

SCHEME AND SYLLABUS FOR RECRUITMENT TO THE POST OF RANGE FOREST OFFICERS IN JHARKHAND

The Competitive examination shall comprise

(A) The written examination consisting of the following papers -

PART-A: COMPULSORY PAPERS:		
(i) General English	50 Marks	100 Marks (QUALIFYING)
(ii) General Hindi	50 Marks	
(iii) General Studies	100 Marks	100 Marks
OPTIONAL SUBJECT: (One optional subject with two papers)		
(i) Paper I	200 Marks	400 Marks
(ii) Paper II	200 Marks	
PART-B: Interview (Oral Test)	50 Marks	50 Marks
	550 Marks	550 Marks

List of Optional subjects :-

- (1) Agriculture
- (2) Agriculture Engineering
- (3) Veterinary Science & Animal Husbandry
- (4) Botany
- (5) Chemistry
- (6) Civil Engineering
- (7) Mechanical Engineering
- (8) Chemical Engineering
- (9) Forestry
- (10) Geology
- (11) Mathematics
- (12) Physics
- (13) Statistics
- (14) Zoology
- (15) Environmental Science

3. The standard of papers in General English, General Knowledge and Basic Mathematics will be Such as may be expected of a Science or Engineering Graduate of an Indian University.
4. The scope of the- Syllabus for optional subject papers for the examination is broadly of the Bachelor Degree level. In the case of engineering subjects, the level also corresponds to the Bachelor degree.
5. There will be no practical examination in any of the subjects.

Syllabus

Paper-I

General English: marks : 50

1. Essay writing - 10 marks
2. Comprehension - 20 marks
3. Grammar - 20 marks

General Hindi: : marks : 50

Maximum marks :100

1. Essay - 20 marks
2. Precis - 10 marks
3. Grammar - 20 marks

Paper-II

General Knowledge

Maximum marks: 100

Scope and coverage

- (1) **Current events:** Significant State (Jharkhand), National and International events, personalities (State (Jharkhand), Indian and International) in news, including sports events and personalities.
- (2) **History of India:** Ancient, medieval and recent history including the Indian national movement, its social, economic and political aspects including the nature and character of the 19th century resurgence, growth of nationalism and attainment of independence.
- (3) **Geography:** The earth, its shape and size, latitudes and longitudes, ocean currents and tides, atmosphere and its composition including physical, social and economic geography of India; its climate, vegetation, natural resources, location and distribution of agricultural and industrial activities with special reference to Jharkhand.
- (4) **Indian Polity:** The country's political system and Constitution of India, covering broadly its frame work, main features, different organs of Government and their functioning at the Centre, State and local levels including Panchayati Raj institutions, Fundamental rights, Fundamental duties and Directive principles of state policy, Functioning of Indian democracy and elections.

(5) **Indian Economy:** Economic developments in India, basic foundation of the economy, features and sectors of Indian economy, process of planning and five year plans, markets and State controls, process of liberalization and globalisation, inflation, poverty and unemployment.

(6) History, Geography, Economy and culture of Jharkhand

(7) **General Science and environmental issues:** General appreciation and understanding of science and environment including matters of every day observation and experience. current environmental issues.

Paper-III

OPTIONAL SUBJECTS

Total number of question in the question papers of optional subject will be eight. Out of eight questions, five questions are to be attempted. Each question will carry equal marks.

For each paper Maximum marks: 200

Note:- Candidates shall take up any one subject from the following list of subjects:-

(1) AGRICULTURE

Paper I

Agronomy and its scope, seeds and sowing, tillage and tilth, crop density and geometry, Crop nutrition, manures and fertilizers, nutrient use efficiency, water resources, soil plant water relationship, crop water requirement, water use efficiency, irrigation- scheduling criteria and methods, quality of irrigation water, water logging. Weeds- importance, classification, crop weed competition, concepts of weed management-principles and methods,.

Soil as a natural body, Pedological and edaphological concepts of soil; Soil genesis: soil forming rocks and minerals; weathering, processes and factors of soil formation; Soil Profile, components of soil; Soil physical properties: soil-texture, structure, density and porosity, soil colour, consistence and plasticity; Elementary knowledge of soil taxonomy classification and soils of India; Soil water retention soil organisms: macro and micro organisms, their beneficial and harmful effects; Soil pollution - behaviour of pesticides and inorganic contaminants, prevention and mitigation of soil pollution.

Seed and seed technology, introduction, definition and importance. Deterioration causes of crop varieties and their control, Maintenance of genetic purity during seed production, seed quality; Definition, Characters of good quality seed, different classes of seed.

Weeds and their ecology-control measure, integrated weed management, irrigations method and water use efficiency, water requirement of field crops.

Soil as medium of plant growth and its composition, mineral and organic constituents of the soil and their role in crop production; chemical, physical and microbiological properties of soils. Essential plant nutrients (macro and micro) their functions, occurrence, cycling in soils. Principles of soil fertility and its evaluation for judicious fertilizer use. Organic manures and bio- fertilizers, inorganic fertilizers, integrated nutrient management.

Principles of plant physiology with reference to plant nutrition, absorption, translocation and metabolism of nutrients. Diagnosis of nutrient deficiencies and their amelioration, photosynthesis and respiration, growth and development, auxins and hormones in plant growth.

Paper-II

Cell Theory, Cell structure, cell organelles and their function, Cell division, Reproductive cycle, law of heredity and their significance in plant breeding. Chromosome structure, Principles of genetics, gene-interaction, sex determination, linkage and re-combination, mutation.

Historical development, concept, nature and role of plant breeding, major achievements and future prospects; Genetics in relation to plant breeding, Genetic basis and breeding methods in self-pollinated crops-mass and pure line selection, hybridization techniques and handling of segregating population.

Physiology and its significance in agriculture. Imbibitions, surface tension, diffusion and osmosis. Absorption and translocation of water, transpiration and water economy, enzymes and plant pigments.

Diseases and pests, Causes and classification of plant pests and diseases. Principle of control of plant pests and diseases. Biological control of pests and diseases. Proper use and maintenance of plant protection equipment. Principles of economics as applied to agriculture. Farm planning and optimum resource-use efficiency and maximizing income and employment. Farming systems and their special distribution, their significant roles in regional economic development.

(2) Agricultural Engineering
Paper-I

1. Soil and Water Conservation : Scope of soil and water conservation. Mechanics and types of erosion, their causes. Rainfall, runoff and sedimentation relationships and their measurement. Soil erosion control measures - biological and engineering including stream bank protection-vegetative barriers, contour bunds, contour trenches, contour stone walls, contour ditches, terraces, outlets and grassed waterways. Gully control structures - temporary and permanent - design of permanent soil conservation structures such as chute, drop and drop inlet spillways. Design of farm ponds and percolation ponds. Principles of flood control-flood routing. Watershed Management - investigation, planning and implementation - selection of priority areas and water shed work plan, water harvesting and moisture conservation. Land development - levelling, estimation of earth volumes and costing. Wind Erosion process - design of shelter belts and wind brakes and their management. Forest (Conservation) Act,

2. Aerial Photography and Remote Sensing : Basic characteristics of photographic images, interpretation keys, equipment for interpretation, imagery interpretation for land use, geology, soil and forestry.

Remote sensing - merits and demerits of conventional and remote sensing approaches. Types of satellite images, fundamentals of satellite image interpretation, techniques of visual and digital interpretations for soil, water and land use management. Use of GIS in planning and development of watersheds, forests including forest cover, water resources etc.

3. Irrigation and Drainage : Sources of water for irrigation. Planning and design of minor irrigation projects. Techniques of measuring soil moisture - laboratory and in situ, Soil-water plant relationships. Water requirement of crops. Planning conjunctive use of surface and ground water. Measurement of irrigation water, measuring devices - orifices, weirs and flumes. Methods of irrigation - surface, sprinkler and drip, fertigation. Irrigation efficiencies and their estimation. Design and construction of canals, field channels, underground pipelines, head-gates, diversion boxes and structures for road crossing.

Occurrence of ground water, hydraulics of wells, types of wells (tube wells and open wells) and their construction. Well development and testing. Pumps-types, selection and installation. Rehabilitation of sick and failed wells.

Drainage causes of waterlogging and salt problem. Methods of drainage— drainage of irrigated and unirrigated lands, design of surface, sub-surface and vertical drainage systems. Improvement and utilization of poor quality water. Reclamation of saline and alkali soils. Economics of irrigation and drainage systems. Use of waste water for irrigation — standards of waste water for sustained irrigation, feasibility and economics.

4. Agricultural Structures : Site selection, design and construction of farmstead - farm house, cattle shed, dairy bam, poultry shed, hog housing, machinery and implement shed, storage structures for food grains, feed and forage. Design and construction of fences and farm roads. Structures for plant environment - green houses, poly houses and shade houses. Common building materials used in construction - timber, brick, stone, tiles, concrete etc and their properties. Water supply, drainage and sanitation system.

Paper-II

1. Farm Power and Machinery : Agricultural mechanization and its scope. Sources of farm power - animate and electro-mechanical. Thermodynamics, construction and working of internal combustion engines. Fuel, ignition, lubrication, cooling and governing system of IC engines. Different types of tractors and power tillers. Power transmission, ground drive, power take off (p.t.o.) and control systems. Operation and maintenance of farm machinery for primary and secondary tillage. Traction theory. Sowing transplanting and interculture implements and tools. Plant protection equipment - spraying and dusting. Harvesting, threshing and combining equipment. Machinery for earth moving and land development - methods and cost estimation. Ergonomics of man-machine system. Machinery for horticulture and agro-forestry, feeds and forages. Haulage of agricultural and forest produce.

2. Agro-energy : Energy requirements of agricultural operations and agro-processing. Selection, installation, safety and maintenance of electric motors for agricultural applications. Solar (thermal and photovoltaic), wind and bio-gas energy and their utilization in agriculture. Gasification of biomass for running IC engines and for electric power generation. Energy efficient cooking stoves and alternate cooking fuels. Distribution of electricity for agricultural and agro-industrial applications.

3. Agricultural Process Engineering : Post harvest technology of crops and its scope. Engineering properties of agricultural produces and by-products. Unit operations - cleaning grading, size reduction, densification, concentration, drying/dehydration, evaporation, filtration, freezing and packaging of agricultural produces and by-products. Material handling equipment - belt and screw conveyors, bucket elevators, their capacity and power requirement.

Processing of milk and dairy products - homogenization, cream separation, pasteurization, sterilization, spray and roller drying, butter making, ice cream, cheese and shrikhand manufacture. Waste and by-product utilization - rice husk, rice bran, sugarcane bagasse, plant residues and coir pith.

4. Instrumentation and computer applications in Agricultural Engineering : Electronic devices and their characteristics - rectifiers, amplifiers, oscillators, multivibrators. Digital circuits — sequential and combinational system. Application of microprocessors in data acquisition and control of agricultural engineering processes- measurement systems for level, flow, strain, force, torque, power, pressure, vacuum and temperature. Computers — introduction, input/output devices, central processing unit, memory devices, operating systems, processors, keyboards and printers. Algorithms, flowchart specification, programme translation and problem analysis in Agricultural Engineering. Multimedia and Audio-Visual aids.

(3) VETERINARY SCIENCE & ANIMAL HUSBANDRY

PAPER-I

Animal Nutrition-Energy sources, energy, metabolism and requirements for maintenance and production of milk, meat, eggs and wool. Evaluation of feeds as sources of energy. Trends in protein nutrition: sources of protein metabolism and synthesis, protein quantity and quality in relation to requirements. Energy protein ratios in ration. Minerals in animal diet : Sources, functions, requirements and their relationship of the basic minerals nutrients including trace elements. Vitamins, Hormones and Growth Stimulating substances: Sources, functions, requirements and inter-relationship with minerals.

Animal Physiology : Growth and Animal Production : Prenatal and postnatal growth, maturation, growth curves, measures of growth, factors affecting growth, conformation, body composition, meat quality.

Milk Production and Reproduction and Digestion : Current status of hormonal control of mammary development, milk secretion and milk ejection. Male and Female reproduction organ, their components and function. Digestive organs and their functions.

Livestock Production and Management :

Commercial Dairy Farming-Comparison of dairy farming in India with advanced countries. Dairying under fixed farming and as a specialised farming, economic dairy farming, Starting of a dairy farm. Capital and land requirement, organisation of the dairy farm. Feeding and management of animals under drought, flood and other natural calamities.

Genetics and Animal Breeding : Mitosis and Meiosis; Mendelian inheritance; deviations to Mendelian genetics; Expression of genes; Linkage and crossing over; Sex determination, sex influenced and sex limited characters; Blood groups and polymorphism; Chromosome aberrations; Gene and its structure; DNA as a genetic material; Genetic code and protein synthesis; Recombinant DNA technology, Mutations, types of mutations, methods for detecting mutations and mutation rate.

Breeding Systems : Heritability, repeatability and genetic and phenotypic correlations, their methods of estimation and precision of estimates; Aids to selection and their relative merits; Individual, pedigree, family and within family selection; Progeny testing; Methods of selection; Construction of selection indices and their uses; Comparative evaluation of genetic gains through various selection methods; Indirect selection and Correlated response; Inbreeding, upgrading, cross-breeding and synthesis of breeds; Crossing of inbred lines for commercial production; Selection for general and specific combining ability; Breeding for threshold character.

Paper II

Health and Hygiene

Histology and Histological Techniques : Stains-Chemical classification of stains used in biological work-principles of staining tissues-mordants-progressive & regressive stains-differential staining of cytoplasmic and connective tissue elements-Methods of preparation and processing of tissues-celloidin embedding-Freezing microtomy-Microscopy-Bright field microscope and electron microscope.

Embryology : Embryology of vertebrates with special reference to aves and domestic mammals.

Physiology of blood and its circulation, respiration; excretion, Endocrine glands in health and disease.

Blood constituents : Properties and functions-blood cell formation-Haemoglobin synthesis and chemistry-plasma proteins production, classification and properties; coagulation of blood;

Circulation: Physiology of heart, cardiac cycle-heart sounds, heartbeat, electrocardiograms. **Respiration:** Mechanism of respiration, Transport and exchange of gases, neural control of respiration-chemo receptors-hypoxia-respiration in birds.

Excretion: Structure and function of kidney-formation of urine methods of studying renal function-renal regulation of acid-base balance;

Endocrine glands: Functional disorders, their symptoms and diagnosis. Synthesis of hormones, mechanism and control of secretion-hormonal receptors classification and function.

Animal Diseases: Pathogenesis, symptoms, postmortem lesions, diagnosis, and control of infectious diseases of cattle, pigs and poultry, horses, sheep and goats. Etiology, symptoms, diagnosis, treatment of production diseases of cattle, pig and poultry. Deficiency diseases of domestic animals and birds. Diagnosis and treatment of nonspecific condition like impaction, Bloat, Diarrhoea, Indigestion, dehydration, stroke, poisoning. Diagnosis and treatment of neurological disorders. Principles and methods of immunization of animals against specific diseases-hard immunity-disease free zones-'zero' disease concept-chemoprophylaxis.

Veterinary Public Health

Zoonoses: Classification, definition; role of animals and birds in prevalence and transmission of zoonotic diseases occupational zoonotic diseases.

(4) BOTANY

Paper-I:

Cell Biology: Structure and function of cell wall (extracellular matrix or ECM), cell membrane and cell organelles, Nucleus, nucleolus, nuclear pore complex (NPC), chromosome and nucleosome, Mitosis, meiosis, molecular control involving check-points in cell division cycle. Differentiation, cellular senescence.

Genetics, Molecular Biology and Biotechnology: Laws of inheritance. Concept of gene and allelomorph. Linkage crossing over and gene mapping. Structural and numerical changes in chromosomes and gene mutations. Sex determination and differentiation. Structure and synthesis of nucleic acids and proteins. Genetic code. Regulation of gene expression. Genetic engineering and crop improvement. Protoplast, cell, tissue and organ cultures. Somatic hybridization. Biofertilizers and biopesticides. Biotechnology in agri-horticulture, medicine and industry.

Tissue Systems: Origin, development, structure and function of primary and secondary tissue.

Plant Diversity and Systematics: Structure and function of plant forms from evolutionary aspects (viruses to Angiosperms including fossils. Principles of nomenclature, classification and identification of plants. Modern approaches in plant Taxonomy. Recent classification of living organism into three groups (bacteria, archaea and eukarya).

Plant Physiology: Water relations. Mineral nutrition. Photosynthesis. Respiration. Nitrogen metabolism. Enzymes and coenzymes. Dynamics of growth, growth movements, growth substances, photomorphogenesis. Secondary metabolites. Isotopes in biological studies. Physiology of flowering.

Paper-II:

Methods of Reproduction and Seed Biology: Vegetative, asexual and sexual methods of reproduction. Pollination and fertilization. Sexual incompatibility. Development, structure, dormancy and germination of seed.

Microbiology and Plant Pathology :Viruses,bacteria and plasmids-structure and reproduction. General account of infection, Phytoimmunology.Applications of microbiology in agriculture,industry,medicine and pollution control in air, soil and water.

Important plant diseases caused by viruses, bacteria, mycoplasma, fungi and nematodes. Mode of infection and dissemination .Molecular basis of infection and disease resistance/defence. Physiology of parasitism and control measures .Fungal toxins.

Plant and Environment: Biotic and abiotic components. Ecological adaptation.Types of vegetational zones and forests of India.Deforestation, afforestation, social forestry and plant introduction. Soil erosion, wasteland, reclamation. Environmental pollution and its control (including phytoremediation).Bio-indicators.Global warming.

Biodiversity, plant Genetic Resources:Methods of conservation of plant genetic resources and its importance. Convention of Biological Diversity (CBD).Endangered, threatened and endemic taxa.Role of cell/tissue culture in propagation and enrichment of genetic diversity. Plants as sources of food, fodder, forage, fibres, oils, drugs, wood and timber, paper, rubber, beverages, spices, essential oils and resins, gums, dyes, insecticides, pesticides and ornamentation. Biomass as a source of energy.

Ecology and Plant Geography :Ecological factors. Concepts and dynamics of community.Plantsuccession.Concepts of biosphere.Ecosystems and their conservation.Pollution and its control (including Phytoremediation).

(5) CHEMISTRY

Paper-I

(Physical Chemistry + Inorganic Chemistry)

Gaseous state: Deviation of real gases from the equation of state for an ideal gas, Vander Waals and Virial equation of state, critical phenomena, principle of corresponding states, equation for reduced state.

Thermodynamics: Thermodynamic systems, states and processes, work, heat and internal energy: first law of thermodynamics, work done, heat change, Change in internal energy and entropy in different types of processes. Limitations of First law. Second law of thermodynamics: entropy as state function, entropy changes with respect to pressure, volume and temperature, entropy changes in reversible and irreversible processes. Free energy functions, variation with respect to state variables. Criteria for equilibrium and spontaneity.Relation between equilibrium constant and thermodynamic quantities.

Atomic Structure and periodic table: Bohr's theory of atomic structure, de Broglie hypothesis, Heisenberg's uncertainty principle, quantum numbers, shapes of s, p, and d orbitals. Pauli's exclusion principle, Hund's rule, electronic configuration of elements up to atomic number 30. Classification of elements into s,p,d& f blocks. Atomic radii, ionisation energy, electron affinity and electronegativity-definition and their variation along a Period and in a Group.d and f block elements, Electronic configuration,oxidation states, colour, magnetic properties, complexation, lanthanide contraction.

Chemical bonding: Ionic bond, characteristics of ionic compounds, factors effecting stability of ionic compounds, lattice energy, Born-Haber cycle: Covalent bond: hybridization of orbitals (sp, sp and sp²), G and Tt bonds- general characteristics, polarities of bonds in molecules and dipole moments. Valence bond theory: concept of resonance and resonance energy. Molecular orbital theory (LCAO) method, bonding in H₂, He₂, O₂, N₂, NO, CO and HIF, bond energy and bond strength.

Co-ordination and Bio-inorganic Chemistry: Definition of complex ions, ligands and co-ordination number, types of ligands. IUPAC nomenclature of co-ordination compounds. Isomerism in co-ordination compounds. Stereochemistry of complexes with 4 and 6 co-ordination numbers. Stability of complexes: stability constant and factors influencing stability. Valence bond and Crystal field theories of bonding. Spectrochemical series.

Metal ions in biological systems: essential and non-essential metals, oxygen uptake proteins, haemoglobin and myoglobin and nitrogen fixation.

Paper-II

Chemical kinetics, Surface phenomena and Catalysis: Concentration dependence of rate of reaction, differential and integral equations for first and second order reactions. Parallel, consecutive and chain reactions. Effect of temperature on rate constant. Theories of reaction rates- Collision and Transition State theories. Surface phenomena: adsorption: types, adsorption isotherms- Freundlich and Langmuir. Catalysis: types and characteristics of catalysis. Half-life of a reaction. General methods for determination of order of a reaction. Concept of activation energy and its calculation from Arrhenius equation. Theories of Reaction Rates: Collision theory and Activated Complex theory of bimolecular reactions.

Comparison of the two theories (qualitative treatment only).

Electrochemistry: Ions in solutions, ionic equilibria, dissociation constants of acids and bases, hydrolysis, pH and buffers, Conductance- specific, molar and equivalent, and variation of conductance with concentration. Ostwald dilution law and Kohlrausch law and their application. Electrochemical cells/ Galvanic cells, Nernst equation. measurement of cell e.m.f. Cell emf and its relation with thermodynamic quantities. Determination of pH and potentiometric titrations. Electrochemical series.

Basic organic chemistry: Classification of reagents and reactions: Electrophiles and nucleophiles. Homolytic and heterolytic fission of covalent bond. Reactive intermediates: Carbocations, carbanions and free radicals (generation, stability, reactions and geometry). Substitution, addition, elimination and rearrangement reactions. Electronic effects: Inductive, Mesomeric and Hyperconjugation effects. Hydrogen bonding and its effects, Mechanism of SN1, SN2, E1 and E2 reactions. Huckel's theory for aromaticity.

Mechanism of aromatic electrophilic substitution reactions (Nitration, halogenation, sulphonation and Friedel Craft's alkylation). Directive influence of groups already present in aromatic ring.

Mechanism and application of reactions: Cannizzaro, Beckmann, Benzoin, Aldol, Perkin, Reformatsky reactions & Arndt-Estert Synthesis.

Stereochemistry & Spectroscopy: Optical activity, chirality in organic molecules. D, L, and R. S notations. Fischer, Newman and Saw-horse formulae. Enantiomers and diastereomers. Racemization and resolution of racemic mixtures. Geometrical isomers: Geometrical isomerism in maleic & fumaric acids, aldoximes and mixed ketoximes, determination of their configurations. Syn & anti and E & Z notations.

Spectroscopy: Applications of IR, UV-Visible and NMR spectroscopy for structural elucidation of organic compounds.

Carbohydrates: Classification, Monosaccharides open and ring structures of Glucose and Fructose (Pyranose ring structures) Step-up and step down of aldoses and ketoses and their interconversion. Amino acids and proteins: Definition, classification and synthesis of amino acids. Zwitterion and isoelectric point. Peptide bond, synthesis of polypeptides. Proteins: Classification-Primary & Secondary structures.

Active methylene compounds: Diethyl malonate, and ethyl acetoacetate (preparation and applications in organic synthesis, tautomerism (keto-enol)).

(6) Civil Engineering

Paper-1

Fluid Mechanics : Fluid properties and their role in fluid motion, fluid statics including forces acting on plane and curve surfaces. Kinematics and Dynamics of Fluid flow : Velocity and accelerations, stream lines, equation of continuity, irrotational and rotational flow, velocity potential and stream functions, flownet, methods of drawing flownet, sources and sinks, flow separation, free and forced vortices. Control volume equation, continuity, momentum, energy and moment of momentum equations from control volume equation, Navier-Stokes equation, Euler's equation of motion, application to fluid flow problems, pipe flow, plane, curved, stationary and moving vanes, sluice gates, weirs, orifice meters and Venturi meters.

Dimensional Analysis and Similitude : Buckingham's Pi-theorem, dimensionless parameters, similitude theory, model laws, undistorted and distorted models.

Laminar Flow : Laminar flow between parallel, stationary and moving plates, flow through tube.

Boundary layer : Laminar and turbulent boundary layer on a flat plate, laminar sublayer, smooth and rough boundaries, drag and lift. Turbulent flow through pipes : Characteristics of turbulent flow, velocity distribution and variation of pipe friction factor, hydraulic grade line and total energy line, siphons, expansion and contractions in pipes, pipe networks, water hammer in pipes and surge tanks.

Open channel flow : Uniform and non-uniform flows, momentum and energy correction factors, specific energy and specific force, critical depth, resistance equations and variation of roughness coefficient, rapidly varied flow, flow in contractions, flow at sudden drop, hydraulic jump and its applications surges and waves, gradually varied flow, classification of surface profiles, control section, step method of integration of varied flow equation, moving surges and hydraulic bore.

Hydraulic Machines and Hydropower :

Centrifugal pumps—Types, characteristics, Net Positive Suction Height (NPSH), specific speed. Pumps in parallel. Reciprocating pumps, Airvessels, Hydraulic ram, efficiency parameters, Rotary and positive displacement pumps, diaphragm and jet pumps. Hydraulic turbines, types classification, Choice of turbines, performance parameters, controls, characteristics, specific speed. Principles of hydropower development. Type, layouts and Component works. Surge tanks, types and choice. Flow duration curves and dependable flow. Storage anpondage. Pumped storage plants. Special features of mini, micro-hydel plants. **Geo Technical Engineering** Types of soil, phase relationships, consistency limits particles size distribution, classifications of soil, structure and clay mineralogy. Capillary water and structural water, effective stress and pore water pressure, Darcy's Law, factors affecting permeability, determination of permeability, permeability of stratified soil deposits. Seepage pressure, quick sand condition, compressibility and consolidation, Terzaghi's theory of one dimensional consolidation, consolidation test. Compaction of soil, field control of compaction. Total stress and effective stress parameters, pore pressure coefficients. Shear strength of soils, Mohr Coulomb failure theory, Shear tests. Earth pressure at rest, active and passive pressures, Rankine's theory, Coulomb's wedge theory, earth pressure on retaining wall, sheetpile walls, Braced excavation. Bearing capacity, Terzaghi and other important theories, net and gross bearing pressure. Immediate and consolidation settlement. Stability of slope, Total Stress and Effective Stress methods, Conventional methods of slices, stability number. Subsurface exploration, methods of boring, sampling, penetration tests, pressure meter tests. Essential features of foundation, types of foundation, design criteria, choice of type of foundation, stress distribution in soils, Boussinessq's theory, Newmarks's chart, pressure bulb, contact pressure, applicability of different bearing capacity theories, evaluation of bearing capacity from field tests, allowable bearing capacity, Settlement analysis, allowable settlement. Proportioning of footing, isolated and combined footings, rafts, buoyancy rafts, Pile foundation, types of piles, pile capacity, static and dynamic analysis, design of

pile groups, pile load test, settlement of piles, lateral capacity. Foundation for Bridges. Ground improvement techniques—preloading, sand drains, stone column, grouting, soil stabilisation.

Paper –II

Construction Technology, Equipment, Planning and Management

Construction Technology : Engineering Materials : Physical properties of construction materials : Stones, Bricks and Tiles; Lime, Cement and Surkhi Mortars; Lime Concrete and Cement Concrete, Properties of freshly mixed and hardened concrete, Flooring Tiles, use of ferro-cement, fibre-reinforced and polymer concrete, high strength concrete and light weight concrete. Timber : Properties and uses; defects in timber; seasoning and preservation of timber. Plastics, rubber and damp-proofing materials, termite proofing, Materials, for Low cost housing.

Construction : Building components and their functions; Brick masonry : Bonds, jointing. Stone masonry. Design of Brick masonry walls as per I.S. codes, factors of safety, serviceability and strength requirements; plastering, pointing. Types of Floors & Roofs. Ventilators, Repairs in buildings.

Functional planning of building : Building orientation, circulation, grouping of areas, privacy concept and design of energy efficient building; provisions of National Building Code. Building estimates and specifications; Cost of works; valuation. 2. Construction Equipment : Standard and special types of equipment, Preventive maintenance and repair, factors affecting the selection of equipment, economical life, time and motion study, capital and maintenance cost. Concreting equipments, Earth-work equipment

Construction Planning and Management : Construction activity, schedules, job layout, bar charts, organization of contracting firms, project control and supervision. Cost reduction measures.

New-work analysis : CPM and PERT analysis, Float Times, cashing of activities, contraction of network for cost optimization, up dating, Cost analysis and resource allocation.

Survey and Transportation Engineering

Survey : Common methods of distance and angle measurements, plane table survey, levelling traverse survey, triangulation survey, corrections, and adjustments, contouring, topographical map. Surveying instruments for above purposes. Tacheometry. Circular and transition curves. Principles of photogrammetry.

Railways : Permanent way, sleepers, rail fastenings, ballast, points and crossings, design of turn outs, stations and yards, turntables, signals, and interlocking, level-crossing. Construction and maintenance of permanent ways : Superelevation, creep of rail, ruling gradient, track resistance, tractive effort, relaying of track.

Highway Engineering : Principles of highway planning, Highway alignments. Geometrical design : Cross section, camber, superelevation, horizontal and vertical curves. Classification of roads : low cost roads, flexible pavements, rigid pavements. Design of pavements and their construction, evaluation of pavement failure and strengthening. .

Traffic Engineering : Forecasting techniques, origin and destination survey, highway capacity. Channelised and unchannelised intersections, rotary design elements, markings, sign, signals, street lighting; Traffic surveys. Principle of highway financing.

Hydrology, Water Resources and Engineering :

Hydrology : Hydrological cycle, precipitation, evaporation, transpiration, depression storage, infiltration, overland flow, hydrograph, flood frequency analysis, flood estimation, flood routing through a reservoir, channel flow routing-Muskingam method.

Ground water flow : Specific yield, storage coefficient, coefficient of permeability, confined and unconfined aquifers, aquitards, radial flow into a well under confined and unconfined conditions, tube wells, pumping and recuperation tests, ground water potential.

Water Resources Engineering : Ground and surface water resource, single and multipurpose projects, storage capacity of reservoirs, reservoir losses, reservoir sedimentation, economics of water resources projects.

Irrigation Engineering : Water requirements of crops : consumptive use, quality of water for irrigation, duty and delta, irrigation methods and their efficiencies. Canals : Distribution systems for canal irrigation, canal capacity, canal losses, alignment of main and distributory canals, most efficient section, lined canals, their design, regime theory, critical shear stress, bed load, local and suspended load transport, cost analysis of lined and unlined canals, drainage behind lining. Water logging : causes and control, drainage system design, salinity. Canal structures : Design of cross regulators, head regulators, canal falls, aqueducts, metering flumes and canal outlets. Diversion head work : Principles and design of weirs of permeable and impermeable foundation, Khosla's theory, energy dissipation, stilling basin, sediment excluders. Storage works : Types of dams, design, principles of rigid gravity and earth dams, stability analysis, foundation treatment, joints and galleries, control of seepage. Spillways : Spillway types, crest gates, energy dissipation. River training : Objectives of river training, methods of river training.

Environmental Engineering

Water Supply : Estimation of surface and subsurface water resources, predicting demand for water, impurities, of water and their significance, physical, chemical and bacteriological analysis, waterborne diseases, standards for potable water.

Intake of water : pumping and gravity schemes. **Water treatment** : principles of coagulation, flocculation and sedimentation; slow-; rapid-, pressure-, filters; chlorination, softening, removal of taste, odour and salinity.

Water storage and distribution : storage and balancing reservoirs : types, location and capacity. Distribution system : layout, hydraulics of pipe lines, pipe fittings, valves including check and pressure reducing valves, meters, analysis of distribution systems, leak detection, maintenance of distribution systems, pumping stations and their operations.

Sewage systems : Domestic and industrial wastes, storm sewage—separate and combined systems, flow through sewers, design of sewers, sewer appurtenances, manholes, inlets, junctions, siphon. Plumbing in public buildings.

Sewage characterisation : BOD, COD, solids, dissolved oxygen, nitrogen and TOC. Standards of disposal in normal water course and on land.

Sewage treatment : Working principles, units, chambers, sedimentation tanks, trickling filters, oxidation ponds, activated sludge process, septic tank, disposal of sludge, recycling of waste water.

Environmental pollution : Sustainable development. Radioactive wastes and disposal. Environmental impact assessment for thermal power plants, mines, river valley projects. Air pollution. Pollution control acts.

(7) Mechanical Engineering

Paper-I

Theory of Machines

Kinematic and dynamic analysis of planar mechanisms. Cams, Gears and gear trains, Flywheels, Governors, Balancing of rigid rotors, Balancing of single and multicylinder engines, Linear vibration analysis of mechanical systems (single degree and two degrees of freedom), Critical speeds and whirling of shafts, Automatic Controls, Belts and chain drives. Hydrodynamic bearings.

Mechanics of Solids

Concept of Stress - Tension and Compression- pure shear – uni-axial stress and strain, Hooke's Law, Stress-strain diagrams for brittle and ductile materials, elastic constant, Relation between elastic constants - Strain energy in tension and compression - Impact loading, Statically Indeterminate structure, Thermal stress, Biaxial stress and strain, stress at a point, stress transformation, analysis of strain, strain displacement relation, strain transformation, strain measurement, Principal stress and strains, Mohr's Circle of stress and strain. Theory of Simple Bending: Assumptions - Bending stresses in beams - Efficiency of various cross sections - Composite beams. Strain energy in bending, Statically Indeterminate problem. Unsymmetrical Bending, bending of curved bars. Shear Stress

Distribution: Flexural shear stress distribution in different cross sections of beams. Shear Centre. Torsion of Circular cross sections: Theory of pure torsion - transmission of power through solid and hollow circular shafts. Compound shaft, Tapered shaft, statically indeterminate problem, strain energy in torsion, closed coiled spring - Combined Loading: Bending, axial, shear and torsion. Deflection of Beams: Slope and deflection of beams - Double Integration method - Macaulay's method - moment area method- conjugate beam method-strain energy method. Thin and Thick cylinders and Spheres: Stresses in Thin shell, Thick shell, Compound cylinders Introduction to Theory of Failure, Euler's theory of long column, Rankin-Gordon formula, Empirical Formulae, Eccentrically loaded columns.

Design of Machine Elements

Introduction: Engineering materials and their properties, manufacturing considerations in machine design. Simple stresses in machine parts, Torsional and bending stresses, Dynamic loads, different couplings. Design of pressure vessels and pipe joints. Design of keys, couplings, shafts, levers, columns, studs, and power screw, cotter joint, knuckle joints. Design of Belt drives, pulleys, springs, clutches and brakes.

Manufacturing Processes -

Introduction to metal casting processes: Casting terms, Sand mould making procedure, Composition of moulding sand and its different properties, Advantages and limitations of casting processes, Application of casting process. Patterns, Materials, Allowances in patterns, Types of patterns, Pattern color code, Gating and riser design, Melting furnaces, Casting defects. Special casting techniques - Shell mould casting, Investment casting, Die casting and its variants, Centrifugal casting and its variants, Continuous casting. Introduction to Metal forming processes: Classification of metal forming processes, Plastic deformation and Yield criteria, Hot and Cold working, Forging, Rolling, Extrusion, Wire drawing, Sheet metal operations. Classification of joining processes, Types of joints and welding positions, Welding heat sources and their characteristics. Various welding processes: Electric arc welding, Gas welding, Resistance welding, Solid state welding processes, Electron beam welding and Laser beam welding, Metallurgical characteristics of welded joints, Welding defects, Weld testing and Inspection.

PAPER-II

1. THERMODYNAMICS :

Basic concept. Open and closed systems, Applications of Thermodynamic Laws, Gas equations, Clapeyron equation, Availability, Irreversibility and Tds relations.

2. I.C. Engines, Fuels and Combustion :

Spark Ignition and compression ignition engines, Four stroke engine and Two stroke engines, mechanical, thermal and volumetric efficiency, Heat balance. Combustion process in S.I. and C.I. engines, pre-ignition detonation in S.I. engine Diesel knock in C.I. engine. Choice of engine fuels, Octane and Cetane ratings. Alternate fuels Carburation and Fuel injection, Engine emissions and control. Solid, liquid and gaseous fuels, stoichiometric air requirements and excess air factor, fuel gas analysis, higher and lower calorific values and their measurements.

3. Heat and Mass Transfer Introduction: basic concepts and models, Relationship to thermodynamics. Conduction mechanism: Fourier's generation conduction equation in 3-D, 1-D study state conduction with heat generation, Composite plane wall and cylinders, Thermal resistance network, Critical Thickness of Insulations, Extended surface heat transfer 2-D steady state conduction: Solutions for simple boundary conditions, Un-steady heat conduction: Lumped parameters systems, semi-infinite wall with convection boundary conditions, use of Heisler chart. Convection: Review of hydrodynamics equations of boundary layer theory, velocity and thermal boundary layers, laminar boundary layer analysis on flat plates. Fully developed heat transfer through a smooth pipes, relation between fluid friction and heat transfer, turbulent boundary layers, forced convection correlations. Free convection: Laminar free convection on a vertical flat plate, empirical

co-relations. Boiling and condensation: Mechanism, Laminar film condensation on a vertical plate. Heat Exchangers: Types analysis, LMTD, effectiveness-NTU method. Radiation: Physical mechanism, radiation properties, black body radiation, grey body, spectra dependence of radiation properties, Kirchoff's Law, Wien's displacement law, View factor, radiation exchange between infinite planes, and between grey bodies, radiation shields, reradiating surface and 3- surface encloses, network representations. Fick's law of diffusion coefficient, analogy between heat and mass transfer.

4. TURBO-MACHINES AND POWER PLANTS :

Continuity, momentum and Energy Equations. Adiabatic and Isentropic flow, Fanno lines, Rayleigh lines. Theory and design of axial flow turbines and compressors, Flow through turbo-machine blade, cascades, centrifugal compressor. Dimensional analysis and modelling. Selection of site for steam, hydro, nuclear and stand-by power plants, selection base and peak load power plants Modern High pressure, High duty boilers, Draft and dust removal equipment, Fuel and cooling water systems, heat balance, station and plant heat rates, operation and maintenance of various power plants, preventive maintenance, economics of power generation. Thermodynamic SI Unit, Definitions & Concepts: System, Property, Energy, Thermodynamic Equilibrium, Work interaction & various modes of work, Heat, State Postulate; Zeroth Law of Thermodynamics, Temperature Scale. Thermodynamic Properties of Fluids: Pure substance, Phase of substances, Molecular models of matter, Phase change processes in pure substance, Graphical representation of phase change processes.

(8) CHEMICAL ENGINEERING

PAPER-I

- (a) **Fluid and Particle Dynamics** -Viscosity of fluids. Laminar and turbulent flows. Equation of continuity and Navier-Stokes equation-Bernoulli's theorem. Flow meters. Fluid drag and pressure drop due to friction, Reynold's Number and friction factor - effect of pipe roughness. Economic pipe diameter. Pumps, water, air/steam jet ejectors, compressors, blowers and fans. Agitation and mixing of liquids. Mixing of solids and pastes. Crushing and Grinding - principles and equipment. Rittinger's and Bond's laws. Filtration and filtration equipment. Fluid-particle mechanics - free and hindered settling. Fluidisation and minimum fluidization velocity, concepts of compressible and incompressible flow. Transport of Solids.
- (b) **Mass Transfer** -Molecular diffusion coefficients, First and second law and diffusion, mass transfer coefficients, film and penetration theories of mass transfer. Distillation, simple distillation, relative volatility, fractional distillation, plate and packed columns for distillation. Calculation of theoretical number of plates. Liquid-liquid equilibria. Extraction - theory and practice; Design of gas-absorption columns. Drying. Humidification, dehumidification. Crystallisation. Design of equipment.
- (c) **Heat Transfer** - Conduction, thermal conductivity, extended surface heat transfer. Convection - free and forced. Heat transfer coefficients - Nusselt Number. LMTD and effectiveness. NTU methods for the design of Double Pipe and Shell & Tube Heat Exchangers. Analogy between heat and momentum transfer. Boiling and condensation heat transfer. Single and multiple-effect evaporators. Radiation - Stefan-Boltzman Law, emissivity and absorptivity. Calculation of heat load of a furnace. Solar heaters.
- (d) **Novel Separation Processes** -Equilibrium separation processes - ion-exchange, osmosis, electro-dialysis, reverse osmosis, ultra-filtration and other membrane processes. Molecular distillation. super critical fluid extraction.

- (e) **Process Equipment Design** - Factors affecting vessel design criteria - Cost considerations. Design of storage vessels-vertical, horizontal spherical, underground tanks for atmospheric and higher pressure. Design of closures flat and elliptical head. Design of supports. Materials of construction-characteristics and selection.
- (f) **Process Dynamics and Control** - Measuring instruments for process variables like level, pressure, flow, temperature pH and concentration with indication in visual/pneumatic/analog/digital signal forms. Control variable, manipulative variable and load variables. Linear control theory-Laplace, transforms. PID controllers. Block diagram representation transient and frequency response, stability of closed loop system. Advanced control strategies. Computer based process control.

Paper -II

- (a) **Material and Energy Balances** - Material and energy balance calculations in processes with recycle/bypass/purge. Combustion of solid/liquid/gaseous fuels, stoichiometric relationships and excess air requirements. Adiabatic flame temperature.
- (b) **Chemical Engineering Thermodynamics** - Laws of thermodynamics. PVT relationships for pure components and mixtures. Energy functions and inter-relationships - Maxwell's relations. Fugacity, activity and chemical potential. Vapour-liquid equilibria, for ideal/non-ideal, single and multi component systems. Criteria for chemical reaction equilibrium, equilibrium constant and equilibrium conversions. Thermodynamic cycles - refrigeration and power.
- (c) **Chemical Reaction Engineering** - Batch reactors - kinetics of homogeneous reactions and interpretation of kinetic data. Ideal flow reactors - CSTR, plug flow reactors and their performance equations. Temperature effects and run-away reactions. Heterogeneous reactions - catalytic and non-catalytic and gas-solid and gas-liquid reactions. Intrinsic kinetics and global rate concept. Importance of interphase and in traparticle mass transfer on performance. Effectiveness factor. Isothermal and non-isothermal reactors and reactor stability.
- (d) **Chemical Technology** - Natural organic products - Wood and wood-based chemicals, pulp and paper, Agro industries - sugar, Edible oils extraction (including tree based seeds), Soaps and detergents. Essential oils - Biomass gasification (including biogas). Coal and coal chemical. Petroleum and Natural gas-Petroleum refining (Atmospheric distillation/cracking/reforming) - Petrochemical industries - Polyethylenes (LDPE/HDPE/LLDPE), Polyvinyl Chloride, Polystyrene. Ammonia manufacture. Cement and lime industries. Paints and varnishes. Glass and ceramics. Fermentation - alcohol and antibiotics.
- (e) **Environmental Engineering and Safety** - Ecology and Environment. Sources of pollutants in air and water. Green house effect, ozone layer depletion, acid rain. Micrometeorology and dispersion of pollutants in environment. Measurement techniques of pollutant levels and their control strategies. Solid wastes, their hazards and their disposal techniques. Design and performance analysis of pollution control equipment. Fire and explosion hazards rating - HAZOP and HAZAN. Emergency planning, disaster management. Environmental legislations - water, air environment protection Acts. Forest (Conservation) Act.
- (f) **Process Engineering Economics** - Fixed and working capital requirement for a process industry and estimation methods. Cost estimation and comparison of alternatives. Net present value by discounted cash flow. Pay back analysis. IRR, Depreciation, taxes and insurance. Break-even point analysis. Project scheduling - PERT and CPM. Profit and loss account, balance sheet and financial statement. Plant location and plant layout including piping.

- (g) **Fluid and Particle Dynamics-** Viscosity of fluids. Laminar and turbulent flows. Equation of continuity and Navier- Stokes equation- Bernoulli's theorem. Flow meters. Fluid drag and pressure drop due to friction, Reynold's Number and friction factor - effect of pipe roughness. Economic pipe diameter. Pumps, water, air/steam jet ejectors, compressors, blowers and fans. Agitation and mixing of liquids. Mixing of solids and pastes. Crushing and Grinding - principles and equipment. Rittinger's and Bond's laws. Filtration and filtration equipment. Fluid-particle mechanics - free and hindered settling. Fluidisation and minimum fluidization velocity, concepts of compressible and incompressible flow. Transport of Solids.
- (h) **Mass Transfer-** Molecular diffusion coefficients, First and second law and diffusion, mass transfer coefficients, film and penetration theories of mass transfer. Distillation, simple distillation, relative volatility, fractional distillation, plate and packed columns for distillation. Calculation of theoretical number of plates. Liquid-liquid equilibria. Extraction - theory and practice; Design of gas-absorption columns. Drying. Humidification, dehumidification. Crystallisation. Design of equipment.
- (i) **Heat Transfer-** Conduction, thermal conductivity, extended surface heat transfer. Convection - free and forced. Heat transfer coefficients - Nusselt Number. LMTD and effectiveness. NTU methods for the design of Double Pipe and Shell & Tube Heat Exchangers. Analogy between heat and momentum transfer. Boiling and condensation heat transfer. Single and multiple-effect evaporators. Radiation - Stefan- Boltzman Law, emissivity and absorptivity. Calculation of heat load of a furnace. Solar heaters.
- (j) **Novel Separation Processes-** Equilibrium separation processes - ion-exchange, osmosis, electro-dialysis, reverse osmosis, ultra-filtration and other membrane processes. Molecular distillation. super critical fluid extraction.
- (k) **Process Equipment Design-** Factors affecting vessel design criteria - Cost considerations. Design of storage vessels-vertical, horizontal spherical, underground tanks for atmospheric and higher pressure. Design of closures flat and elliptical head. Design of supports. Materials of construction-characteristics and selection.
- (l) **Process Dynamics and Control**
Measuring instruments for process variables like level, pressure, flow, temperature pH and concentration with indication in visual/pneumatic/analog/digital signal forms. Control variable, manipulative variable and load variables. Linear control theory- Laplace, transforms. PID controllers. Block diagram representation transient and frequency response, stability of closed loop system. Advanced control strategies. Computer based process control.

(9) **FORESTRY**

PAPER-1:

Forests - definitions, role, benefits - direct and indirect. History of Forestry - definitions, divisions and interrelationships. Classification of forests - High forests, coppice forests, virgin forest and second growth forests, pure and mixed forests - even and uneven aged stands. Forest types of India-classification. Agroforestry - farm forestry, social forestry, joint forest management concepts, programmes and objectives. Important acts and policies related to Indian forests. Global warming - forestry options for mitigation and adaptation - carbon sequestration. Important events/dates related to forests and environment - themes and philosophy

Silviculture General: General Silvicultural Principles: Ecological and physiological factors influencing vegetation, natural and artificial regeneration of forests; methods of propagation, grafting techniques; site factors; nursery and planting techniques -nursery beds, polybags, root trainers and

maintenance, grading and hardening of seedlings. Tending operations special approaches; establishment and tending.

Silviculture - systems: Clear felling, uniform shelter wood selection, coppice and conversion systems. Management of silviculture systems of temperate, subtropical, humid tropical, dry tropical and coastal tropical forests with special reference to plantation silviculture, choice of species, establishment and management of standards, enrichment methods, technical constraints, intensive mechanized methods, aerial seeding thinning.: Mangrove Habitat and - characteristics, mangrove, plantation-establishment and rehabilitation of degraded man grove formations; silvicultural systems for mangrove; protection of habitats against natural disasters. Cold Desert Characteristics, identification and management of species.

Silviculture of trees: Origin, distribution, general description, phenology, silvicultural characters, regeneration methods, silvicultural systems, standmanagement practices pest and diseases and economic importance of the following tree species of India. Broadleaved species: *Tectonagrandis*, *Shorea robusta*, *Dalbergialatifolia*, *Dalbergiasissoo*, *Anogeissus spp*, *Terminalia spp.*, *Santalum album*, *Swieteniamacrophylla*, *Albiziaspp*, *Pterocarpusmarsupium*, *Gmelinaarborea*, *Pterocarpussantalinus*, *Azadirachta indica*, *Hopeaparviflora*, *Lagerstroemia microcarpa*, Bamboos, reeds and rattan, *Quercus spp*. Conifers: *Abiespindrow*, *Piceasmithiana*, *Cedrusdeodara*, *Pinusroxburghii*, *Pinuswallichiana*. Fast growing MPTs: Tropical pines, *Eucalyptus spp*, *Casuarinaequisetifolia*, *Leucaenaleucocephala*, *Ailanthustriphysa*, *Grevillea robusta*, *Pongamiapinnata*, *Meliadubia*, *Acacia spp*, *Populus spp*.

Agroforestry, Social Forestry, Joint Forest Management and Tribology: Agroforestry-Scope and necessity; role in the life of people and domestic animals and in integrated land use, planning especially related to (i) soil and water conservation; (ii) water recharge; (iii) nutrient availability to crops; (iv) nature and eco-system preservation including ecological balances through pest-predator relationships and (v) providing opportunities for enhancing biodiversity, medicinal and other flora and fauna. Agroforestry systems under different agro-ecological zones; selection of species and role of multipurpose trees and NTEPS techniques, food fodder and fuel security. Research and Extension needs. Social/Urban Forestry: Objectives, scope and necessity: peoples participation. JFM: Principles, objective, methodology, scope, benefits and role of NGOs. Tribology tribal science in India; tribes, concept of races, principles of social grouping, stages of tribal economy, education, cultural tradition, customs, ethos and participation in forestry programmes.

Forest Soils, Soil Conservation and Watershed management: forest soils vs. cultivated soils, special features of forest soils, forest soil formation and vegetation development. Pedogenic processes – Podzolization and Laterization. Properties of soils under different forest ecosystems. Forest floor – stratification– types of humus. Essential nutrient elements-occurrence, availability and their functions. Diagnosis of nutrient deficiencies-visual symptoms, soil fertility evaluation methods. Site productivity and nutrient cycling in forest soils. N, P and K, macro and micronutrient fertilizers and their uses. Forest soil biology-distribution of various microorganisms in soil ecosystem and their interaction effects.

Role of microorganisms in soil fertility. Mineral transformations-carbon cycle with reference to organic matter decomposition and humus formation, Microbial degradation of cellulose & lignin. Bio-fertilizers – their importance. Nitrogen fixation-Rhizobium-tree legume symbiosis, Frankia X non-legume symbiosis, asymbiotic and associative N₂ fixation. Nitrification and denitrification in forest ecosystems. Microbial transformation of phosphorous, sulphur, and micronutrients. Mycorrhizae: types, biology and importance with specific relevance to tree crops and mobilization of phosphorus and micro-nutrients. Rhizosphere and phyllosphere concept. Fertility management of forest soils. Integrated nutrient management in plantation forestry.. Watershed Management: Concepts of watershed; role of mini-forests and forest trees in overall resource management, forest hydrology, water shed development in respect of torrent control, river channel stabilization, avalanche and landslide controls, rehabilitation of degraded areas; hilly and mountain areas; watershed management and environmental functions of forests; Water -

harvesting and conservation; ground water recharge and watershed management, role of integrating forest trees, horticultural crops, field crops, grass and fodders.

Environmental Conservation and Biodiversity: Environment: Components and importance, principles of conservation, impact of deforestation; forest fires and various human activities like mining, construction and developmental projects, population growth on environment. Pollution: Types, global warming, green house effects, ozone layer depletion, acid rain, impact and control measures, environmental monitoring: concept of sustainable development. Role of trees and forests in environmental conservation; control and prevention of air, water and noise pollution. Environmental policy and legislation in India. Environmental Impact Assessment. Economics assessment of watershed development vis-a-vis ecological and environmental protection.

Tree Improvement and seed Technology: Introduction – history and development of tree improvement – its relation to other disciplines of forestry. Reproduction in forest trees. Anthesis and pollination – their importance in tree breeding. Incompatibility and sterility. Quantitative inheritance. Relevance in forestry. Genetic, environmental and interaction components of variation - heritability and genetic advance, Importance of seed in present day forestry, seed and fruit development, seed dispersal.

Planning seed collection - Collection of immature fruits - Methods of seed collection. Fruit and seed handling - maintaining viability and identity - special precautions for recalcitrant seeds. Seed processing - operations prior to extraction - pre-cleaning, methods of extraction - operations after extraction - cleaning, grading and control of moisture level - factors affecting drying of orthodox seeds. Types of forest nursery, types of nursery beds, preparation of beds, fumigation. Methods of seed sowing and mulching, seedling growth and development, pricking, weeding, hoeing, rotation, organic matter supplements and cover crops, mycorrhizae, fertilization, shading, pruning, root culturing techniques, lifting windows, grading, packaging

PAPER II:

FOREST MANAGEMENT

Definition, scope, objective and principles of forest management, organization of state forests - sustained yield - definition, principles and limitations. Sustainable forest management - criteria and indicators - Increasing and progressive yields - Rotation - definitions - various types of rotations - length of rotations - choice of type and kind of rotation. Normal forest - definitions basic factors of normality. Factors governing the yield and growth of forest stands - Working plan - preparations - objectives and uses - forest maps and their uses. Joint forest management - concept and principles - Modern tools in forest management. Introduction to the concept of forestry as a common property resource - Definition, Scope and necessity of community forestry - Forests and man - Forestry in support to agriculture, animal husbandry and horticulture - development of cottage industry in rural environment - NFP 1988 and the importance of people in forest conservation. Community forest management, Community forest development, social economical and environmental aspects, Community forest development through NGOs, civil societies, citizen groups - Gender dimensions in Community forest management. Social Forestry - definition - NCA report of 1976 - need and purpose - Social Forestry for - fodder production - fuel wood - leaf manure - timber production. Integrated rural development approach - with proper marketing facility - employment generation in raising, tending and harvesting of tree crops. Place of social forestry in the national forest policy of India - role of forest department.

Forest Working Plan: Forest planning, evaluation and monitoring tools and approaches for integrated planning; multipurpose development of forest resources and forest industries development; working plans and working schemes, their role in nature conservation, bio-diversity and other dimensions; preparation and control. Divisional working Plans, Annual Plan of Operations.

Forest Mensuration and Remote Sensing: Methods of measuring-diameter, girth, height and volume of trees; form-factor; volumes estimation of stand, current annual increment; mean annual increment. Sampling methods and sample plots. Yield calculation; yield and stand tables, forest cover monitoring through remote sensing: Geographic Information Systems for management and modeling. 4. Surveying and Forest Engineering: Forest surveying-different methods of surveying, maps and map reading. Basic principles of forest engineering. Building materials and construction. Roads and Bridges, General principles, objects, types, simple design and construction of timber bridges.

Forest Ecology and Ethnobotany: Biotic and abiotic components, forest ecosystems; forest community concepts, vegetation concepts, ecological succession and climax, primary productivity, nutrient cycling and water relations; physiology in stress environments (drought, water logging salinity and alkalinity). Forest types in India, identification of species, composition and associations; dendrology; taxonomic classification, principles and establishment of herbaria and arboreta. Conservation of forest ecosystems. Clonal parks. Role of Ethnobotany in Indian Systems of Medicine; Ayurveda and Unani - Introduction, nomenclature, habit, distribution and botanical features of medicinal and aromatic plants. Factors affecting action and toxicity of drug plants and their chemical constituents.

Forest Resources and Utilization: Environmentally sound forest harvesting practices; logging and extraction techniques and principles, transportation system, storage and sale; Non-Timber forest Products (NTFPs) definition and scope; gums, resins, oleoresins, fibres, oil seeds nuts, rubber, canes, bamboos, medicinal plants, charcoal, lac and shellac, Katha and Bidi leaves, collection; processing and disposal. Need and importance of wood seasoning and preservation; general principles of seasoning, air and kiln seasoning, solar dehumidification, steam heated and electrical kilns. Composite wood; adhesives-manufacture, properties, uses, plywood manufacture properties, uses, fibre boards manufacture properties, uses, particle boards manufacture, properties uses. Present status of composite wood industry in India in future expansion plans. Pulp-paper and rayon; present position of supply of raw material to industry, wood substitution, utilization of plantation wood; problems and possibilities. Anatomical structure of wood, defects and abnormalities of wood, timber identification-general principles.

Importance of protection in Indian Forestry – classification of injurious agencies. Injury to forest due to fires, causes and character of forest fires – fire prevention activity– fire suppression – fire fighting equipments – fire control policy and objectives. Fire fighting in other countries. Injury to forest due to man, lopping – cutting for fuel wood

Encroachment-different types, control of encroachment illegal felling of trees- method of control legislation. Forest weeds and weed management, management of woody climbers, parasites and epiphytes. Importance of Forest Pathology, tree disease classification, Principles of tree disease management, - Causes and symptoms- losses due to forest tree diseases, root diseases (wilt, root-and butt rot), stem diseases (heart rots, stem blisters, rusts, stem wilt, cankers, pink diseases, gummosis, water blister) and foliar diseases (rust, powdery mildew, leaf spot, leaf and twig blight, abnormal leaf fall, needle blight etc.) Etiology, symptoms, mode of spread, epidemiology and management, including chemical, biological, cultural and

silvicultural practices. Nursery diseases and their management. Disease due to physiological causes. Abiotic diseases. Forest Entomology in India. Methods and principles of pest control: Mechanical, physical, silvicultural, legal, biological and chemical.

Principles and techniques of Integrated Pest Management in forests. Classification of forest pests: types of damages and symptoms; factors for outbreak of pests. Nature of damage and management: Insect pests of forest seeds, forest nursery and standing trees of timber yielding species of natural forest and Plantation forest species. Insect pests of freshly felled trees, finished timbers and their management.

Forest Economics and Legislation: Forest economics: Fundamental principles, cost-benefit analyses; estimation of demand and supply; analysis of trends in the national and international market and changes in production and consumption patterns; assessment and projection of market structures; role of private sector and co-operatives; role of corporate financing. Socio-economic analyses of forest productivity and attitudes; valuation of forest goods and service.

Legislation: History of forest development; Indian Forest policy of 1894, 1952 and 1990. National Forest Policy, 1988 of people's involvement, Joint Forest management, involvement of women; Forestry Policies and issues related to land use, timber and non-timber products, sustainable forest management; industrialisation policies; institutional and structural changes. Decentralization and forestry Public Administration. Forest laws, necessity; general principles, Indian Forest Act 1927; Forest Conservation Act, 1980; wildlife protection Act 1972 and their amendments; Application of Indian Penal Code to Forestry. Scope and objectives of Forest inventory.

(10) GEOLOGY

Paper-I

General Geology : The Solar System, meteorites, origin and interior of the earth. Radioactivity and age of earth; Volcanoes-causes and products, volcanic belts. Earthquakes-causes, effects, earthquake belts, seismicity of India, intensity and magnitude, seismographs. Island arcs, deep sea trenches and mid-ocean ridges. Continental drift-evidences and mechanics; sea-floor spreading, plate tectonics. Isostasy, orogeny and epeirogeny. Continents and oceans.

Geomorphology and Remote Sensing: Basic concepts of geomorphology. Weathering and mass wasting. Landforms, slopes and drainage. Geomorphic cycles and their interpretation, Morphology and its relation to structures and lithology. Geomorphology of Indian sub-continent. Aerial photographs and their interpretation merits and limitations. The Electromagnetic Spectrum. Orbiting satellites and sensor systems. Indian Remote Sensing Satellites. Applications of remote sensing in geology. The Geographic Information System and its applications. Global Positioning System.

Structural and field Geology: Primary and secondary structures. Dip and strike of beds. Unconformities. Study of folds, joints, faults, foliation and lineations. Overthrusts and nappes structures. Solutions of simple problems by stereographic net. Topographic maps and their interpretation. Use of clinometer compass in the field. Measurements of bed, foliation, folds joints, faults and lineations in the field. Effects of topography on outcrops.

Stratigraphy and Geology of India: Fundamental laws of stratigraphy. Stratigraphic classification lithostratigraphic, biostratigraphic and chronostratigraphic. Geological time scale. Physiographic divisions and outline of stratigraphy of India. Brief study of Dharwar, Vindhyan and Gondwana Supergroups and Siwalik Group with reference to their major subdivisions, lithology, fossils, aerial distribution and economic importance.

Paleontology: Fossils and fossilization. Modes of preservation. Application of fossils, Study of morphology and geological history of Foraminifera, Brachiopoda, Lamellibranchia, Gastropoda, Cephalopoda, Trilobita. Mammals of Siwalik Group. A brief study of Gondwana flora.

Paper-II

Mineralogy: Physical, chemical and optical properties of the following common rock forming minerals: quartz, feldspar, mica, pyroxene, amphibole, olivine, garnet, chlorite, carbonates. Structure of silicates and crystal chemistry of minerals. Gemstones.

Crystallography: Elements of crystal structure. Laws of crystallography, Symmetry elements of normal classes of seven crystal systems. Petrological microscope and accessories. Construction and use of Nicole prism. Pleochroism, double refraction, extinction angle, birefringence and twinning in crystals, Isotropic, uniaxial and biaxial minerals.

Petrology: Igneous Petrology: Origin of magma and formation of igneous rocks..Bowen's reaction principle.Crystallisation of binary systems.Classification of igneous rocks.Textures and structures of igneous rocks.

Sedimentary Petrology: Sedimentary process and products. Classification of sedimentary rocks.Primary sedimentary structures.Clastic deposits - their classification, mineral composition and texture.

Metamorphic Petrology: Types and factors of metamorphism. Zones, grades and facies of metamorphism.Regional and contact metamorphism.Textures and structures of metamorphic rocks.

ECONOMIC GEOLOGY & HYDROLOGY-Concept of ore and ore deposits, ore minerals and gangue minerals; Tenor of ores;Metallic and non-metallic ore minerals; Strategic, Critical and essential minerals.Processes of formation of ore deposits; Magmatic, contact metasomatic, hydrothermal, sedimentation, Residual.Study of important metallic (Cu, Pb, Zn Mn, Fe, Au, Al) and non-metallic (industrial)minerals (gypsum, magnesite, mica).Distribution of coal and petroleum in India;

Definition of hydrogeology, Hydrological cycle;Hydrological parameters - Precipitation, evaporation, transpiration and infiltration.Origin of groundwater; Vertical distribution of groundwater; Types of aquifers;Water bearing properties of rocks - Porosity and Permeability; specific yield, specific retention.

Surface and subsurface geophysical and geological methods of ground water exploration; Groundwater provinces of India.

(11) MATHEMATICS

Paper-I

- 1. Algebra:** Division algorithm, Euclidean algorithm. Euclid's lemma, Notion of groups with examples, Residue classes, Formulation of groups, Elementary properties of groups, cancellation laws, Solvability of equations, Subgroups, cyclic group, order of an element. Cosets and Lagrange's theorem, Homomorphism and Isomorphism of groups, Normal Subgroup, Quotient subgroup, Fundamental theorem of homomorphism of groups.
- 2. Geometry and Vectors:** Analytic Geometry of straight lines and conics in Cartesian and Polar coordinates; Three Dimensional geometry for planes, straight lines, sphere, cone and cylinder. Addition, Subtraction and Products of Vectors and Simple applications to Geometry.
- 3. Calculus:** Functions, Sequences, Series, Limits, Continuity, Derivatives. Application of Derivatives: Rates of change, Tangents, Normals, Maxima & Minima, Rolle's Theorem, Mean value Theorems of Lagrange and Cauchy, Asymptotes, Curvature. Methods of finding indefinite integrals, Definite Integrals, Fundamental Theorem of integrals Calculus.Application of definite integrals to area, Length of a plane curve, Volume and Surfaces of revolution.

Paper II

- 1. Ordinary Differential Equations:** Formulation of differential equations, order and degree, equations of first order and first degree, integrating factor, equation of first order but not of first degree. Higher order linear equations, with constant coefficients, complementary function and particular integral, general solution.
- 2. Mechanics:** Concepts of particles-Lamina; Rigid body; Displacement; force, Mass; Weight; Motion, Velocity: Speed; Acceleration: Parallelogram of forces; Parallelogram of velocity, acceleration; resultant; equilibrium of coplanar forces; Moments; Couples; Friction; Centre of mass, Gravity: Laws of motion; Motion of a particle in a straight line; simple Harmonic motion: Motion under conservative forces; Motion under gravity; Projectile.

3. Vector Spaces and Matrices: Vector Space, Linear Dependence and Independence. Sub-spaces. Basis and Dimensions, Finite Dimensional Vector Spaces. Linear Transformation of a Finite dimensional vector Space, Matrix Representation. Singular and Nonsingular Transformations. Rank and nullity. **Matrices:** Definitions, Operations on Matrices, Matrix Algebra, Type of Matrices, Transpose, Adjoint and Inverse of a matrix, Solution of system of linear equations.

4. Probability and Statistics: Introduction to random variables (discrete and continuous), cumulative distribution function (c.d.f.), probability mass/density functions, joint p.d.f., joint p.m.f., marginal and conditional distributions, joint c.d.f. and its properties. Mathematical expectations, moments, moment generating function: limitations and properties, characteristic function. Discrete distributions: uniform, binomial & Poisson. Continuous distributions: uniform and normal. Properties of a Random Sample: Basic concepts of Random Sample, convergence in probability, almost sure convergence, convergence in distribution. Order statistics and their distributions. Events - space, Axiomatic foundation, Baye's theorem. Histogram, Mean, Median, Mode, Variance; Mathematical expectation of a set of data: Binomial, Normal poissonian distributions with simple examples.

(12) PHYSICS

Paper I

1. Mechanics and Waves: Vector algebra. Scalar and vector products. Derivatives of a vector with respect to a parameter. 1st order homogeneous differential equations. 2nd order homogeneous differential equations with constant coefficients. Frames of reference. Newton's Laws of motion. Dynamics of a system of particles. Centre of Mass. Conservation of momentum. Work and energy. Conservation of energy. Motion of rockets. Angular velocity and angular momentum. Torque. Conservation of angular momentum. Newton's Law of Gravitation. Motion of a particle in a central force field (motion is in a plane, angular momentum is conserved, areal velocity is constant). Kepler's Laws (statement only). Satellite in circular orbit and applications. Geosynchronous orbits. Basic idea of global positioning system (GPS). Weightlessness. Physiological effects on astronauts. Simple harmonic motion. Differential equation of SHM and its solutions. Kinetic and Potential Energy, Total Energy and their time averages. Damped oscillations. Hooke's law - Stress-strain diagram - Elastic moduli - Relation between elastic constants - Poisson's Ratio - Expression for Poisson's ratio in terms of elastic constants - Work done in stretching and work done in twisting a wire - Twisting couple on a cylinder - Determination of Rigidity modulus by static torsion - Torsional pendulum - Determination of Rigidity modulus and moment of inertia - q , η and σ by Searles method. Constancy of speed of light. Postulates of Special Theory of Relativity. Length contraction. Time dilation. Relativistic addition of velocity.

2. Geometrical and Physical Optics: Laws of reflection and refraction from Fermat's principle. thin lens formula, nodal planes, system of two thin lenses. Chromatic and spherical aberrations. Simple optical instruments - magnifier, eyepieces, telescopes and microscopes. Huygen's principle - reflection and refraction of waves. Interference of light - Young's experiment, Newton's rings, interference by thin films, Michelson interferometer. Fraunhofer diffraction - single slit, double slit, diffraction grating, resolving power. Fresnel diffraction - half-period zones and zone plate. Production and detection of linearly, circularly and elliptically polarized light. Double refraction, quarter waves plates and half-wave plates. Polarizing sheets. Optical activity and applications. Elements of fibre optics - attenuation; pulse dispersion in step index and parabolic index fibres; material dispersion. Lasers, characteristics of laser light - spatial and temporal coherence. Focusing of laser beams and applications.

3. Laws of Thermodynamics:

Zeroth Law of thermodynamics and temperature. First law and internal energy, conversion of heat into work, Various Thermodynamical Processes, Applications of First Law: General Relation between CP and CV, Work Done during Isothermal and Adiabatic Processes, Compressibility and Expansion Coefficient, Reversible and irreversible processes, Second law and Entropy, Carnot's

cycle & theorem, Entropy changes in reversible & irreversible processes, Entropy-temperature diagrams, Third law of thermodynamics, Unattainability of absolute zero.

Paper II

1. Electricity and Magnetism:

Electrostatic Field, electric flux, Gauss's theorem of electrostatics. Applications of Gauss theorem- Electric field due to point charge, infinite line of charge, uniformly charged spherical shell and solid sphere, plane charged sheet, charged conductor. Electric potential as line integral of electric field, potential due to a point charge, electric dipole, uniformly charged spherical shell and solid sphere. Calculation of electric field from potential. Capacitance of an isolated spherical conductor. Parallel plate, spherical and cylindrical condenser. Energy per unit volume in electrostatic field. Dielectric medium, Polarisation, Displacement vector. Gauss's theorem in dielectrics. Parallel plate capacitor completely filled with dielectric. Biot-Savart's law and its applications- straight conductor, circular coil, solenoid carrying current. Divergence and curl of magnetic field. Magnetic vector potential. Ampere's circuital law. Magnetic properties of materials: Magnetic intensity, magnetic induction, permeability, magnetic susceptibility. Brief introduction of dia-, para- and ferromagnetic materials. Faraday's laws of electromagnetic induction, Lenz's law, self and mutual inductance, L of single coil, M of two coils. Energy stored in magnetic field. Equation of continuity of current, Displacement current, Maxwell's equations, Poynting vector, energy density in electromagnetic field, electromagnetic wave propagation through vacuum and isotropic dielectric medium, transverse nature of EM waves, polarization.

2. Atomic Physics, Quantum theory, and Nuclear Physics: Photoelectric effect, Einstein's photon theory. Bohr's theory of hydrogen atom. Stern Gerlach experiment, quantisation of angular momentum, electron spin. Pauli exclusion principle and applications. Zeeman effect. X-ray spectrum. Bragg's law, Bohr's theory of the Mosley plot. Compton effect, Compton wavelength. Wave nature of matter, de Broglie wavelength, wave-particle duality. Heisenberg's uncertainty relationships. Schrodinger's equation-eigenvalues and eigenfunctions of (i) particle in a box, (ii) simple harmonic oscillator and (iii) hydrogen atom. Potential step and barrier penetration. Natural and artificial radioactivity. Binding energy of nuclei, nuclear fission and fusion. Classification of elementary particles and their interactions.

3. Electronics. qualitative ideas of semiconductors p type and n type semiconductors, junction diode, Diodes in half-waves and full-wave rectification Zener diode, transistors and its construction, working and characteristic, transistor as amplifier and oscillator binary numbers, Logic gates and truth tables, flip-flop, registers and counters.

4. Solid State Physics: Concept of crystal structure Bravais lattice, Crystal planes, Miller indices. Bragg's Law, Free-electron theory of metals, expression for electrical conductivity by Drude model. Specific Heat of solids. Dulong and Petit's law. Einstein's theory of Specific Heat of solid, band theory of solid. Distinction between metals, insulators and semiconductors.

(13) STATISTICS

Paper-I

Probability:

Random experiment, sample space, event, algebra of events, probability on a discrete sample space, basic theorems of probability and simple examples based theorem, conditional, probability of an event, independent events, Bayes's theorem and its application, discrete and continuous random variables and their distributions, expectation, moments, moment generating function, joint distribution of two or more random variables, marginal and conditional distributions, independence of random variables, covariance, correlation coefficient, distribution of a function of random variables. Bernoulli, binomial, geometric, negative binomial, hypergeometric, poisson, multinomial,

uniform, beta, exponential, gamma, cauchy, normal, longnormal and bivariate normal distributions, real-life situations where these distributions provide appropriate models, Chebyshev's inequality, weak law of large numbers and central limit theorem for independent and identically distributed random variables with finite variance and their simple applications.

Statistical Methods:

Concept of a statistical population and a sample, types of data, presentation and summarization of data, measures of central tendency, dispersion, skewness and kurtosis, measures of association and contingency, correlation, rank correlation, intraclass correlation, correlation ratio, simple and multiple linear regression, multiple and partial correlations (involving three variables only), curvefitting and principle of least squares, concepts of random sample, parameter and statistic.

Paper II

Statistical Inference:

Unbiasedness, consistency, efficiency, sufficiency, completeness, minimum variance unbiased estimation, Rao-Blackwell theorem, Lehmann-Scheffe theorem. Cramer- Rao inequality and minimum variance bound estimator, moments maximum likelihood, least squares and minimum chisquare methods of estimation, properties of maximum likelihood and other estimators, idea of a random interval, confidence intervals for the parameters of standard distributions, shortest confidence intervals, large-sample confidence intervals. Simple and composite hypotheses, two kinds of errors, level of significance, size and power of a test, desirable properties of a good test, most powerful test, Neyman-Pearson lemma and its use in simple example, uniformly most powerful test, likelihood ratio test and its properties and applications. Chi-square test.

Sampling Theory and Design of Experiments:

Complete enumeration vs. sampling, need for sampling, basic concepts in sampling, designing large-scale sample surveys, sampling and nonsampling errors, simple random sampling, properties of a good estimator, estimation of sample size, stratified random sampling, systematic sampling cluster sampling, ratio and regression methods of estimation under simple and stratified random sampling, double sampling for ratio and regression methods of estimation, two-stage sampling with equal-size first-stage units. Analysis of variance with equal number of observations per cell in one, two and three-way classifications, analysis of covariance in one and two-way classifications, completely randomized design, randomized block design, latin square design, missing plot technique, 2n factorial design, total and partial confounding, 32 factorial experiments, split-plot design and balanced incomplete block design.

(14) ZOOLOGY

PAPER-1

1. Cell structure and function:

- (a) Prokaryote and eukaryote
- (b) Structure of animal cell, structure and functions of cell organelles.
- (c) Cell cycle-mitosis, meiosis.
- (d) Structure and contents of nucleus including nuclear membrane, structure of chromosome and gene, chemistry of genetic components.
- (e) Mendel's laws of inheritance, linkage and genetic recombination; cytoplasmic inheritance.

- (f) Function of gene: replication, transcription and translation; mutations (spontaneous and artificial); Recombinant DNA; principle and application
- (g) Sex determination in *Drosophila* and man; sex linkage in man.

2 Systematics:

- (a) Classification of non-chordates (upto sub-classes) and chordates (up to orders) giving general features and evolutionary relationship of the following phyla: Protozoa, Porifera, Coelenterata, Platyhelminthes, Nematelminthes, Annelida, Arthropoda, Mollusca, Echinodermata, Minor Phyla (Bryozoa, Phoronida and Chaetognatha) and Hemichordata.
- (b) Structure reproduction and life history of the following types: Amoeba, Monocystis, Plasmodium, Paramecium, Sycon, Hydra, Obelia, Fasciola, Taenia, Ascaris, Neanthes, Pheretima, Hirudina, Palaemon, Buthus, Periplaneta, Lamellidens, Pila, Asterias and Balanoglossus.
- (c) Classification of chordates (up to orders), giving general features and evolutionary relationship of the following: Protochordata; Agnatha; Gnathostomata-Pisces, Amphibia, Reptilia, Aves and Mammalia.
- (d) Comparative functional anatomy of the following based on type animals (*Scoliodon*, *Rana*, *Calotes*, *Columba* and *Oryctolagus*): integument and its derivatives, endoskeleton, digestive system, respiratory system, circulator system including heart and aortic arches, urinogenital system; brain and sense organs (eye and ear); endocrine glands and other hormone producing structures, (Pituitary, thyroid, parathyroid, adrenal, pancreas, gonads) their function.

3. Vertebrate Physiology and Biochemistry:

- (a) Chemical composition of protoplasm; nature and function of enzymes; vitamins, their sources and role; colloids and hydrogen ion concentration; biological oxidation, electron transport and role of ATP, enegetics, glycolysis, citric acid cycle; vertebrate hormones; their type, sources and function; pheromones and their role.
- (b) Neuron and nerve impulse-conduction and transmission across synapses; neurotransmitters and their role, including acetyl cholinesterase activity.
- (c) Homeostasis; osmoregulation; active transport and ion pump. d) Composition of carbohydrates, fats, lipids and proteins; steroids.

PAPER II

1. Embryology:

- (a) Gametogenesis, fertilization, cleavage; gastrulation in frog and chick
- (b) Metamorphosis in frog and retrogressive metamorphosis in ascidian; extra-embryonic membranes in chick and mammal; placentation in mammals; Bio-genetic law, in-vitro fertilization (IVF), sperm bank, surrogate mother, cloning.

2. Evolution:

- (a) Origin of life; principles, theories and evidences of evolution; species concept.
- (b) Zoogeographical realms, insular fauna; geological eras. c) Evolution of man; evolutionary status of man.

Evolutionary Theories- Lamarckism, Darwinism, Neo-Darwinism.

3. Ecology, Wildlife and Ethology:

- (a) Abiotic and biotic factors; concept of ecosystem, food chain and energy flow; adaptation of aquatic, terrestrial and aerial fauna; intra-and inter-specific animal relationships; environmental pollution: Air pollution, Water pollution, Soil pollution, Sound pollution and Radiation with regard to Source, Causes(effects) prevention and control; Types, sources, causes, control and prevention.
- (b) Wildlife of India; endangered species of India; sanctuaries and national parks of India.
- (c) Biological rhythms.

4. Economic Zoology:

Apiculture,sericulture,lacculture,carp culture, pearl culture,prawn culture.

Major infectious and communicable diseases (small pox,plague,malaria,tuberculosis,cholera and AIDS) their vectors , pathogens and prevention.

Cattle and livestock diseases,their pathogens (helminthes)and vectors (ticks,mites,Tabanus,Stomoxys).

Pests of sugarcane (Pyrillaperpusiella) oil seed (Achaea Janata) and rice (Sitophilusoryzae).

(15) ENVIRONMENTAL SCIENCE

PAPER-1:

Fundamentals of Environment: Concept of environment hydrosphere, lithosphere, atmosphere and biosphere; impact of man and environment; period of hunting and food gathering; period of plant and animal domestication; period of science, technology and industrialization.

Ecosystem: Concept, components, food chain and food web, energy flow and productivity in ecosystem, nutrient cycle in ecosystem, types of ecosystems (forest, grassland, desert, aquatic, marine) and their problems, ecological imbalance.

Natural Resources and their management: Water, land, forest, minerals, soil, agriculture, wildlife and energy resources status and their proper management/conservation; non-conventional resources.

Environmental Pollution: Cause, effect and prevention of air, water, soil, thermal, noise and marine pollution,and hazardous wastes : socio-economic consequences of pollution in urban, industrial and rural areas of India.

PAPER-II:

Global Environmental Problems:Green house effect, acid rain, El-nino, Ozone layer depletion, deforestation, desertification, salinization, habitat and diversity loss. chemical and radiation hazards (Chernobyl disaster, Bhopal tragedy etc.) and their management. Environment Laws: Environment Protection Act; Air (Prevention & Control of Pollution)Act; Water (Prevention and control of Pollution) Act; Wildlife Protection Act; Forest Conservation Act.

Environment and Public Health: Major water, food and air-borne diseases of menand animals, civic sense and personal hygiene issues, health hazards in agricultural pest control, heavy metal toxicity.

Environmental Monitoring and Impact Assessment:BioindicatorsandMonitoring; environmental impact assessment and management, safe limits of the key environmental pollutants.

Waste Management and Bioremediation: Treatment of waste water, solid wastemanagement, management of persistent organic pollutants, Silent valley project, theGanga action plan, cost effective abatement technology.

The Environment Protection Laws and Human Rights: Sustainable development environmental policies, environmental ethics, human rights issues relating to environment human population growth and lifestyle, HIV/AIDS, Mission LiFE .