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

SCHEME

WRITTEN EXAMINATION (OBJECTIVE TYPE) BACHELOR’S DEGREE STANDARD

**PART-A: COMPULSORY PAPERS:**

<table>
<thead>
<tr>
<th>Paper</th>
<th>Marks</th>
<th>Questions</th>
<th>Time</th>
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<tbody>
<tr>
<td>i) General Studies</td>
<td>150</td>
<td>150</td>
<td>150 minutes</td>
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<tr>
<td>ii) General English</td>
<td>100</td>
<td>100</td>
<td>100 minutes</td>
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<tr>
<td>iii) Mathematics (SSC (High school) standard)</td>
<td>150</td>
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<td>150 minutes</td>
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**OPTIONAL SUBJECT:** (One optional subject only)

<table>
<thead>
<tr>
<th>Subject</th>
<th>Marks</th>
<th>Questions</th>
<th>Time</th>
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<tr>
<td>Optional Subject (1 only)</td>
<td>200</td>
<td>200</td>
<td>180 minutes</td>
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**PART-B:** Interview (Oral Test) 70 Marks

**List of Optional Subjects:**

The candidates have to choose one optional subject from the following:

<table>
<thead>
<tr>
<th>01. Agriculture</th>
<th>08. Geology</th>
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<tbody>
<tr>
<td>02. Agricultural Engineering</td>
<td>09. Horticulture</td>
</tr>
<tr>
<td>03. Botany</td>
<td>10. Mathematics</td>
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<tr>
<td>04. Chemistry</td>
<td>11. Mechanical Engineering</td>
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<td>05. Chemical Engineering</td>
<td>12. Physics</td>
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<td>06. Civil Engineering</td>
<td>13. Statistics</td>
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<td>07. Forestry</td>
<td>14. Zoology</td>
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**Proviso:** Provided that the candidates will not be allowed to offer the following combination of subjects:

1. Agriculture and Agricultural Engineering
2. Chemistry and Chemical Engineering
3. Mathematics and Statistics
4. Not more than one Engineering subject among the Engineering subjects.
5. Agriculture and Horticulture

**N.B.:**

1. After written examination, eligible candidates will be called for interview (Oral test) at the ratio of 1:3 category-wise, duly following the special representation as laid down in General Rule 22 of State and Subordinate Service Rules.
2. A candidate will be required to undergo a walking test and also a Medical Examination (conducted by a Medical Board) before he/she is finally called for interview. Both the tests shall be arranged by the Forest Department, duly taking concurrence of A.P.P.S.C..
3. Appearance at all the above tests is compulsory for eligibility of candidature for Interview. Absence at any or all of the papers will render the candidature invalid.
4. The minimum qualifying Marks for Interview and selection are 40% for OCs; 35% for BCs and 30% for SC&ST.
5. The candidates belonging to SCs/STs/BCs may be called for interview by relaxing the minimum qualifying marks at the discretion of the Commission, if the Commission is of the opinion that sufficient number of candidates from these communities are not likely to come-up for Interview.
SYLLABUS

(i) GENERAL STUDIES

1. General Science – Contemporary developments in Science and Technology and their implications including matters of every day observation and experience, as may be expected of a well-educated person who has not made a special study of any scientific discipline.

2. Current events of national and international importance.

3. History of India – emphasis will be on broad general understanding of the subject in its social, economic, cultural and political aspects with a focus on AP Indian National Movement.

4. World Geography and Geography of India with a focus on AP.

5. Indian polity and Economy – including the country’s political system- rural development – Planning and economic reforms in India.

(ii) GENERAL ENGLISH

a) Comprehension
b) Usage and idiom
c) Vocabulary and punctuation
d) Logical re-arrangement of sentences

(iii) MATHEMATICS


ALGEBRA: Basic Operations, simple factors, Remainder Theorem, H.C.F., L.C.M. Theory of polynomials, solutions of quadratic equations, relation between its roots and coefficients (Only real roots to be considered). Simultaneous linear equations in two unknowns – analytical and Graphical solutions. Simultaneous linear inequations in two variables and their solutions. Practical problems leading to two simultaneous linear equations or inequations in two variables or quadratic equations in one variable and their solutions. Set language and set notation, Rational expressions and conditional identities, laws of indices.

TRIGONOMETRY: Sine x, Cosine x, Tangent x when O° ≤ x ≤ 90° values of sin x, cos x and tan x, for x= O°, 30°, 45°, 60° and 90°. Simple trigonometric identities. Use of trigonometric tables. Simple cases of heights and distances.


MENSURATION: Areas of squares, rectangles, parallelograms, triangle and circle. Areas of figures which can be split up into these figures (Field Book), Surface area and volume of cuboids, lateral surface and volume of right circular cones and cylinders, surface area and volume of spheres.

STATISTICS: Collection and tabulation of statistical data, Graphical representation frequency polygons, histograms, bar charts, pie charts etc. Measures of central tendency.
OPTIONAL SUBJECTS

01. AGRICULTURE

Agriculture, its importance in National economy. Factors determining agro-ecological zones and geographic distribution of crop plants. Importance of crop plants, cultural practices for cereal, pulses, oilseed, fibre, sugar, tuber and fodder crops and scientific basis for these crop-rotations, multiple and relay cropping, intercropping and mixed cropping.


Principles of economics as applied to agriculture. Farm planning and optimum resource-use efficiency and maximizing income and employment. Farm systems and their spatial distribution, their significant roles in regional economic development.

02. AGRICULTURAL ENGINEERING

01. Soil Science +soil physics +soil mechanics

02. Agronomy +Agricultural Extension + Agricultural Economics

03. Heat and mass transfer +Refrigeration and Air conditioning

04. Unit operations in Agricultural process Engineering

05. Process Engineering for Agricultural produce starting from crop threshing and upto storage of crops

06. Process Engineering for horticulture produce + dairy Engineering

07. Strength of materials and theory of structures

08. Electrical Engineering and farm electrification

09. Alternate energy sources

10. Thermodynamics-heat engines and farm power

11. Farm machinery and equipment

12. Instrumentation-design of Agricultural machines-Industrial Engineering

13. Land development machinery

14. Surveying and levelling

15. Open channels-wells and pumps

16. Irrigation + drainage + sprinkler and drip systems

17. Soil and water conservation + soil conservation structures.
03. BOTANY

1. **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.


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

4. **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).


7. **Plant Pathology:** Diseases of rice, wheat, sugarcane, potato, mustard, groundnut and cotton crops. Factors affecting infection (host factors, pathogen factors, biotic factors like rhizosphere and phyllosphere organisms). Chemical, biological and genetic methods of disease control (including transgenic plants).


10. **Origin of Life and Evolution:** Basic concept of origin of earth and origin of life. Theories of organic evolution, molecular basis of evolution.
SECTION-A: (INORGANIC CHEMISTRY):

1.1 Atomic structure: Schrödinger wave equation, significance of \( \Psi \) and \( \Psi^2 \) quantum numbers and their significance, radial and angular probability, shapes of orbitals, relative energies of atomic orbitals as a function of atomic number. Electronic configurations of elements; Aufbau principle, Hund’s multiplicity rule, Pauli exclusion principle.

1.2 Chemical periodicity: Periodic classification of elements, salient characteristics of s,p,d and f block elements. Periodic trends of atomic radii, ionic radii, ionization potential, electron affinity and electronegativity in the periodic table.

1.3 Chemical bonding: Types of bonding, overlap of atomic orbitals, sigma and pi-bonds, hydrogen and metallic bonds. Shapes of molecules bond order, bond length, V.S.E.P.R. theory and bond angles. The concept of hybridization and shapes of molecules and ions.

1.4 Oxidation states and oxidation number: Oxidation and reduction, oxidation numbers, common redox reactions, ionic equations. Balancing of equations for oxidation and reduction reactions.

1.5 Acids and bases: Bronsted and Lewis theories of acids and bases. Hard and soft acids and bases. HSAB principle, relative strengths of acids and bases and the effect of substituents and solvents on their strength.

1.6 Chemistry of elements:
   i) **Hydrogen**: Its unique position in the periodic table, isotopes, ortho and para hydrogen, industrial production, heavy water.
   ii) **Chemistry of ‘s’ and ‘p’ block elements**: Electronic configuration, general characteristics properties, inert pair effect, allotropy and catenation. Special emphasis on solutions of alkali and alkaline earth metals in liquid ammonia. Preparation, properties and structures of boric acid, borates, boron nitrides, borohydride (diborane), carboranes, oxides and oxyacids of nitrogen, phosphorous, sulphur and chlorine; interhalogen compounds, polyhalide ions, pseudohalogens, fluorocarbons and basic properties of halogens. Chemical reactivity of noble gases, preparation, structure and bonding of noble gas compounds.
   iii) **Chemistry of ‘d’ block elements**: Transition metals including lanthanides, general characteristic properties, oxidation states, magnetic behaviour, colour. First row transition metals and general properties of their compounds (oxides, halides and sulphides); lanthanide contraction.

1.7 Extraction of metals: Principles of extraction of metals as illustrated by sodium, magnesium, aluminum, iron, nickel, copper, silver and gold.

1.8 Nuclear Chemistry: Nuclear reactions; mass defect and binding energy, nuclear fission and fusion. Nuclear reactors; radioisotopes and their applications.

1.9 Coordination compounds: Nomenclature, isomerism and theories of coordination compounds and their role in nature and medicine.

1.10 Pollution and its control: Air pollution, types of air pollution, control of air and water pollution, radioactive pollution.

SECTION-B: (ORGANIC CHEMISTRY):

2.1 Bonding and shapes of organic molecules: Electronegativity, electron displacements-inductive, mesomeric and hyperconjugative effects; bond polarity and bond polarizability, dipole moments of organic molecules; hydrogen bond; effects of solvent and structure on dissociation constants of acids and bases; bond formation, fission of covalent bonds; homolysis and heterolysis; reaction intermediates-carbocations, carbanions, free radicals and carbenes; generation geometry and stability; nucleophiles and electrophiles.

2.2 Chemistry of aliphatic compounds: Nomenclature alkanes-synthesis, reactions (free radical halogenation) – reactivity and selectivity, sulphonation-detergents; cycloalkanes-Baeyer’s strain theory; alkanes and alkynes-synthesis, electrohilic addition; reactions, Markownikov’s rule, peroxide effects, 1,3-dipolar addition; nucleophilic addition to electron-deficient alkenes; polymerization; relative acidity; synthesis and reactions of alkyl halides, alkanols, alkanals, alkanones, alkanolic acids, esters, amides, nitriles, amines, acid anhydrides, \( \alpha\beta \)-unsaturated ketones, ethers and nitro compounds.
2.3 **Stereochemistry of carbon compounds**: Elements of symmetry, chiral and achiral compounds. Fischer projection formulae; optical isomerism of lactic and tartaric acids, enantiomerism and diastereoisomerism; configuration (relative and absolute); conformations of alkanes up to four carbons, cyclohexane and dimethylcyclo-hexanes their potential energy $\text{D,L}$ and $\text{R,S}$ notations of compounds containing chiral centers; projection formulae-Fischer, Newman and sawhorse of compounds containing two adjacent chiral centers; meso and dl-isomers, erythro and threo isomers; racemization and resolution; examples of homotopic, enantiotopic and diastereotopic atoms and groups in organic compounds, geometrical isomers; $\text{E}$ and $\text{Z}$ notations. Stereo-chemistry of SN1, SN2, E1 and E2 reactions.

2.4 **Organometallic compounds**: Preparation and synthetic uses of Grignard reagents, alkyl lithium compounds.

2.5 **Active methylene compounds**: Diethyl malonate, ethyl acetoacetate. ethyl cyanoacetate-applications in organic synthesis; tautomerism (keto-enol).

2.6 **Chemistry of aromatic compounds**: Aromaticity; Hückel’s rule; electrophilic aromatic substitution-nitration, sulphonation, halogenation (nuclear and side chain), Friedel-Crafts alkylation and acylation, substituents effect; chemistry and reactivity of aromatic halides, phenols, nitro, diazo, diazonium and sulphonlic acid derivatives, benzene reactions.

2.7 **Chemistry of biomolecules**: (i) **Carbohydrates**: Classification, reactions, structure of glucose, D,L-configuration, osazone formation; fructose and sucrose; step-up step-down of aldoses and ketoses; and their interconversion, (ii) **Amino acids**: Essential amino acids; zwitterions, isoelectric point, polypeptides; proteins; methods of synthesis of $\alpha$-amino acids. (iii) Elementary idea of oils, fats, soaps and detergents.

2.8 Basic principles and applications of UV, visible, IR and NMR spectroscopy of simple organic molecules.

**SECTION-C: (PHYSICAL CHEMISTRY):**

3.1 **Gaseous state**: Deviation of real gases from the equation of state for an ideal gas, Vander Waals and Viril equation of state, critical phenomena, principle of corresponding states, equation for reduced state. Liquification of gases, distribution of molecular speed, collisions between molecules in a gas; mean free path, specific heat of gases.

3.2 **Thermodynamics**: (i) **First Law and its applications**: Thermodynamic systems, states and processes work, heat and internal energy, zeroth law of thermodynamics, various types of work done on a system in reversible and irreversible processes. Calorimetry and thermo-chemistry, enthalpy and enthalpy changes in various physical and chemical processes, Joule-Thomson effect, inversion temperature. Heat capacities and temperature dependence of enthalpy and energy changes.

(ii) **Second Law and its applications**: Spontaneity of a process, entropy and entropy changes in various processes, free energy functions, criteria for equilibrium, relation between equilibrium constant and thermodynamic quantities.

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

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

3.5 **Colligative Properties**: Dilute solutions and colligative properties, determination of molecular weights, using colligative properties.

3.6 **Electro-chemistry**: Ions in solutions, ionic equilibria, dissociation constants of acids and bases, hydrolysis, pH and buffers, theory of indicators and acid-base titrations. Conductivity of ionic solutions, its variation with concentration, Ostwald’s dilution law, Kohrausch law and its application. Transport number and its determination. Faraday’s laws of electrolysis, galvanic cells and measurements of their e.m.f., cell reactions, standard cell, standard reduction potential Nernst equation, relation between thermodynamic quantities and cell e.m.f., fuel cells, potentiometric titrations.
3.7 **Chemical kinetics**: Rate of chemical reaction and its dependence on concentrations of the reactants, rate constant and order of reaction and their experimental determination; differential and integral rate equations for first and second order reaction, half-life periods; temperature dependence of rate constant and Arrhenius parameters; elementary ideas regarding collision and transition state theory.

3.8 **Photochemistry**: Absorption of light, laws of photochemistry, quantum yield, the excited state and its decay by radiative, non-radiative and chemical pathways; simple photochemical reactions.

3.9 **Catalysis**: Homogeneous and heterogeneous catalysis and their characteristics, mechanism of heterogeneous catalysis; enzyme catalysed reactions (Michaelis-Menten mechanism)

3.10 **Colloids**: The colloidal state, preparation and purification of colloids and their characteristics properties; lyophilic and lyophobic colloids and coagulation; protection of colloids; gels, emulsions, surfactants and micelles.
05. CHEMICAL ENGINEERING

PROCESS CALCULATIONS AND THERMODYNAMICS: Laws of conservation of mass and energy; use of tie components; recycle, bypass and purge calculations; degrees of freedom.

First & Second law of thermodynamics and their applications; equations of state and thermodynamic properties of real systems; phase equilibria; fugacity; excess properties and correlations of activity coefficients; chemical reaction equilibria.

FLUID MECHANICS AND MECHANICAL OPERATIONS: Fluid statics, Newtonian and non-Newtonian fluids, macroscopic energy balance, Bernoulli equation, dimensional analysis, continuity equation, flow through pipeline systems, flow meters, pumps and compressors, packed and fluidized beds, elementary boundary layer theory.

Size reduction, and size separation, free and hindered settling, centrifuges, and cyclones, thickening and classification, filtration, mixing and agitation, storage and handling of solids.

HEAT TRANSFER: Conduction, convection and radiation, heat transfer coefficients, study and unsteady heat conduction, boiling, condensation and evaporation, types of heat exchangers & evaporators and their design principles.

MASS TRANSFER: Fick's law, mass transfer coefficients, film, penetration and surface renewal theories; momentum, heat and mass trans analogies; stage wise continuous contacting and stage efficiencies; design principles and operation of equipment for distillation absorption, leaching, liquid-liquid extraction, crystallization, drying, humidification, dehumidification and adsorption.

CHEMICAL REACTION ENGINEERING: Theories of reaction rates; kinetics of homogeneous reactions, interpretation of kinetic data, single and multiple reactions in ideal reactors; non-isothermal reactors; basics of non-ideal flow, F& E curves, axial dispersion; kinetics of heterogeneous catalytic reactions; diffusion effects in catalysis.

INSTRUMENTATION AND PROCESS CONTROL: Measurement of process variables; dynamics of simple systems such as CSTRs, heat exchanges, transfer functions, response of systems, process reaction curve, controller modes (P, PI, and PID); control valves; analysis of closed loop systems including stability, frequency response (including Bode plots) and controller tuning.

PLANT DESIGN AND ECONOMICS: Design of chemical process plants; principles of process economics and cost estimation.

CHEMICAL TECHNOLOGY: Inorganic chemical reactions; sulfuric acid, sodium hydroxide, fertilizers; ammonia, urea, di-ammonium phosphate super phosphate; natural product industries; pulp and paper, sugar, oil and fats; petroleum refining and petrochemicals; polymerization industries; poly ethylene, poly propylene, and synthetic fibres.
06. CIVIL ENGINEERING

PART-A

1. Engineering Mechanics: Units and Dimensions, SI Units, Vectors, Concept of Force, Concept of particle and rigid body. Concurrent, non-concurrent and parallel forces in a plane, moment of force and Varignon’s theorem, free body diagram, conditions of equilibrium, Principle of virtual work, equivalent force system.
First and Second Moments of area, Mass moment of Inertia.
Static Friction Inclined plane and bearings.


Deflection of beams: Macaulay’s method, Mohr’s moment area method, Conjugate beam method, unit load method. Torsion of Shafts, Transmission of power, close coiled helical springs, Elastic stability of columns: Euler’s, Rankine’s and Secant formulae. Principal Stresses and Strains in two dimension, Mohr’s Circle. Theories of Elastic failure, Thin and Thick cylinders: Stresses due to internal and external pressures-Lame’s equation.


PART-B

Geotechnical Engineering: Types of soil, field identification and classification, phase relationships, consistency limits, particle size distribution, classification 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, optimum moisture content, Proctor Density.
Subsurface exploration, methods of boring, sampling, types of sampler, field tests. 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. Bearing capacity, Terzaghi and other important theories, net and gross bearing pressure, immediate and consolidation settlement.

Transportation Engineering: Highway alignment, choice of layout and capacity of highways, location survey, geometric design of highways-various elements, curves, grade separation and segregation of traffic, inter-section design, highway materials and testing subgrade and pavement components, type of pavements, road drainage, elements of airport engineering.
Railway engineering-elements of permanent track-rails, sleepers, ballast and rail fastenings, tractive resistance, elements of geometric design-gradients and grade compensation on curves, cant transition curves and vertical curves, stresses in railway tracks, points and crossing, signaling and inter-locking, maintenance of railway track. Culverts and small bridges.

PART-C

Fluid Mechanics: fluid properties, fluid statics, forces on plane and curved surfaces, stability of floating and submerged bodies.

Kinematics: Velocity, streamlines, continuity equation, accelerations irrotational and rotational flow, velocity potential and stream functions, flownet, separation.
Dynamics: Euler’s equation along streamline, control volume equation, continuity, momentum, energy and moment of momentum equation from control volume equation, applications to pipe flow, moving vanes, moment of momentum, Dimensional analysis. Boundary layer on a flat plate, drag and lift on bodies. Laminar and Turbulent Flows. Laminar and turbulent flow through pipes, friction factor variation, pipe networks, water hammer and surge tanks.

Open Channel Flow: Energy and momentum correction factors, uniform and non-uniform flows, specific energy and specific force, critical depth, Friction factors and roughness co-efficients, flow in transitions, free overfall, weirs, hydraulic jump, surges, gradually varied flow equations, surface profiles, moving hydraulic jump.

PART-D

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, water borne 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 reservoir types, location and capacity. Distribution systems: 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.

Sewerage 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.

Sewerage characterization: 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 tank, trickling filters, oxidation ponds, activated sludge process, septic tank, disposal of sludge, recycling of waste water.

07. FORESTRY

1. 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 and maintenance, water budgeting, grading and hardening of seedlings, special approaches, establishment and tending.

2. MANGROVE:
   Habitat and characteristics, mangrove, plantation-establishment and rehabilitation of degraded mangrove formations; protection of habitats against natural disasters.

3. SILVICULTURE OF TREES:
   Traditional and recent advances in tropical silvicultural research and practices. Silvi-culture of some of the economically important species in India such as Acacia Sundra, Acacia nilotica, Acacia auriculiformis, Albizia lebbeck, Albizia procera, Anogeissus latifolia, Azadirachta indica, Bamboo spp, Butea monosperma, Cassia siamea, Casuarina equisetifolia, Dalbergia sisoo, Dipterocarpus spp., Emblica officinalis, Eucalyptus spp, Gmelina arborea, Hardwickia binata, Lagerstomelia lanceolata, Pterocarpus marsupium, Prosepsis juliflora, Santalum album, Semi-carpus anacardium, Salmalia malabaricum, Tectona grandis, Terminalia tomentosa, Tamarindus indica.

4. AGROFORESTRY, SOCIAL FORESTRY, JOINT FOREST MANAGEMENT:
   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. Agro forestry systems under different agro-ecological zones, selection of species and role of multipurpose trees and NTFPs, techniques, food, fodder and fuel security. Research and Extension needs. Social/Urban Forestry: objectives, scope and necessity; peoples participation. JFM – principles, objectives, methodology, scope, benefits and role of NGOs.

5. FOREST SOILS, SOIL CONSERVATION AND WATERSHED MANAGEMENT:
   Forest soils, classification, factors affecting soil formation; physical, chemical and biological properties.
   Soil conservation – definition, causes for erosion, types – wind and water erosion; conservation and management of eroded soils/areas, wind breaks, shelter belts; sand dunes; reclamation of saline and alkaline soils, water logged and other waste lands. Role of forests in conserving soils. Maintenance and build up of soil organic matter, provision of loppings for green leaf manuring; forest leaf litter and composing; Role of microorganisms in ameliorating soils; N and C cycles, VAM.

6. WATERSHED MANAGEMENT:
   Concepts of watershed; role of mini-forests and forest trees in overall resource management, forest hydrology, watershed development in respect of torrent control, river channel stabilization, 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.

7. 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.

8. 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.

9. FOREST MANAGEMENT AND MANAGEMENT SYSTEMS:
   Objective and principles; techniques; stand structure and dynamics, sustained yield relation; rotation, normal forest, growing stock; regulation of yield; management of forest plantation, commercial forests, forest plantations, forest cover monitoring. Approaches viz., i) site-specific planning, ii) strategic
planning, iii) Approval, sanction and expenditure, iv) Monitoring, v) Reporting and governance. Details of steps involved such as formation of Village Forest Committees, Joint Forest Participatory Management.

10. 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. Annual Plant of Operations.

11. FOREST MENSURATION AND REMOTE SENSING:
Methods of measuring – diameter, girth, height and volume of trees; form-factor; volume 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.

12. FOREST ECOLOGY AND ETHNOBOTANY:
Forest ecology – Biotic and abiotic components, forest eco-systems; 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. Clonal parks. Role of Ethnobotany in Indian Systems of Medicine; Ayurveda and Unani – Introduction, nomenclature, habitat, distribution and botanical features of medicinal and aromatic plants.

13. FOREST RESOURCES AND UTILIZATION:
Environmentally sound forest harvesting practices, logging and extraction techniques and principles, transportation systems, 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 and 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.

14. FOREST PROTECTION AND WILDLIFE BIOLOGY:
Injuries to forest – abiotic and biotic destructive agencies, insect – pests and disease, effects of air pollution on forests and forest die back. Susceptibility of forests to damage, nature of damage, cause, prevention, protective measures and benefits due to chemical and biological control. General forest protection against fire, equipment and methods, controlled use of fire, economic and environmental costs; timber salvage operations after natural disasters. Role of afforestation and forest regeneration in absorption of CO₂. Rotational and controlled grazing, different methods of control against grazing and browsing animals; effect of wild animals on forest regeneration, human impacts; encroachment, poaching, grazing live fencing, theft, shifting cultivation and control.

15. FOREST ECONOMICS AND LEGISLATION:
Forest economics – fundamental principles, cost-benefit analysis; estimation of demand and supply; role of private sector and cooperatives; role of corporate financing.

08. GEOLOGY

Part - I

Part – II
b) Mineralogy: Physical, chemical and optical properties of the following common rock forming minerals: quartz, feldspar, mica, pyroxene, amphibole, olivine, garnet, chlorite, carbonates, aluminosilicates. Structure of silicates and crystal chemistry of minerals. Gemstones.
c) Economic Geology: Ore, ore mineral and gangue. Classification of ore deposits. Important processes of their formation. Occurrence, origin and distribution in India of the ores of aluminium, chromium, copper, gold, lead, zinc, iron, manganese and radioactive elements. Deposits of minerals use as abrasives, refractories and in ceramics, deposits of coal and petroleum. Elements of prospective of mineral deposits.

Part – III
a) 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. Composition, origin and mode of occurrence of granite, syenite diorite, mafic and ultramafic rocks.

Part – IV
9. HORTICULTURE

I.

a) Importance of horticulture in terms of economy, production, employment generation, environmental protection and human resource development. Nutritional value of horticultural crops. Divisions of horticulture and their importance.

b) Temperature, light, humidity, rainfall and soil requirements for horticultural crops. Selection of site for establishing an orchard, orchard plan, systems of planting. Establishment of an orchard. Objectives of orchard management culture, different methods of orchard culture. Pruning and training – objectives, methods and effects.


II.

a) Principles and classification of plant propagation methods. Plant propagation structures, containers and media.

b) Sexual propagation and its importance. Factors affecting germination and pregermination treatments.


d) Propagation by grafting, importance of graftage. Factors for successful grafting., Selection of rootstock and scion. Methods of budding and grafting Rootstocks for commercial fruit plants. Stock scion relations and role of Rootstocks in fruit production.

III.

Area, production, importance in national economy, nutritive values, origin and distribution botany, classification and identification of species and varieties, root stocks, role in high density planting climate, soils, planting methods training and pruning, nutrition, irrigation scheduling, intercrops, and management of practices of

a) fruit crops mango, banana, citrus, grape, pineapple, guava, papaya, sapota.

b) Plantation Crops: Coconut, cashew nut, oil palm, coffee, tea, cacao, areca nut and rubber.

IV.

Origin, importance, export potential, varieties, climate, soil requirements, propagation and planting and after care, manuring, irrigation, training, pruning, harvesting and post harvest handling, curing and processing practices, storage methods, yield and distillation of essential oils of the following crops.

a) Medicinal plants: Dioscorea, Opium poppy, Rauwolfia, Solanum Khasianum, Catharanthus roseus, Pyrethrum, Isabgol Digitalis, Belladona, Senna and Trichonas nuxvomica.

b) Aromatic crops: Citronella, lemon grass, palmarosa, vetiver, geranium, davana, mint, lavender, vanilla.

c) Spices and Condiments: Cardamom, pepper, cinnamon, Clove and nutmeg.

V.

a) Importance and scope, production of horticultural crops in greenhouse. Status and development of greenhouse production of horticultural crops. Points to be considered before establishing a greenhouse. Greenhouse and related structures location, types, size and arrangement, types of greenhouse framework, types of greenhouse covering materials, ventilation and air circulation, greenhouse benches etc.,

b) Control of environmental factors influencing the growth i.e., light, temperature (greenhouse heating and cooling) moisture, and relative humidity. Role of growth regulators on the growth and development of greenhouse crops.

c) Preparation of growing media requirement and its management at different stages of crop growth. Management of nutrients through fertigation at various stages of crop growth in different crops.
10. MATHEMATICS

1. **Algebra:** Elements of Set Theory; Algebra of Real and Complex numbers including Demovire’s between Coefficients and Roots, symmetric functions of roots; Elements of Group Theory; Sub-Group, Cyclic groups, Permutation, Groups and their elementary properties. Rings, Integral Domains and Fields and their elementary properties.


3. **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.


5. **Ordinary Differential Equations:** Order and Degree of a Differential Equation, First order differential Equations, Singular solution, Geometrical interpretation, Second order equations with constant coefficents.

6. **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; Escape velocity; Motion of artificial satellites.

7. **Elements of Computer Programming:** Binary system, Octal and Hexadecimal systems. Conversion to and from Decimal systems. Codes, Bits, Bytes and Words. Memory of a computer, Arithmetic and Logical operations on numbers. Precision. AND, OR, XOR, NOT and Shit/Rotate operators, Algorithms and Flow charts.
11. MECHANICAL ENGINEERING

STATICS: Simple applications of equilibrium equations.
DYNAMICS: Simple applications of equations of motion, work, energy and power.
THEORY OF MACHINES: Simple examples of kinematic chains and their inversions.
Different types of gears, bearings, governors, flywheels and their functions.
Static and dynamic balancing of rigid rotors.
Simple vibration analysis of bars and shafts.
Linear automatic control systems.
MECHANICS OF SOLIDS: Stress, strain and Hooke's Law. Shear and bending moments in beams.
Simple bending and torsion of beams, springs and thin walled cylinders. Elementary concepts of elastic
stability, mechanical properties and material testing.
MANUFACTURING SCIENCE: Mechanics of metal cutting, tool life, economics of machining, cutting
Metal forming processes and machines-shearing, drawing, spinning, rolling, forging, extrusion. Types of
casting and welding methods. Power metallurgy and processing of plastics.
MANUFACTURING MANAGEMENT: Methods and time study, motion economy and work space
design, operation and flow process charts. Cost estimation, break-even analysis. Location and layout of
plants, material handling. Capital budgeting, job shop and mass production, scheduling, dispatching,
Routing, Inventory.
THERMODYNAMICS: Basic concepts, definitions and laws heat, work and temperature, Zeroth law,
temperature scales, behaviour of pure substances, equations of state, first law and its corollaries,
second law and its corollaries. Analysis of air standard power cycles, carnot, otto, diesel, brayton cycles.
Vapour power cycles, Rankine reheat and regenerative cycles, Refrigeration cycles-Bell Coleman,
Vapour absorption and Vapour compression cycle analysis, open and closed cycle gas turbine with inter-
cooling, reheating.
ENERGY CONVERSION: Flow of steam through nozzles, critical pressure ratio, shock formation and its
effect. Steam generators, mountings and accessories. Impulse and reaction turbines elements and
layout of thermal power plants.
Hydraulic turbines and pumps, specific speed, layout of hydraulic power plants.
Introduction to nuclear reactors and power plants, handling of nuclear waste.
REFRIGERATION AND AIR CONDITIONING: Refrigeration equipment and operation and
maintenance, refrigerants, principles of air conditioning, psychrometric chart, comfort zones,
humidification and dehumidification.
FLUID MECHANICS: Hydrostatics, continuity equation, Bernouilli's theorem, flow through pipes,
discharge measurement, laminar and turbulent flow, boundary layer concept.
12. PHYSICS


6. Electronics: Diodes in half-waves and full-wave rectification, qualitative ideas of semiconductors p type and n type semiconductors, junction diode, Zener diode, transistors, binary numbers, Logic gates and truth tables, Elements of microprocessors and computers.
13. STATISTICS

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 or 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), curve-fitting and principle of least squares, concepts of random sample, parameter and statistic, Z, X², t and F statistics and their properties and applications, distributions of sample range and median (for continuous distributions only), censored sampling (concept and illustrations).


Sampling Theory and Design of Experiments: Complete enumeration vs. sampling, need for sampling, basic concepts in sampling, designing large-scale sample surveys, sampling and non-sampling 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

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, Nemathelminthes, 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, Paramaecium, Sycon, Hydra, Obelia, Fasiola, Taenia, Ascaris, Neanthes, Pheretima, Hirudina, Palaeomon, Bathus, 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, circulatory 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, enegy, 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.

4. 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.

5. 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.

6. 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; Types, sources, causes, control and prevention.
   b) Wildlife of India; endangered species of India; sancturaries and national parks of India.
   c) Biological rhythms.

7. Economic Zoology:
   a) Beneficial and harmful insects including insect vectors of human diseases.
   b) Industrial fish, prawn and molluscs of India.
   c) Non-poisonous and poisonous snakes of India
   d) Venomous animals-centipede, wasp, honey bee
   e) Diseases caused by aberrant chromosomes/genes in man; genetic counselling; DNA as a tool for forensic investigation.