum, Pogonatum and Funaria.*

5. Classification and origin of pteridophyta, microphylls and megaphylls. Stelar theory, Telome theory, Heterospory, Sporophyte and Gametophyte, Monographic study of the sporophyte body of the following: *Osmunda, Ophioglossum, Lygodium, Gleichenia, Cyathea, Pteris, Dryopteris, Adiantum* and *Polypodium.*

6. Classification, Anatomy, cone organization, life history and distribution of gymnosperms, Study of general characters of: Pteridospermales (*Calymmatotheca, Hoeninghausi*), Glosopteridales, Caytoniales (*Caytonia*), Cycadales, Bennettitales (*Williamsonia* sp.), Pentoxylales, Corditales (*Cordaites* sp.), Ginkgoales (*Ginkgobiloba*) Coniferales (general anatomy, cone organization, life history and distribution). Ephedrales (*Ephedra* sp.) Gnetales (*Gnetum* sp.) and Welwitschiales (*Welwitschia* sp.). Principles of Paleobotany and geological time scale, Process of fossilization and types of fossils, Carbon dating

Section-B

1. ICBN, Rules of Botanical Nomenclature. Role of different disciplines in taxonomy, recent trends, Phylogeny of Angiosperms, Advancement Index, Systems of Classification, Description of local plants in semi-technical language, belonging to dicot families: Magnoliaceae, Nymphyaeaceae, Annonaceae, Caryophyllaceae, Tamaricaceae, Teliaceae, Sterculiaceae, Linaceae, Rutaceae, Meliaceae, Vitaceae, Sapindaceae, Anacardiaceae, Fabaceae, Caesalpinaceae, Mimosaceae, Rosaceae, Myrtaceae, Lythraceae, Combretaceae, Onagraceae, Passifloraceae, Sapotaceae, Oleaceae, Apocynaceae, Asclepiadaceae, Boraginaceae, Scrophluriaceae, Bignoniaceae, Pediliaceae, Acanthaceae, Verbinaceae, Lamiaceae, Polygonaceae, Euphorbiaceae, Moraceae, Hydrocharitaceae, Orchidaceae, Commelinaceae, Zingiberaceae, Alismaceae, Cyperaceae, Poaceae.

2. Male and Female Gametophyte of angiosperms, Fertilization and its control, Endosperm, Embryo, Apomixis, Polyembryony, parthenocarpy. Organisation of root and shoot apices, Cambium and cork cambium, Structure, weight, strength and durability of wood, anatomy of floral structures, Stomata and secretory structures. Importance of plant biodiversity, Origin of cultivated plants, Center of origin, criteria and Vavilov's center of origin. Study of families, genera and species, morphology of the part used, mode of extraction, nature and economic importance with reference to Cereals, legumes, Forage crops, Fiber plants, Medicinal plants, Beverage yielding plants, wood and timber, Sugar, Tropical and subtropical fruits, Spices, Vegetables, Drugs and narcotics, Gum and dye, Latex, Fumitories, Insecticide yielding plants. Principles, *In situ* conservation and *Ex situ* conservation.

Section-C

1. Concept and scope of ecology; habitat and niche; Ecological model, Population Ecology, Community Ecology, Ecosystem Ecology, Evolutionary Ecology, Ecological Applications and ecological economics. Pedogenesis, Soil formation processes, Physical and chemical properties, Soil organisms. Plant Distribution pattern, Age area hypothesis, Floristic regions of India.

2. Photochemistry and Photosynthesis, Respiration, Lipid Metabolism, Plant Growth Regulators, Floral Induction, Photoperiodism, Vernalization, Sensory Potobiology. Enzymes, Co-enzymes, Mechanism of action of ATP, NADH and Co-A, Carbohydrates, Bioenergetics, Nucleic acids, Biosynthetic and degradation of purines and pyrimidines, denaturation, renaturation and degradation of nucleic acids.

3. Cell membrane, Cytoskeleton, Nucleus and nucleolus, Chromosome, Chromatin fibers, nucleolus, solenoid model, heterochromatin and euchromatin, Cell cycle, mitosis and meiosis; Spindle organization, Synaptonemal complex, crossing over, mechanism and cytological proof. Genes and evolution of species, Karyotype, Genetic Code, Gene Expression and its regulation, Genome analysis, Structural and Numerical chromosomal aberration, Chromosome engineering, Heterosis. Domestication, plant introduction and acclimatization, Selection and hybridization, Selfing and crossing, Cytoplasmic male sterility, Hybrid seed production, Mutant breeding, Polyploidy in plant breeding.
4. Structure and forms of DNA, DNA Replication, Mutation, Gene Recombination, Recombinant DNA technology, Tissue and Organ Culture: Micropropagation, somaclonal variation, haploid production, protoplast culture and somatic hybridization.
5. Probability, Measures of central tendency, Measures of dispersion, Test of significance, Analysis of variance, Correlation and Regression.