AGRICULTURE
PART-I

Ecology and its relevance to man. Natural resources, their management and conservation. Physical and social environment as factors of crop distribution and production. Climatic elements as factors of crop growth, impact of changing environment on cropping pattern,plants as indicators of environments. Environmental pollution and associated hazards to crops, animals and humans.

Cropping patterns in different agro-climatic zones of the country - impact of high yielding and short duration varieties on shifts in cropping patterns. Concepts and principles of multiple cropping - multistorey, relay and inter-cropping and their importance in relation to food production; Package of practices for production of important cereals, pulses, oilseeds, fibre, sugar and commercial crops grown during Kharif and Rabi seasons in different regions of the country.

Weeds, their characteristics, dissemination and association with various crops; their multiplication; cultural, biological, chemical and integrated control of weeds.

Processes and factors of soil formation, classification of Indian soils including modern concepts, mineral and organic constituents of soil and their role in maintaining soil productivity. Problem soils, extent and distribution in India and their reclamation. Essential plant nutrients and other beneficial elements in soils and plants, their occurrence; factors affecting their distribution, availability functions and recycling in soils; symbiotic and non-symbiotic nitrogen fixation. Principles of soil fertility and its evaluation for judicial fertilizer use.

Watershed management. Soil Conservation planning on watershed basis. Erosion and run of management in hilly, foothills and valley lands - processes and factors affecting them. Dry lands agriculture, its problems and crop production techniques.

Water use efficiency in relation to crop production, criteria for scheduling irrigation, ways and means of reducing runoff losses of irrigation water.

Farm management, scope, importance and characteristics, farm planning and budgeting. Economics of different types of farming systems.

Agriculture extension – its importance and role. Extension techniques, methods of evaluation of extension programs, socio-economic survey and status of big, small and marginal farmers training programs for extension workers. Training and extension programs.

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PART-II

Heredity and variation, Mendel's Law of inheritance, Chromosomal theory of inheritance. Cytoplasmic inheritance, Quantitative characters.

Origin and domestication of field crop. Morphology and patterns of variations in varieties and related species of important field crops. Causes and utilization of variations in crop improvement.

Application of the principles of plant breeding to the improvement of major field crops, methods of breeding of self and cross pollinated crops. Introduction, selection, hybridisation, heterosis and its exploitation. Male sterility and self-incompatibility, utilization of mutation and polyploidy in breeding.

Seed and seed technology, importance, types and seeds and their production, processing and testing of seeds of crops and seed certification regulation.

Climatic requirements and cultivation of major fruits, plants and vegetable crops with special reference to commercial fruits and vegetables, the package of practices and the scientific basis for same. Handling and Marketing problems of fruits and vegetables, principal methods of preservation of important fruits and vegetable products, processing techniques and equipment. Role of fruits and vegetables in human nutrition, landscape and floriculture, including raising of ornamental plants and design and lay out of lawns and gardens.

Diseases and pests of fields, vegetable, orchard and plantation crops of India and measures to control these. Causes and classification of plant diseases. Principles of plant disease control including exclusion, eradication, immunization and production. Biological control of pests and diseases. Integrated management of pests and diseases. Pesticides and their formulations, plant protection equipment, their care and maintenance.

Growth and Development of Vegetable Crops **-** Physiology of dormancy and germination of vegetable seeds and tubers. Tissue culture techniques.

Post-harvest technology **-** Maturity and ripping process and factors affecting them. Quality evaluation for fresh market and processing. Factors responsible in deterioration of harvested fruits and vegetables, role of growth substances and irradiation in decay control, respiration and transpiration, storage of fresh fruits and vegetables, theories of chilling injury and symptoms of chilly injured. Modified gas storage.

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BOTANY
PART-I

(MICROBIOLOGY, PATHOLOGY, PLANT GROUPS AND THEIR MORPHOLOGY, ANATOMY, TAXANOMY, EMBRYOLOGY OF ANGIOSPERMS)

1. **Microbiology -** (Viruses and Bacteria). Their structure, classification, reproduction and physiology. Mode of infection of Viruses and Bacteria. Role of microbes in industry and agriculture.

2. **Pathology -** Knowledge of common and important plant diseases caused by fungi and bacteria (Special reference to diseases common in Himachal Pradesh), mode of infection of fungi and control of disease.

3. **Plant Groups -** Classification, structure, reproduction, life history and economic importance of Algae, Fungi, Bryophytes Pteridophytes and Gymnosperms (including comparative study of various groups). A general knowledge of distribution of important genera of principal sub-division of above groups in India (Emphasis of Western Himalayas).

4. **Morphology, Anatomy, Embryology and Taxonomy of Angiosperms** – Morphology and Anatomy of Stem, Root, Leaf (excluding anomalous growth). Tissue and Tissue system. Structure of Anther and Ovule. Fertilization and development of seed. Classification of Angiosperms, Principles of Nomenclature. Modern trends in Taxonomy. A general knowledge of following families of Angiosperms:

   Ranunculaceae, Brassicaceae, Malvaceae, Rutaceae, Rosaceae, Leguminosea, Cucurbitaceae, Umbelliferae, Asteraceae, Solanaceae, Lamiaceae, Euphorbiaceae, Liliaceae and Gramineae.

PART-II

(CELL BIOLOGY, GENETICS AND EVOLUTION, PHYSIOLOGY, ECOLOGY AND ECONOMIC BOTANY)

1. **Cell Biology** – Cell as a unit of structure and function. Ultrastructure of Cell and its various organelles. Chromosomes – the physical and chemical structure, its behaviour during mitosis and meiosis.

2. **Genetics and Evolution –** Pre and Post Mandelian concept of Genetics. Development of Gene concept. Genetic code. Nucleic acids, their structure and role in reproduction and protein biosynthesis, Mutations. Role of mutations in plant breeding (wheat, gram, tobacco, cotton only). Organic evolution – evidences and theories.

3. **Physiology –** Photosynthesis, Absorption and conduction of water, Transpiration, Mineral absorption, Role of elements, Enzymes, Respiration, Fermentation, Growth, Photoperiodism and Vernalisation. Plant Hormones – their type and role. Dormancy of seeds.

4. **Plant Ecology –** Its scope, plant communities, plant succession, factors. Applied ecology with special reference to pollution and conservation.

5. Economic Botany – Importance of plants, Important plants yielding food, fibre, wood and drugs.

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CHEMISTRY

(*Note*:- The student will be expected to solve simple structural, synthetic, mechanistic, conceptual and numerical problems based on and relevant to the syllabus. They are also expected to be acquainted with the S.I. units)

PART-I

***Atomic Structure and Chemical bonding*: –** Quantum theory, Schrodinger equation, particle in a box, hydrogen atom. Hydrogen molecule. Elements of valence bond and molecular orbital theories (idea of bonding, non-bonding and anti-bonding orbitals). Sigma and Pi bonds.

***Chemical Kinetics*: -** Kinetics of reactions involving free radicals, Kinetics of polymerisation and photochemical reactions.

***Surface chemistry and catalysis*:-** Physical absorption, isotherms, surface area determination, heterogenous catalysis, acid bases and enzyme catalysis.

***Electrochemistry*: -** Lomic equilibra; theory of strong electrolytes; Debye, Huckel theory of activity coefficients; electrolytic conduction, galvanic cell, membrane equilibrium and fuel cells. Electrolysis and overvoltage.

***Thermodynamics*: -** Laws of Thermodynamics and application to physiochemical processes systems of variable compositions.

***Electronic structure of transition metal complexes*: -** Crystal field theory and modifications, complexes of Pi-acceptor ligands, organometallic compounds of transition metals.

***Lanthanides Actinides*:-** Separation Chemistry, Oxidation state, magnetic properties. Reaction in non-aqueous solvents.

PART-II

PHYSICAL ORGANIC CHEMISTRY

***Electronic displacements*:-** Inductive, electromeric, mesomeric and hyper-conjugative effects. Electrophiles, nucleophiles and free radicals. Resonance and its application to organic compounds. Effect of structure on the discotiation constants of organic acids and basis. Hydrogen bond and its effects on the properties of organic compounds.

Modern concepts of organic reaction mechanisms, addition, substitution, elimination and rearrangement. Reaction involving free radicals. Mechanisms of aromatic substitution. Benzene intermediates.

***Aliphatic Chemistry*: -** Chemistry of simple oganic compounds belonging to the following classes –alkanes, alkynes, alkyl halides, alcohol, thiols, aldehydes, ketones, acids and their derivatives, ethers, amines, amino acids, hydroxy acids, unsaturated acids, dibasic acids.

Synthetic uses of the following: -

Acetoacetic and malonic esters, organometallic compounds of magnesium and lithium, ketene, carbene and diazomethane.

***Carbohydrates*:-** Classification and general reactions of simple monosaccharides, hemistry of glucose, fructose and sucrose.

***Stereo Chemistry*: -** Elements of symmetry and simple symmetry operation, Optical and geometrical isomerism in simple organic molecules, E.Z and R.S notations. Conformations of simple organic molecules. Sterecochemistry of inorganic co-ordination compounds.

***Atomic Chemistry*: -** Benzene, toluene and their helegeno, hydroxy, nitro and amino derivatives, Sulphuric acid, Zylenes, Benzaldehyde, Salicylaldehyde, acetophenone, Benzonic, pathalic, salicylic, cinnamic and mandelic acids. Reduction products of nitrobenzene, Diazonium salts and their synthetic uses.

Structure, synthesis and important reactions of naphhtalenes anthracene, Phenantherene, Pyridine and quinoline.

***Basic concepts regarding the following materials of economic and medical importance*:-** Cellulose and starch, coal tar, chemicals, organic polymers. Oils and fats, petrochemicals, vitamins, harmones, alkaloids (fermentation products including antibiotics, proteins).

***Organic Photochemistry*:-** Energy level diagrams, quantum yield, Photochemistry of simple organic molecules.

***Polymers*:-** Physical chemistry of Polymers. Molecular weight averages and group analysis, sedimentation light scattering and viscosity of Polymer solutions.

Alloys and inter-metallic compounds.

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COMPUTER APPLICATION/COMPUTER SCIENCE

PART-I

Introduction to Computing

Number Systems, Binary numbers, Boolean logic, History Computer system, basic machine organization, Von Neumann Architecture, Algorithm definition, design, and implementation, Programming paradigms and Languages, Graphical programming, Overview of Software Engineering and Information Technology,

Operating system, Compiler, Computer networks and Internet, Computer graphics, Al, Social and legal issues.

Programming Solving Techniques

Algorithms and problem solving, development of basic Algorithms, analyzing problem, designing solution, testing designed solution, fundamental programming constructs, translation of algorithms to programmes, data types, control structures, functions, arrays, records, files, testing programmes.

Computer Communications & Networks

Analogue and digital Transmission, Noise, Media, Encoding, Asynchronous and Synchronous transmission, Protocol design issues, Network System architecture (OSI, TCP/IP), Error control, Flow Control, Data Link Protocols (HDLC,PPP). Local Area Networks and MAC Layer protocols (Ethernet, Token ring), Multiplexing, Switching and IP Networks, Internetworking, Routing, Bridging, Transport layer protocols TCP/IP, UDP. Network security issues, Programming exercises or projects involving implementation of protocols at different layers.

Digital Logic & Computer Architecture

Logic design of Digital Systems, Fundamental and advanced concepts of Logic Designs, Boolean Algebra & functions, Designing and implementation of combinational and Sequential logic, minimization techniques, number representation and basic binary arithmetic Logic families and digital integrated circuits, use of CAD tools for logic designs. Topics of Computer Architecture.

Data Structures & Algorithms

Basic database concepts; Entity Relationship modelling, Relational data model and algebra, Structured Query Language, RDBMS, Database design, functional dependencies and normal forms, Transaction processing and optimization concepts, concurrency control and recovery techniques, Database recovery techniques, Database security and authorization, Small Group Project implementing a database, Physical database design. Storage and file structure, indexed files, hashed files, signature files, b-trees, files with dense index, file with variable length records, database efficiency and tuning.

Operating Systems

History and Goals, Evolution of multi-user systems, Process and CPU management, Multithreding, Kernel and User Modes, Protection, Problems of cooperative processes, Synchronization, Deadlocks, Memory management and virtual memory, Relocation, External Fragmentation, Paging and Demand Paging, Secondary storage, Security and Protection, File systems, I/O systems, Introduction to distributed operating systems. Scheduling, dispatch and Introduction to concurrency.

PART-II

Theory of Automata and Formal Languages.

Finite State Models: Language definitions preliminaries, Regular expressions/Regular

languages, Finite automatas (FAs), Transition graphs (TGs),NF As, kleene's theorem, Transducers (automata with output), Pumping lemma and non regular language *Grammars and PDA:* Context free grammars, Derivations, derivation trees and ambiguity, Simplifying CFLs , Normal form grammars and parsing, Push-down Automata, Pumping lemma and non-context free languages, Decidability, Chomsky's hierarchy of grammars, *Turing Machines Theory:* Turing machines, Post machine, Variations on 1M, 1M encoding, Universal Turing Machine, Context sensitive Grammars, Defining Computers by TMs.

Compiler Theory & Design

Compiler techniques and methodology. Organization of compilers. Lexical and syntax analysis. Parsing techniques. Object code generation and optimization, detection and recovery from errors. Comparison between compilers and interpreters.

Numerical Methods

Mathematical Preliminaries, Solution of Equations in one variable, Interpolation and Polynomial Approximation, Numerical Differentiation and Integration, Initial Value Problems for Ordinary Differential Equations, Direct Methods for Solving Linear Systems, Iterative Techniques in Matrix Algebra, Solution of non-linear equations, Approximation Theory, Eigenvalues and Eigenvector computation.

Data Base Systems

Basic database concepts, Entity Relationship modelling, Relational data model and algebra, Structured Query language, RDBMS; Database design, functional dependencies and normal forms, Transaction processing and optimization concepts, concurrency control and recovery techniques, Database recovery techniques, Database security and authorization. Small Group Project implementing a database. Physical database design: Storage and file structure, indexed files, hashed files, signature files, b-trees, files with dense index, files with variable length records, database efficiency and tuning Data Warehousing and Data Mining, Emerging Database Technologies and Applications.

Software Engineering

Software Engineering, Process Models, Software verification and validation. Techniques are introduced to evaluate software correctness, efficiency, performance and reliability, integration of these techniques into a verification and validation plan. Technical reviews, software testing, programme verification, prototyping, and requirement tracing. Attitude of industry toward reliability and performance.

Artificial Intelligence

Introduction to Common Lisp. AI classical systems: General Problem Solver, rules, simple search, meansends analysis. ElIZA, pattern matching, rule based translators, OPS-5. Knowledge Representation: Natural language, rules, productions, predicate logic, semantic networks, frames, objects, scripts. Searching, Depth first search, breadth first search, best first search, hill climbing, min-max search. Symbolic Mathematics: student solving algebra problems, translating English equations, solving algebraic equations, simplification rules, rewrite rules, meta-rules, Macsyma, PRESS, ATLAS. Logic Programming: Resolution, unification, hornclause logic, Prolog, Prolog programming. Sample case studies of shells and Knowledge Based Systems. A brief appreciation of state of the art computational techniques like neural networks, genetic algorithm, fuzzy sets.

Computer Graphics

Graphics hardware, Fundamental algorithms, Applications of graphics. Interactive graphics programming -graph plotting, windows and clipping, and segmentation. Programming raster display systems, panning and zooming. Raster algorithms and

software Scan-Converting lines, characters and circles. Region filling and clipping. Two and three dimensional imaging geometry and transformations. Curve and surface design, rendering, shading, colour and animation.

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AGRICULTURE ENGINEERING
PART-I

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

Aerial Photography and Remote Sensing: Basic characteristics of photographic images, interpretation keys, equipment for interpretation, imagery interpretation for land use, geology, soil and forestry. Remote sensing – merits and demerits of conventional and remote sensing approaches. Types of satellite images, fundamentals of satellite image interpretation, techniques of visual and digital interpretations for soil, water and land use management. Use of GIS in planning and development of watersheds, forests including forest cover, water resources etc.

2. ***Irrigation and Drainage*****:** Sources of water for irrigation. Planning and design of minor irrigation projects. Techniques of measuring soil moisture - laboratory and *in situ*. Soil water plant relationships. Water requirement of crops; planning conjunctive use of surface and ground water. Measurement of irrigation water, measuring devices - orifices, weirs and flumes. Methods of irrigation - surface, sprinkler and drip, fustigation. Irrigation efficiencies and their estimation. Design and construction of canals, field channels, underground pipelines head gates, diversion boxes and structures for road crossing. Occurrence of ground water, hydraulics of wells, types of wells (tube wells and open wells) and their construction. Well development and testing. Pumps - types, selection and installation. Rehabilitation of sick and failed wells. Drainage - causes of water loggingand salt problem. Methods of drainage - drainage of irrigated and un-irrigated lands, design of surface, sub-surface and vertical drainage systems. Improvement and utilization of poor quality water. Reclamation of saline and alkali soils. Economics of irrigation and drainage systems. Use of wastewater for irrigation – standards of wastewater for sustained irrigation, feasibility and economics.

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

PART- II

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

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

6. ***Agricultural Process Engineering*****:** Post harvest technology of crops and its scope. Engineering properties of agricultural produces and by-products. Unit operation -cleaning grading, size reduction, densification, concentration drying/ dehydration, evaporation, filtration, freezing andpackaging of agricultural produces and by-products. Material handling equipment-belt and screw conveyors, bucket elevators, their capacity and power requirement. Processing of Milk and dairy products - homogenisation, cream separation, pasteurisation, sterilization, spray and roller drying, butter making, ice cream, cheese and shrikhand manufacture. Waste and by-product utilization-rice husk, rice bran, sugar can bagasse, plant residues and coir pith.

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

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CHEMICAL ENGINEERING

PART-I

(a) Fluid and Partical Dynamics**:** Viscosity of fluids. Laminar and turbulent flows. Equation of continuity and Navier-Stokes equation; Bernoulli's theorem. Flow meters. Fluid drag and pressure drop due to friction, Reynold's Number and friction factor – effect of pipe roughness. Economic pipe diameter. Pumps, water air/steam jet ejectors, compressors, blowers and fans. Agitation and mixing of liquids. Mixing of solid and pastes. Crushing and grinding - principles and equipment. Rittinger' and Bond's laws; Filtration and filtration equipment. Fluid - partical mechanics - free and hindered settling. Fluidization and minimum fluidization velocity, concept of compressible and incompressible flow. Transport of solids.

***(b) Mass Transfer*:** Molecular diffusion coefficients, first and second law and diffusion, mass transfer coefficients, film and penetration theories of mass transfer. Distillation, simple distillation, relative volatility, fractional distillation, plate and packed columns for distillation. Calculation of theoretical numbers of plates. Liquid-liquid equilibria. Extraction theory and practice; Design of gas absorption columns. Drying, humidification, de-humidification. Crystalisation. Design of equipment.

(c) Heat Transfer: Conduction, thermal conductivity, extended surface heat transfer. Convection – free and forced. Heat transfer coefficient – Nusselt number. LMTD and effectiveness. NTU methods for the design of Double Pipe and Shell & Tube Heater Exchangers. Analogy between heat and momentum transfer. Boiling and condensation heat transfer, single and multiple-effect evaporators. Radiation: Stefan-BoltzmanLaw, emissivity and absorptivity. Calcuation of heat load of a furnance. Solar heaters.

***(d) Noval Separation Processes*:** Equilibrium separation processes: ion-exchange, osmosis, electrodialysis, reverse osmosis, ultra-filtration and other membrane processes. Molecular distillation, super critical fluid extraction.

***(e) Process Equipment Design*:** Factors affecting vessel design criteria-Cost consideration. Design of storage vessels - vertical, horizontal spherical, underground tanks for atmospheric and higher pressure. Design of closures flat and elliptical head. Design of support. Materials of construction – characteristics and selection.

(f) ***Process Dynamic and control*:** Measuring instruments for process variables like level, pressure flow, temperature PH and concentration with indication in visual/ pneumatic/ analog/ digital signal forms. Control variable, manipulative variable & load variables. Linear control theory - Laplace, transforms, PID controllers, Block diagram representation transient and frequency response, stability of closed loop system. Advanced control strategies. Computer bases process control.

PART-II

***(a) Material and Energy Balance*:** Material and energy balance calculations in process with recycle/ bypass/ purge. Combustion of solid/ liquid/ gaseous fuels, stoichiometric relationships and excess air requirements. Adaiabatic flame temperature.

(b) ***Chemical Engineering thermodynamics*:** Laws of thermodynamics. PVT relationships for pure components and mixtures. Energy functions and inter-relationships - Maxwell's relations. Fugacity, activity and chemical potential. Vapour-liquid equilibria, for ideal/ non-ideal, single and multicomponent systems. Criteria for chemical reaction equilibrium, equilibrium constant and equilibrium conversions. Thermodynamic cycles – refrigeration and power.

(c) ***Chemical Reaction Engineering*:** Batch reactors - kinetics and homogeneous reactions and interpretation of kinetic data. Ideal flow reactors - CSTR, plug flow reactors and their performance equations. Temperature effects & run-away reactions. Heterogeneous reactions - catalytic and non-catalytic & gas-solid & gas –liquid reactions. Intrinics kinetics and global rate concept. Importance of interphase & interparticle mass transfer on performance. Effectiveness factor. Isothermal and non-isothermal reactors and reactor stability.

(d) ***Chemical Technology*****:** Natural organic products -Wood and wood-based chemicals, pulp and paper, Agro-industries-sugar, Edible oils extraction (including tree based seeds), Soaps and detergents. Essential oils - Biomass gassification (including biogas). Coal and coal chemical. Petroleum and Natural gas - petroleum refining (Atmospheric distillation/ cracking/ reforming) - Petrochemical industries – Polythylenes (LDPE/ HOPE/ LLDPE), Polyvinyl Chloride, Polystyrene. Ammonia manufacture. Cement and lime industries. Paints and varnishes. Glass and ceramics. Fermentation - alcohol and antiboitics.

(e) ***Environmental Engineering and Safety*****:** Ecology and Environment. Sources of pollutants in air and water. Green house effect, ozone layer depletion, acid rain. Micrometeorology and dispersion of pollutants in environment.Measurement techniques of pollutant levels and their control strategies. Solid waste, their hazards and their disposal techniques. Design and performance analysis of pollution control equipment. Fire and explosion hazards rating-HAZOP and HAZAN. Emergency planning, disaster, management. Environmental legislation's-water air environment protection Acts. Forest (Conservation) Act.

(f) Process Engineering Economics**:** Fixed and working capital requirement for a process industry and estimation methods. Cost estimation and comparison of alternatives. Net present value by discounted cash flow. Pay back analysis. IRR, depreciation, taxes and insurance. Break-even point analysis. Project scheduling -PERT and CPM - Profit and loss account, balance sheet and financial statement. Plant location and plant layout including piping.

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CIVIL ENGINEERING

PART-I

(A) THEORY AND DESIGN OF STRUCTURES:

(a) ***Theory*****:**

Principle of superposition, reciprocal theorem, unsymmetrical bending.

Determinate and indeterminate structures, simple and space frames, degrees of freedom, virtual work, energy theorems, deflection of trusses, redundant frames, three moment equation, scope deflection and moment distribution methods. Column analogy, energy methods, approximate and numerical methods.

Moving loads - Shearing force and bending moment diagrams, influence lines for simple and continuous beams and frames.

Analysis of determinate and indeterminate arches, spandrel braced arch.

Matrix methods of analysis, stiffness and flexibility matrix. Elements of plastic analysis.

(b) Steel Design:

Factors of safety and load factor, design of tension, compression and flexural members built upbeams and plate girders, semi-rigid and rigid connections.

Design of stancheons, slab and gussetted bases, crane and gantry girders, roof trusses, industrial and multi-storeyed building, water tanks.

Plastic design of continuous frames and portals.

(c) ***R.C Design***:

Design of slabs, simple and continuous beams, columns, footings single and combined reft foundations, elevated water tanks, encased beams and columns, ultimate load design. Methods and system of prestressing, anchorages, losses in prestress design of prestressed girders, ultimate load design.

(B) FLUID MECHANICS AND HYDRAULIC ENGINEERING:

Dynamics of fluid equations of continuity, energy and momentum. Barnoullis theorem, cavitation, Velocity potential and stream function, rotational and irrotationan flow, free and forced vortices, flownet.

Dimensional analysis and its application to practical problems.

Viscous flow:- Flow between static and moving parallel plates, flow through circular tubes, film lubrication, velocity distribution in laminar and turbulent flow, boundary layer.

Incompressible flow through pipes:- Laminar and turbulent flow, critical velocity, losses, stamaton diagram. Hydraulic and energy grade lines, siphons pipe not work forces on pipe bends.

Compressible flow:- Adiabatic and isentropic flow subsonic and supersonic velocity, Machnumber, shock waves, water hammer.

Open channel flow:- Uniform and non-uniform flow, best hydraulic cross-section. Specific energy and critical depth gradually varied flow classification of surface profiles, control sections, standing wave flume, surges and wave and waves, hydraulic jump.

Design of canals:- Unlined channel in alluvium, the critical tractive stress, principles of sediment transport regime theories, lined channels, hydraulic design and cost analysis, drainage behind lining.

Canal structures:- Designs of regulation work, cross drainage and communication work – cross regulators, head regulator, canal falls, aqueducts, metering flumes etc., canal outlets.

Diversion Head works:- Principles of design of different parts on impermeable and permeable foundations, Khosla's theory, energy dissipation, sediment analysis.

Dams:- Design of rigid dams, earth dams, forces acting on dams, stability analysis.

Design of Spillways, Wells and Tube Wells.

(C) SOIL MECHANICS AND FOUNDATION ENGINEERING:

Soil Mechanics:- Original classification of soil, atterburglimits, void ratio, moisture contents, permeability, laboratory and field tests. Seepage and flow nets, flow under hydraulic structures, uplift and quick sand condition; Unconfined and direct shear tests, triaxial test, earth pressure theories, stability of slopes, theories of soil consolidation, rate of settlement. Total and effective stress analysis, pressure distribution in soils, Boussinasque and Wasterguard theories. Soil stabilization.

Foundation Engineering. Bearing capacity of footings piles and wells; design of retaining walls, sheet piles and caissons.

PART-II

(D) BUILDING CONSTRUCTIONS:

Building materials and constructions:- Timber, stones, brick, sand, surkhi, mortar, concrete, paints and varnishes, plastic, etc.

Detailing of walls, roofs, floors, ceilings, staircases, doors and windows. Finishing of buildings -plastering, pointing, painting etc. Use of building codes, ventilation, air conditioning, lighting and acoustics.

Building estimates and specifications, construction scheduling, PERT and CPM methods.

(E) RAILWAYS AND HIGHWAYS ENGINEERING:

(a) ***Railways***:- Permanent way, ballast, sleeper, chairs and fastenings, points and crossing, differenttypes of turn outs, cross-overs, setting out of points.

Maintenance of track, super elevation, creep of rain, ruling gradients, track resistance, tractive effort,curve resistance.

Station yards and machinery, station buildings, platform sidings, turn tables.

Signal and inter locking, level crossings.

(b) ***Roads and Runways***:- Classification of roads, planning, geometric design of flexible and rigid pavements, sub-bases and wearing surfaces. Traffic engineering and traffic surveys, intersections road signs, signals and markings.

(F) WATER RESOURCES ENGINEERING:

Water requirements for crops: - Quality of irrigation water, consumptive use of water, water depth and frequency of irrigation, duty of water, irrigation methods and efficiencies.

Distribution system for canal irrigation: -Determination of required channal capacity, channel losses, alignment of main and distributory channels. *Water logging:-* Its causes and control, design of drainage system, soil salinity. *River training*:- Principles and methods.

Storage works: - Types of dams (including earth dams) and their characteristics, principles of design, criteria for stability. Foundation treatment, joints and galleries. Control of seepage.

Spillways:- Different type and their suitability, energy dissipation, spillway crest gates.

(G) SANITATION AND WATER SUPPLY:

Sanitation:- Site and orientation of buildings, ventilation and damp proof course, house drainage, conservancy and water borne system of waste disposal. Sanitary appliances – latrines and urinals.

Disposal of sanitary sewage, industrial waste, storm sewage - separate and combined system, flow through sewers, design of sewers, sewer appurtenances, manholes, inlets, junctions, siphon, ejection etc. Sewer treatment working principles, units, chambers, sedimentation tank etc. Activated sludge prepuces, septic tank, disposal of sludge. Rural sanitation, environment pollution and ecology.

Water supply:- Estimation of water resources, ground water hydraulics, predicting demand of water. Impurities of water - physical, chemical and bacteriological analysis. Water borne diseases.

Intake of water:- Pumping and gravity schemes. Water treatment. Principles of settling, coagulation, flocculation and sedimentation. Slow, rapid and preassure filters, softening, removal of taste, odour and salinity.

Water distribution:- Layout storage, hydraulic pipelines, pipe fittings, pumping stations and their operations.

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COMPUTER ENGINEERING

PART-I

Digital Electronics

Introduction to number System and their conversions. Arithmatic with bases other than ten. Boolean Algebra and Simplification of Boolean expressions. Standard form of boolean functions, Minterm Maxterm designation of functions, Combinational Circuits. Introduction to switching devices, positive and negative logic of OR, AND, NOR, NAND, Exclusive OR, and Exclusive NOR gates, IC digital logic families. implification of function by karrnaugh maps. Quine McCluskey tabular methods for simplification of Boolean function and determination of prime implicants. Selection of an optimal set of prime implicants, multiple output circuits and map minimization of multiple output circuits;. General characteristics of sequential circuits. Clock, puls and level mode sequential circuits. Analysis and design of a sequential circuit.

Programming Languages

Structured programming and object oriented programming. Abstraction, encapsulation, data hiding, Polymorphism, Scope rules, Parameter passing, run time environment, Static and dynamic storage management, garbage collection, exception handling, task and concurrency in programming language like C, C++. JAVA. Concepts of 4GL

Data Structure And Algorithms

Elementary and structured data types, Linear Structures: Arrays and Records, Stacks, Queues and Linked Lists, Strings Prefix, Postifix, infix expressions. Non linear structures: generalized linked list, trees, graphs and their traversals, trie and dictionary. Built in Data structures such as Records, Files Sets, Graphs and Pointers. Recurssion, Sorting-Internal and External, Searching, Hashing, Symbol Tables. Problem solving and algorithms development and analysis.

Computer Architecture

Processor Organization, Instruction fetch and executic cycles, information representation, Number formats and their representation in memory. Common addressing techniques, instruction types, Arithmetic operatiojnns and their implementations. Memories : types, characteristics and organization. System modeling, Design levels. Register level design, Description language, Processor level design, Design Techniques. Instruction Sequencing and interpretation hardwired controls and its implementation concepts, microprogrammed control Conversional and unconversional microprogrammed control computers.

Data Base Management System

Need, Purpose and Goals of DBMS. Physical and Logical data bases, data abstraction and data independence, data aggregation, data mdels: ER and object Oriented Models, Introduction to relational model, relation algebra, theory of normalization. SQL. Physical data organization in sequential, Indexed, Random and Hashed files. Inverted and multilist structures, B+ Trees. Transaction processing, concurrency control, recovery management and database security, Transaction model properties and state serializability, Lock based protocols. Deadlock prevention and detection. Introduction to Distributed DBMS

PART-II

System Programming and Operating System

Concept of machines and assembly language programming, representation of instruction and data, assemblers, and macro assemblers. Introduction to Operating System, Operating System Services and Kernael. Multiprogramming & Time Sharing, Memory management, Paging and Segmenting, Input Output and Device Management, Disk and File management. Deadlocks and concurrent processes. Protection and security, Introduction to multiprocessors and distributed operating systems. Case studies of UNIX and WINDOWS operating systems.

Theory of Computation and Compile Design

Introduction to Automata Theory, Language, regular expression, finite automata, transition graph, nondeterminism, Push Down Automata Theory, context free grammars, trees, regular grammars, context-free languages. Introduction to compliers, translators and interpreters, compilation process. Lexical and Syntactical analysis. Top Down and Bottom up parsing, syntax directed translation. Symbol tables organizations : Hashing, Linked List, Tree structures. Code generation : Compilation of expressions and control structures. Error detection and recovery. Code optimization : Optimizing transformation, local and global optimization.

Computer Networks

Data communication Fundamentals, Computer Network, Architecture, Packet and circuit switching. Functions and working of OSI layers. Satellite and packet radio network. Local area network. Internetworking and ISDN/B-ISDN. Network Protocols: Ethernet, TCP/IP. Network management and Interoperability. Performance issues of LAN and WAN.

Software Engineering

Introduction to Software Engineering, Requirement Engineering, Structural System Design, Data Oriented analysis and Design, Object Oriented Analysis and Design, Software Quality Assurance. User interface design, Software complexity and reliability. Software project management.

Computer Graphics

Introduction to interactive computer graphics, picture analysis overview of programmer's model of interactive graphics. Fundamental problems in geometry. Basic Raster Graphics: Scan Conversion, filling and clipping. Geometric manipulations : Transformation, Matrices and homogeneous coordinates. Elementary 3-D graphics, plane projections, vanishing points, specification of 3-D view. Visibility, image and object precision, z-buffer algorithms, area based algorithms, floating horizon. Curves and surfaces: parametric representation, Bezer and B-spline curves. Rendering: Ray tracing, antialiasing, Gourard and Phong Shading.

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Electrical Engineering

PART-I

1. EM Theory

Electric and magnetic fields. Gauss's Law and Amperes Law. Fields in dielectrics, conductors and magnetic materials. Maxwell's equations. Time varying fields. Plane-Wave propagating in dielectric and conducting media. Transmission lines.

2. ELECTRICAL MATERIALS

Band Theory, Conductors, Semi-conductors and Insulators. Super-conductivity. Insulators for electrical and electronic applications. Magnetic materials. Ferro and ferri magnetism. Ceramics, Properties and applications. Hall effect and its applications. Special semi conductors.

3. ELECTRICAL CIRCUITS

Circuits elements. Kirchoff's Laws. Mesh and nodal analysis. Network Theorems and applications. Natural response and forced response. Transient response and steady state response for arbitrary inputs. Properties of networks in terms of poles and zeros. Transfer function. Resonant circuits. Threephase

4. MEASUREMENTS AND INSTRUMENTATION

Units and Standards. Error analysis, measurement of current, Voltage, power, Power-factor and energy. Indicating instruments. Measurement of resistance, inductance, Capacitance and frequency. Bridge measurements. Electronic measuring instruments. Digital Voltmeter and frequency counter. Transducers and their applications to the measurement of non-electrical quantities like temperature, pressure, flow-rate displacement, acceleration, noise level etc. Data acquisition systems. A/D and D/A converters.

5. CONTROL SYSTEMS

Mathematical modeling of physical systems. Block diagrams and signal flow graphs and their reduction. Time domain and frequency domain analysis of linear dynamical system. Errors for different type of inputs and stability criteria for feedback systems. Stability analysis using Routh-Hurwitz array, Nyquist plot and Bode plot. Root locus and Nicols chart and the estimation of gain and phase margin. Basic concepts of compensator design. State variable matrix and its use in system modelling and design. Sampled data system and performance of such a system with the samples in the error channel. Stability of sampled data system. Elements of non-linear control analysis. Control system components, electromechanical, hydraulic, pneumatic components.

6. ELECTRCIAL MACHINES AND POWER TRANSFORMERS

Magnetic Circuits - Analysis and Design of Power transformers. Construction and testing. Equivalent circuits. Losses and efficiency. Regulation. Auto-transformer, 3-phase transformer. Parallel operation. Basic concepts in rotating machines. EMF, torque, basic machine types. Construction and operation, leakage losses and efficiency. B.C. Machines. Construction, Excitation methods. Circuit models. Armature reaction and commutation. Characteristics and performance analysis. Generators and motors. Starting and speed control. Testing, Losses and efficiency. Synchronous Machines. Construction. Circuit model. Operating characteristics and performance analysis. Synchronous reactance. Efficiency. Voltage regulation. Salient-pole machine, Parallel operation. Hunting. Short circuit transients. Induction Machines. Construction. Principle of operation. Rotating fields. Characteristics and performance analysis. Determination of circuit model. Circle diagram. Starting and speed control. Fractional KW motors. Single-phase synchronous and induction motors.

PART-II

1. **POWER SYSTEMS**

Types of Power Stations, Hydro, Thermal and Nuclear Stations. Pumped storage plants. Economics and operating factors. Power transmission lines. Modeling and performance characteristics. Voltage control. Load flow studies. Optimal power system operation. Load frequency control. Symmetrical short circuit analysis. ZBus formulation. Symmetrical Components. Per Unit representation. Fault analysis. Transient and steady-state stability of power systems. Equal area criterion. Power system Transients. Power system Protection Circuit breakers. Relays. HVDC transmission.

2. **ANALOG AND DIGITAL ELECTRONICS AND CIRCUITS**

Semiconductor device physics, PN junctions and transistors, circuit models and parameters, FET, Zener, tunnel, Schottky, photo diodes and their applications, rectifier circuits, voltage regulators and multipliers, switching behavior of diodes and transistors. Small signal amplifiers, biasing circuits, frequency response and

improvement, ultistage amplifiers and feed-back amplifiers, D.C. amplifiers, Oscillators. Large signal amplifiers, coupling methods, push pull amplifiers, operational amplifiers, wave shaping circuits. Multivibrators and flip-flops and their applications. Digital logic gate families, universal gates-combination circuits for arithmetic and logic operational, sequential logic circuits. Counters, registers, RAM and ROMs.

3. **MICROPROCESSORS**
   Microprocessor architecture-Instruction set and simple assembly language programming. Interfacing for memory and I/O. Applications of Micro-processors in power system.

4. **COMMUNICATION SYSTEMS**
   Types of modulation; AM, FM and PM. Demodulators. Noise and bandwidth considerations. Digital communication systems. Pulse code modulation and demodulation. Elements of sound and vision broadcasting. Carrier communication. Frequency division and time division multiplexing, Telemetry system in power engineering.

5. **POWER ELECTRONICS**
   Power Semiconductor devices. Thyristor. Power transistor, GTOs and MOSFETS. Characteristics and operation. AC to DC Converters; 1- phase and 3-phase DC to DC Converters; AC regulators. Thyristor controlled reactors; switched capacitor networks. Inverters; single-phase and 3-phase. Pulse width modulation. Sinusoidal modulation with uniform sampling. Switched mode power supplies.

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Electronics Engineering

PART-I

BASIC ELECTRONICS - MATERIALS AND DEVICES

Materials and Components :

Structure and properties of Electrical Engineering materials, Conductors, Semiconductors and Insulators, magnetic, Ferroelectric, Piezoelectric, Ceramic, Optical and Super-conducting materials. Passive components and characteristics Resistors, Capacitors and Inductors, Ferrites, Quartz crystal, Ceramic resonators, Electromagnetic and Electromechanical components.

Physical Electronics, Electron Devices and ICs :

Electrons and holes in semiconductors, Carrier Statistics, Mechanism of current flow in a semiconductor, Hall effect; Junction theory; Different types of diodes and their characteristics; Bipolar Junction transistor; Field effect transistors; Basics of ICs - bipolar, MOS and CMOS types, basic of Opto-electronics. IC Technologies : Fabrication techniques Basic CMOS VLSI, Full custom VLSI design, Inverter analysis, layout rules, layout of basic gates, circuit extraction, Layout of basic data path.

ELECTRONICS CIRCUITS AND APPLICATIONS

Analog Electronic Circuits :

Transistor biasing, bias stabilization and Small signal and frequency response analysis of transistor circuits. Power amplifiers. Feedback amplifiers, Tuned

amplifiers, Wide-banding techniques. Transistor oscillators. Diode rectifiers, regulators and power supplies. Operational Amplifiers, Phase Locked Loops and other linear integrated circuits with applications. Pulse shaping circuits and waveform generators.

Industrial Electronics :

Thyristor family, principle of operation, commutation circuits Controlled rectifiers, single phase and three phase with different loads. DC choppers : step-up and step-down choppers, chopper circuits, switched mode regulators, effect of source and load inductance. Cyclo-converters: Single and three phase cyclo-converters. Inverter circuits: Single phase bridge inverters, three phase inverters, voltage control of three phase inverter, harmonic reduction. Industrial applications: Induction and dielectric heating, Basic concepts of speed control of DC/AC drives.

SIGNALS AND SYSTEM

Signals and Systems :

Classification of signals and systems: System modeling in terms of differential and difference equations; Electronics Engineering MPSC, Maharashtra Public Service Commission Electronics Engineering Exam http://www maharashtraeducation.net/Civil_Services/mains/Electronics.asp [16-11-2009 16:11:36]. State variable representation and solution of state of variable equations for continuous and discrete time systems. Fourier series, Fourier transforms, properties and their applications to system analysis.

Laplace transform : properties and its application to system analysis. Convolution integral, superposition integral and their applications.

Z-transform : properties and its applications to the analysis and characterisation of discrete time systems. Discrete time signals and systems, System Classification, stability, DTFT, DFT, FFT algorithms: Decimation in time and frequency. Linear and circular convolution. Designing of Digital filters - FIR and IIR filters, Butterworth and Chebycheff filters.

Network theory :

Network analysis techniques; Network theorems, transient and sinusoidal steady state response. Network graphs and their applications in network analysis; Tellegen's theorem. Two port networks; Z, Y, h and transmission parameters. Analysis of two port networks, Network functions, parts of network functions, obtaining a network function from a given part.

Transmission criteria: delay and rise time, Elmore's and other definitions, effect of cascading.Elements of one-port and two-port network synthesis.

INSTRUMENTATION AND CONTROL

Electronic Measurements and instrumentation :

Basic concepts, standards and error analysis; Measurements of basic electrical quantities and parameters. Analog and digital electronic measuring instruments, their principles of working their comparison, characteristics and applications.

Transducers: Electronic measurements of non-electrical quantities like temperature, pressure, humidity. Basics of telemetry for industrial use.

Control Systems :

Transient and steady state analysis of systems. Block diagram reduction and signal flow graphs, Mason's gain formula.Effect of feedback on the performance of systems. Absolute and relative stability of systems.

Frequency response analysis :

Bode diagram, Root Locus, Principle of argument and Nyquist criteria. Constant-M and Constant-N Loci. Nichol's Chart. Stability analysis of continuous time systems with respect to the state space model and Jury's stability criterion for the stability of discrete time systems.

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PART-II

DIGITAL ELECTRONICS AND MICROPROCESSORS :

Transistor as a switching element. Boolean algebra, Number theory. Simplification of Boolean functions, Karnaugh maps and applications. IC Logic gates and their characteristics.

IC logic families: DTL, TTL, ECL, NMOS, PMOS and CMOS gates and their comparison.

Combinational logic Circuits: Half adder, Full adder; Digital comparator; Multiplexer, Demultiplexer ; ROM and their applications and Design. Flip flops. R-S, J-K,D and T flip-flops; Different types of counters and registers, Design using flip flops. Waveform generators. A/D and D/A converters. Semi conductor memories. Digital design-POS,SOP minimization, PAL and PLAs, PLDs, FPGA

Sequential machine design : Mealy and Moore machines, Asynchronous machines-Analysis and design: Races and Hazards. Microprocessors: Architecture and instruction set of Microprocessors 8085 and 8086, Assembly language Programming.

Microprocessor based system design: typical examples, PLCs. Personal computers and their typical uses.

COMMUNICATION SYSTEMS :

Random signals and probability, Correlation functions; Spectral density; Response of linear system to random inputs. Basic information theory. Sampling, quantisation and introduction to coding techniques.

Analog Modulation and demodulation techniques: AM, FM and PM, Radio broadcast transmitters and receivers.

Digital modulation and demodulation techniques, data recovery: integrator, matched filters, correlation receivers and their error probability analysis. Time division and frequency division multiplexing. Equalization.

Telephone networks: Modern telephone exchanges, switching techniques. Elements of Mobile communication. Satellite Communication, Multiple access techniques –FDMA, CDMA.

ELECTROMAGNETICS AND MICROWAVE ENGINEERING

Electromagnetic Theory :

Analysis of electrostatic and magnetostatic fields; Laplace's and Poisson's equations. Boundary value problems and their solutions; Maxwell's equations. Wave propagation through bounded and unbounded media.

Transmission lines:

basic theory, standing waves, stub matching techniques. Microstrip lines. Propagation of signals at HF, VHF, UHF and microwave frequency. Elements of antenna theory.

Microwave Engineering :

Analysis of Microwave Tubes. Solid state microwave devices and their applications. Analysis of waveguides (rectangular and cylindrical). Microwave Components and Circuits. Micro strip circuits. Microwave Measurements. Microwave Antennas.

Optical Communication:

Basics of optical fibre: Numerical aperture, cone of acceptance, rectilinear and curvilinear propagation of light waves through fibre single mode and multi- mode propagation, Optical fibre as a cylindrical wave guide, dispersion and attenuation, splicing techniques, fibre losses, link length calculations, Optical sources and amplifiers, optical detectors, dispersion management in optical fibres. Microwave Communication Systems (terrestrial and Satellite based).

Data structures and computer algorithms :

Electronics Engineering MPSC, Maharashtra Public Service Commission Electronics Engineering Exam Data representation, Programming, Elements of a high level programming language C. Use of data structures such as stacks, queues, linked lists, trees and graphs. Algorithms for insertion and deletion of elements in these data structures. Complexity of algorithms, sorting and searching techniques, Spanning trees, shortest path, Knapsack problem, Traveling sales person's problem, NP-Hard, NP-Complete. Design techniques(Greedy/Dynamic programming/ Divide and conquer).

Computer Organisation :

Fundamentals of computer architecture. Processor design; Control unit design. Memory organisation, I/O System Organisation. Advanced architectures- Parallel processing.

Computer Networks :

ISO/OSI model, packet switching, congestion in communication networks Sliding window protocol. LAN technologies (Ethernet/UDP), TCP, Internet Protocol. Basic concepts of switches, gateways and routers, Internet technologies. Network security.

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MECHANICAL ENGINEERING

PART-I

***Statics*:-** Equilibrium in three dimensions. Suspension cables. Principle of virtual work.

***Dynamics*:-** Relative motion, coriolis force, Motion of a rigidbody Gyroscopic motion. Impulse.

Theory of Machines:- Higher and lower pairs, inversions, steering mechanism, Hooks joint, velocity and acceleration of lines, inertia forces. Cams. Conjugate action in gearing and interference, gear trains, epicyclic gear. Clutches, belt drives, brakes, dynamometers, fly wheels, governors, balancing of rotating and reciprocating masses and multicylinder engines. Free, force and damped vibration for a single degree of freedom. Degrees of freedom. Critical speed and whirling of shafts.

Mechanics of Solids:- Strees and strain in two dimensions. Mohr's Circle. Theories of failure, deflection of beams, buckling of columns; combined bending and torsion. Castiglianos theorem. Thick cylinders, rotating disk. Shrink fit. Thermal stress.

Manufacturing Science:- Merchant's theory, Taylor's equation, Machineability. Unconventional machining methods including EDM, ECM and ultrasonic machining. Use of lasers and plasmas. Analysis of forming processes. High velocity forming. Explosive forming. Surface roughness, gauging, compactors, jigs and fixtures.

***Production Management*:-** Work simplification, work sampling, value engineering. Line balancing, work station design, storage space requirement. ABC analysis, Economic order, quantity including finite production rate; Graphical and simplex methods for linear programming; transportation model; elementary queuing theory. Quality control and its uses in product design. Use of X.R.P. and C charts, Single sampling plans, operating characteristics curves. Average sample size, Regression analysis.

PART-II

***Thermodynamics*:-** Applications of the first and second laws of thermodynamics. Detailed analysis of thermodynamic cycles.

Fluid Mechanics:- Continuity, momentum and energy equations. Velocity distribution in laminar and turbulent flow, dimensional analysis. Boundary layer on a flat plate. Adiabatic and isentropic flow, Mach number.

Heat Transfer:- Critical thickness of insulation. Conduction in the presence of heat sources and sinks. Heat transfer from fins. One dimensional unsteady conduction. Time constant for thermocouples, Momentum and energy equations of boundary layers on a flat plate. Dimensionless numbers. Free and forced convection, boiling and condensation. Nature of

radiant heat. Stefan Bolzmann law. Configuration factor, logarithmic mean temperature difference. Heat exchanger effectiveness and number of transfer units.

Energy Conversion:- Combustion phenomenon in C.I. and S.I. engines. Carburetion and fuel injection, Selection of pumps, classification of hydraulic turbines, specific speed. Performances of compressors. Analysis of steam and gas turbines. High pressure boilers. Unconventional power systems including Nuclear power and MHD systems. Utilisation of solar energy.

Environmental Control:- Vapour compression, absorption, steam jet and air refrigeration system. Properties and characteristics of important refrigerants. Use of psychometric chart and comfort chart. Estimation of cooling and heating loads. Calculation of supply air state rate. Air conditioning plant layout.

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Environmental Science

PART-I

Life Sciences

(Basic Biology and Natural Resources)

Basic Biology

Introduction to biology, branches, scope and importance from environmental point of view. What is life?

The evolution of life on earth: Origin of life - Microbes, Plants and Animals, fossils and sediments, distribution and pattern of life in past, Paleontological evidences, Mass extinction

Life forms on Earth (all forms of plants and animals), Life in Water, Life on Land, Microbial life in air, water and soils, microbes and diseases, decomposing soil microbes, marine biology.

Taxonomic principles: History, aims, objectives, hierarchy and kingdoms, identification and nomenclature

Classification of plants and animals based on form-relationship, species concept, organization of living things, microbial classification, Ecological Classification Systems, Collection and Herbarium, Preservation, flora, fauna, preservation of insects

Ecological adaptation under various environmental conditions, Hydrophytes, Xerophytes, Halophytes, Mesophytes, Epiphytes

Distribution of life on earth and factors responsible for present day distribution. Continental drift.

Natural Resources

Introduction, scope and importance of natural resources, biotic and abiotic resources Renewable and nonrenewable natural resources and their limitations.

Renewable resources: Forest and wildlife resources, forest wealth of India, animal resources, livestock and fisheries.

Food Resources: World food problems, agricultural resources, agricultural potential of India, effects of modern agriculture

Non-renewable resources: Fossil fuels – coal, oil and natural gas, Consequences of rapid consumption of fossil fuels

Fresh and marine Water resources: global distribution of fresh water and its limits, The sources of fresh water for terrestrial life, fresh water resources of India, mans water requirement, floods and droughts

Soil and Mineral resources: global status, mineral resources of India, metals and minerals

Energy resources: Global energy consumption, energy needs, conventional and non-conventional energy sources, alternative energy sources, energy resources of India.

PART-II

Earth Sciences
(Environmental Chemistry and Basic Geosciences)

Environmental Chemistry

Chemistry of atmosphere, Chemical reactions involved in atmosphere, chemistry in ozone depletion, chemical reactions of global warming

Chemistry of water, unusual physical properties, changes in water properties by addition of solute, hydrogen bonding, gases present in water, basic reversible and irreversible reactions in water, sources of cations and anions in water, changes in water properties by addition of solute

Stichiometry, Gibb's energy, chemical potential, chemical equilibria, acid-base reactions, solubility product, carbonate system

Chemistry of carcinogenic compounds and their effects on human body.

Surfactants: Cationic, anionic and non-ionic detergents, modified detergents.

Pesticides: Classification, degradation, analysis, pollution due to pesticides and DDT problems

Lead and its compounds: Physical and chemical Properties, behaviour, human exposure, absorption, influence. Mercury and its compounds: Physical and chemical Properties, behaviour, human exposure, absorption, influence.

Hydrocarbons: Chemistry of hydrocarbon decay, environmental effects, effects on macro and microorganism.

Destruction of some hazardous substances: acid halide, anhydrides, cyanides and cyanogens bromides, chromium, aflotoxins, halogenated compounds.

Basic Geosciences

Atmosphere: Evolution, structure and chemical composition of atmosphere.

Temperature measurement and controls, Environmental lapse rate, dry and wet adiabatic lapse rate, inversion of temperature and atmospheric stability.

Atmospheric pressure and winds, factors affecting on wind, Forms of condensation, precipitation, hydrological cycle.

Internal structure of earth, Geological evolution, plate tectonic, formation of lithosphere. Continental and oceanic crust formation.

Types of rocks, Rock cycle, basic minerals of rock, clay minerals, mineral chemistry.

Soil and its formation, weathering processes, soil profiles, physical and chemical properties of soil, composition of soil. Macro and micro plant nutrients in soil, Soil classification, Soils of India.

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FORESTRY
PART—I

1 Silviculture

1.1 General Silvbiculture Principles : ecological and physiological factors influencing vegetation, natural and artificial regeneration of forests; methods of propagation 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.

1.2 Silvicultural Systems- clear felling uniform, shelter wood, selection coppice, and conversion systems, Management of silvicultural system of temperate, subtropical, humid tropical, dry tropical and coastal tropical forests with special reference to nplantation silvitural choice of species, establishment and management of standards, seeding thining.

1.3 Silviculture of Mangrove and Cold deset: Managrove habitate and characteristics mangrove, plantation establishment and rehabilitation of degraded mangrove formations, silvitural systems for mangrove, protection of habitats, against natural disasters.

Cold desert- characteristics, identification and management of species.

1.4 Silviculture of trees: Tradition and recent advances in tropical silvicultural research and practices, Silviculture of some of the economically important species in India such as Acacia catechu, Acacia nitotica, Acacia auriculiformis, Albizzia Albizzia procera Anthocephalus cadamba, anogeissus latifolia, Azadirachta indica, Bamboo spp, Butea monosperma, Cassia siamea, Casuarina equisetifolia Cedrus deodara, Eucalyptus spp, Gnelina Arborea Hardwickia binata, Iargerstoremia Lanceolata, Pinus rosburghi, Populus SPP, Pterocarpus marsupium, Prosopis juliflora, Santalum album, Semecarpus anacardium, Shorea, robusta, Salmalia malabaricum, Techtonagrandis, Terminlis temimtosa,Tamarindus indica.

2 Forest Ecology and Ethnobotany: Biotic and aboitic components, forest ecosystems, forest community concepts;vegetation concepts, ecological succession and climaxprimary productivity, nutrient cycling and water relation; physiology in stress environments(drought, water togging salinity and alkalinity). Forest types in India, indentification of species, composition and associations; dendrology; taxonomic classification, principles and establishment of herbaria and arporeta, Conservation of forest ecosystems. Clonal parks.

Role of Ethnobotany in Indian Systems of Medicine; Ayurveda and Unani-Introduction, nomenelature, habvitate, distribution and botanical features of medicinal and arnomatic plants, factors affecting action and toxicity of drug plants and their chemical constituents.

3. **Environmental Conservation and bio diversity:**

3.1 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.

3.2 Bio diversity: concepts and principles, importance of bio-diversity conservation instuand ex-situ method of conservation, measurement of diversity, diversity indices, Biosphere concept, hotspots of bio-diversity, Indian bio-diversity and gene pool. Conservation efforts in india and world-wide, bio-diversity conventions and treaties.

3.3 **Pollution**- types, global warming, green hose effects, ozone layer depletion, acid rain, impact and control measures, environmental monitoring, concept of sustainable development. Role of trees and forests in environmental conservation control and prevention of air water and noise pollution, Environmental Impact Assessment, Economics assessment of watershed development vis-à-vis ecological and environmental protection.

1. **Tree improvement, Seed Technology and Biotechnology:**

4.1 General concept of tree improvement, methods and techniques, variation and its use provenance, seed source, exotics, quantitiative aspects of forest tree improvement, seed production and seed orchards, progeny tests, use of tree improvement in natural forest and stand improvement genetic testing programming, selection and breeding, for resistance to diseases, insects, and adverse environment, the genetic base, forest genetic resources and gene conservation in situ and ex-situ Cost benefit ratio economic evaluation.

4.2 **Biotechnology:** Historical developments, scope of biotechnology in agriculture, forestry and industry, Plant tissue culture, response patterns, Application of plant tissue culture in plant improvement, in vitro selection, micro propagation of forest trees and medicinal plants germ plasm conservation and enrichment, recent developments, Gene regulation, genetic engineering techniques, transgenic plants and animals, case studies with special reference to genetic modification of tree species to diseases, pest and other forms of stress.

Modication of plant species to practice desired products, Bio-degradation of agriculture and forestry wastes through genetically engineered microbes.

2. **Forest Pathology:** Importance and brief history of Forest pathology, terminology concept, causes and classification of plant discases; symptomatology; stages in discase development; dissemination of pathogens; inoculums and inoculums potential; pathogenesisrole of toxins and enzymes; variability in pathogens; disease resistance; plant disease epidemics; disease forecasting; management of disease through regulatory, cultural, physical, chemical and biological methods; integrated disease management; biotechnology in plant pathology Common forest fungi diseases and methods of control. Nursery discases of important tree species.

Principal of Forest disease management Definition and scope of disease management of forestry. Importance of disease cycle and economic threshold in disease management. Principles of disease management such as exclusion, cultural, chemical, dialogical and immumization, Nature of disease resistance. Fungicides and their use in nurseries and plantations. Integration of cultural, chemical, biological and host resistance in effective disease management, Meristem and tissue culture techniques in disease management.

Bio-degration of wood in use. Types of wood decay, gross characters of decay, sap-stain, different types of rots in hardwoods softwoods and their prevention, Graveyard test and decay resistant wood.

3. **Forest Entomology:** Definition importance and scope of Entomology, Definition of insect and its position in the Animal kingdom. Important characters of phylum arthropoda and class insect. External morphology of generalized insect. Insect growth and development, reproduction in insects immature states (Egg. Larvae/ nymph and pupae), metamorphosis in insects.
Texonomic classification of class insects, diagnostic characters of the orders and major families of economic importance.

History and importance of Forest Entomology in india, methods and principles of pest control; Mechanical, physical, silviculture legal, biological and chemical principles and techniques of in--------pest management in forests.

Classification of forest pests; Types of damages and symptoms; factors for out break of pests, Nature of damage and management; Insect pests of forest seeds, forest nursery and standing trees of timber yielding species of natural forest (ectona, Dalbergia sp. Albiziaspp. Sandal, ailantints, Gmelina, Terminalia, Deodar, Pines); Plantation forest species (Eucalyptus, Bamboo, Casurina, neem, Acacia), Fruit trees, (Emblica, Ver, Eugenia, Tarnarind0 Insect pests of freshly felled trees, finished timbers and their management. Morphology of plant parasitic namatodes, brief classification of important genera of nematodes, important diseases caused by different genera and their management practices.

4. **Wildlife Management and Conservation:** History of wildlife management and conservation in India; cultural background, Habitate management: purposes, principles, practices and tools-fire, cutting, grazing, Habitat interspersion and edge effect. Provision of water saltlicks and food. Soning core, buffer, tourism and multiple use in protected areas. Wildlife damage control; Mitigating, human wildlife conflict-fences, trenches, walls, lure crops, repellents, translocation and compensation.

Captive wildlife; Zoos and safari parks, Captive breeding for conservation, Role of Central Zoo Authority of India.

Wildlife census; Purpose, techniques, Direct and indirect methods of population estimation, Sample and total counts, indices, encounter rates and densities.

Wildlife (Protection) Act, 1972, Protected areas – Sanctury National Partk and Biosphere Reserves, Special projects for Wildlife conservation . Project Tiger and Musk Deer Project. Introduction and reintroduction of species, Wildlife corridors, MAB, Red Date book, Category of threat, CITES, Conservation, meaning, principles and strategies, in-situ and ex-situ conservation, conserving bio-diversity, Politics-socio-economic, role of education and extension.

5. **FOREST MANAGEMENT**

8.1 **Forest Management and Management Systems:** Objective and principles; techniques; forest management systems – their evolution and application world forestry systems, Forest sources and forestry practices in different regions of the world, international forestry organizations; stand structure and dynamics, sustained yield relation, rotation normal forest growing stock regulation of yield; management of forest plantations, commercial forests, forest cover monitoring. Approaches, viz. (1) site-specific planning (ii) strategic planning (iii) Approval, sanction and expenditure (iv) Monitoring (v0 Reporting and governance. Range land management – need and importance. Distribution, characteristics, status and management of range lands, ecology and range lands and impact of grazing, range land inventory mythology -----age equipment techniques, alpine pastures, their importance in nomadic grazing and growth of medicinal shrubs and herbs.

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

8.3 **Forest mensuration, Inventory and Statistics:** Methods of measuring – diameter girth height and Volume of trees; form –factor; volume

estimation of stand, current annual increment; mean annual increment, Sampline methods and sambleplots.
Yield calculation; yield and stand tables, Forest inventory –definition, object, kind of enumeration, Sampling-advantages, kinds of sampling, random sampling simple, stratified, multiphase sampling non-random sampling selective, Systematic and sequential sampling. Sampling design, size and shapes of sampling, units. Point sampling; horizontal and vertical point sampling, forest cover monitoring through remote sensing; Geographic, Information Systems for management and modeling, Forest statistcs- Definition and scope, collection of data and their presentation, measures of central tendency; lawa of probability, linear correlation and its measure, tests of significance, sampling methods and designs, analysis of variance.

8.4 **Surveying and Forest Engineeraing:** Forest surveying – different methods for surveying maps and map reading, Basic principles of forest engineering, Buidling materials and construction , Roads and Bridges; General principles; objects, types, simple design and construction of timber bridges.

6. **Forest Protection:** Injuries to forest, abiotic and biotic actors, destructive agencies, insect-pests and disease, effects of air pollution on forests and forest die bck. Susceptibility of forests to damage, nature of damage, cause, prevention, perfective measures and benefits due to chemical and biological control. General forest protection against fire equipment and methods, controlled use of fire, economic and environmental cost; timber salvage operations fter natural disasters, Role of afforestation and forest regeneration in absorption of CO2. Rational and controlled grazing, different methods of control against grazing and browing animals; effect of wild animals on forest regeneration, human impacts; encroachment, poaching, grazing, --- fencing, theft, shifting cultivation and control.

7. **Watershed Management and Hydrology:** concepts of watershed: role of mini-forests and forest trees in overall resource management, forest hydrology, water development in respect of torrent control, river channel stabilization, avalanabe and landslide controls, rehabilitation of degraded areas; hilly and mountain areas; watershed management and environmental fuction of forests; water-harvesting and conservation; ground water recharge and watershed management; role of integrating forest trees, horticulture crops, field crops, grass and fodders, Hydrology, Water resources and Engineering – Hydrological cycle, presipitation, evaporation, transpiration, depression, storage, infiltration, overland flow, hydrograph, flood frequency analysis, flood estimation, flood routing through a reservoir Water logging-its causes and control, design of drainage system, soil salinity, river training- principles and methods.

8. **Water science and Technology:** Wood as raw material, kinds of wood-hardwood, soft-wood, bamboos and palms, wood as raw material,. The physical features of wood Mechanical properties of wood. Suitability of wood for variousend-uses based on mechanical and physical properties. Electrical and acoustic properties of wood.

Wood water relationship-shrinkage, swelling, movement, fibre saturation, and equilibrium moisture contract, Wood seasoning – merits, principles and types – air seasoning, kiln seasoning, chemical seasoning, Refractory classes of timbers kiln schedules, Seasoning defects and their control. Wood preservation-principles, processes, need, Types of wood preservatives (Water-soluble, oil based, etc.) classification of timbers based on the----------General idea about fire retardant and their usage.

Non-pressure methods – steeping, dipping, soaking open tank process, Boucherie process, pressure methods – full cell process, emptycell process (Lutory and Ruping) Wood machining.

Sawing- techniques, kinds of sews –cross cut saw, edging saws, cudless saws; handsaw, and circular saw, quarter sawing bow saws, Wood working, tools used in wood working (parting tools, slicing tools, shaping tools, measuring and marking tools, various stages of wood working. Dimensional stabilization of wood by surface coating method bulking method and impregnation of resins and polymers.

9. **Computer application in Forestry:** Introcduction to computers – Hardware, software, firware, Components of computer system-Central Processing Unit, Input output devices, Operating system – Batel Processing, Multi-user, Personal computer operation. Computer languages – Machine language, assemble language, high level languages, Compilers and interpreters. Problem solving on a computer simple algorithms, flowchart marking, BASIC language, constants and variable, Operations- arithmetic, relational and logical operations.

Writing simple programmes in BASIC language to compute the Mean Variance Correlation Regression, work processing and spreadsheets, preoaratuib of forest databases.

10. **Remote Sensing and GIS in Forestry:** Principle, forest cover mapping through remote sensing, use of remote sensing in forest inventories, GIS fundamentals, GIS in modeling and management of forest resources.

PART-II

1. **Social, Agro and Farm Forestry:**

1.1 Social Forestry: Objective, scope and necessity, evolution of social forestry in India, people participation, experiences of Social Forestry Projects in India.

1.2 **Agro – Forestry:** scope and necessary, place of Agro-forestry in National Forest Policy, role in the life of people and domestic animlas and integrated land use, planning especially related to (i) soil and water conservation: (ii) water recharge; (iii) nutrient availability to crops; (iv) pasture

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, fodder and fuel security. Research and Extension needs, social forestry in Himachal Pradesh, Van mahotsava and Chipko movement.

1.3 **Farm Forestry:** definition, its resemblance and difference from agro-forestry, farm wood lots. High-density plantations. Economics of farm forestry; Different farm forestry systems – tagunya, shifting cultivation, alley cropping, wind braks, shelterbelts, dryland and wetland farm forestry.

1.4 **Tribology:** tribal scen in India; tribes, concept of rages, principles of social grouping, stages of tribal economy, education, cultural tradition, customs, othes and participation in forestry programmes with special reference to Himachal Pradesh.

2. **Joint Forest Management:** Need principles, objectives, methodology, scope, benefits and role of NGOs mahila mandals and other voluntary organizations, details of steps involved such as formation of Village Forest Committees, Joint Forest participatory Management committees.

3. **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.

Need and importance of wood seasoning and preservation; general principles of seasoning, air and kiln seasoning, solar dehumidification, steam heated and electrical kilris Composite wood; adhesibes –manufacture, properties, uses, plywood manufacture-properties, uses, fibre boards-manufacture properties, uses; particle hoards manufacture properties, uses. Presestatus of composite wood industry in India in future expension plans. Pulp-pager and rayon; present position of supply of raw material to industry, wood substitution, utilization of plantation wood; problems and possibilities.

Anatomical structure of wood, defects and amnormalities of wood timber identification – general principles.

4. **Non-Timber Forest Products:** Introduction, fodder, grasses and tree leaves, canes and bamboos, and their uses, methods of collection of Non-timber Forest products (NTFPs), Essential Oils, extraction classification. Storage and uses, Non essential oils –nature, occurrence, methods of extraction of oils from seeds, Important oil yielding trees. Gums and Resina- sources, collection and uses, the occurrence and origin of gums in plants, properties of gums, important Indian gums, uses of gums, resins and oleoresins, formation of resins in plants, classification of resins, Tans and Dyes-nature and kinks of tannins,

Dyes-classification and sources of dyes, Beedi leaves, sources collection and processing, Fibres and Flosses, Cutch and Katha –sources, extraction and uses, Drups, Spices, poisons and Biopesticids.

5. **Marketing and Trade of forest Produce:** Basic concepts of demand, supply of forest produce, demand, demand and supply schedules, types of markets for timber and non-timber forest produce, market iocations of timber and non-timber forest produce and their features,----------forests.

Price determination in timber and non-timber forest produce, Economic feature of specialized markets in terms of degree and type of competition in buying and selling, price spread, costs of marketing functions involved like pre-commercial thinning, commercial thinning, harvesting hauling, sawing, transportation, treatment of wood carpentry, and other processing activities involves in teak-wood, rose wood, match wood, pulpwood, sandalwood, veneers-type and degree of competition in market for services of sawmill and other intermediate wood processing industries, price spreads across different channels of marketing, Economic features of specialized markets in terms of degree and type of competition for bamboo, canes, lacs, gums, resins, hides and skins forest based medicinal plants and trees and trees and other non-timber forest products.

Economics of gathering medicinal plants from forests Economics of processing medicinal plants.

Domestic demand and trade in timber and non-timber forest products.

International demand and trade in timber and non-timber forest product. Market inefficiencces in timber, non-timber forest produce ----------.

6. **Forest Soils, Soil Conservation:** 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 soil/ areas wind breaks shelter heits sand dunes; reclamation of salins and alkinline soil water logged and other waste lands. Role of Forests as conserving soil organic matter, provision of lopping for green leaf manuring; forest leaf litter and composting; Role of micro- organisms in ameliorating soils N and C cycles, VAM.

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

8. **Forest Policy & legislation:** Policy-definition, necessity and scope Legal and institutional approaches to forest resource management. National

Forest Policies, Forest Law, Legal definition Objects of special forest Law Indian Forest Act Detailed study of IFA, 1927. HP State Forest Acts and Rules, History of forest development Indian Forest policy of 1894, 1952 and 1990. National Forest Policy, 1988 of Peiople's involvement, Joint Forest Management, involvement of women; Forestry Policies and issues related to land use timber and non-timber products sustainable forest management; industrialization policies; institutional and structural changes. Decentralization and Forestry Public Administration, Forest laws, necessary, general principles, Indian Forest Act, 1927 (Forest Conservation Act, 1980; Wildlife protection Act, 1972 and their amendments; Application or Indian Penal code to forestry Scope and objectives of Forest inventory. History of Forest Development in India, Forest Policy of 1894, 1952 and amendment of 1980. Forest Law –its necessity Indian Forest Act, 1927; Forest Conservation Act, 1980.

9. **Extension & Education:** meaning definition nature; scope objectives; principles approaches and history, Forestry extension; process principles and selected programmes, ICFRE and its institutes; People's participation in forestry programmes; motivation of women community; children youth and voluntary organizations for forestry extension work, Rural Development, meaning , definition, objective and genesis. Transfer of technology programmes like ORP, LLP, ND, FLD, KUK, TARP etc. of ICAE.

10. **Communication:** meaning, definition, elements and selected models, Audio visual aids meaning, importance, classification and selection, programme, planning process-meaning scope. Principles and steps, Evaluation meaning, importance and methods. Scope importance of PRA & RRA. Management and administration- meaning, definition, principles and functions. Concepts of human resource development (hRD) rural leadership.

11. **Project Planning, monitoring & evaluation:** Needs, scope and types of projects, project methodology, components and cycle, stages of project formulation, projet budgeting, sensitivity analysis, cost benefit ratio and analysis, need for project monitoring and evaluation. M7F techniques and methodology.

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GEOLOGY

PART-I

1 Physical Geology and geomorphology - Origin, structure, interior and age of the Earth Geosynclines and Mountains. Isostasy. Origin of continents and oceans. Continental drift. Seismology, Volcanology, Geological action of surface agencies.

2 Structural and field geology - Common structure of igneous, sedimentary and metamorphic rocks, study of folds, faults, inconformities, joints and thrusts. Elementary ideas of methods of geological surveying and mapping.

3 Stratigraphy and Palaemology - Principles of Stratigraphy. Indian Stratigraphy. Lithological and Chronological sub-division of Geological record. Fossils, nature and its mode of preservation, bearing or organic evolution, Invertebrate and plant fossils.

PART-II

1 Crystallography and Mineralogy - Elements of crystal forms and symmetry. Laws of Crystallography. Crystal systems and classes, Crystal habits. Twinning. Stereographic projections. Physical, chemical and optical properties of minerals, study of more important rock-forming and economic minerals regarding their chemical, physical properties, crystallographic and optical characters; alterations, occurrence and commercial uses.

2 Economic Geology - Theories of Ore genesis. Classification, geology, occurrence, localities and resources of chief metallic and non-metallic minerals of India, Mineral industries in India. Principles of geophysical prospecting and ore dressing.

3 Petrology – Origin, constitution, structure and classification of igneous, sedimentary and metamorphic rocks. Study of common Indian rock types.

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HORTICULTURE

PART-I

Fruit Industry in India and its potential. General principles of cultivation. Method of propagation. Physiological basis of rooting. Special plant growing structures – mist propagation, green house and glass house. Promising root stocks for fruit crops. Plant growth regulators, retardants and inhibitors relating to flowering, sex expression, fruit set, fruit development and ripening. Dormancy and rest and rest period. Pollination and fruit set. Growth and fruiting habits of fruits and nut species. Parthenocarpy. Orchard management practices, manure and manuring, irrigation, training and pruning high density planting. Fruit thinning and fruit drop.

Origin, history, pomological description, climatic requirements and production techniques of important temperate, sub-tropical and tropical fruit crops. Important pests, diseases and physiological disorders and their management. Integrated management of pests and diseases. Harvesting and harvest maturity indices. Handling and marketing problems of major fruits. Special problems of production.

Principal methods of preservation. Important fruit and vegetable products. Processing techniques and equipments. Wastes from processing factory and their impact on environment. By-products and utilization. Nutritive value of fresh and processed fruits and vegetables. Standards of fruit and vegetable products.

Economic principles in fruit and vegetable production. Use of planning and budgeting techniques. Efficiency measures of orchard management.

Extension education and its importance. Methods of evaluation of extension programmes. Socioeconomic survey and status of different categories of farmers. Training programmes for extension workers. Lab to field and T&V programmes.

PART-II

Importance, nutritive value and classification of vegetables. Types of vegetable gardening. Principle of vegetables, cultivation including nursery management. Climatic requirement and cultivation of major summer and winter vegetable crops. Off-season vegetable production. Diseases and pests of vegetable crops and measures to control.

Weeds, their characteristics and association with various vegetable crops.

Principles of plant breeding in the improvement of major vegetable crops. Methods of breeding of

self, cross-pollinated and vegetatively propagated crops. Seed technology and its importance. Production, processing, testing and marketing of vegetable seeds.

Plant physiology and its significance. Growth and development factors affecting growth. Absorption and translocation of water transpiration and water economy. Modern concepts of photosynthesis and respiration.

Processes and factors of soil formation. Mineral and organic constituents of soil and their role in maintaining soil productivity. Plant nutrient elements in soils and their availability. Nitrogenous, phosphatic potassic and micronutrient fertilizers and their use. Problem soils and their reclamation. Water conservation and watershed management. Water use efficiency in relation to crop production. Criteria for scheduling irrigation, ways and means of reducing run off losses.

Importance and scope of floriculture, landscaping and interior-scaping. History, theory and principles of landscape, planting and lawns. Beautification of slopes, forests and wastelands. Layout of home gardens and public parks. Propagation of ornamentals. Cultural requirement of ornamental trees, shrubs, climbers, bulbs and annuals for winter and summer season. Production technology and post harvest management of cut flowers, bulbs, house plants and bedding plants.

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MATHEMATICS

PART-I

MATHEMETICS PURE

(1) ***Algebra***:- Sets, Union, Intersection difference and complementation properties, Venn Diagram. Properties of natural numbers. Real numbers and their representation by decimals. Complex number, Argand Diagram. Cartesian Product Relation. Mapping. Function as a mapping. Equivalence relation. Groups, Isomorphism or groups. Sub-groups, Normal sub-groups. Legrange's theorem . Frobenius theorem.

The definitions and illustrations of rings and field. Divisors of zero and Homomrohisms. Vector spaces.

Determinants addition, sub-straction, multiplication and inversion of matrix. linear homogeneous and non-homogeneous equations, Cayley Hamilton theorem.

Elementary number of theory. Fundamental theorem of arithmetic. Congruences. Theorems of Format and Wilson. Inequalities. Arithmetical and Geometrical means. Inequalities of Caucuy, Schwz, Holder and Minkowsky.

(2) Infinite sequences and series:- Concept of limit infinite series. Convergent, divergent and oscillatory series. Caucuy's general principle of convergence. Comparison and ratio test. Guess's test. Absolute convergence and de-arrangements of series.

(*3) Trigonometry*:- De Movine's theorem for rational index and tits applications. Inverse, Circular and Hyperbolic functions. Expansions and summation of trigonometrical series. Expressions for sine and cosine in terms of infinite products.

(4) Theory of Equation:- General properties of polynomial equation. Transformation of equations.Nature of the roots of cubic and biquadratic, Cardan's solution of the cubic, Resolution of biqadratic into quadratic factors. Location of roots and Newton's method of divisors.

(*5) Analytic Geometry of two and three dimentions*:- Straight lines. Pair of straight lines, Circle, system of circle. Ellips Parabola, Hyperbola, Reduction of second degree equation to a standard form. Plane, straight lines, sphere, cone, concides and their tangent and normal properties (Vector methods will be permissible).

***(6) Analysis*:-** Concept of limit, continuity, derivation, differentiability of a function of one real variable, properties of continuous functions. Characterisation of discontinutes. Mean value theorems. Evaluation of indeterminate forms. Taylor's and Maclrauin's theorems with Laran's and Cauchy's form of remainders. Maxima and minima of function of one variable. Plane curves, singular points, curvature curve tracing. Envelopes, Partial differentiation. Differentiability of function of more than one real variable. Standard methods of integration. Rirman's definition of definite-integral of continuous function. Fundamental theorem of integral culculus. First mean value of theorem of integral culculus. Rectification, quadrature volumes and surfaces of solids of revolution and their applications.

(*7) Differential Equation*:- Formation of ordinary differential equation order and degree.

Geometrical demonstration of the existing theorem for sx/sy = S(x,y.). First order linear and non-linear.equations. Singular points. Singular solutions. Linear differential equations and their important properties. Liners differential equations with constant co-efficients. Cauchy-Euler type of equations. Extcta differential equations and equations admitting integrating factor. Second order equations. Changing of dependent and independent variables, Solution when integral is known variation of parameters.

PART-II
MATHEMATIC APPLIED

(*1) Vector Analysis*:- Vector Algebra , Differentiation of Vector function of a scalar variable. Gradient, Divergence and Curl in Cartesion, cylindrical and spherical co-ordinates and their physical interpretation. Higher order derivatives. Vector identities and Vactor equations. Guess and Stocks theorems.

(*2) Static*:- Fundamental laws of Newtonian Mechanics. Theory of Dimension. Plan Statics. Equilibrium of system of particles. Works and potential energy, Centre of mass and centre of

gravity.Frictions, common Catenary, Principle of virtual work. Stability of equilibrium. Equilibrium of forces in three dimensions.

Attraction potential of rods, rectangular and circular discs, spherical shell, sphericel equipotential surfaces and their properties. Properties of potentials. Greens equivalent stratum. Laplacels and Poissons equations.

***(3) Dynamics*:-** Velocity vector, Relative velocity. Acceleration. Angular velocity. Degrees of freedom and constraints. Rectilinear motions; Simple harmonic motion. Motion in a plane. Projectiles. Constrained motion. Work and energy. Motion under impulsive forces. Kepler's laws, Orbits under central forces. Motion of varying mass. Motion under resistance. Moments and products of inertia. Two dimensional motion of a rigid body under finite and impulsive forces. Compound pendulum.

(4) Hydrostatics:- Pressure of heavy fluids. Equilibrium of fluids under given system of forces. Centre of pressure. Thrust on curved surfaces. Equilibrium of floating bodies. Stability of equilibrium. Pressure of gases and problems relating to atmosphere.

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PHYSICS
PART—I

***1 Mechanics*:-** Galileans, Transformation, concept of mass and Newton's laws of motion conservation laws, Motion of rigid bodies, Coriolis Forces, Kepler's laws of gravitation, measurement of 'F' of Artificial satellites. Fluid motion, Bernoullis theorem, circulation, Reynold number, turbulence. Viscosity, surface tension, Elasticity, Relativistics mechanic and simple applications, elements of general relativity.

***2 Thermal Physics*:-** Perfect gas, Vander Weals equations. Laws of Thermodynamics. Production and measurement of low temperatures. Kinetic theory of gases; Brownian motion. Black body radiation. Plank's law. Specific heat of gases and solids. Thermionic emission. Fermi Dirac and Bose-Einstein distribution laws. Thermal ionization. Elements of irreversible thermodynamics. Solar energy and its utilisation.

***3 Waves and Oscillations*:-** Oscillations with one and two degrees of freedom, forced vibrations and resonance wave motion. Phase and group velocity.

Huygen's Principle, Reflection, refraction, interference, diffraction and polarization of waves, Optical instruments and resolving power. Multiple beam interference. Ex-M. wave equation, Fresnels formula, normal and anomalous dispersion coherence. Laser and its application.

PART-II

Poisson's and Laplace's equations and simple applications. Dielectric and polarization, capacitors. Dia-para and ferromagnetic materials. Kirchhoffs laws. Amperes law, Faradays laws of electromagnetic induction. L.C.R. circuits, alternating currents, Maxwll's equations.

***Atomic Physics*:-** Bohr's theory, Electron spin, Lande's factor. Paul's principle. Spectre of one electron system. Zeeman effect, wave particle. Elements of X-ray spectra. Compton

scattering. Wave particle duality, Schrodinger's equation and simple applications. Uncertainty principles.

Basic properties and structure of nuclei, mass spectrometry, radio activity, mechanism, band and decay, properties of neutron, electron microscope, nuclear fission and reactor, nuclear fusion, cosmic ray showers, pair production. Simple properties of elementary particles. Symmetry in physical laws.

***Electronics*:**- Electron emission from solids, Child-Langmuir Law, Static and dynamic characteristics of diodes, triodes, tetrodes and pentodes; thyraton. Band structure of metals and semiconductors, doped semi-conductors; P-N diodes, transistor.

Simple (vacuum tubes and transistor) circuits for Rectification, amplification, oscillation, modulation and detection of r.f. waves. Basic principles of radio reception and transmission. Television. Elementary principles of microscope solid state device.

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STATISTICS

PART-I

(*1) **Probability***:- Classical and Statistical definitions of probability, Simple theorems of probability with examples. Conditional probability and statistical independence. Bayer's theorem. Random variables – Discreet and continuous. Probability function and probability density functions. Probability distribution in one or more varieties. Mathematical expectations. Chebyshev's inequality, weak-law of large numbers. Simple form of central limit theorem.

(*2) **Statistical methods***:- Compilation, classification, tabulation and diagrammatic representation of various types of statistical data.

Concepts of statistical population and frequency curve, measures of central tendency and dispersion, moments and cumulants. Measures of Skewness and Kurtosis. Moment-generating functions. Study of standard probability distributions. Binomial, Poison, Hypergeometric, Normal, Negative, Binomial rectangular and log normal distributions. General description of the Pearsenian system of curves.

General properties of a bivariate distributions, bivariate normal distribution. Measures of association and contingency, Correlation and Linear regression involving two or more variables. Correlation ratio. Interclass correlation, Bank correlation. Nonlinear regression analysis.

Curve fitting by methods of free hand curves, moving average's, group average, least squares and movements. Orthogonal polynomials and their uses.

(*3) **Sampling distribution and statistical inference***:- Random sample statistics, concepts of sampling distribution and standard error.

Derivation of sampling distribution of mean of independent normal varieties X_2 T and F Statistics, their properties and uses. Derivation of sampling distributions of sample means, variances and correlation coefficient from a vicariate normal population. Derivation (in large samples) and uses Pearsonian X_2.

(4) *Theory of Estimation*:- Requirements of a good estimates/ unbiasedness, consistency, efficiency and sufficiency. Cramer-Rao lower bound to variance of estimates. Best linear unbiased estimates.

Methods of estimation, General descriptions of the methods of moments, Methods of maximum likelihood method, of least squares and method of minimum x^2 properties of maximum likelihood estimators (without proof). Theory of confidence intervals, sample problems of setting confidence limits.

PART-II

***Theory of testing of Hypotheses*:-** Simple and composite hypotheses. Statistical test and critical regions. Two kinds of error, level of significance and power of test.

Optimum critical regions of simple hypotheses concerning one parameter. Construction of such regions for simple hypotheses relating to a normal population.

***Likelihood ratio tests*:-** Tests involving mean, variance correlation and regression co-efficient in univariable and bivariate normal population. Simple, non-parametric tests, sign, runmedian, rank and randomisation tests.

Sequential test of a simple hypotheses against a simple alternative (without derivation).

(I) *Sampling techniques*:- Sampling versus complete enumeration. Principles of sampling. Frames and sampling units. Sampling and non-sampling errors. Simple random sampling. Stratified sampling. Cluster sampling, Systematic sampling. Description of multi-stage and multiphase sampling. Ratio and regression methods of estimation. Designing of sample surveys with reference to recent large-scale surveysin India.

(II) *Design of experiments*:- Analysis of variance and covariance with equal number of observations in the cells.

Transformation of variate to stabilise variance.

Principles of experimental designs. Completely Randomised, randomised block and Latin square design. Missing plot techniques. Factorial experiments with confounding in 2^s ($s=2(i)$, 3^2 and 3^3 designs. Splitplot design. Balanced incomplete designs and simple lattice.

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VETERINARY SCIENCE
PART—I (ANIMAL HUSBANDRY)

1. Animal Nutrition:

Energy sources, energy metabolism and requirements for maintenance and production of milk, meat, eggs and work. Evaluation of feed as sources of energy.

1.1 *Advanced studies in Nutrition*: Protein - sources of protein, metabolism and synthesis, protein quantity and quality in relation to requirements. Energy-protein ratios in a ration.

1.2 *Advanced studies in Nutrition Minerals*: Sources, functions, requirements and interrelationship of the basic mineral nutrients including trace elements.

1.3 *Vitamins, Hormones and Growth Stimulating substances*: Sources, functions, requirements and inter-relationship with minerals.

1.4 *Advanced Ruminant Nutrition - Dairy Cattle*: Nutrients and their metabolism with reference to milk production and its composition. Nutrient requirements for calves, heifers, dry and milking cows and buffaloes. Limitations of various feed systems.

1.5 *Advanced Non-Ruminant Nutrition – Poultry*: Nutrients and their metabolism with reference to poultry, meat and egg production. Nutrient requirements and feed formulation for broilers at different ages.

1.6 *Advanced Non-Ruminant Nutrition - Swine*: Nutrients and their metabolism with special reference to growth and quality of meat production. Nutrient requirements and feed formulation for baby, growing and finishing pigs.

1.7 *Advanced Applied Animal Nutrition*: A critical review and evaluation of feed experiments, digestibility and balance studies. Feeding standards and measure of feed energy. Nutrient requirements for growth, maintenance and production. Balanced rations.

2. Animal Physiology

2.1 *Growth and Animal Production*: Pre-natal and post-natal growth, restoration growth curves, measures of growth, factors affecting growth, conformation, body composition, meat quality.

2.2 Milk *production and reproduction and Digestion*: Current status of hormonal control of mammary development, milk secretion and milk ejection. Composition of milk of cows and Buffaloes. Male and female reproduction organs, their components and functions. Digestive organs and their functions.

2.3 Environmental *Physiology*: Physiological relations and their regulation mechanisms of adaption, environmental factors and regulatory mechanism involved in animal behavior, methods of controlling climatic stress.

2.4 *Semen quality, Preservation and Artificial Insemination*: Components of semen, composition of spermatozoa, chemical and physical properties of ejaculated semen, factors affecting semen *in vive* and *in vitre*. Factors affecting semen preservation, composition of dilutents, sperm concentration, transport of diluted semen, deep freezing techniques in cows, sheep and goats, swine and poultry.

3. Livestock production and management

3.1 *Commercial Dairy Farming*: Comparison of dairy farming in India with advanced countries. Dairying under mixed farming and as a specialized farming, economic dairy farming. Starting of a dairy farm, capital and land requirement, organization of the dairy farm, procurement of goods. Opportunities in dairy farming. Factors determining the efficiency of dairy animals. Herd recording, budgeting, cost of milk production, pricing policy, personnel management.

3.2 Feeding *practices of dairy cattle*: Developing practical and economic rations for dairy cattle, supply of greens throughout the year, fields and fodder requirements of dairy farm, feeding regimes for day per young stock and bulls, heifers and breeding animals, new trends in feeding young and adult stock, feeding records.

3.3 General problems of sheep, goat, pigs and poultry management.

3.4 Feeding of animals under drought conditions.

4. Milk Technology

4.1 Organization of rural Milk procurement, collection and transport of raw milk.

4.2 Quality, testing and grading raw milk, quality storage grades of whole milk, skimmed milk and cream.

4.3 Processing, packaging, storing, distributing, marketing defects and their control and nutritive properties of the following milks: Pasteurised, standardized, toned, double toned, sterilized, homogenized, reconstituted, recombined, filled and flavoured milks.

4.4 Milk *Product Technology*: Selection of raw materials, assembling production, processing, storing, distributing and marketing milk products such as Butter, Ghee, Khoa, Chhaina, Cheese, condensed evaporated dried milk and baby foods, ice cream and kulfi, bye-products, whey products, butter milk, lactose and casein, testing, grading, judging milk products and agents specifications (ISI and Agmark). Legal standards, quality control, nutritive properties, packaging, processing and operational control. Costs.

4.5 Preparation of cultured milks, cultures and their management. Vitamin-D, soft and other special milks.

4.6 Legal standards, sanitation requirement for clean and safe milk and for the Milk Plant equipment.

PART—II (Veterenery science)

Genetics and Animal Breeding: Probability applied to Mendelian inheritance. Hardy-Weinberg Law. Concept and measurement of inbreeding and heretrozygosity - Wright's approach in contrast to Malecost's Estimation of Parameters and Measurements. Fisher's theorem of natural selection, polymorphism, polygenic systems and inheritance of quantitative traits. Casual components of variation. Biometrical models and covariance between relatives. The theory of patheo efficient applied to quantitative genetic analysis. Heritability, repeatability and selection models.

1.1 *Population Genetics applied to Animal Breeding*: Population vs. individual, population size and factors changing it. Gene number and their estimation in farm animals, gene frequency and zygotic frequency and forces changing them, mean and variance approach to equilibrium under different situations. Sub-division of phenotypic variance, estimation of additive, non-additive genetic and environmental variances in Animal population, Mendelism and blending inheritance. Genetic nature of differences between species, races, breeds and other sub-specific grouping and the grouping and the origin of group differences. Resemblance between relatives.

1.2 *Breeding systems*: Heritability, repeatability, genetics and environmental correlation, methods of estimation and the precision of estimates of animal data. Review of biometerical relations between relatives, mating systems, inbreeding, out-breeding and uses. Phenotypic assertive mating. Aids to selections. Family structures of animal. population under non-random- mating systems. Breeding for threshold traits, selection index, its precision, general and specific and combining ability, choice of effective breeding plants.

Different types and methods of selection, their effectiveness and limitations, selection indices, construction of selection in retrospect, evaluation of genetic gains through selection, correlated response in animal experimentation's.

Approach to estimation of general and specific combining ability, Diallete, fractional diallete crosses reciprocal recurrent selection, inbreeding and hybridization.

2. *Health and Hygiene*: Anatomy of Ox and Fowl. Histological technique, freezing, paraffin embedding etc. Preparation and staining of blood films.

2.1. Common histological stains, embryology of a cow.

2.2. Physiology of blood and its circulation, respiration, excretion, endocrine glands in health and disease.

2.3 General knowledge of pharmacology and therapeutics of drugs.

2.4. Vet-hygiene with respect of water, air and habitation.

2.5. Most common cattle and poultry diseases, their mode of infection, prevention and treatment etc. Immunity. General principles and problems of meat inspection, jurisprudence of Vet. practice.

2.6 Milk Hygiene**.**

3. Meat Hygiene:

3.1 Zoonosis. Diseases transmitted from animals to man.

3.2 Duties and role of Veterinarians in a slaughter house to provide their meat that is provided under ideal hygienic conditions.

3.3 By-Products from slaughter houses and their economic utilization.

3.4 Methods of collection, preservation and processing of hormonal glands for medicinal use.

4. Extension

4.1 Extension. Different methods adopted to educate farmers under rural conditions.

4.2 Utilization of fallen animals for profit - extension education etc.

4.3 Define Trysem. Different possibilities and methods to provide self-employment to educated youth under rural conditions.

4.4 Crossbreeding as a method of upgrading and local cattle.

ZOOLOGY

PART-I

(NON-CHORDATE AND CHORDATE)

1. A general survey, classification and relationship of various phyla.

2. *Protozoa* - Study of structure, life history of Paramaecium, Vorticella, Monocyotis, Malerial Parasite, Euglena, Trypanosoma.

3. *Porifera* **-** Study of structure of cycon, canal system and skeleton in porifera.

4. *Coelenterata* **–** Obelia, Aurelia (Structure and Life History), polymorphism in Hydrozoa, coral formation, metagenesis.

5. *Helminthes* **-** Planaria, Fasciola, Taenia, Ascaris (Structure and Life History). Parasitism and Parasitic adaptation, Evolution of Parasitism. Helminths in relation to man.

6. *Annelida* **-** Neries, Earthworm, Leech (detailed history)

7. *Arthropoda* - Palaemon, Scorpion, Cockroach, Crustacean Larvae. Economic importance of insects.

8. *Mollusca* - Unio, Pila, Torsion, and detossion in Gastropoda.

9. *Echinodermata* **-** Starfish, larval form of Echinodermata.

10. Structure and bionomics and classification of the following:

Balanoglossus, *Herdmania, Branchiostoma/ Scoliodon, Frog, Uromastex, Pigeon, Rabbit***.**

11. Comparative account of the various systems of a vertebrate (Digestive system, Respiratory system, Nervous system, Receptor system, Circulatory system, Urinogenital system.

12. *Retrogressive Metamorphosis, Coclom in Branchiostoma.*

PART-II

(CELL BIOLOGY, CYTOGENETICS, ANIMAL PHYSIOLOGY, EVOLUTION, EMBRYOLOGY AND HISTOLOGY)

1. *Cell Biology* **-** Cell theory, structure and function of cell and cyto-plasmic constituents; structure of Plasma Membrane, Endoplasmic reticulum, Golgi Bodies, Mitochondria, Ribosomes, Nucleus. Cell division **-** Mitosis and Meiosis.Gene structure and Function; Watson and Crick Model of DNA, replication of DNA.

2. *Cytogenetics* **–** Menedlian Laws of inheritance, recombination, multiple alleles, Mutation – natural and induced. Polyploidy. Sex determination, Cytoplasmic inheritance.

3. *Physiology* **–** Chemical composition of protoplasms. Animal Physiology; Digestion and Absorption; Respiration (including Cell Respiration). Kidney and physiology of excretion. Physiology of nerve's impulse; Physiology of muscular contraction; Physiology of Endrocrine glands, Physiology of osmoregulation.

4. *Evolution* **-** Origin of life, history of evolutionary thought. Evidences of evolution (Anatomical, embryological, comparative physiology evidence for geographical distribution, palaentological evidence).Theoriesof evolution-Lamarckism, Neolamarcism, Darwinism, New Darwinism, Hardy-Weinberg law.

5. *Embryology and Histology* **–** Gametogenesis, fertilization, types of eggs, cleavage, development upto gastrulation in Branchiostoma, Frog and Chick. Fate maps of frog and chick; Metamorphosis in Frog; Formation and fate of extra embryonic membranes in chick; formation of amnion, allentiois, and types of placenta in Mammal.

Histology of the following Tissues and Organs of Mammals:

Epitheliel Tissue, Connective tissue (connective tissue proper, cartilage, bone, blood and lymph). Muscular tissue and nervous tissue.

Histology of skin, stomach, intestine, liver, pancreas, lung, kidney, testis, ovary, spleen.

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