SYLLABUS – FOREST RANGERS

01. GENERAL KNOWLEDGE

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 – Ancient, Medieval and Modern India.
4. World Geography and Geography of India with a focus on Andaman and Nicobar Islands.
5. Indian polity and Economy – including the country's political system- rural development – Planning and economic reforms in India.
6. Basic Knowledge of Indian Society.

02. ENGLISH

Objective Type:

1. COMPREHENSION From a given passage (prose or poem) comprehend and identify the central theme and answer questions based thereon. The candidate would not be asked to evaluate or assess the argument, its tone or style.
2. USE OF VERBS, ARTICLES AND PREPOSITIONS Use of verbs, articles and prepositions in different contexts. Construction of sentence. Detecting common mistakes in the usage of verbs, articles and prepositions.
3. VOCABULARY Knowledge of words, phrases and idiomatic expression in common English usage to describe different activities, situations and contexts. Differentiate between the usage and meaning of words having similar vocalization (example: flora/fauna; efficiency/efficacy/ effectiveness; price/prize; affect/effect; etiquette/ attitude etc.) and detect the commonly committed mistakes. Construction of sentence.

Descriptive Type:

1. PRECIS WRITING: Read and understand a given passage, sifting the essential from the non-essential information and prepare a cohesive summary not exceeding 1/3rd the size of the given passage and give a suitable eye-catching title.
2. ESSAY WRITING: Write an essay of 250 to 300 words on a matter of topical interest (Political, economic, religious, cultural, environmental, social, socio-economic etc.)

03. OPTIONAL SUBJECTS

01. AGRICULTURE

1. 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.

2. 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.

3. 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.

4. 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.

5. Cell and cell organelles. Cell division. Reproductive cycle, Principles of genetics, gene-interaction, sex determination, linkage and re-combination, mutation, extra chromosomal inheritance, polyploidy.

6. Origin and domestication of crop plants. Genetic resources-conservation and utilization. Floral biology 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.

7. 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.

8. Landscaping and ornamental horticulture, commercial floriculture. Medicinal and aromatic plants.

9. 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.

10. Principles of economics as applied to agriculture. Farm planning and optimum resource-use efficiency and maximizing income and employment.

11. 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 $\Psi 2$ 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 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*: 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, 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. 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, aluminium, 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 diastereoisomerism; 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 cyanoacetateapplications in organic synthesis; tautomerism (keto-enol).

2.6 *Chemistry of aromatic compounds*: Aromaticity; Huckel's rule; electrophilic aromatic substitutionnitration, 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*: (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.

04. COMPUTER APPLICATIONS

1. BASIC MATHEMATICS: Prepositional logic sets, relations, functions, partial orders, matrix, algebra, integration, differentiation.

2. DIGITAL COMPUTER FUNDAMENTALS Number systems - Decimal, Binary, Octal, Hexadecimal - Conversion from one to another -Characters and codes - ASCII code, Excess-3 code, gray code - Binary addition, subtraction, multiplication and division - Unsigned binary numbers - Signed magnitude numbers - Complements in number systems - Truth tables, AND, OR, NOT, NOR & NAND gates, EX-OR gates - Parity generators and checkers. Boolean Algebra and Digital Circuits : Boolean laws and theorems - De Morgan's theorems - Duality theorem - Simplification of sum of 2 product and product of sum expressions - Karnaugh map and simplifications - Simple arithmetic circuits - Half and Full adders - Binary adder/subtracter - BCD adder - Data processing circuits - Multiplexers - Demultiplexers - Encoders and Decoders. Operating Systems: Types - Scheduling algorithms, Memory Management - Requirements - Partitioning - Paging - Segmentation - Virtual memory.

3. PROGRAMMING IN C AND C++ Data Types - Variables - Operators - Control structures - Looping structures - Arrays - Strings - Built-in-functions. Function - Scope of Variables - Advanced features of functions. Pointer - Pointers to Array - Pointer Array - Pointer Arithmetic - Pointer of Pointer -Functions and Pointers - Structures and Pointers - Dynamic Allocation - Function pointer. C++: Objects - Classes - Inheritance-reusability - Creating new data types - Polymorphism and overloading.

4. MANAGEMENT INFORMATION SYSTEMS Fundamentals of Information System – Overview of Information of System Solving Business Problems with Information Systems : System Approach to Problem Solving –Developing Information System Solution – Information Systems for Strategic Advantages – Fundamentals of Strategic Advantage - Strategic Applications and Issues in It; Managing IT : Enterprise and Global Management. Business applications of Information Technology: The Internet and Electronic Commerce – Fundamentals of Electronic

Commerce – Information System for Business Operations: Business Information System – Transaction – processing Systems. Information systems for Managerial Decision Support : Decision Support Systems – Artificial Intelligence technology in Business – Managing IT – Planning for Business change with IT – Implementing business change with IT – Security & Control Issues in I/S - Ethical and societal challenges of Information Technology.

5. COMPUTER NETWORKS Introduction to Computer Networks and Data Communication: Need for computer networks - evolution - Data Communication - Data Transmission - Transmission media - Classification of Networks - Switching and Routing - Routing - Multiplexing and Concentration Concentrator - Terminal Handling - Components of a Computer Network. Network Standards and OSI - Need for network standard - OSI reference model - Physical layer - Data link layer - Network layer - Transport layer - Session layer - Application layer.

6. FUNDAMENTALS OF DATABASES Early Information Systems - Problems with Early Information Systems - Organization of Data Base - Components of Data Base Management System-Data Models - Entity -Relationship Model - Network Data Model, Hierarchical Data Model - Semantic Data Modelling. File Organization - Sequential file organization - The indexed sequential file organization -Creation and manipulating of indexed sequential file - Hashing - Key-to- address transformation. Relational Data Model: Introduction - Basic definition and terminology - Relational algebra.

7. OFFICE AUTOMATION Features of MS – Windows, Control Panel, Taskbar, Desktop, Windows Application, Icons, Windows Accessories, Notepad, Paintbrush. Editors and Word Processors: Basic Concepts, Examples: MS-Word, Introduction to desktop publishing. Spreadsheets and Database packages: Purpose, usage, command, MS-Excel, Creation of files in MS-Access, Switching between application, MS-Power Point.

8. MULTIMEDIA AND APPLICATIONS Uses of Multimedia – Introduction to making multimedia – Multimedia skills. Multimedia hardware and software – Connections – Memory and storage devices – Input devices – Output devices – Communication devices. Basic software tools – Text editing and word processing tools – Painting and drawing tools – 3-D modelling and animation tools – Image editing tools – Animation, video and digital movie tools. Making instant multimedia – Multimedia authoring tools. Multimedia Building Blocks – Text – Sound – Multimedia System Sounds – MIDI versus Digital Audio – Digital Audio – Making MIDI Audio – Audio File Formats – Production tips - Images – Animation - Video.

9. WEB TECHNOLOGIES The world wide web: Browsing the Web - Web address - Web browser basics - Strong and managing (book marks) - Surfing the web with web browser - Searching the web directory - Search engines - Navigation tools. Email: Sending - Reading - Replying - Deleting - Exiting - Sending Mail to more than one person sending folder - Forwarding a mail - Checking the spelling - Attachments. HTML: Overview of HTML - Adding structure to a page formatting text and pages - Linking page to the world - Including picture - Clearing lists - Arranging items within tables - Getting feedback from form - Splitting a page into frames.

10. ORGANIZATIONAL BEHAVIOUR Organizational Behaviour models, Foundation of individual Behaviour, Concept of Attitude, Concept of value, concept of JOB Satisfaction learning theories, Foundation of GROUP BEHAVIOUR – reasons for GROUP formation by people, Leadership concept.

05. COMPUTER SCIENCE

1. MATHEMATICAL FOUNDATIONS Prepositional logic sets, relations, functions, partial orders and lattices, regular and context free languages, finite state machines and pushdown automata.

2. COMPUTER ORGANIZATION Function organization, machine instructions, addressing modes, introduction to microprocessors, study of 8085/8086 communication between processor and I/O via DMA and interrupt priority, I/O processors, problems associated with bus scheduling. Micro computer memory, virtual memory, basic concepts, problems of virtual memory, page replacements algorithms, cache memory, associative memory. Fundamentals of parallel processing and its necessity pipelined processors and multiprocessors.

3. DATA STRUCTURES IN C Data types, control statements, procedures, Scope rules, arrays and records, enumerated data types, sets, pointers, recursion. Sequential, indexed files, sorting and merging report generations. Arrays, queues, linked lists, stacks, tree traversal, evaluation of expressions using postfix notation, sorting algorithms, bubble sort, quick sort, heap sort, complexity of algorithms.

4. SYSTEMS SOFTWARE Editors, loaders, linkers, assemblers, phases of a compiler and their function, lexical analysers and parsers, parsing techniques, symbol table, code generation. Batch, Multi-programming and time sharing systems, processor memory, device and file management, virtual memory, process scheduling, inter process communication, I/O redirection, process synchronization and concurrency, deadlocks, prevention, avoidance, detection and recovery, auxiliary storage management, file system functions and its hierarchy.

5. DATABASE SYSTEMS File organisation techniques: indexing, relational and network data models, study of ORACLE as a relational DBMS. Data dictionary, normal forms and query languages.

6. COMPUTER NETWORKS Data communication concepts, concepts of LAN, evolution of LAN, OSI - 7 layer reference model and design issues. Physical layer-transmission media, packet and circuit switching, topologies, Data link layer, token passing, sliding window protocols, protocols specification and verification, network layer, routing, congestion control, transport layer, session and presentation layers, design issues, application layer, file transfer, electronic mail.

7. SOFTWARE ENGINEERING Systems analysis, detailed analysis, feasibility study, tools for system designer, input and output design, program definition, module design and design review, structured programming and conversion, testing, training and documentation, systems life cycle, role of System Analyst. Tools for office Automation, word processing Spreadsheets, Financial and Statistical packages, payroll, inventory, picture generation and display in computers, Multimedia systems, Application of computers in Government, Defence, Agriculture, Medicine and Education.

8.COMPUTER GRAPHICS Introduction – Point plotting techniques – Line drawing displays – Two dimensional displays – Clipping and Windowing. Graphics package – Segmented display files – Display file compilation – Geometric models – Picture structure. Graphical input units – graphical input techniques – Event handling – Input functions. Raster graphics fundamentals – Solid area scan conversion – Interactive raster graphics – Raster graphics systems – Raster display hardware. Two dimensional and three dimensional transformations.

9. OBJECT ORIENTED PROGRAMMING (C++ & JAVA) C++ and Java programming, objects and data, derived types, loops and relational expressions, branching statements and logical operators, functions, objects and classes, operator overloading, conversion of functions, dynamic memory and classes, class inheritence, input/ output and files, benefits of OOP, object oriented system development tools.

10. WEB TECHNOLOGIES The world wide web: Browsing the Web - Web address - Web browser basics - Strong and managing (book marks) - Surfing the web with web browser - Searching the web directory - Search engines - Navigation tools. Email: Sending - Reading - Replying - Deleting - Exiting - Sending Mail to more than one person sending folder - Forwarding a mail - Checking the spelling - Attachments. HTML: Overview of HTML - Adding structure to a page formatting text and pages - Linking page to the world - Including picture - Clearing lists -

Arranging items within tables - Getting feedback from form - Splitting a page into frames.

06. AGRICULTURAL ENGINEERING

1. Soil Science +soil physics +soil mechanics
2. Agronomy +Agricultural Extension + Agricultural Economics
3. Heat and mass transfer +Refrigeration and Air conditioning.
4. Unit operations in Agricultural process Engineering
5. Process Engineering for Agricultural produce starting from crop threshing and upto storage of crops
6. Process Engineering for horticulture produce + dairy Engineering
7. Strength of materials and theory of structures
8. Electrical Engineering and farm electrification, Thermodynamics-heat engines and farm power and alternate energy sources
11. Farm machinery and equipment
12. Instrumentation-design of Agricultural machines-Industrial Engineering, Land development machinery
13. Surveying and levelling
14. Open channels-wells and pumps, Irrigation + drainage + sprinkler and drip systems, Soil and water conservation + soil conservation structures.

07. CHEMICAL ENGINEERING

1. 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.

2. 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.

3. 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.

4. 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 adsorption.

5. 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.

6. 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.

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

8. 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

1. Building Materials:

Stone, Lime, Glass, Plastics, Steel, FRP, Ceramics, Aluminum, Fly Ash, Basic Admixtures, Timber, Bricks and Aggregates: Classification, properties and selection criteria;

Cement: Types, Composition, Properties, Uses, Specifications and various Tests; Lime & Cement Mortars and Concrete: Properties and various Tests; Design of Concrete Mixes: Proportioning of aggregates and methods of mix design.

2. Solid Mechanics:

Elastic constants, Stress, plane stress, Strains, plane strain, Mohr's

circle of stress and strain, Elastic theories of failure, Principal Stresses, Bending, Shear and Torsion.

3. Structural Analysis:

Basics of strength of materials, Types of stresses and strains, Bending moments and shear force, concept of bending and shear stresses; Analysis of determinate and indeterminate structures; Trusses, beams, plane frames; Rolling loads, Influence Lines, Unit load method & other methods; Free and Forced vibrations of single degree and multi degree freedom system; Suspended Cables; Concepts and use of Computer Aided Design.

4. Design of Steel Structures:

Principles of Working Stress methods, Design of tension and compression members, Design of beams and beam column connections, built-up sections, Girders, Industrial roofs, Principles of Ultimate load design.

5. Design of Concrete and Masonry structures:

Limit state design for bending, shear, axial compression and combined forces; Design of beams, Slabs, Lintels, Foundations, Retaining walls, Tanks, Staircases; Principles of pre-stressed concrete design including materials and methods; Earthquake resistant design of structures; Design of Masonry Structure.

6. Construction Practice, Planning and Management:

Construction - Planning, Equipment, Site investigation and Management including Estimation with latest project management tools and network analysis for different Types of works; Analysis of Rates of various types of works; Tendering Process and Contract Management, Quality Control, Productivity, Operation Cost; Land acquisition; Labour safety and welfare.

7. Fluid Mechanics, Open Channel Flow, Pipe Flow:

Fluid properties; Dimensional Analysis and Modeling; Fluid dynamics including flow kinematics and measurements; Flow net; Viscosity, Boundary layer and control, Drag, Lift, Principles in open channel flow, Flow controls. Hydraulic jump; Surges; Pipe networks.

8. Hydraulic Machines and Hydro power -

Various pumps, Air vessels, Hydraulic turbines – types, classifications & performance parameters; Power house – classification and layout, storage, pondage, control of supply.

9. Hydrology and Water Resources Engineering:

Hydrological cycle, Ground water hydrology, Well hydrology and related data analysis; Streams and their gauging; River

morphology; Flood, drought and their management; Capacity of Reservoirs. Water Resources Engineering : Multipurpose uses of Water, River basins and their potential; Irrigation systems, water demand assessment; Resources - storages and their yields; Water logging, canal and drainage design, Gravity dams, falls, weirs, Energy dissipaters, barrage Distribution works, Cross drainage works and head-works and their design; Concepts in canal design, construction & maintenance; River training, measurement and analysis of rainfall.

10. Water Supply Engineering:

Sources, Estimation, quality standards and testing of water and their treatment; Rural, Institutional and industrial water supply; Physical, chemical

and biological characteristics and sources of water, Pollutants in water and its

effects, Estimation of water demand; Drinking water Standards, Water Treatment Plants, Water distribution networks.

11. Waste Water Engineering:

Planning & design of domestic waste water, sewage collection and disposal; Plumbing Systems. Components and layout of sewerage system; Planning & design of Domestic Waste-water disposal system; Sludge management including treatment, disposal and re-use of treated effluents; Industrial waste waters and Effluent Treatment Plants including institutional and industrial sewage management.

12. Solid Waste Management:

Sources & classification of solid wastes along with planning & design of its management system; Disposal system, Beneficial aspects of wastes and Utilization by Civil Engineers.

Air, Noise pollution and Ecology:

Concepts & general methodology.

13. Geo-technical Engineering and Foundation Engineering :

(a) Geo-technical Engineering: Soil exploration - planning & methods, Properties of soil, classification, various tests and inter- relationships; Permeability & Seepage, Compressibility, consolidation and Shearing resistance, Earth pressure theories and stress distribution in soil;

Properties and uses of geo-synthetics.

(b) Foundation Engineering: Types of foundations & selection criteria, bearing capacity, settlement analysis, design and testing of shallow & deep foundations; Slope stability analysis, Earthen embankments, Dams and Earth retaining structures: types, analysis and design, Principles of ground modifications.

14. Surveying and Geology:

a. Surveying: Classification of surveys, various methodologies, instruments & analysis of measurement of distances, elevation and directions; Field astronomy, Global Positioning System; Map preparation; Photogrammetry; Remote sensing concepts; Survey Layout for culverts, canals, bridges, road/railway alignment and buildings, Setting out of Curves.

b. Geology: Basic knowledge of Engineering geology & its application in projects.

15. Transportation Engineering:

Highways - Planning & construction methodology, Alignment and geometric design; Traffic Surveys and Controls; Principles of Flexible and Rigid pavements design.

Tunneling - Alignment, methods of construction, disposal of muck, drainage, lighting and ventilation.

Railways Systems – Terminology, Planning, designs and maintenance practices; track modernization.

Harbours – Terminology, layouts and planning.

Airports – Layout, planning & design.

09. COMPUTER ENGINEERING

1. C PROGRAMMING AND OOP Functions and Pointers in C: Storage classes – Recursion – Preprocessor directives – Arrays – Strings – Arrays, pointers and strings. Pointers to functions – Dynamics Memory Allocation – Structures – Unions – Enumeration Types – Bit fields – Files – Object Oriented Programming: Classes and methods – Constructors and Destructors – Class and Object – Scope – Overloading – Arrays – Type Casting – Pointer. Java API Packages –Inheritance – Sub Classes – Implications of Inheritance – Exception Handling – Assertions – Garbage Collection – String Class – Inheritance – Multiple Inheritance – Polymorphism – Abstract Classes and Methods – Overloading and Overriding – Pure Polymorphism – Operator instance of and Down Casting – Final Methods and

Classes – Clone class – Multithreading – Files and Streams – Formatted Output – Object Concurrency – Serialization – Generic Collections – Generic Classes and Methods – Applets – Frameworks.

2. DATA STRUCTURES AND DESIGN AND ANALYSIS OF ALGORITHMS Arrays - Lists – Singly and Doubly linked lists – Stacks – Queues – Insert, Delete and Search operations – Trees – Binary Trees – Binary Search Trees – Representation, Insert, Delete, Traversal – AVL Trees, Heaps – Priority Queues – Graphs – Representation, Traversals – Hashing Algorithms – Growth of Functions – Asymptotic Notation, O, Ω, θ – Solving Recurrence Equations – Algorithms Strategies – Divide and Conquer – Quicksort, Merge Sort, Binary Search – Dynamic Programming – Warshall and Floyd's algorithms –Greedy Strategy – Minimum Spanning Tree – Shortest Path Algorithm – String Matching algorithms – Naïve, Knuth Morris Pratt – NP Problems – NP Complete – NP Hard – Reducibility – Vertex Cover, Hamiltonian Cycle – Travelling Salesperson Problem – Approximation algorithms.

3. DIGITAL LOGIC, COMPUTER ORGANIZATION AND COMPUTER ARCHITECTURE Boolean Algebra and Logic Gates – Combinational Logic – Sequential logic – Functional Units of a Digital Computer – Instruction Set Architecture – RISC and CISC Architectures – Data path and Control – Hazards – Structural, Data and Control Hazards – Dynamic Scheduling – Speculation – ILP and Thread Level Parallelism – Arithmetic – Addition and Subtraction – Binary Multiplication – Binary Division – Floating Point Numbers – Cache Memories – Virtual Memory – Associative memories – Accessing I/O devices – Interrupts - Direct Memory Access – Interface Circuits.

4. OPERATING SYSTEMS AND SYSTEM SOFTWARE INTERNALS Evolution of OS-Virtual Machines – multiprocessor and multi core. Process states – description, control-execution of OS-Security issues. Threads - Types of threads, multi core and multithreading. Uni and multiprocessor scheduling, real time scheduling. Mutual exclusion, semaphores, monitors, massage passing, reader-writer problem. Deadlock prevention, avoidance, detection, integrated deadlock strategy, dining philosopher's problem. Address binding, logical versus physical address space, dynamic loading and linking, shared libraries, overlays, swapping, contiguous memory allocation, paging, segmentation-Demand paging, process creation, page replacement, frame allocation, thrashing-I/O devices, Organization of I/O function, I/O buffering, disk scheduling. File Management. Access and organization, file directories and sharing, secondary storage management. Linux Systems. One and Two Pass Assemblers – One and Two Pass Loaders, Linkers – One pass

Macroprocessors and Emulators – Virtual Machines – Object Oriented VMs – Java VM Architecture – Profiling – Migration – Grids.

5. DATABASE MANAGEMENT SYSTEMS Database Applications – Data Models – Database Architecture – Key issues and Challenges in Database Systems – ER Models – ER to Relational Mapping – Object Relational Mapping – Relational Model - Constraints – Keys – Dependencies – Relational Algebra – Normalization – First, Second, Third & Fourth Normal Forms – BCNF – Join Dependencies – SQL – Embedded & Dynamic SQL – Data Constraints – Database Security – Transaction Systems – ACID Properties – System & Media Recovery – Concurrency – Lacking Protocols – Log Based Recovery – Two Phase Commit Protocol -Recovery – Deadlocks & Managing Deadlocks – Indexing & Hashing Techniques – Query Processing & Optimization – Sorting & Joins – Database Tuning – Data Mining and Warehousing.

6. SOFTWARE ENGINEERING Software life-cycle and process models; Process assessment models; Project management activates. Requirements elicitation and analysis; Functional and non-functional requirements; User and system requirements, Requirement validation and specification. Design principles; System Models-Context, Behavioural, Data and object models, Architectural design-system structuring, Control models; Structured and object- oriented design; User interface design; Verification and validation planning; Test plan creation and test case generation; Black-box and White-box testing techniques; Unit, integration, validation and system testing; Object-oriented testing; Software inspections. Software maintenance; Reengineering; Legacy systems; Software reuse. Roles and responsibilities in a software team, Project Planning and Scheduling; Software measurement and estimation; Risk analysis and management; Quality management; Configuration management. Quality assurance and Process Improvement; ISO 9000, CMMI, TQM and Six Sigma; programming environments; Project management tools; Requirements analysis and design tools; Testing tools; Configuration management tools; CASE tools.

7. COMPUTER NETWORKS AND SECURITY ISO/OSI Model – HTTP – FTP – Telnet – Email – DNS – Application Performance. User Datagram Protocol (UDP) – Reliable Data Transfer – Transmission control Protocol (TCP) - Flow Control – Congestion Control. Internet Protocol – IPV4 Packet Format – IP Addressing – Subnetting – Classless Inter Domain Routing (CIDR) – BOOTP/DHCP-ICMP – Routing Principles – Distance Vector Routing (RIP) – Link State Routing (OSPF) – Path Vector Routing (BGP). Framing – Addressing – Error Detection/ Correction – Multiple Access Protocols – Address Resolution Protocol (ARP) – Ethernet Basics – CSMA/CD –

Frame Format – Switching – Types (datagram, virtual) – Wireless LAN (802.11). Encryption Techniques – DES – Modes of operation – Triple DES – AES – RSA - Attacks. Diffie – Hellman key exchange – Elliptic curve cryptography key exchange – Message Authentication codes – Hash functions – Digital Signatures. Kerberors – X.509 – PGP, S/MIME-IP Security – Web Security – SSL, TLS, SET – System security.

8. EMBEDDED SYSTEMS Embedded System design process, Embedded processors – ARM Processor – Architecture, ARM and Thumb Instruction sets – Embedded C Programming – Looping Structures – Register Allocation – Function calls – Pointer aliasing – Structure arrangement – bit fields – unaligned data and endianness – inline functions and inline assembly – portability issues. Profiling and cycle counting – instruction scheduling – Register allocation – Conditional execution – looping constructs – bit manipulation – optimized primitives. Multiple tasks and processes – Context switching – Scheduling policies – Interprocess communication mechanisms – Exception and interrupt handling –Performance issues. Meeting real time constraints – Multi-state systems and function sequences – Embedded software development tools – Emulators and debuggers – Design methodologies.

9. CLOUD COMPUTING AND VIRTUALIZATION Cloud Components, Infrastructure, Architecture, Applications, Benefits, Limitations, Cloud Deployment Models, Cloud Technologies. Infrastructure as a Service (IaaS) – Storage as a Service – Compute as a Service – Platform as a Service (PaaS) – Software as a Service (SaaS) : CRM as a Service, Social Computing Services, Document Services. Taxonomy, Server Virtualization, Desktop Virtualization, Network Virtualization, Storage Virtualization, Hypervisor. Hardware and Infrastructure – Server, Clients, Network, Services. Accessing the Cloud-Web Applications, Web API, Web Browsers. Scalable data storage techniques. Map reduce Framework – Hadoop, HDFS. Cloud Security: Requirements, Security Threats, Cloud Security Mechanisms. Scalability, Availability, Migration, Security, Network Congestion, Leasing and Billing, on demand allocation problems.

10. WEB TECHNOLOGY AND MOBILE COMPUTING Internet and WWW Protocols, Client side Programming: HTML, CSS, JavaScript, XML, DTD, Schema, XSLT, server side Programming: Python, PHP, Web Servers: configuration, security, Core Java: I/O, AWT, Network Programming, RMI, JDBC, Applets, Swing, Advanced Java: JSP, Servlets, Beans, MVC. Web Frameworks: sessions, user management, legacy databases and applications, Web Application development. Web Services: SOAP, UDDI, WSDL. Pervasive Computing – Architecture and Applications –Smart devices and operating systems, secure services – Mobile Applications: Mobile

Ecosystem – Medium Access and Telecommunications: Frequencies – Signals – Antennas – Signal propagation – Media Access Control – Protocols, Localization and calling, Handove – GPRS. Wireless Networks: Infrastructure and ad hoc networks – WLAN, IEEE 802.11 standards protocols. Piconet – Bluetooth – architecture and services. Mobile IP – DHCP – Routing in Mobile ad hoc networks.

10. ELECTRICAL ENGINEERING

1. Engineering Mathematics

Matrix theory, Eigen values & Eigen vectors, system of linear equations, Numerical methods for solution of non-linear algebraic equations and differential equations, integral calculus, partial derivatives, maxima and minima, Line, Surface and Volume Integrals. Fourier series, linear, non-linear and partial differential equations, initial and boundary value problems, complex variables, Taylor's and Laurent's series, residue theorem, probability and statistics fundamentals, Sampling theorem, random variables, Normal and Poisson distributions, correlation and regression analysis.

2. Electrical Materials

Electrical Engineering Materials, crystal structures and defects, ceramic materials, insulating materials, magnetic materials

– basics, properties and applications; ferrities, ferro-magnetic materials and components; basics of solid state physics, conductors; Photo-conductivity;Basics of Nano materials and Superconductors.

3. Electric Circuits and Fields

Circuit elements, network graph, KCL, KVL, Node and Mesh analysis, ideal current and voltage sources, Thevenin's, Norton's, Superposition and Maximum Power Transfer theorems, transient response of DC and AC networks, Sinusoidal steady state analysis, basic filter concepts, two-port networks, three phase circuits, Magnetically coupled circuits, Gauss Theorem, electric field and potential due to point, line, plane and spherical charge distributions, Ampere's and Biot- Savart's laws; inductance, dielectrics, capacitance; Maxwell's equations.

4. Electrical and Electronic Measurements:

Principles of measurement, accuracy, precision and standards; Bridges and potentiometers; moving coil, moving iron, dynamometer and induction type instruments, measurement of voltage, current, power, energy and power factor, instrument transformers, digital voltmeters and

multi-meters, phase, time and frequency measurement, Q-meters, oscilloscopes, potentiometric recorders, error analysis, Basics of sensors, Transducers, basics of data acquisition systems

5. Computer Fundamentals:

Number systems, Boolean algebra, arithmetic functions, Basic Architecture, Central Processing Unit, I/O and Memory Organisation; peripheral devices, data representation and programming, basics of Operating system and networking, virtual memory, file systems; Elements of programming languages, typical examples.

6. Basic Electronics Engineering:

Basics of Semiconductor diodes and transistors and characteristics, Junction and field effect transistors (BJT, FET and MOSFETS), different types of transistor amplifiers, equivalent circuits and frequency response; oscillators and other circuits, feedback amplifiers.

7. Analog and Digital Electronics:

Operational amplifiers – characteristics and applications, combinational and sequential logic circuits, multiplexers, multi-vibrators, sample and hold circuits, A/D and D/A converters, basics of filter circuits and applications, simple active filters; Microprocessor basics- interfaces and applications, basics of linear integrated circuits; Analog communication basics, Modulation and de-modulation, noise and bandwidth, transmitters and receivers, signal to noise ratio, digital communication basics, sampling, quantizing, coding, frequency and time domain multiplexing, power line carrier communication systems.

8. Systems and Signal Processing:

Representation of continuous and discrete-time signals, shifting and scaling operations, linear, time-invariant and causal systems, Fourier series representation of continuous periodic signals, sampling theorem, Fourier and Laplace transforms, Z transforms, Discrete Fourier transform, FFT, linear convolution, discrete cosine transform, FIR filter, IIR filter, bilinear transformation.

9. Control Systems:

Principles of feedback, transfer function, block diagrams and signal flow graphs, steady-state errors, transforms and their applications; Routh-hurwitz criterion, Nyquist techniques, Bode plots, root loci, lag, lead and lead-lag compensation, stability analysis, transient and frequency response analysis, state space model, state transition matrix,

controllability and observability, linear state variable feedback, PID and industrial controllers.

10. Electrical Machines:

Single phase transformers, three phase transformers-connections, parallel operation, auto-transformer, energy conversion principles, DC machines - types, windings, generator characteristics, armature reaction and commutation, starting and speed control of motors, Induction motors - principles, types, performance characteristics, starting and speed control, Synchronous machines - performance, regulation, parallel operation of generators, motor starting, characteristics and applications, servo and stepper motors.

11. Power Systems:

Basic power generation concepts, steam, gas and water turbines, transmission line models and performance, cable performance, insulation, corona and radio interference, power factor correction, symmetrical components, fault analysis, principles of protection systems, basics of solid state relays and digital protection; Circuit breakers, Radial and ring-main distribution systems, Matrix representation of power systems, load flow analysis, voltage control and economic operation, System stability concepts, Swing curves and equal area criterion. HVDC transmission and FACTS concepts, Concepts of power system dynamics, distributed generation, solar and wind power, smart grid concepts, environmental implications, fundamentals of power economics.

12. Power Electronics and Drives:

Semi conductor power diodes, transistors, thyristors, triacs, GTOs, MOSFETs and IGBTs- static characteristics and principles of operation, triggering circuits, phase control rectifiers, bridge converters - fully controlled and half controlled, principles of choppers and inverters, basis concepts of adjustable speed DC and AC drives, DC-DC switched mode converters, DC-AC switched mode converters, resonant converters, high frequency inductors and transformers, power supplies.

11. ELECTRONICS ENGINEERING

1. **Basic Electronics Engineering:**

Basics of semiconductors; Diode/Transistor basics and characteristics; Diodes for different uses; Junction & Field Effect Transistors (BJTs, JFETs, MOSFETs); Transistor amplifiers of different types, oscillators

and other circuits; Basics of Integrated Circuits (ICs); Bipolar, MOS and CMOS ICs; Basics of linear ICs, operational amplifiers and their applications-linear/non-linear; Optical sources/detectors; Basics of Optoelectronics and its applications.

2. **Basic Electrical Engineering:**

DC circuits-Ohm's & Kirchoff's laws, mesh and nodal analysis, circuit theorems; Electro-magnetism, Faraday's & Lenz's laws, induced EMF and its uses; Single-phase AC circuits; Transformers, efficiency; Basics-DC machines, induction machines, and synchronous machines; Electrical power sources- basics: hydroelectric, thermal, nuclear, wind, solar; Basics of batteries and their uses.

3. **Materials Science:**

Electrical Engineering materials; Crystal structure & defects; Ceramic materials-structures, composites, processing and uses; Insulating laminates for electronics, structures, properties and uses; Magnetic materials, basics, classification, ferrites, ferro/para-magnetic materials and components; Nano materials-basics, preparation, purification, sintering, nano particles and uses; Nano-optical/magnetic/electronic materials and uses; Superconductivity, uses.

4. **Electronic Measurements and Instrumentation:**

Principles of measurement, accuracy, precision and standards; Analog and Digital systems for measurement, measuring instruments for different applications; Static/dynamic characteristics of measurement systems, errors, statistical analysis and curve fitting; Measurement systems for non-electrical quantities; Basics of telemetry; Different types of transducers and displays; Data acquisition system basics.

5. **Network Theory:**

Network graphs & matrices; Wye-Delta transformation; Linear constant coefficient differential equations- time domain analysis of RLC circuits; Solution of network equations using Laplace transforms- frequency domain analysis of RLC circuits; 2-port network parameters-driving point & transfer functions; State equations for networks; Steady state sinusoidal analysis.

6. **Analog and Digital Circuits:**

Small signal equivalent circuits of diodes, BJTS and FETs; Diode circuits for different uses; Biasing & stability of BJT & JFET amplifier circuits; Analysis/design of amplifier-single/multi-stage; Feedback & uses; Active

filters, timers, multipliers, wave shaping, A/D-D/A converters; Boolean Algebra& uses; Logic gates, Digital IC families, Combinatorial/sequential circuits; Basics of multiplexers, counters/registers/memories/ microprocessors, design & applications.

7. Analog and Digital Communication Systems:

Random signals, noise, probability theory, information theory; Analog versus digital communication & applications: Systems- AM, FM, transmitters/receivers, theory/practice/ standards, SNR comparison; Digital communication basics: Sampling, quantizing, coding, PCM, DPCM, multiplexing-audio/video; Digital modulation: ASK, FSK, PSK; Multiple access: TDMA, FDMA, CDMA; Optical communication: fibre optics, theory, practice/standards.

8. Control Systems:

Classification of signals and systems; Application of signal and system theory; System realization; Transforms & their applications; Signal flow graphs, Routh-Hurwitz criteria, root loci, Nyquist/ Bode plots; Feedback systems-open & close loop types, stability analysis, steady state, transient and frequency response analysis; Design of control systems, compensators, elements of lead/ lag compensation, PID and industrial controllers.

9. Computer Organization and Architecture:

Basic architecture, CPU, I/O organisation, memory organisation, peripheral devices, trends; Hardware /software issues; Data representation & Programming; Operating systems-basics, processes, characteristics, applications; Memory management, virtual memory, file systems, protection & security; Data bases, different types, characteristics and design; Transactions and concurrency control; Elements of programming languages, typical examples.

10. Electro Magnetics:

Elements of vector calculus, Maxwell's equations-basic concepts; Gauss', Stokes' theorems; Wave propagation through different media; Transmission Lines-different types, basics, Smith's chart, impedance matching/transformation, S-parameters, pulse excitation, uses; Waveguides-basics, rectangular types, modes, cut-off frequency, dispersion, dielectric types;Antennas-radiation pattern, monopoles/dipoles, gain, arrays-active/passive, theory, uses.

11. Advanced Electronics Topics:

VLSI technology: Processing, lithography, interconnects, packaging, testing; VLSI design: Principles, MUX/ROM/PLA-baseddesign, Moore & Mealy circuit design; Pipeline concepts & functions; Design for testability, examples; DSP: Discrete time signals/systems, uses; Digital filters: FIR/IIR types, design, speech/audio/radar signal processing uses; Microprocessors &microcontrollers, basics, interrupts, DMA, instruction sets, interfacing; Controllers & uses; Embedded systems.

12. MECHANICAL ENGINEERING

1. Fluid Mechanics:

Basic Concepts and Properties of Fluids, Manometry, Fluid Statics, Buoyancy, Equations of Motion, Bernoulli's equation and applications, Viscous flow of incompressible fluids, Laminar and Turbulent flows, Flow through pipes and head losses in pipes.

2. Thermo dynamics and Heat transfer:

Thermodynamic systems and processes; properties of pure substance; Zeroth, First and Second Laws of Thermodynamics; Entropy, Irreversibility and availability; analysis of thermodynamic cycles related to energy conversion: Rankine, Otto, Diesel and Dual Cycles; ideal and real gases; compressibility factor; Gas mixtures. Modes of heat transfer, Steady and unsteady heat conduction, Thermal resistance, Fins, Free and forced convection, Correlations for convective heat transfer, Radiative heat transfer–Radiationheattransferco-efficient;boilingandcondensation, Heat exchanger performance analysis.

3. IC Engines, Refrigeration and Air conditioning:

SI and CI Engines, Engine Systems and Components, Performance characteristics and testing of IC Engines; Fuels; Emissions and Emission Control. Vapour compression refrigeration, Refrigerants and Working cycles, Compressors, Condensers, Evaporators and Expansion devices, other types of refrigeration systems like Vapour Absorption, Vapour jet, thermo electric and Vortex tube refrigeration. Psychometric properties and processes, Comfort chart, Comfort and industrial air conditioning, Load calculations and Heat pumps.

4. Turbo Machinery:

Reciprocating and Rotary pumps, Pelton wheel, Kaplan and Francis Turbines, velocity diagrams, Impulse and Reaction principles, Steam and

Gas Turbines, Theory of Jet Propulsion – Pulse jet and Ram Jet Engines, Reciprocating and Rotary Compressors – Theory and Applications.

5. Power Plant Engineering:

Rankine and Brayton cycles with regeneration and reheat, Fuels and their properties, Flue gas analysis, Boilers, steam turbines and other power plant components like condensers, air ejectors, electrostatic precipitators and cooling towers – their theory and design, types and applications;

6. Renewable Sources of Energy:

Solar Radiation, Solar Thermal Energy collection - Flat Plate and focusing collectors their materials and performance. Solar Thermal Energy Storage, Applications – heating, cooling and Power Generation; Solar Photovoltaic Conversion; Harnessing of Wind Energy, Bio-mass and Tidal Energy– Methods and Applications, Working principles of Fuel Cells.

7. Engineering Mechanics:

Analysis of System of Forces, Friction, Centroid and Centre of Gravity, Dynamics; Stresses and Strains-Compound Stresses and Strains, Bending Moment and Shear Force Diagrams, Theory of Bending Stresses- Slope and deflection-Torsion, Thin and thick Cylinders, Spheres.

8. Engineering Materials:

Basic Crystallography, Alloys and Phase diagrams, Heat Treatment, Ferrous and Non Ferrous Metals, Non metallic materials, Basics of Nano-materials, Mechanical Properties and Testing, Corrosion prevention and control.

9. Mechanisms and Machines:

Types of Kinematics Pair, Mobility, Inversions, Kinematic Analysis, Velocity and Acceleration Analysis of Planar Mechanisms, CAMs with uniform acceleration and retardation, cycloidal motion, oscillating followers; Vibrations –Free and forced vibration of undamped and damped SDOF systems, Transmissibility Ratio, Vibration Isolation, Critical Speed of Shafts. Gears–Geometry of tooth profiles, Law of gearing, Involute profile, Interference, Helical, Spiral and Worm Gears, Gear Trains- Simple, compound and Epicyclic; Dynamic Analysis – Slider –crank mechanisms, turning moment computations, balancing of Revolving & Reciprocating masses, Gyroscopes–Effect of Gyroscopic couple on automobiles, ships and aircrafts, Governors.

10. Design of Machine Elements:

Design for static and dynamic loading; failure theories; fatigue strength and the S-N diagram; principles of the design of machine elements such as

riveted, welded and bolted joints. Shafts, Spur gears, rolling and sliding contact bearings, Brakes and clutches, flywheels.

11. Manufacturing, Industrial and Maintenance Engineering:

Metal casting-Metal forming, Metal Joining, Machining and machine tool operations, Limits, fits and tolerances, Metrology and inspection, computer Integrated manufacturing, FMS, Production planning and Control, Inventory control and operations research - CPM-PERT. Failure concepts and characteristics-Reliability, Failure analysis, Machine Vibration, Data acquisition, Fault Detection, Vibration Monitoring, Field Balancing of Rotors, Noise Monitoring, Wear and Debris Analysis, Signature Analysis, NDT Techniques in Condition Monitoring.

12. Mechatronics and Robotics:

Microprocessors and Microcontrollers: Architecture, programming, I/O, Computer interfacing, Programmable logic controller. Sensors and actuators, Piezoelectric accelerometer, Hall effect sensor, Optical Encoder, Resolver, Inductosyn, Pneumatic and Hydraulic actuators, stepper motor, Control Systems- Mathematical modeling of Physical systems, control signals, controllability and observability. Robotics, Robot Classification, Robot Specification, notation; Direct and Inverse Kinematics; Homogeneous Coordinates and Arm Equation of four Axis SCARA Robot.

13. ENVIRONMENTAL SCIENCE

1. SCOPE AND IMPORTANCE OF ENVIRONMENTAL SCIENCE Definition; multidisciplinary nature of environmental science, scope and importance; global environmental problems; components of environment: biotic, abiotic. Atmosphere. Lithosphere: case study on major geological formations; Hydrosphere case study on major river systems in India.

2. ECOLOGICAL CONCEPTS Ecosystem definition; structure and function; energy flow, food chain and food web; ecological pyramids, biogeochemical cycles (Carbon, Nitrogen and Phosphorus); Hydrological cycle; ecosystem types: ponds, ocean, river, cropland, wetland, desert, forests and grassland; ecological succession; primary, secondary and tertiary producers. Examples of plant and animal adaptations for arid (desert and semi-desert) and humid (rain forest) biomes.

3. ENVIRONMENTAL RESOURCES Non-renewable resources - Mineral use and exploitation; fossil fuels. Renewable resources: water – surface and ground water, supply, demand, dams-benefits and problems; soil and land resources – Structure,

formation, erosion, conservation of soil, agricultural practices, land use, land degradation, desertification; Fisheries – inland and marine fisheries, aquaculture, overharvesting. Forest resources – Timber, medicinal plants, fuel-wood, deforestation, forest management. Management of renewable and non- renewable resources; sustainable use.

4. BIODIVERSITY AND CONSERVATION Biodiversity - Definition; Introduction to genetic, species and ecosystem diversity; biogeographical classification of India: tropical dry evergreen, thorny scrub, wet evergreen forests, grasslands, sholas, dry and mixed deciduous forests, mangroves. Coral reefs. Agro-biodiversity, land races and genetic resources. Valuation of biodiversity; Consumptive, productive, cultural value. Threats to biodiversity: habitat loss, poaching, over-utilisation, invasive species. Endemic and threatened species of Andaman and Nicobar Islands, Red data book, National Biodiversity Act, Wildlife Protection Act (1972).

5. HUMAN POPULATION AND ENVIRONMENT Population growth and regulation: Age pyramids, Malthusian theory, global trends of population growth, variation among nations and zero population growth. Environmental health, Nutrition and health. Communicable diseases such as typhoid, cholera, tuberculosis, hepatitis, influenza, HIV- social issues. Non-communicable diseases such as heart disease, diabetes, asthma. Epidemics. Environmental risk factors. Human displacement and rehabilitation, tribal population and welfare schemes, women and child welfare; Human rights, Intellectual Property Rights.

6. NATURAL CATASTROPHIES AND DISASTER MANAGEMENT Causes and effects of natural catastrophies – Earthquakes, floods, cyclones, hurricanes, storms, landslides, drought, famine, tsunami; pre-disaster and post - disaster management, risk assessment, early warning systems and forecasting. Role of administrators, scientists, planners, volunteers.

7. ENVIRONMENTAL POLLUTION Definition of pollution and pollutants; types of pollution - Air, water, soil, noise, thermal, nuclear; causes of pollution, effects of pollution and control measures; liquid and solid waste management, nuclear holocausts. Case studies: leather industry, fly ash, thermal stations, nuclear power plants.

8. ENVIRONMENTAL MANAGEMENT AND LEGISLATION Environmental Impact Assessment (EIA) : Objectives, Principles of Process, screening of projects, methodologies, checklist and documentation, prediction methodologies, public participation, limitation of EIA ; Environmental Protection Acts in India : air, water. Lake and River action programmes; coastal zone management; pollution control

boards, Management plans using Geographic Information System (GIS) and Remote Sensing (RS)tools.

9. ENVIRONMENTAL ORGANISATIONS AND AGENCIES International Organisations: United Nations Environment Programme (UNEP), International Union for Conservation of Nature and Natural Resources (IUCN), International Panel on Climate Change (IPCC), International Panel on Oceans (IPO), Earth Summit, Convention on Biological Diversity (CBD), World Wide Fund for Nature (WWF), Man and Biosphere Programme (MAB), India: Ministry of Environment, Forests and Climate Change (MoEFCC), Ministry of Earth Sciences (MoES), NGO's.

10. GLOBAL CLIMATE CHANGE Introduction to climate change, past climatic fluctuations. Current climate and weather –Wind, monsoon, cyclones. Global ocean circulation. Global warming and greenhouses gases – Carbon dioxide, methane, nitrous oxide, ozone. Sources of green house gases – Fossil fuel use, vehicle emissions, industry; agricultural practices, deforestation. Role of UNFCC (United Nation Framework Convention on Climate Change) in monitoring green house gas emissions. International treaties: Kyoto protocol, Paris agreement. Acid rain, source, impacts and management. Ozone layer depletion: causes, impacts and remediation.

14. FORESTRY

1. SILVICULTURE: 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.

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 12 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 modelling.

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 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.

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 a) General Geology: Solar System. The Earth: its origin, age and internal constitution. Volcanoestypes, 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.

b) 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.

c) 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 a) 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.

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 groups, anorthosites and alkaline rocks.

b) 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.

c) 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 a) 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.

b) 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.

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 Trichonasnuxvomica.

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

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; SubGroup, Cyclic groups, Permutation, Groups and their elementary properties. Rings, Integral Domains and Fields and their elementary properties.

2. 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.

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.

4. 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.

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

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.

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. Transport 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. Circulating 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

1. 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, long normal 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.

2. 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).

3. *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, 2n factorial design, total and partial confounding, 32 factorial experiments, split-plot design and balanced incomplete block design.

20. VETERINARY SCIENCE

1. GENERAL Role of livestock and their products in Indian economy and human health, current livestock programmes and policies of State and Nation – Economics of dairy, sheep, goat, poultry, pig and rabbit farming; constraints to the livestock development programs, common offences against animals – SPCA, Animal Welfare Board of India, NGOs.

2. LIVESTOCK MANAGEMENT Common terms used in Animal Husbandry – Identification of age of animals – Livestock and poultry breeds and breed characters; housing systems, and requirements of space, ventilation, water, sanitation and waste disposal. Management of milk, meat, egg and wool producing livestock, breeding bulls and draft animals and wild animals in captivity, farm records and their maintenance, systems and strategies for livestock improvement for enhancing productivity.

3. LIVESTOCK NUTRITION Nutritional terms and definitions – Role of nutrition in health and production; classification and composition of feed and fodders including forest grasses; anti-nutritional factors and toxins in feeds and fodders; feeding standards and nutrient requirements of different categories of livestock/ poultry and computation of rations. Nutritional deficiency and its influence on livestock performance; feed supplements and additives; conservation and preservation of feed and fodders; economic utilization of agro by-products for feeding livestock – Utilisation of unconventional feeds – Wildlife nutrition. Quality control of feed, feed block/baling, By-Pass Proteins and by-pass Fat, Feeding livestock during scarcity, Metabolic disorders in Livestock and Poultry, Processing of feeds and forage to improve nutritive value.

4. LIVESTOCK BREEDING AND GENETICS Important breeds of cattle, buffalo, sheep, goat, pig and poultry with special reference to economic characters – Important species of wild animals and their breeding in captivity. Selection of Livestock for production, reproduction and disease resistance traits. Principles of genetics and basis of population genetics, genetic parameters. Nature of DNA and RNA-their models and functions; applications of recombinant DNA technology, cloning and marker Assisted selection and Cytogenetics. Animal breeding policies and programmes in state and Nation.

5. VETERINARY ANATOMY, PHYSIOLOGY AND BIOCHEMISTRY Gross study of bones, joints and muscles of skeleton. Gross study of heart and its conduction system. Gross study of organs of digestive, respiratory urinary and reproductive systems. Digestion, metabolism and absorption of carbohydrates, proteins and fats in simple stomach animals and ruminants – mechanism of respiration. General functions of blood (blood cells, plasma & serum) coagulation, cardiac cycle, Blood circulation, Blood pressure, renal function Hormonal control of Lactogenesis. Environmental factors affecting animal production – Environmental stress on animal performance – Green Houses Gases – Role of ruminants.

6. VETERINARY MICROBIOLOGY, VETERINARY PREVENTIVE MEDICINE Bacteriology & Mycology: Classification - isolation, identification and culturing of

bacteria and fungi -Methods of transmission of infection - Sterilization and disinfection - Antibiogram. Virology: Classification, - cultivation, replication General characteristics of various families of RNA and DNA viruses. Immune system organs, tissues and cells; infection and immunity; type and grade of immunity, serological reactions and modern diagnostic techniques – vaccine. Epidemiology - Concept, Scope, Objectives and Uses. Monitoring and surveillance-epidemiological disciplines. Pathogenesis, clinical signs, differential diagnosis, prevention and control of common bacterial, viral, fungal, rickettsial and parasitic diseases of livestock, poultry and pet animals including wild life species- Regional, endemic, emerging and re-emerging important disease. Allergic skin tests and modern diagnostic techniques.

7. PATHOLOGY AND PARASITOLOGY Concept and causes of diseases in animals; general principles and procedures of necropsy; collection, preservation and dispatch of morbid materials for laboratory diagnosis, disease investigation; common pathological conditions seen in domestic, wild, zoo and laboratory animals and birds. Vetro-legal implications. Classification of Parasites – Parasite and parasitism in animals; important morphological features, life-cycles, mode of transmission, pathogenesis, diagnosis, chemotherapy and general control measures of parasites associated with disease in animals, birds and zoo animals.

8. PHARMACOLOGY Drug action – Pharmacokinetics (absorption, distribution, biotransformation and excretion), Pharmacodynamics – local and general anesthetics. Antibiotics and chemotherapy – Toxicology - Ethnoveterinary practices.

9. VETERINARY CLINICAL MEDICINE, VETERINARY GYNAECOLOGY ANDOBSTETRICS AND VETERINARY SURGERY AND RADIOLOGY General and special clinical examination, etiology, clinical signs, pathogenesis, diagnosis, prevention and control of metabolic, deficiency diseases. Ethics and jurisprudence in domestic and wild animals. Reproductive physiology; hormones and reproduction; Accidents of gestation, livestock fertility and infertility; artificial insemination; semen characteristics of different species of livestock and cryopreservation. Multiple ovulation and embryo transfer technology in livestock and zoo animals Reproductive disorders and their management. General surgical principles – Pre and post-operative considerations, anesthesia, asepsis and anti-sepsis and sterilization; scope, history and development of veterinary radiology; Imaging pathology of different parts of body-surgical emergencies – Intensive care – Physiotherapy – Diathermy.

10. LIVESTOCK PRODUCTS TECHNOLOGY Ante mortem and Post mortem inspection – Objectives of meat inspection – Abattoir practices, methods of

slaughtering and dressing; Meat inspection Laws, utilization of by products; unsound meat and its disposal; quality control of meat and eggs and their products. Milk: Proximate Composition, milk collection, cooling / chilling and transportation; physio-chemical and nutritional characters of milk and milk products; processing of raw milk and production of market milk. Condensed and dried milk, special milk and Indian Dairy Products - Packaging and storage. Cleaning and sanitization of dairy equipments and plants; role of microorganisms in milk and milk products; legal standards and quality assessment of milk and milk products-role of milk and milk products, meat and egg in human nutrition – Detection of adulterants in milk. Good Manufacturing Practices (GMP) in dairy and Hazard analysis in critical control point (HACCP) in dairy Processing. FSSAI laws.

21. 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 membrance, 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-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. b) 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. c) Classification of chordates (up to orders), giving general features and evolutionary relationship of the following: Protochordata; Agnatha; Gnathostomata-Pisces, Amphibia, Reptilia, Aves and Mammalia. d) Comparative functional anatomy of the following based on type animals (Scoliodon, Rana, Calotes, Columba and Oryctolagus): integument and its derivatives, endoskeleton, digestive system, respiratory system, circulator system including heart and aortic arches, urinogenital system; brain and sense organs (eye and ear); endocrine glands and

other hormone producing structures, (Pituitary, thyroid, parathyroid, adrenal, pancreas, gonads) their function.

3. Vertebrate Physiology and Biochemistry: a) Chemical composition of protoplasm; nature and function of enzymes; vitamins, their sources and role; colloids and hydrogen ion concentration; biological oxidation, electron transport and role of ATP, energetics, 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; sanctuaries 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.