ANNEXURE-III

SCHEME & SYLLABUS FOR THE POST OF FOREST RANGE OFFICER IN FOREST DEPARTMENT (EFS&T)

Scheme of Examination

1	General English Paper *	100 Questions	100 Minutes	100 Marks
2	Mathematics Paper * (SSC/Higher School Standard)	100 Questions	100 Minutes	100 Marks

***The marks in the above two exams are treated as qualifying marks only**

1	General Studies Paper	150 Questions	150 Minutes	150 Marks
2	Optional Paper (One Only)	150 Questions	150 Minutes	300 Marks
			Interview	50 Marks
			Total	500 Marks

List of Optional Papers:

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

01. Agriculture	08. Civil Engineering	15. Geology
02. Botany	09. Computer Engineering	16. Horticulture
03. Chemistry	10. Electrical Engineering	17. Mathematics
04.Computer Applications	11.Electronics Engineering	18. Physics
05. Computer Science	12.Mechanical Engineering	19. Statistics
06.Agriculture Engineering	13. Environmental Science	20. Veterinary Science
07. Chemical Engineering	14. Forestry	21. Zoology

SYLLABUS

1. GENERAL ENGLISH PAPER (10TH STANDARD)

1. Vocabulary: synonyms, antonyms, phrasal verbs, commonly missed words, homonyms, homophones.

2. Parts Of Speech: Noun, Pronoun, verb, adverb, adjectives, articles, conjunctions, prepositions.

3. Tenses.

4. Direct Speech, Indirect Speech.

5. Simple, Compound and Complex Sentences.

6. Linkers and Clauses.

7. Idioms and One Word Substitutions.

8. Comprehension.

9. Degrees of Comparision.

10. Question Pattern and Question Tags.

2. MATHEMATICS PAPER

(SSC /High School Standard)

ARITHMETIC: Number System-Natural numbers, Integers, Rational and Real numbers, Fundamental operations, addition, subtraction, multiplication, division, Square roots, Decimal fractions.

Unitary method-time and distance, time and work, percentages, applications to simple and compound interest, profit and loss, ratio and proportion, variation.

Elementary Number Theory – Division algorithm. Prime and composite numbers. Tests of divisibility by 2,3,4,5,9 and 11. Multiples and factors. Factorisation Thorem. H.C.F. and L.C.M. Euclidean algorithm. Logarithms to base 10, laws of logarithms, use of logarithmic tables.

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 $O^o = x = 90^o$ values of sin x, cos x and tan x, for $x= O^o , 30^o, 45^o, 60^o$ and 90^o.

Simple trigonometric identities.

Use of trigonometric tables.

Simple cases of heights and distances.

GEOMETRY: Lines and angles, Plane and plane figures, Theorems on (i) Properties of angles at a point, (ii) Parallel lines, (iii) Sides and angles of a triangle, (iv) Congruency of triangles, (v) Similar triangles, (vi) Concurrence of medians and altitudes, (vii) Properties of angles, sides and diagonals of a parallelogram, rectangle and square, (viii) Circles and its properties including tangents and normals, (ix) Loci.

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.

Syllabus

1. GENERAL STUDIES PAPER

1. Current affairs – Regional, National and International.
2. International Relations and Events.
3. General Science; India's Achievements in Science and Technology.
4. Environmental issues; Disaster Management- Prevention and Mitigation Strategies.
5. Economic and Social Development of India and Telangana.
6. Physical, Social and Economic Geography of India.
7. Physical, Social and Economic Geography and Demography of Telangana.
8. Socio-economic, Political and Cultural History of Modern India with special emphasis on Indian National Movement.
9. Socio-economic, Political and Cultural History of Telangana with special emphasis on Telangana Statehood Movement and formation of Telangana state.
10. Indian Constitution; Indian Political System; Governance and Public Policy.
11. Social Exclusion; Rights issues such as Gender, Caste, Tribe, Disability etc. and inclusive policies.
12. Society, Culture, Heritage, Arts and Literature of Telangana.
13. Policies of Telangana State.

OPTIONAL PAPER

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.

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, transactions and metabolism of nutrients.

Diagnosis of nutrient deficiencies and their amelioration photosynthesis and respiration, growth and development, auxins and hormones in plant growth.

Cell and cell organelles. Cell division. Reproductive cycle, Principles of genetics, gene-interaction, sex determination, linkage and re-combination, mutation, extra chromosomal inheritance, polyploidy. Origin and domestication of crop plants. Genetic resources-conservation and utilization. Floralbiology in relation to selfing and crossing.

Genetic basis of plant breeding pureline selection, mass selection, male sterility and incompatibility and their use in plant breeding. Pedigree selection, back-cross method of selection. Heterosis and its exploitation. Development of hybrids, composites and synthetic, important varieties, hybrids, composites and synthetic of major crops. Seeds and seed production techniques.

Important fruit and vegetable crops of India, method of propagation-Sexual and asexual. Package and practices and their scientific basis. Crop rotation, intercropping, companion crops, role of fruits and vegetables in human nutrition, post-harvest handling and processing of fruits and vegetables. Landscaping and ornamental horticulture, commercial floriculture. Medicinal and aromatic plants. Serious pests and diseases affecting major crops. Principles of control of crop pests and diseases, integrated management. 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. Farm systems and their spatial distribution, their significant roles in regional economic development.

02. BOTANY

1. **Cell Biology:** Structure and function of cell wall (extracelluar 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.

2. **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.

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).

5. **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.

6. **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.

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).

8. **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.

9. **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.

10. **Origin of Life and Evolution**: Basic concept of origin of earth and origin of life. Theories of organic evolution, molecular basis of evolution.

03. CHEMISTRY

SECTION-A: (INORGANIC CHEMISTRY):

1.1 **Atomic structure:** Schrodinger wave equation, significance of Ψ and Ψ^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 electro-negativity 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:**

- **Hydrogen**: Its unique position in the periodic table, isotopes, ortho and para hydrogen, industrial production, heavy water.
- **Chemistry of 's' and 'p' block elements**: Electronic configuration, general characteristics properties, inert pair effect, allotrophy 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.
- **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-Baeyers' 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, alkanoic acids, esters, amides, nitriles, amines, acid anhydrides, αβ -unsatuarated 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 diastereo-isomerism; configuration (relative and absolute); conformations of alkanes upto four carbons, cyclohexane and dimethylcyclo-hexanes their potential energy **D,L** and **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 diasteretopic atoms and groups in organic compounds, geometrical isomers; **E** and **Z** notations. Stero-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; Huckel'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, dia-zonium and sulphonic acid derivatives, benzyne reactions.

2.7 **Chemistry of biomolecules**: (i) **Carobhydrates**: 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 α-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**:

- **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.
- **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.

04. COMPUTER APPLICATIONS

Computer Fundamentals and Applications

Generation of Computers, PC Family of Computers, Different I/O devices; Introduction to Operating System, Overview of different Operating Systems, Functions of Operating System; Introduction to Windows, Working with Accessories (Notepad, WordPad and Paint); Personalizing Windows, Installing and Removing Applications, Boot Options and Concept of Registry.

Introduction to Office Tools: Word Processing, Advantages of Work Processing, fundamentals of MS-Word, Working with Menus and Toolbars, Introduction to Macros. Overview of Excel, Working with Cells, Creating Worksheets, Working with Formulae Bar. Introduction to PowerPoint, Creating and Designing Slides, Working with Hyperlinks & Animation.

Data and File Structures

Introduction: Introduction to Data Structures; Primitive and non-primitive data structure; Linear and non-linear data structure; Recursion Function and its examples. String Manipulation, String Matching Techniques & Applications.

Concept of Stack and Queue. Single and Doubly – Linked Lists. Circular linked List, their implementation and comparison. Array based and Linked List based Implementation of stack and Queues and their applications.

Searching: Sequential and Binary Search on Array – based ordered lists. Sorting Techniques: Insertion Sort, Selection Sort, Quick Sort, Heap Sort. External Sorting: K-way Merge Strategy. File Structures: Sequential Files, Indexed Files, Direct Files.

Binary Trees, their implementation and traversals. Binary Search Tree: Searching, Insertion and Deletion of nodes.

Database Management Systems

Elementary Database Concepts. Relational model – Concept, Algebra and Constraints, Use of SQL as a Relational database language in data definition and query formulation. ER Model, Normalization: First, Second, Third Normalizations. Database backup, recovery.

Programming concepts in C/C++

C Language fundamentals, Data types, Variables, Operators. Functions, Parameter passing techniques, storage classes, Recursion. Arrays: Declaration; initialization; 2-dimensional and 3-dimensional array, passing array to function, strings and string functions, and character arrays. File I/O.

Introduction to classes and objects; Constructor; destructor; Operator overloading; Function Overloading; function overriding; friend function; copy constructor;

Inheritance: Single, Multiple and Multilevel Inheritance; Virtual functions and Polymorphism: Dynamic binding, Static binding; Virtual functions; Pure virtual function; Concrete implementation of virtual functions; Dynamic binding Call mechanism, Implementation of Polymorphism, virtual destructors.

Templates: function Templates, Class Templates, Member function Template and Template Arguments, Exception Handling, Standard Template Library; Containers, Algorithms, Iterators and Function Objects.

Software Engineering

Introduction: Software Engineering, Evolving role of Software, Concept of Software, Changing nature of Software, Software Myths, Software Importance, Characteristics, Software Components, Software crises, Software engineering Challenges (Scale, Quality Productivity, Consistency and Repeatability, Change), Software standard, Software Engineering Approach.

Introduction to Software Requirement Analysis and Specification: Software requirement, (need for SRS requirement process), problem analysis (informal approach, data flow modelling, Object oriented modelling, prototyping), requirement specification (characteristics, components), Concept of Use Cases, Concept of validation

Design Engineering: Function oriented design, Design principles, Coupling and Cohesion, Design Notations & Specifications, Structured Design Methodology.

Operating Systems

Overview of an Operating System, Resource Management, Operating System Interface, Process Management concepts, Inter-Process Communication, Process Scheduling, Synchronization, Deadlocks.

Memory Management, Linking, Loading, Memory Allocation, Design Issues and Problems, Virtual Memory, Fragmentation, Implementing Virtual Memory Paging, Segmentation, Virtual Memory Design Techniques, Buffering Techniques, Spooling.

File Management- File Systems & I/O Device Drivers, Access Strategies, File Systems, File System Oraganization, Design Techniques.

Case Studies, Unix/Linux Operating Systems, Users View, design Principles, Implementation, Process Management, File System, I/O System, Windows 2003.

Java Programming

An overview to Java, Comparison with other languages (C & C++), Java and Internet, Features of Java, Introduction to Java Virtual Machine, Object Oriented Programming concepts (Abstraction, Encapsulation, Inheritance, Polymorphism). Data types, Variables, Operators.

Arrays: Single and Multidimensional. Input, output, Error Statements, Control Statements and Looping Structures. Typecasting, Classes & Objects: Class Fundamentals, Declaring Objects, Constructors, Overloading, Access specifiers, static, the final modifier, Command Line arguments & Argument passing. Inheritance : Basics of Inheritance, Super class, Member Access, Creating a Multilevel Hierarchy, Method Overriding, Dynamic Method Dispatch & Abstract Class.

Packages and Interfaces, Exception Handling; fundamentals of Exceptions, Exception types, using Try and Catch, Throwing Exceptions, Multithreaded Programming: Java Thread Model, Creating & working with threads, String handling functions.

File Handling, File Class, Streams: Stream Classes, Reading & writing to Console, Accessing Files & Directories, File Input and Output Stream, Byte Array Input & Output Stream. Character streams.

Applets: Overview, Life cycle of an Applet, HTML tag, Parameter Passing, Applet vs Applications. Introduction, working with AWT Controls and Layout Manager, Event Handling. Introduction to Swings, JDBC.

05. COMPUTER SCIENCE

- **Digital Computer Fundamentals**: Number Systems and Information Codes- Binary, octal and Hexadecimal systems, Computer Arithmetic, BCD, EBCIDIC and ASCII codes. Boolean Algebra , Demorgans Law, Logic gates, K-maps and logic design of Flip Flops. Decoders, Registers and Counters.

- **Computer Organization and Architecture:** Fixed point and Floating point Number Representations. Computer Hardware and flow of Information, CPU, , Buses and Peripheral Equipment, Memory Hierarchy, Interrupts, I/O organization, DMA

- **Programming:** C Programming - Datatypes, operators, expressions, control statements, structures and union, functions, pointers, fileprocessing.

- **Data Structures and Algorithms:** Stacks, Queues, Array and Linked representation, Singly and doubly linked lists, Trees, Traversal and Insertion and Deletion operations, Graphs, representation and basic operations, Sorting and searching, Analysis of Algorithms, order notation

- **Operating Systems:** Basic OS functions, Process management, Process Scheduling, Memory Management, Virtual Memory, Device Management, File system Management.

- **Data Base Management Systems:** Database models, data Independence, DDL and DML, E-R Diagrams, Logical and Physical structures, Relational Database Structure, Normalization, SQL, Database transaction, backup and recovery management.

- **Computer Communications:** : LAN, WAN, Network Topologies, Error Detection and Correction Codes, OSI Reference model, TCP/IP protocol stack, Data Link protocols, IP addressing, Packet Switching, Circuit Switching and message switching, cryptography, FTP and TELNET.

- **System Analysis and Design:** System Analysis and Design Life cycle, Requirements analysis, Feasibility Study. Tools for system Analysis, DFDs, Design Tables, Object oriented system modelling, Verification and validation.

- **Systems Software**: Loaders, Linkers, Assemblers, Compilers, Macroprocessors, Major Functions and Design Principles.

- **Internet Technologies:** : Introduction to Internet, www, Internet browsers Netscape & Explorer, Telnet, Search Engines. Hypertext Markup Language, HTML Tags, Frames, Creating HTML documents, DHTML

06. 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.

07. 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: Flick'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 absorption.

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.

08. 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.

Kinematics and Kinetics: Kinematics in Cartesian and polar co-ordinates, motion under uniform and non-uniform acceleration, motion under gravity. Kinetics of particle: Momentum and Energy principles, D Alembert's Principle, Collision of elastic bodies, rotation of rigid bodies, simple harmonic motion.

2. **Strength of Materials**: Simple Stress and Strain, Elastic constants, axially loaded compression members, Shear force and bending moment, theory of simple bending moment, Shear Stress distribution across cross sections, Beams of uniform strength, Leaf spring, Strain Energy in direct stress, bending and shear.

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 sprints, 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.

3. **Structural Analysis**: Analysis of pin jointed plane trusses, deflection in trusses. Three hinged and two hinged arches, rib shortening, temperature effects, influence lines in arches. Analysis of propped cantilevers, fixed beams, continuous beams and rigid frames. Slope deflection, moment distribution, Kani's method and Matrix method: Force and Displacement methods. Rolling loads and influence lines for determinate beams and pin jointed trusses.

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.

Load carrying capacity of pile groups.

Stability of slope-conventional method of slices, stability numbers.

Transportation Engineering: Highway alignment, choice of layout and capacity of highways, location survey, geometric design of highways-various elements, curves, grade separation and

egregation 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 loating 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.

Construction Management: Elements and principles of Activity on Arrow (AOA) and Activity on Node (AON) networks and work breakdown structure. Interfaces. Ladder networks. Activity time. Time computations and works. ATC and PTC trade-off. Work study and sampling. Scheduling principles-material schedules. ABC and EOQ analysis of inventory. Budgeting with bar-charts. Working capital. PERT, probability of completion.

Elements of Engineering Economics, methods of appraisal, present worth, annual cost, benefit-cost, incremental analysis. Economy of scale and size. Choosing between alternatives including levels of investments. Project profitability.

9. COMPUTER ENGINEERING

01. Logic families, gates, flip-flops, Multiplexers, decoders, registers, counters, adder circuits, Boolean algebra, Combinational circuit design, minimisation, sequential circuit design, number systems, inter conversion, number representation, computer organisation, instruction formats, addressing modes, micro-programming, ALU organisation, multiplication and division algorithms, memory hierarchy, cache and associate memories, virtual memory, memory IC's, I/Oo organisation schemes, interrupts, arbitration, DMA, IOP, micro processors, interfacing, pipeline, SIMD and MIMD organisations, proposition and predicate logic's, methods of deduction, set theory, relations, functions, algebraic structures, lattices, recursion, combinatorics, graph theory, representation, path matrix, warshall's algorithm, cyclic and bipartite graphs, planner graphs, Hamiltonian graph, chromatic number, trees, binary tree traversals, representation of expressions, spanning trees, breadth-first and depth-first algorithms, finite automation, pushdown automation, Turing machine, grammars, type 0, 1, 2, and 3, LL and LR grammars.

02. Algorithms, flow-charts, programming methodology, data structures, PASCAL, FORTRAN, COBAL and 'C' languages, theory of programming languages, file organisation, searching and sorting; methods, DBMS, database models, query languages, operating system, directory concept, processor scheduling, memory allocation, paging and segmentation, device management, deadlocks and prevention, concurrent processing. DOS and UNIX features, language processors, syntax and semantic analysis, code generation, optimisation, assemblers, loaders and linkers, algorithm design techniques, Computer networks, digital modulation techniques, modems, error detection and error correction, BISYNC and HDLC protocols, OSI model, network routing algorithms, LAN operation methods, Computer graphics, DDA algorithms, graphic primities, 2-D transformations, graphic input devices, software engineering development life-cycle, system analysis, modular design, testing and validation, CASE tools, AI techniques, natural language understanding, learning, knowledge representation, expert systems, LISP, PROLOG.

10. ELECTRICAL ENGINEERING

I. ELECTRICAL CIRCUITS:

Basic electrical laws, Analysis of DC networks, transient response of RLC networks excited by impulse, step, ramp and sinusoidal excitations. Transform methods, transfer functions, poles and zeros steady state AC networks, frequency domain analysis, resonance, coupled circuits, two port networks, three phase networks, power in a.c. networks, power measurement in 3-phase networks.

II. E.M. THEORY:

Electro static and electro magnetic fields, vector methods, Fields in dielectric, conducting and magnetic materials, Laplace and Poisson's equation. Time varying fields, Maxwell's equation, Poynting Theory, properties of transmission lines.

III. ELECTRICAL MEASUREMENT AND INSTRUMENTS:

Electrical standards, Error analysis, Measurement of current, voltage, power, energy, power factor, resistance, inductance capacitance frequency and loss angle. Indicating instruments, extension of range of instruments, DC and AC bridges. Electronic measuring instruments. Electronic multimeter, CRO, frequency counter, digital voltmeter, transducers, Thermocouples, Thermistor, LVDT, strain gauges, Piezo electric crystal, Measurement of non-electrical quantities like, pressure, velocity, temperature, flow rate, displacement acceleration and strain.

IV. CONTROL SYSTEMS

Open and closed loop control systems, Mathematical modelling, block diagram, signal flow graphs, time response and frequency response of linerar systems, error constants and series Rootlocus technique, Bodeplot, polar plot, M-circles, N-circles, Nichol's charts, stability, Routh Hurwitz criteria. Nyquist stability criteria, compensators, design in frequency domain. Control system components. Servo motors, synchros, tacho generator, error detector. State variable approach, modelling, state transition matrix, transfer function, response.

V. ELECTRONICS:

Solid state devices and circuits. Small and large signal-amplifiers with and without feedback at audio and radio frequency, multistage amplifiers. Operational amplifiers and applications. Integrated circuits oscillators, RC, LC and crystal oscillators wave form generators, multi-vibrators – Digital circuits, Logic gates, Boolean algebra combinational and sequential circuits. A to D and D to A converters Micro processors (8085) instruction set, memories, interfacing programmable peripheral devices – Number system flow charts – expressions and statements in C – language – simple programs for engineering application.

VI. D.C. ELECTRICAL MACHINES:

Fundamentals of electro mechanical energy conversion, constructional features of D.C. Machines, emf equation types and characteristics of generators application, Torque in DC motor, types of DC motors, applications. Testing of D.C. motors, efficiency, and starting and speed control.

VII. TRANSFORMERS:

Construction – Principle of operation of 1-phase transformers – Vector diagram on No Load and – Load – Parallel operation – Regulation – efficiency – Equivalent circuit 3 phase transformer connections – Scott connection.

VIII. INDUCTION MOTORS:

Production of rotating magnetic field, production of torque types of motors equivalent circuits, Circle diagram, torque slip characteristics, starting and maximum torque, speed control, principle of single phase induction motors, Applications.

IX. SYNCHRONOUS MACHINES:

Generation of emf in 3 phase AC Generator, Armature reaction, regulation by Synchronous inpedance and Ampere turn methods, parallel operation, transient and sub-transiat reactances, theory of salient pole machines.

Synchronous Motor: Torque production, performance characteristics, methods of starting, V-Curves, synchronous condenser.

Special Machines: Stepper motor, Methods of operation, Amplidyne and metadyne-applications.

X. ELECTRICAL POWER GENERATION:

General layout – Types of power stations, economics of different types, base load and peak load stations, load factor and its effects, pumped storage schemes.

XI. POWER TRANSMISSION:

Calculation of line parameters, concepts of short, medium and long transmission lines, ABCD parameters, insulators, Corona, P.U. quantities, fault calculations, symmetrical components load flow analysis using Gauss Seidal, New-ton Raphson, methods, economic operation, stability, steady state and transient stability, equal area criterion, ALFC and AVR control for real time operation of interconnected systems.

XII. POWER SYSTEM PROTECTION:

Principles of arc quenching, circuit breaker classification, Recovery and restriking voltages, relaying principles over current, directional over current relays-generator and transformer protection using differential relays-line protection using distance relays Surgeo phenomena in transmission lines – Travelling wave theory, protection against surges.

XIII. UTILISATION:

Industrial Drives – Motors for various drives – Braking methods – Speed control of motors – Economics of rail traction – Mechanics of train movement – Estimation of power and energy requirements – Illumination – Laws Factory lighting – Street lighting – Induction and dielectric heating.

11. ELECTRONICS ENGINEERING

1. Electronic Devices and Circuits

Semiconductor Diodes-Varactor Diode-Zener Diode- Transistors –BJT, FET, UJT-Power supplies-Rectifiers and filters, regulators, Transistor amplifiers-CE, CB, CC configurations-RC coupled amplifiers-Differential amplifiers –feedback amplifiers-operational amplifier-applications, Oscillators-RC,LC and crystal oscillators-Astable, bistable and monostable multivibrators-555 timer, Schmitt trigger-sweep circuits-Miller and boot strap circuits.

2. Networks and circuit theory

Mesh current and node voltage analysis, Network theorems-thevenin's, Norton's, maximum Power transfer, super position, Reciprocity Theorems-series and parallel resonance-Q factor-Linear wave shaping circuits-transmission lines-losses and impedance matching.

3. Electronic measurements

Analog and Digital measuring instruments:- Ammeter, voltmeter, ohmmeter, frequency meter, power meter, Q-meter, CRO-CRT-time base generator-deflection sensitivity-CRO applications-Digital IC tester, logic and spectrum analyzer.

4. Industrial and Power electronics

Thyristor family-SCR, TRAIC, Power BJT-IGBT-convertors- Half wave, full wave controlled choppers-Invertors – cyclo converters-PWM inverter-speed control of AC/DC motors-opto electronic Devices –Transducers-LVDT-strain gauge-thermistors, thermo couple – ultrasonic

5. Communications

Analog communications-AM, FM, PM modulations-Power requirements – Transmitters – Receivers – Ground wave propagation- Sky and Space propagation. Digital communications – Pulse modulations – PCM, Delta modulation – ASK, PSK, FSK and QAM- generation and detection- multiplexing-TDM, FDM, WDM, multiple access-TDMA, CDMA, WDMA., Antennas, wave guides, satellite communications, optical communications.

6. Digital Electronics & computer networks

Number systems – logic gates-Boolean algebra, adders and sub tractors – flip flops-registers and counters-memories-A/D and D/A converters – peripherals, 8085 microprocessor – 8051 micro controllers transmission media in computer networks – network topologies – packet, message switching-OSI architecture and functions-wireless LAN, Blue tooth-ISDN, frame relay. ATM networks – HTTP, DNS, POP, SMTP, FTP protocols.

12. 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 Hookes 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 tool materials. Basic types of machine tool and their processes. Automatic machine tools, transfer lines. 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, Bernoulli’s theorem, flow through pipes, discharge measurement, laminar and turbulent flow, boundary layer concept.

13. ENVIRONMENTAL SCIENCE

Unit 1: The Multidisciplinary nature of environmental studies

Definition, scope and importance

Need for public awareness.

Unit 2: Natural Resources:

Renewable and non-renewable resources:

Natural resources and associated problems.

a) Forest resources: Use and over-exploitation, deforestation, case studies. Timber extraction, mining, dams and their effects on forests and tribal people.

b) Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems.

c) Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies.

d) Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies.

e) Energy resources: Growing energy needs, renewable and non renewable energy sources, use of alternate energy sources. Case studies.

f) Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification.

Role of an individual in conservation of natural resources.

Equitable use of resources for sustainable lifestyles.

Unit 3: Ecosystems

- Concept of an ecosystem.
- Structure and function of an ecosystem.
- Producers, consumers and decomposers.
- Energy flow in the ecosystem.
- Ecological succession.
- Food chains, food webs and ecological pyramids.
- Introduction, types, characteristic features, structure and function of the following ecosystem:-

  a. Forest ecosystem

  b. Grassland ecosystem

  c. Desert ecosystem

  d. Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries)

Unit 4: Biodiversity and its conservation

- Introduction – Definition: genetic, species and ecosystem diversity.
- Biogeographical classification of India

- Value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values
- Biodiversity at global, National and local levels.
- India as a mega-diversity nation
- Hot-spots of biodiversity.
- Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts.
- Endangered and endemic species of India
- Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity

Unit 5: Environmental Pollution

Definition

Causes, effects and control measures of :-

a. Air pollution

b. Water pollution

c. Soil pollution

d. Marine pollution

e. Noise pollution

f. Thermal pollution

g. Nuclear hazards

- Solid waste Management: Causes, effects and control measures of urban and industrial wastes.
- Role of an individual in prevention of pollution
- Pollution case studies
- Disaster management: floods, earthquake, cyclone and landslides.

Unit 6: Social Issues and the Environment

- From Unsustainable to Sustainable development
- Urban problems related to energy
- Water conservation, rain water harvesting, watershed management
- Resettlement and rehabilitation of people; its problems and concerns. Case studies.
- Environmental ethics: Issues and possible solutions.
- Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Case studies.
- Wasteland reclamation
- Consumerism and waste products.
- Environment Protection Act.
- Air (Prevention and Control of Pollution) Act.
- Water (Prevention and control of Pollution) Act
- Wildlife Protection Act
- Forest Conservation Act
- Issues involved in enforcement of environmental legislation
- Public awareness.

Unit 7: Human Population and the Environment

- Population growth, variation among nations.
- Population explosion- Family Welfare Programme
- Environment and human health.
- Human Rights.
- Value Education.
- HIV / AIDS.
- Women and Child Welfare.
- Role of Information Technology in Environment and Human Health.
- Case Studies.

Unit 8: Field work

- Visit to a local area to document environmental assets-river / forest / grassland / hill / mountain

14. 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. Silviculture of some of the economically important species in India such as Acacia Sundra, Acacia nilotica Acacia auriculiformis, Albizzia lebbeck, Albizzia procera, Anthocephalus Cadamba, Anogeissus latifolia, Azadirachta indica, Bamboo spp, Butea monosperma, Cassia siamea, Casuarina equisetifolia, Dalbergia sisoo, Dipterocarpus spp., Emblica officinalls, Eucalyptus spp, Gmelina arborea, Hardwickia binata, Lagerstoremia lanceolata, Pterocarpus marsupium, Prosepis 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

- soil and water conservation;
- water recharge;
- nutrient availability to crops;
- nature and eco-system preservation including ecological balances through pest-predator relationships and
- 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 aboitic 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 CO_2. 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.

16. 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.

15. GEOLOGY

Part - I

- **General Geology:** Solar System. The Earth: its origin, age and internal constitution. Volcanoes-types, distribution geological effects and products. Earth-quakes-intensity, magnitude, distribution, causes and effects. Elementary ideas about isostasy, geosynclines, mountain building, continental drift, sea floor spreading and plate tectonics.
- **Geomorphology:** Basic concepts. External and internal processes. Rock weathering. Cycle of erosion. Fluvial landforms and drainage patterns. Landforms of Aeolian, marine, glacial and 'Karst' landscapes. Elements of Remote Sensing.
- **Structural and field Geology:** Primary and secondary structures. Dip and strike of beds. Unconformities. Study of folds, joints, faults, foliation and lineations. Overthrusts and nappe structures. Stages of rock deformation. Construction of block diagrams, Stereographic and equal-area nets. 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. Principles of geological mapping. Effects of topography on outcrops. Drawing of sections.

Part – II

- **Crystallography:** Elements of crystal structure. Laws of crystallography, Symmetry elements of normal classes of seven crystal systems. Properties and interaction of light and crystalline matter. 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.
- **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.
- **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

- **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 groups, anorthosites and alkaline rocks.
- **Sedimentary Petrology:** Sedimentary process and products. Classification of sedimentary rocks. Sedimentary structures. Residual deposits – their mode of formation, chacteristics and types, Clastic deposits – their classification, mineral composition and texture. Elementary ideas about the origin and characteristics of quartz arenites, arkoses and greywackes. Siliceous and calcareous deposits of chemical and organic origin.
- **Metamorphic Petrology:** Types and factors of metamorphism. Zones, grades and facies of metamorphism. Regional and contact metamorphism. Textures and structures of metamorphic rocks. Metamorphism of argillaceous, arenaceous, calcareous and basic rocks. Metasomatism.

Part – IV

- **Paleontology:** Habits and habitats of animals. Fossils and fossilization. Modes of preservation. Application of fossils, Study of morphology and geological history of Foraminiferida, Brachipoda, Bivalvia, Gastropoda, Cephalopoda, Trilobita, Echinoidea and Anthozoa. Mammals of Siwalik Group. A brief study of Gondwana flora.
- **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.

16. 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.

c) Nutrition of horticultural crops – assessment of nutritional requirements, Identification of deficiency symptoms, methods of nutrient application. Assessment of irrigation requirements for different horticultural crops, irrigation methods.

d) Flower bud initiation and formation. Factors affecting them, environmental influences, chemical, nutritional management practices. Pollination and fruit set, problems and requirements, flower and fruit drop, stages, causes, remedial measures. Unfruitfulness, reasons and remedial measures. Harvesting, maturity indices for horticultural crops. Ripening, chemical, physical changes during ripening, and methods of ripening. Use of growth regulators in Horticulture – propagation sex expression, fruit set, fruit drop and extension of shelf life.

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.

c) Sexual propagation and it's importance. Propagation of plants by cuttage, factors affecting regeneration of plants from cuttings. Types of cuttings, propagation by layerage. Factors affecting regeneration of plants by layerage. Methods of layerage.

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, vettiver, 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.

17. MATHEMATICS

- **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.

- 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:** Addition, Multiplication, Determinants of a Matrix, Properties of Determinants of order in, Inverse of a Matrix, Cramer's rule.

- **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.

- **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.

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

- **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.

- **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.

18. PHYSICS

1. Mechanics and Waves: Dimensional analysis. Newton's laws of motion and applications, variable mass systems, projectiles. Rotational dynamics-kinetic energy, angular momentum, theorems of moment of inertia and calculations in simple cases. Conservative forces, frictional forces. Gravitational potential and intensity due to spherical objects. Central forces, Kepler's problem, escape velocity and artificial satellites (including GPS). Streamline motion, viscosity, Poiseuille's equation. Applications of Bernoulli's equation and Stokes' law.

Special relativity and Lorentz transformation-length contraction, time dilation, mass-energy relation.

Simple harmonic motion, Lissajous figures. Damped oscillation, forced oscillation and resonance. Beats, Phase and group velocities. Stationary waves, vibration of strings and air columns, longitudinal waves in solids. Doppler effect. Ultrasonics and applications.

2. **Geometrical and Physical Optics**: Laws of reflection and refraction from Fermat's principle. Matrix method in paraxial optics- 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. Raman & Rayleigh scattering 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. Heat and Thermodynamics: Thermal equilibrium and temperature. The zeroth law of thermodynamics. Heat and the first law of thermodynamics. Efficiency of Carnot engines. Entropy and the second law of thermodynamics. Kinetic theory and the equation of state of an ideal gas. Mean free path, distribution of molecular speeds and energies. Trasport phenomena. Andrew's experiments-van der Waals equation and applications. Joule-Kelvin effect and applications. Bronian motion. Thermodynamic potentials-Maxwell relations. Phase transitions. Kirchhoff's laws. Black-body radiation – Stefan-Boltzmann law, spectral radiancy, Wien displacement law, application to the cosmic microwave background radiation, Planck radiation law.

4. Electricity and Magnetism: Electric charge, Coulomb's law, electric field, Gauss' law. Electric potential, van de Graff accelerator. Capacitors, dielectrics and polarization. Ohm's law, Kirchhoff's first and second rules, resistors in series and parallel, applications to two-loop circuits. Magnetic field-Gauss' law for magnetism, atomic and nuclear magnetism, magnetic susceptibility, classification of magnetic materials. Cirulating charges, cyclotron, synchrotron. Hall effect. Biot-Savart law, Ampere's law, Faraday's law of induction – Lenz's law. Inductance. Alternating current circuits – RC, LR, single-loop LRC circuits, impedance, resonance, power in AC circuits. Displacement current, Maxwell's equations (MKS Units), electromagnetic waves, energy transport and Poynting vector.

5. Atomic 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. Schroedinger'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.

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.

19. 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, Bayer'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. Bernouli, 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).

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, sign test, Wald-Wolfowitz runs test, run test for randomness, median test, Wilcoxon test and Wilcoxon-Mann-Whitney test.

Wal's sequential probability ratio test, OC and ASN functions, application to binomial and normal distributions. Loss function, risk function, mini-max and Bayes rules.

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, 2^n factorial design, total and partial confounding, 3^2 factorial experiments, split-plot design and balanced incomplete block design.

20. VETERINARY SCIENCE

ANIMAL HUSBANDRY

1. **General**: Role of Livestock in Indian Economy and human health. Mixed farming. Agroclimatic zones and livestock distribution. Socioeconomic aspects of livestock enterprise with special reference to women.

2. **Genetics and Breeding**: Principle of genetics, chemical nature of DNA and RNA and their models and functions. Recombinant DNA technology, transgenic animals, multiple ovulation and embryo-transfer. Cytogenetics, immunogenetics and biochemical polymorphic and their application in animal improvement. Gene actions. Systems and strategies for improvement. Geneaction. Systems and strategies for improvement of livestock for milk, meat, wool production and drought and poultry for eggs and meat. Breeding of animals for disease resistance. Breeds of livestock, poultry and rabbits.

3. **Nutrition:** Role of nutrition in animal health and production. Classification of feeds, Proximate composition of feeds, feeding standards, computation of rations. Ruminant nutrition. Concepts of total digestible nutrients and starch equivalent systems. Significance of energy determinations. Conservation of feeds and fodder and utilization of agro by-products. Feed supplements and additives. Nutrition deficiencies and their management.

4. **Management**: Systems of housing and management of livestock poultry and rabbits. Farm record. Economics of livestock, poultry and rabbit farming. Clean milk production. Veterinary hygiene with reference to water, air and habitation. Sources of water and standards of potable water. Purification of water. Air changes and thermal comfort. Drainage systems and effluent disposal Biogas.

5. **Animal Production**: (a) Artificial insemination, fertility and sterility. Reproductive physiology, semen characteristics and preservation. Sterility its causes and remedies. (b) Meat eggs and wool production. Methods of slaughter of meat animals, meat inspection, judgment, carcass characteristics, adulteration and its detection processing and preservation; Meat products, quality control and nutritive value, By-products. Physiology of egg production, nutritive value, grading of eggs preservation and marketing.

Types of wool, grading and marketing.

6. **Veterinary Science**: (i) Major contagious diseases affecting cattle, buffaloes, horses, sheep and goats, pigs, poultry, rabbits and pet animals-Etiology, symptoms, pathogenicity, diagnosis, treatment and control of major bacterial, viral, rickettsial and parasitic infections. (ii) Description, symptoms, diagnosis and treatment of the following:

- Production diseases of milk animals, pig and poultry.
- Deficiency diseases of domestic livestock and birds
- Poisonings due to infected/contaminated foods and feeds, chemicals and drugs.

7. **Principles of immunization and vaccination**: Different types of immunity, antigens and antibodies. Methods of immunization. Break-down of immunity, Vaccines and their use in animals.

Zoonoses, Foodborne infections and intoxications, occupation hazards.

8. (a) Poisons used for killing animals euthanasia.

(b) Drugs used for increasing production/performance efficiency and their adverse effects.

(c) Drugs used to tranquilize wild animals as well as animals in captivity.

(d) Quarantine measures in India and abroad. Act, Rules and Regulations.

9. **Dairy Science**: Physicochemical and nutritional properties of milk.

Quality assessment of milk and milk products, Common tests and legal standards. Cleaning and sanitation of dairy equipment. Milk collections, chilling, transportation processing, packaging, storage and distribution. Manufacture of market milk, cream butter, cheese, ice-cream, condensed and dried milk, by products and Indian Milk products.

Unit operations in dairy plant.

Role of micro organisam in quality of milk and products physiology of milk secretion.

21. ZOOLOGY

1. **Cell structure and function**:

- Prokaryote and eukaryote
- Structure of animal cell, structure and functions of cell organelles.
- Cell cycle-mitosis, meiosis.
- Structure and contents of nucleus including nuclear membrance, structure of chromosome and gene, chemistry of genetic components.
- Mendel's laws of inheritance, linkage and genetic recombination; cytoplasmic inheritance.
- Function of gene: replication, transcription and translation; mutations (spontaneous and artificial); Recombinant DNA; principle and application
- Sex determination in Drosophila and man; sex linkage in man

2 **Systematics**:

- Classification of non-chodrates (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.
- Structure reproduction and life history of the following types: Amoeba, Monocystis, Plasmodium, Paramaecium, Sycon, Hydra, Obelia, Fasiola, Taenia, Ascaris, Neanthes, Pheretima, Hirudina, Palaemon, Buthus, Periplaneta, Lamellidens, Pila, Asterias and Balanoglossus.
- Classification of chordates (up to orders), giving general features and evolutionary relationship of the following: Protochordata; Agnatha; Gnathostomata-Pisces, Amphibia, Reptilia, Aves and Mammalia.
- Comparative functional anatomy of the following based on type animals (Scoliodon, Rana, Calotes, Columba and Oryctolagus): integrument 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**:

- 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.
- Neuron and nerve impulse-conduction and transmission across synapses; nenurotrasmitters and their role, including acetyl cholinesterase activity.
- Homeostasis; osmoregulation; active transport and ion pump.
- Composition of carbohydrates, fats, lipids and proteins; steroids.

4. **Embryology**:

- Gametogenesis, fertilization, cleavage; gastrulation in frog and chick
- Metamorphosis in frog and retrogressive metamorphosis in ascidian; extra-emhryonic membranes in chick and mammal; placentation in mammals; Bio-genetic law.

5. **Evolution**:

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

6. **Ecology, Wildlife and Ethology**:

- 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.
- Wildlife of India; endangered species of India; sancturaries and national parks of India.

- Biological rhythms.

7. **Economic Zoology**:

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