

Dryland agriculture and its problems. Technology for stabilising agriculture production in rainfed agriculture area. Water-use efficiency in relation to crop production, criteria for scheduling irrigations, ways and means of reducing run-off losses of irrigation water. Methods of irrigation and drainage. Drip and sprinkler irrigation. Drainage of water-logged soils. Soil-water-plant relationship.

Types of soils in India. Soil as medium of plant growth and its composition. Mineral and organic constituents of the soil and their role in maintaining soil productivity. Chemical, physical and microbiological properties of soil. Soil colloids. Essential plant nutrients (macro and micro) and their functions. Deficiency symptoms of plant nutrients. Mechanism of nutrient absorption. Problem soils –distribution and their reclamation. Principles of soil fertility. Organic manures and bio-fertilizers. Inorganic fertilizers (straight, complex and mixed). Integrated nutrient management. Losses of nitrogen in soil, nitrogen-use efficiency in submerged rice soils, nitrogen fixation in soils. Fixation of P and K in soil and scope for their efficient use.

Principles of economics as applied to agriculture. Farm management—scope, importance, characteristics. Farm planning and budgeting. Types and systems of farming and factors effecting them. Farm mechanization. Social marketing.

Philosophy, objectives, scope and principles of extension. Early extension efforts in India. Methods of communication. Evaluation of extension programmes. CD programmes. On farm testing and frontline demonstration.

Part-II

Cell division. Nucleic acids—structure and function. Gene and chromosome. Laws of heredity, their significance in plant breeding. Chromosomal theory of inheritance. Cytoplasmic inheritance. Qualitative and quantitative characters.

Modes of reproduction. Selfing and crossing techniques. Application of principles of plant breeding to the improvement of major field crops. Methods of breeding of self and cross pollinated crops and vegetatively propagated crops. Plant introduction. Pureline selection and mass selection. Handling of hybrid populations—bulk, pedigree, backcross and single seed descent method. Hybrid vigour and its exploitation. Heterosis breeding. Male sterility and self incompatibility. Composites, synthetics and multiline varieties. Top cross and polycross. Apomixis. Clonal selections. Tissue culture. Interspecific and intergeneric hybridization. Breeding for disease resistance. Role of mutation and polyploidy in plant breeding. Seed production and certification.

Physiology and its significance in agriculture. Absorption and translocation of water, transpiration. Photosynthesis—modern concepts and factors affecting the process. Aerobic and anaerobic respiration. C_3 , C_4 and CAM mechanisms. Photoperiodism and vernalization. Auxins, hormones and other plant regulators and importance in agriculture. Dormancy.

Climatic requirements and cultivation of major fruits plants, vegetable crops and flower plants; their package of practices with scientific basis. Post harvest handling and marketing problems of fruits, flowers and vegetables. Preservation of important fruits and vegetable products. Role of fruits and vegetables in human nutrition.

Diseases and pests of fields, vegetables and fruit crops of India and measures to control them. Causes and classification of plant diseases. Principles of plant disease control. Biological control of pests and diseases. Integrated pest and disease management. Storage pests of cereals and pulses, and their management.

2. ANIMAL HUSBANDRY AND VETERINARY SCIENCE

Part-I

1. Animal Nutrition

Energy sources, energy metabolism and requirements for maintenance and production of milk, meat, eggs. Evaluation of feeds as sources of energy. Sources of protein metabolism and synthesis, protein quantity and quality in relation to requirements. Energy protein ratios in ration. Sources, functions and requirements of minerals in animal diet. Inter relationship of the basic mineral nutrients including trace elements. Vitamins, hormones and growth stimulating substances. Their sources, functions, requirements and inter relationship with minerals.

Advances in 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 feeding systems.

Advance in Non-Ruminant Nutrition (Poultry) – Nutrients and their metabolism with reference to poultry, meat and egg production. Nutrients requirements and feed formulation and broilers at different ages.

Advances in Applied Animal Nutrition—A critical review and evaluation of feeding experiments, digestibility and balance studies. Feeding standards and measures of feed energy. Nutrition requirements for growth, maintenance and production. Balanced rations.

2. Animal Physiology

Prenatal and postnatal growth, maturation, growth curves measures of growth, factors affecting growth, conformation, body composition, meat quality.

Current status of hormonal control of mammary development, milk secretion and milk ejection. Male and female reproduction organs, their components and functions. Digestive organs and their functions.

Physiological relations and their regulation; mechanisms of adaption, environmental factors and regulatory mechanism involved in animal behaviour, methods of controlling climatic stress.

Components of semen, composition of spermatozoae, chemical and physical properties of ejaculated semen, factors affecting semen in vivo and in vitro. Factors affecting semen production and quality preservation. Detection of oestrus and time of insemination for better conception.

3. Livestock Production and Management

Comparison of dairy farming in India with advanced countries. Dairying under mixed farming and as a specialised farming, economic dairy farming. Starting of a dairy farm and factors for success of a dairy entrepreneur. Capital and land requirement, organisation of the dairy farm. Procurement of goods, opportunities in dairy farming, factors determining the efficiency of dairy animal. Herd recording, budgeting, cost of milk production, pricing policy. Personnel management. Feeding and management of animals under drought, flood and other natural calamities.

4. Genetics and Animal Breeding

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

Population genetics as applied to animal breeding. Quantitative Vs. qualitative traits. Hardy Weinberg Law. Population Vs. individual. Gene and genotypic frequency. Forces changing gene frequency. Random drift and small population. Theory of path coefficient. Inbreeding, methods of estimating inbreeding coefficient, systems of inbreeding. Effective population size. Breeding value, estimation of breeding value, dominance and epistatic deviation. Partitioning of variation. Genotype \times environment correlation and genotype \times environment interaction.

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

Part-II

1. Health and Hygiene

Structure of cell, organells and inclusions. Cell division. Cell types. Tissues and their classification. Embryonic and adult tissues. Embryology of vertebrates with special reference to aves and domestic mammals. Gametogenesis, fertilization, germ layers, foetal membranes and placentation; types of placenta in domestic mammals.

Physiology of blood and its circulation—blood constituents; properties and functions; coagulation of blood; haemorrhagic disorders; anticoagulants; blood groups; circulation; physiology of heart. Respiration—mechanism of respiration; transport and exchange of gases; neural control of respiration. Excretion—structure and function of kidney; formation of urine. Endocrine glands—functional disorders; their symptoms and diagnosis; synthesis of hormones, mechanism and control of secretion.

General knowledge of pharmacology and therapeutics drugs. Cellular level pharmacodynamics and pharmacokinetics. Modern concepts of anaesthesia and dissociative anaesthetics. Autocoids. Antimicrobials and principles of chemotherapy in microbial infections. Use of hormones in therapeutics. Chemotherapy of parasitic infections.

Veterinary hygiene with reference to water, air and habitation. Assessment of pollution of water, air and soil. Importance of climate in animal health. Effect of environment on animal function and performance. Housing requirements for specific categories of domestic animals viz. pregnant cows and sows, milking cows, broiler birds. Stress, strain and productivity in relation to animal habitation.

2. Animal Diseases

Pathogenesis, symptoms, post mortem lesions, diagnosis, and control of infection diseases of cattle, pigs and poultry, horses, sheep and goats. Etiology, symptoms, diagnosis, treatment of production of cattle, pig and poultry. Deficiency diseases of domestic animals and birds. Diagnosis and treatment of non-specific condition like impaction, bloat, diarrhoea, indigestion, dehydration, stroke, poisoning. Diagnosis and treatment of neurological disorders. Principles and methods of immunisation of animals against specific diseases—hard immunity, disease free zones—'zero' disease concept—chemoprophylaxis. Immunity and immunoregulation in animals—role of cytokines in protection of animals from diseases as well as role of immune response in allergic and autoimmune diseases. Diagnosis and treatment of immunological disorders and diseases of animals. Anaesthesia—local, regional and general. Pre-anesthetic medication.

3. Veterinary Public Health

Zoonoses—classification, definition, role of animals and birds in prevalence and transmission of zoonotic diseases, occupational zoonotic diseases.

Epidemiology—principle, definition of epidemiological terms, application of epidemiological measures in the study of diseases and disease control. Epidemiological features of air, water and food borne infections.

Veterinary Jurisprudence—rules and regulations for improvement of animal quality and prevention of animal diseases. State and control rules for prevention of animal and animal product borne diseases, S.P.C.A., veterolegal cases, certificates. Duties and role of veterinarian in slaughter house to provide meat that is product under ideal hygienic conditions. By-products from a slaughter houses and their economic utilization.

4. Milk and Milk Products Technology

Milk Technology—Organization of rural milk procurement collection and transport of raw milk. Quality, testing and grading raw milk. Quality storage grades of whole milk. Skimmed milk and cream. Processing, packaging, storing, distributing, marketing defects and their control and nutritive properties of the following milks: pasteurized, standardized, toned, double toned, sterilized, homogenized, reconstituted, recombined and flavoured milks. Preparation of cultured milks, cultures and their management, yoghurt, Dahi, Lassi and Srikhand. Preparation of flavoured and sterilized milks. Legal standards. Sanitation requirement for clean and safe milk and for the milk plant equipment.

Milk Products Technology—Selection of raw materials, assembling, production, processing, storing, distributing and marketing of milk products.

5. Meat Hygiene

Ante mortem care and management of food animals, stunning, slaughter and dressing operations. Battoir requirements and designs. Meat inspection procedures and judgement of carcass meat cuts. Grading of carcass meat cuts. Duties and functions of veterinarians in wholesome meat production.

6. Extension

Basic philosophy, objectives, concept and principles of extension. Different methods adopted to educate farmers under rural conditions. Generation of technology, its transfer and feedback. Problems of constraints in transfer of technology. Animal husbandry programmes for rural development.

3. BOTANY**Part - I****1. Microbiology and Plant Pathology**

Main features that characterize microbes. Bacteria : Structure and modes of nutrition and reproduction. Role of bacteria in agriculture, forestry, industry and medicine. Applications of microbiology in agriculture, industry and medicine. Nature, structure of TMV and bacteriophage. Classification of plant diseases on the basis of causal organisms and symptoms. Modes of infection and dissemination. Symptoms, causal organisms and control of late-blight of potato, black-stem rust of wheat, red-rot of sugarcane, citrus canker and Bhindi Mosaic Virus.

2. Cryptogams

Algae : Economic importance of algae. Vegetative and reproductive features of *Nostoc*, *Volvox*, *Ulothrix* and *Batrachospermum*. Fungi : Economic importance of fungi. Vegetative and reproductive features of *Phytophthora*, *Penicillium*, *Agaricus*, *Puccinia* and *Collectorichum*. General account of Lichens.

3. Bryophytes

Main morphological features (excluding developmental details) of *Marchantia* and *Funaria*.

4. Pteridophytes

Morphological features (excluding developmental details) of *Selaginella* and *Pteris*. Heterospory, seed habit and its significance in Selaginells.

5. Gymnosperms

Characteristic features of sporophytes and gametophytes of *Cycas* and *Pinus*.

6. Phytogeography

Concept and significance of various floristic regions of India. Endemism and endemic plants of India.

7. Systematics

Concept and basis of species, genera and families. Bentham and Hooker's classification—its basis, merits and demerits. Diagnostic floral features of Compositae, Cruciferae, Graminae, Leguminosae, Malvaceae and Solanaceae.

8. Anatomy

Anatomical features of monocot and dicot roots and shoots. Secondary growth in roots and shoots. Anomalous secondary growth in *Boerhaavia* and *Dracaena*.

9. Embryology

Structure and morphology of anther, pollen and embryo sac (polygonum type). Structure of mature monocot and dicot embryo and seed.

10. Economic Botany

Morphological and economic utility of the edible parts of wheat, rice, maize, sugar-cane, groundnut, gram, beans, potato, tomato, onion, banana, apple, fig and mango. Morphological nature and economic utility of coriandrum, turmeric, ginger, cardamom & cinchona. Medicinal utility of opium, *Atropa*, *Azadirachta*, *Rauwolfia* and *Cannabis*.

Part - II**1. Cytogenetics**

Basic differences between prokaryotic and eukaryotic cells. Physical and chemical structure of higher plant chromosomes. Mendelism and principles of segregation and independent assortment. Gene interactions—complementary, supplementary, inhibitory, epistasis. Sex linked genes and their inheritance pattern. Sex determination in lower and higher plants. Male sterility – concept, gene-control and use. Extra chromosomal inheritance. Mutations—Concept, types (spontaneous and induced, macro and micro-mutations) and their role in evolution and crop improvement. Polyploidy—concept, types (Allo-, auto-, eu- and aneuploidy) and role in plant evolution. Mechanism of DNA transcription and RNA translation. Gene regulation as revealed by Lac-operon. Modern concept about gene structure and function.

2. Plant Breeding and Biostatistics

Methods of breeding—introduction, selection, hybridization and backcrossing. Heterosis and use in crop breeding. Malesterility. Use of apomixis in plant breeding. Transgenic crops. Brief idea about mean, mode median, standard deviation, standard error and correlations (bivariate only). Coefficient of variation (CV). Test of significance (t, chi square)

3. Physiology and Biochemistry

Ascent of sap. Transpiration. Role of light in carbon fixation and photosynthesis. Carbon fixation in C_3 , C_4 , CAM plants. Photorespiration. Mechanism and significance of respiration (aerobic and anaerobic). Nitrogen fixation and its genetic control. Role of micro-nutrients in plant nutrition. Role of growth regulators (auxins, gibberellins, cytokinins) in plant development, differentiation and development. Physiology of dormancy and seed germination. Photoperiodism and vernalization.

4. Plant Ecology.

Environment and its factors (biotic, climatic, edaphic and physiographic) which influence plant growth and development. Ecosystem—Structure and function. A brief account of food chain, ecological pyramids, energy flow, pollution, acid-rain, global-warming. Biodiversity—concept, definition, depletion and conservation. Endangered and the threatened plants, extinction and biosphere reserves.

5. Applied Botany

Cell, organ and tissue culture—procedure and utility. Protoplast—isolation and culture (a brief account). Recombinant DNA technology—methods to produce DNA and its utility in plants. In-vitro gene transfer—agrobacterium mediated gene transfer, direct gene transfer by electroporation, microinjection and biolistic methods (brief accounts only). Utility of transgenic plants in agriculture, horticulture and forestry.

4. CHEMISTRY**Part-I**

1. Atomic Structure : Heisenberg's uncertainty principle, Schrodinger wave equation (time independent). Particle in one-dimensional box, quantum numbers. Shapes of s, p and d orbitals.

2. Chemical bonding: Ionic bond, characteristics of ionic compounds, factors affecting stability of ionic compounds, covalent bond and its general characteristics, polarities of bonds in molecules and their dipole moments. Valence bond theory, concept of resonance and resonance energy. Molecular orbital theory (LCAO method); bonding in homonuclear molecules; H_2 , H_2 to Ne_2 . Comparison of valence bond and molecular orbital theories, bond order, bond strength and bond length.

3. Solid State: Bragg's law. X-ray diffraction by crystals. Close packing, radius ratio rules, Structures of NaCl, ZnS, CsCl. Imperfections in crystals, Schottky and Frenkel defects, impurity defects, semi-conductors.

4. The Gaseous State: Equation of state for real gases, Maxwell's distribution of speeds.

5. Thermodynamics and Statistical Thermodynamics: Thermodynamics systems, states and processes, work, heat and internal energy first law of thermodynamics, work done in isothermal and adiabatic expansion and enthalpy changes in various processes. Hess's Law. Second law of Thermodynamics; Entropy of perfect gas in terms of volume, temperature and pressure. Nernst Heat theorem, Third law of Thermodynamics—its purpose, Plank's formulation, Statement of Lewis and Randall. Micro and macro states; canonical ensemble and canonical partition function; electronic, rotational and vibrational partition functions.

6. Clausius-Clapeyron equation, partial molar quantities, chemical potential and Gibbs-Duham equation, variation of chemical potential with temperature and pressure.

7. Electrode potential, Standard hydrogen electrode, Electro-chemical series and its application in determining E.M.F. of cell and feasibility of a reaction, Nernst Equation.

8. Chemical Kinetics: Concentration dependence of rate of reaction—law of mass action and rate law expression; order of reaction, integrated rate equations for first order reactions; effect of temperature on rate constant. Elementary idea about collisions and transition state theories and their comparison.

9. Photochemistry: Absorption of light; laws of photochemistry, quantum yield, decay of excited state by different routes; Fluorescence and phosphorescence.

10. Surface Phenomena and Catalysis: Adsorption from and solutions on solid adsorbents, adsorption isotherms—Langmuir and B.E.T. isotherms; determination of surface area by B.E.T.

11. Coordination Chemistry : IUPAC nomenclature, Isomerism and stereo-chemistry of complexes with coordination numbers four and six. Crystal field Theory, Factors affecting Crystal field splitting, Jahn Teller effect.

12. Chemistry of d block elements: Transition metals including Lanthanides – General characteristic properties oxidation states, magnetic behaviour, colour etc. Lanthanide contractions, its cause and consequences.

Part-II

1. (a) Reaction mechanisms : Kinetic versus Thermodynamic control, Hammond's Postulate, Method of determining reaction mechanism – isotope effect, solvent effect, catalysis and steric effect, Potential energy diagram transition state and Intermediates.

(b) Reactive intermediates : Structure and stability of carocations, carbanions, carbenes and free radicals.

2. Substitution reactions : Nucleophilic substitution first order and second order (S_N1 and S_N2) reactions, stereo-chemistry of these reactions and their comparison. Mechanism of Rearrangements: Pinacol-pinacolone, Beckmann, Claisen, Cope and Fries rearrangement.

3. Chemistry and mechanism of reactions: Aldol condensation. Claisen condensation, Perkin, Knoevenagel, Wittig, Cannizzaro and benzoin condensations, Sandmeyer, Reimer-Tiemann and Reformatsky reactions.

4. Polymeric Systems: (a) Physical chemistry of polymers : number and weight average molecular weights of polymers. Determination of molecular weights by sedimentation, osmotic pressure, viscosity. (b) Preparation and properties of polymers: Organic polymers—polyethylene, polystyrene, polyvinyl chloride, Teflon, nylon, terylene, synthetic and natural rubber.

5. Principles of spectroscopy and applications in structure elucidation: (a) Rotational spectra—diatomic molecules; isotopic substitution and rotational constants. (b) Vibrational spectra—diatomic molecule; linear triatomic molecules.

(c) Electronic spectra :— Singlet and triplet states, $n \rightarrow \pi^*$ and $\pi \rightarrow \pi^*$ transitions; application to conjugated double bonds and conjugated carbonyls— Woodward-Fieser rules. (d) Nuclear magnetic resonance : chemical shift and coupling constants; Application of 1H NMR to simple organic molecules.

5. CIVIL ENGINEERING

Part-I

1. Engineering Mechanics

Units and dimensions. SI Units. Vectors. Concept of force. Concept of particle and rigid body. Concurrent, Non Concurrent and parallel forces in a plane. Moment of force. Free body diagram. Conditions of equilibrium. Principle of virtual work. Equivalent force system. First and Second Moment of area. Mass moment of inertia. Static Friction, Inclined Plane and bearings. Kinematics and Kinetics. Motion under uniform and non-uniform acceleration, motion under gravity. Kinetics of particle : Momentum and energy principles, collision of elastic bodies, rotation of rigid bodies.

2. Strength of Materials

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

Deflection of beams: Macaulay's method, Mohr's Moment area method. Conjugate beam method, unit load method. Torsion of shafts, Elastic stability of columns, Euler's, Rankine's and Secant formulae. Principal stresses and strains in two dimensions, Mohr's Circle, Theories of Elastic Failure, thin and thick cylinders.

3. Structural Analysis

Castigliano's theorems I and II, Unit load method, method of consistent deformation applied to beams and pin jointed trusses. Slope-deflection, moment distribution, indeterminate beams and rigid frames.

Rolling loads and Influences lines : Influences lines for shear force and bending moment at a section of a beam criteria for maximum shear force and bending moment in beams traversed by a system of moving loads. Influences lines for simply supported plane pin jointed trusses. Arches : Three hinged; rib shortening and temperature effects, influence lines in arches.

Force method and displacement method of analysis of indeterminate beams and rigid frames.

Plastic Analysis of beams and frames : Theory of plastic bending, plastic analysis, statical method, Mechanism method. Unsymmetrical bending: Moment of inertia, product of inertia, position of Neutral Axis and Principal Axes, calculation of bending stresses.

4. Design of Structures

Structural steel : Factors of safety and load factors. Rivetted, bolted and welded joints and connections. Design of tension and compression members, beams of built up section, rivetted and welded plate girders, stanchions with battens and lacings.

Design of concrete and masonry structures. Concept of mix design. Reinforced Concrete : Working Stress and Limit State method of design - Recommendations of I.S. codes, design of one way and two way slabs, simple and continuous beams of rectangular, T and L sections. Compression members under direct load with or without eccentricity, Isolated and combined footings. Cantilever and Counterfort type retaining walls.

Prestressed Concrete : Methods and systems of prestressing, anchorages, Analysis and design of sections for flexure based on working stress, loss of prestress.

5. Fluid Mechanics

Fluid properties and their role fluid motion, fluid statics including forces acting on plane and curve surfaces. Kinematics and Dynamics of Fluid flow; Velocity and accelerations, stream lines, equation of continuity, irrotational and rotational flow, velocity potential and stream functions, flownet, methods of drawing flownet, flow separation, free and forced vortices. Control volume equation, continuity, momentum, energy and moment of momentum equations from control volume equation, Navier-Stokes equation, Euler's equation of motion, application to fluid flow problems, pipe flow, plane, curved, stationary and moving vanes, orifice meters and Venturi meters. Dimensional Analysis and Similitudes; Buckingham's Pi-theorem, dimensionless parameters, similitude theory.

Laminar Flow: Laminar flow between parallel plates, flow through tube.

Boundary layer: Laminar and turbulent boundary layer on a flat plate, laminar sublayer, smooth and rough boundaries.

Turbulent flow through pipes; Characteristics of turbulent flow, velocity distribution and variation of pipe friction factor, hydraulic grade line and total energy line.

6. Open channel flow

Uniform and non-uniform flows, momentum and energy correction factors, specific energy and specific force, critical depth, flow in contractions, flow at sudden drop, hydraulic jump and its applications surges and waves, gradually varied flow, classification surface profiles, control section.

7. Geo-technical Engineering

Types of soil, phase relationships, consistency limits, particle size distribution, classification of soil, structure and clay mineralogy. Capillary water and structural water, effective stress and pore water pressure, Darcy's Law, factors affecting permeability, determination of permeability, permeability of stratified soil deposits. Seepage pressure, quick sand condition, compressibility and consolidation, Terzaghi's theory one dimensional consolidation, consolidation test. Compaction of soil, field control of composition, Total stress and effective stress parameters, pore pressure coefficients. Shear strength of soils, Mohr Coulomb failure theory, Shear tests. Earth pressure at rest, active and passive pressures, Rankine's theory, Coulomb's theory, Coulomb's wedge theory, earth pressure on retaining wall. Bearing

capacity, Terzaghi and other important theories, net and gross bearing pressure. Immediate and consolidation settlement. Stability of slope, Total Stress and Effective Stress methods, Conventional methods of slices, stability number. Subsurface exploration, methods of boring, sampling, penetration tests. Essential features of foundation, types of foundation, design criteria, choice of type of foundation, stress distribution in soils, Boussinesq's theory, Newmarks' chart, pressure bulb, contact pressure, applicability of different bearing capacity theories, evaluation of bearing capacity from field tests, allowable bearing capacity, Settlement analysis, allowable settlement. Proportioning of footing, isolated and combined footings, rafts footing, Pile foundation, types of piles, pile capacity, static and dynamic analysis, design of pile groups, pile load test, settlement of piles, lateral capacity. Ground improvement techniques—preloading, sand drains, stone column, grouting, soil stabilisation.

Part-II

1. Construction technolog

Engineering Materials

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

Construction: Building components and their functions; brick masonry; bonds; jointing; stone masonry. Design of brick masonry walls as per I.S. codes, factors of safety, plastering, pointing. Types of floors and roofs.

2. Constructions Equipment

Factors affecting the selection of equipment, study, capital and maintenance cost. Concreting equipments: Weigh batcher, mixer, vibration, batching plant, concrete pump. Earth-work equipments: Power shovel, hoe, bulldozer, dumper, trailers and tractors, rollers, sheep foot roller.

3. Construction Planning and Management

Construction activity, schedules, job layout, bar charts, organization of contracting firms, network analysis; CPM and PERT analysis, Float Time, crashing of activities, contraction of network for cost optimization, cost analysis, floats, slack time, numbering of network, probability of completing the project.

4. Survey

Common methods of distance and angle measurements, compass traversing, plane table survey, levelling, travelling, traverse survey, triangulation survey, balancing of traverse, contouring, topographical map. Technometry. Circular and transition curves.

5. Transporation Engineering

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

Highway Engineering: Principles of highway planning, Highway alignments. Geometrical design: Cross section, camber, superelevation, horizontal and vertical curves. Classification of roads; low cost roads flexible pavements, rigid pavements. Design of pavements and their construction. Drainage of roads : Surface and sub-surface drainage. Traffic Engineering: Forecasting techniques, origin and destination survey, highway capacity. Channelised and unchannelised intersections, rotary design elements markings, signs, signals, street lighting; Traffic surveys.

6. Hydrology

Hydrological cycle, precipitation, evaporation, transpiration, despression storage, infiltration, overland flow, hydrograph. Ground water flow: Specific yield, storage coefficient of permeability, confined and unconfined aquifers,

aquifers, radial flow into a well under confined and unconfined conditions, tube wells, pumping and recuperation tests ground water potential.

7. Irrigation Engineering

Water requirements of crops : consumptive-use, quality of water for irrigation, duty and delta, irrigation methods and their efficiencies. Canals : Distribution systems for canal irrigation, canal capacity, canal losses, most efficient section, lined canals, their design, regime theory, critical shear stress, bed load, local and suspended load transport. Water logging: causes and control, drainage system design, salinity. Canal structures : Khosla's theory, energy dissipation, stilling basin, sediment excluders. Spillways : Spillway types, crest gates, energy dissipation. River training : Objectives of river training, methods of river training.

9. Environment Engineering

Water Supply : Estimation of surface and subsurface water resources, predicting demand for water, impurities of water and their significance, physical, chemical and bacteriological analysis, waterborne diseases, standards for potable water. Intake of water: Pumping and gravity schemes, water treatment; principles of coagulation, flocculation and sedimentation; Slow-rapid-pressure filters; chlorination, softening, removal of taste, odour and salinity. Analysis of distribution systems.

Sewerage systems: Domestic and industrial wastes, sewerage—separate and combined system, flow through sewers, design of sewers. Sewage characterisation: BOD, COD, solids, dissolved oxygen, nitrogen and TOC. Standards of disposal in normal water course and on land. Sewage treatment: Working principles, units, chambers, sedimentation tank, trickling filters, oxidation ponds, activated sludge process, septic tank, disposal of sludge.

6. COMMERCE & ACCOUNTANCY

Part-I : Accounting and Finance

1. Financing Accounting

Accounting as a financial information system. Impact of behavioural sciences. Advanced problems of company accounts. Amalgamations, absorption and reconstruction of companies. Valuation of shares and goodwill.

2. Cost Accounting

Nature and functions of cost accounting. Job costing. Process costing. Marginal costing. Techniques of segregating semivariable costs into fixed and variable costs. Cost-volume-profit relationship. Aid to decision making including pricing decisions, shutdown etc. Techniques of cost control and cost reduction. Budgetary control, flexible budgets. Standard costing and variance analysis. Responsibility accounting, investment, profit and cost centres.

3. Taxation

Definitions. Basis of charge. Incomes which do not form part of total income. Simple problems of computation of income under various heads, i.e. salaries, income from house property, profits and gains from business of profession, capital gains, income of other persons included in assessee's total income. Aggregation of income and set off/carry forward of loss. Deductions to be made in computing total income.

4. Auditing

Meaning and objects of auditing. Internal check and internal audit. Audit of cash transactions, expenses, incomes, purchases, sales. Valuation and verification of assets with special reference to fixed assets, stocks and debts. Verification of liabilities. Audit of limited companies. Appointment, removal, powers, duties and liabilities of a company auditor. Auditor's report and qualifications therein. Board outlines of company audit with reference to share capital transactions and statutory report. Audit of Govt. Companies under sec. 619 of the Companies Act. Cost audit under sec. 233 (B) of the Companies Act. Special points in the audit of different organisations like clubs, hospitals, colleges, charitable societies.

5. Business Finance and Financial Institutions

Finance function. Nature, scope and objectives of financial management. Risk and return relationship. Financial

analysis as a diagnostic tool. Management of working capital and its components. Forecasting working capital needs, inventory, debtors, cash and credit management. Investment decisions. Nature and scope of capital budgeting. Various types of decisions including make or buy and lease or buy. Techniques of appraisal and their application. Analysis of non-financial aspects. Rate of return on investments. Required rate of return. Its measurement. Cost of Capital. Weighted average cost. Different weights. Concept of valuation of firm's fixed income, securities and common stocks. Dividends and retention policy-residual. Actual practices. Capital structure, leverages, significance of leverages, theories of capital structure. Planning the capital structure of a company. EBIT-EPS Analysis Cashflow ability to service debt, capital structure ratios, other methods. Raising finance (short term and long terms). Bank finance (norms and conditions). Money markets. The purposes of money markets. Money markets in India. Organisation and working of capital markets in India. Organisation structure and role of financial institutions in India. Banks and investing institutions. National and international financial institutions. Supervision and regulation of banks. Monetary and credit policy of Reserve Bank of India. Provisions of the Negotiable Instruments Act, 1881 relating to crossings and endorsements with particular reference to statutory protection to the paying and collection bankers. Salient provision of the Banking Regulation Act, 1949 with regard to chartering, supervision and regulation of banks.

Part-II : Organisation Theory and Industrial Relations

1. Organisation Theory

Nature and concept of organisation. Organisation goals. Primary and secondary goals, single and multiple goals, ends means chain-displacement, succession, expansion and multiplication of goals. Formal organisation – type, structure, line and staff. Informal organisation-functions and limitations. Evolution of organisation theory : Classical, neoclassical and system approach. Organisation behaviour as a dynamic system. Technical, social and power system. Interrelations and interactions. Perception. Status system. Theoretical and empirical foundation of theories and models of motivation. Moral and productivity. Leadership. Theories and styles. Management of conflicts in organisations. Limits or rationality. Organisational change, adaptation, growth and development. Professional management Vs. family management. Organisation control and effectiveness.

2. Industrial Relations

Nature and scope of industrial relations the socio economic setup, need for positive approach. Industrial labour in India and its commitment-stages of commitments. Migratory nature-merits and shortcomings. Theories of Unionism. Trade Union movements in India-origin, growth and structure. Attitude an approach of management in India-recognition. Problems before Indian Trade Union movement. Sources of industrial disputes -Strikes and lockouts. Compulsory adjudication and collective bargaining-approaches. Workers participation in management-philosophy, rationale. Present day state of affairs and future prospects. Prevention and settlement of industrial disputes in India. Industrial relations in public enterprises. Absenteeism and labour turnover in Indian industries-causes. Relative wages and wage differentials. Wage policy in India. The Bonus issue. International Labour Organisation and India. Role of personal department in the organisation.

7. ECONOMICS

Part-I

1. Micro Economic Analysis

Concept of equilibrium. Law of demand. Marshallian utility and indifference curve analysis and their comparisons. Concept of consumer surplus. Elasticity of demand. Income elasticity. Theory of production. Production function and technological progress. Law of Returns to Scale. Law of variable proportions. Isocost and Isoquants. Theory of cost. Concept of opportunity cost. Cost curves. Perfect competition. Price determination. Equilibrium of firm and industry in market period. Supply curves. Monopoly. Equilibrium of the monopolist. Comparison of perfect competition and monopoly. Price discrimination. Equilibrium in discriminating monopoly and effects of price discrimination. Monopolistic competition. Demand curves. Firm and group equilibrium. Determination of equilibrium level. Comparison with pure competition and monopoly. Theory of marginal productivity. Theories of wage determination. Modern theory of rent. Theories of interest, classical, neo-classical and liquidity preference. Gross and