1) AGRI- BUSINESS MANAGEMENT

Unit 1: General Management

General Management Theories; Management processes, planning, organizing, staffing, leading, controlling; managerial skills; level of managers; scope and significance of organization behavior, theoretical frameworks, personality traits, attitudes - nature, dimensions and theories; perception and power; motivation types and theories; Transactional analysis-Johari window, Inter personal relations, leadership styles and theories, Group dynamics, Organizational culture, conflicts and change, MBO.

Human resource planning; job analysis and design; recruitment, selection, induction and placement; human resource training and development; performance appraisal; promotions, transfers, separation, absenteeism and employee turnover ; wage and salary administration; variable compensation, industrial relations, participative management ; employee welfare, morale and safety; conflict management. Human resource accounting; valuation of human resources.

Unit 2: Accounting, Financial Management, Project Management And Institutional Financial Management


Project Management- concepts, project life cycle, project feasibility analysis- market, financial, economic, technical, commercial, environmental, socio-cost benefit analysis, risk analysis, project financing, project implementation, Network Analysis, Project scheduling and resource allocation.

Banking system in India, Role and functions of apex institutions in rural finance, importance of agricultural finance , KCC, Prudential norms of agril lending, Rural Financial Institutions- Priority sector and Institutional credit for agriculture development, Agriculture credit planning, Agricultural Insurance, Lead Bank Scheme; Financial Inclusion – microfinance products, SHGs, FPO, Non Farm Sector- MSMEs, Micro insurance; Value Chain Financing, Risk analysis, Credit rating and recovery management.

Unit 3: Business Laws And Taxation

Legal framework in India; The Indian Contract Act- essential elements; Offer; quotation Acceptance; Capacity to contract; Consideration; Free consent; Coercion; Undue influence;
Misrepresentation Performance of contract; Companies Act- MoA, AoA; Types of companies; Major provisions on winding up of a company; Negotiable Instruments- Bill of Exchange – Cheque – Draft; Essential commodities Act; Consumer protection; Redressal Machinery; Taxes- Direct and indirect

**Unit 4 : Strategic Management**

Corporate strategy, mission and objectives; Values, ethics, corporate social responsibility; corporate governance and strategy; Environment, competitor, industry and internal analysis; Generic strategies, vertical integration and capacity expansion; entry into new business and growth and diversification strategies; Strategies during industry maturity and decline Strategy in fragmented industries; Strategy implementation; Strategy and managing change; Evaluation of corporate strategy – control, motivation, criteria, corrective action.

**Unit 5 : Marketing – Marketing Management And Rural Marketing, Agricultural Marketing And Input Marketing**


Rural Marketing - Nature and characteristics, Environmental factors, Rural consumer’s behaviour , Rural marketing strategy with respect to marketing mix decisions.

Agricultural marketing system, market structure; marketable and marketed surplus; marketing functions; channels in marketing, Market Integration, Marketing Efficiency, Marketing Costs, Margins and price spread, government interventions - regulated markets; Co-operative marketing; Price Stabilization measures. Marketing of agricultural inputs- Demand Supply Gap, Product, Price, Place and Promotion Strategies.

**Unit 6 - Managerial Economics**

Scope of managerial economics, Basic economic principles; Consumer theory; Demand analysis; demand function; law of demand, demand elasticity; demand forecasting techniques; Production analysis- Production function, Returns to factors, Returns to scale, Output elasticity – Cobb-Douglas production function; Isoquants; Cost analysis- concepts, nature, determinants, economies and diseconomies of scale; Markets – Market structure, perfect competition , Monopolistic competition, Monopoly- price and output determination. Farm Management Principles; Circular flow of Income, calculation of GDP, National income, consumption, investment and savings; Money supply-functions ; demand and supply; Inflation; Business cycle.

**Unit 7 - Operations And Supply Chain Management**

Nature, Scope and concept of Operations Management; Process characteristics- design, types and operations systems; Facility location; Layouts -Layout Planning and Analysis for products and services, Productivity Variables and Productivity Measurement; Production Planning and Control; Job Order Manufacturing; Product- Selection, Design and Development; Process selection, capacity planning; Scheduling; Work Study, Method Study, Work Measurement, Work Sampling, Work Environment; Industrial Safety; Statistical Process Control; Total Quality Management, ISO standards and their Importance, Introduction to re-engineering, value engineering. Procurement
Management in Agri. Supply Chain; Material Requirements Planning, Just in Time (JIT)- Pull and Push Systems- kanban systems- Vendor Managed Inventory (VMI);

Logistics Management- Functions, Elements and Objectives; Distribution Management & Strategies- Warehousing Functions, Types - Material Handling Equipment and Storage Systems.; Fleet Management; Transportation Management- Principles, Transportation System –Infrastructure, Networks, Freight Management and Transport Economies; Packaging – Functions, Types and Costs, E- Logistics; Third – Party Logistics; Supply chain drivers - Types of Supply Chain; Operational Decisions in Supply Chain; IT Application in SCM; SCM Automation and Integration- Performance Measurement and controls in Agri. Supply Chain Management – Benchmarking

Unit 8: Commodity Markets

Agriculture Commodity Markets- Physical Markets /Spot Market ; Commodity Future Trading-Forward, Futures and options, Commodity Exchanges ; Commodity Market Regulation-Understanding of Future Prices- Basis and Spread; Hedging and Speculation in Futures Market ; Options-put option- Call option-Option Pricing-Hedging with options.

Unit 9: Business Statistics, Research Methodology, And Quantitative Techniques

Descriptive Statistics - Measures of central tendency and dispersion, Exploratory data analysis; Theory of Probability; Discrete and continuous probability distributions; sampling distribution, small and large sample tests- chi-square, t, f, ANOVA, Factor analysis, cluster analysis; Correlation- simple, partial, multiple and rank; Regression- Simple and multiple linear regression; Coefficient of Determination, Non-parametric tests- Sign, Wilcoxon, Mann-Whitney U-test and Wald-Wolfowitz run test; Kruskal-Wallis test; Friedman two-way ANOVA by ranks Kendall’s coefficient of concordance

Research- types and process of research; Research Methodology – Design, Classification-Exploratory, Descriptive, Experimental, Diagnostic; formulation of Hypothesis; Sampling techniques- Probability and Non-probability; Scaling Techniques; data collection; Data Analysis; Multivariate analysis

Linear Programming: Objective, Assumptions, Formulation of Linear Programming problems, Graphic Method, Simplex method; Transportation and Assignment Problems; Inventory Control Models; Waiting Line Models; Decision making under risk and uncertainties; Game Theory - Two -Person Zero-Sum Game; Simulation; Project's life cycle and Network analysis —PERT CPM.

Unit 10: Agribusiness Environment, Policies And International Trade

Role of agriculture in Indian Economy; Backward and forward linkages of agriculture with rest of economy ; Agribusiness sector-salient features, sub sectors of agribusiness-input sector, production sector, processing sector; Economic reforms in Indian agriculture; industrial policies and industrial development programmes relevant to agro industries; land reforms policy; Agricultural price policy; Marketing policy structure of agri markets – regulated markets- structure – APMC act – market legislations; Food policy- role of PDS – FCI – CWC, SWC; Fertilizer policy ; Seed policy; agro-processing: Food Industry- Size, Trends, Growth; Food Business environment and Stakeholders; FSSAI- Role and Functions- Quality Assurance and Control in Production, Processing and Distribution chains - GAP, GMP, QMS – Standards, Agencies and Regulations - Food Packaging
UNIT 11: ENTREPRENEURSHIP

Entrepreneurship significance in economic development; Role of various institutions in developing agribusiness entrepreneurship, Innovation levels, types, process and drivers to improve the innovation competencies; Business Opportunities and guidelines for starting Farm Enterprises, Business plan preparation; Government schemes and incentives for promotion of entrepreneurship; Institutional support to business entrepreneurs. Business incubation and Entrepreneurship; Social entrepreneurship concept and opportunities; New Venture Planning; Environmental factors affecting new business

2) AGRICULTURAL EXTENSION

Unit 1: Fundamentals of Extension and Communication


Unit 2: Extension Methods & Farm Journalism

Concepts of teaching and learning processes - principles of learning as applied to agricultural extension. Individual, group and mass approaches in extension, audio-visual aids classification, selection, use and production. Traditional media for communication in development programmes, Modularized communication- concept, approach, need, process of designing instruction for transfer of technologies. Basics of agricultural journalism, types of publications- bulletins, folders, leaflets, booklets, newsletter,
popular and scientific articles. Selection, planning and use of different extension teaching methods like
demonstration, exhibition, farmers fairs, field days, tours, extension literature, etc. Preparation and
presentation of different projected and non-projected audio-visual aids. Public speaking. Preparation of

**Unit 3: Information Communication Technologies (ICTs)**

Concept of ICT and its role in agriculture and rural development. ICT tools print and electronic media, e-
mail, Internet, use of multimedia, use of mobile phony, video and teleconferencing, computer assisted
instructions, touch screens, micro-computer, web technologies and information kiosks, Networking
system of information and challenges in the use of ICT. E-learning, information resources, sharing and
networking. Types of net work PAN, LAN, WAN, Internet, AGRISNET, AKIS, Indian National
Agricultural Research database. ICT programmes in agricultural development, Problems and prospects of
ICTs in agricultural development, Digitalization, Simulation models, Utilization of Internet for promoting
advanced agricultural practices; communication with rural, semi-urban and urban farming community.
ICT initiatives with regard to agricultural extension in Andhra Pradesh.

**Unit 4: Training & Human Resource Development**

Human resources and their importance in agricultural development. Concept of human resource
management. Training and development of human resources. Identifying training needs and assessment of
training impact. Training principles, importance, methods and factors. Phases of training- pre training,
training and post training. Development of training modules, training requirements, training methods.
Lecture cum demonstration methods, case method, brain storming, syndicate method, business games,
simulation exercises, in-basket exercise, programmed instruction, experiential leaning techniques such as
sensitivity training, T-group, transactional analysis and fish bowl exercise. Evaluation of training-types
and techniques of training evaluation. Motivation, stress management and organizational behavior as

**Unit 5: Research Methodology in Extension Education**

Social research - concept, principles and approaches. Selection and identification of research problems,
methods of data collection interview method and mailed questionnaires variables- meaning and types,
independent, dependent and intervening variables. Hypothesis concept, characteristics, types and testing.
Research design concept and types, field studies, case studies and survey method. Measurement meaning
and levels. Methods of sampling and statistical tests. Reliability and validity of tests, normal distribution,
tests of significance, ANOVA, correlation and regression. Scaling techniques. Processing of data coding-
tabulation. Analysis and interpretation, writing scientific reports, citing references. Participatory
approaches, PRA, RRA, PLA and PTD.

**Unit 6: Programme, Planning, Evaluation & Diffusion and Adoption of Innovations**

Concept, steps, principles and theories of programme planning. Steps in programme planning for
agricultural development, organizing campaigns and variety of extension activities, evaluation of
agricultural extension programmes, compilation and report writing. Evaluation of agricultural
development programmes and schemes. Monitoring and evaluation-concept, significance, types, methods
and tools. Theoretical models of programme planning. Feltneeds; need-based programmes. Social action.
Five Year Plans- critical analysis with special reference to developmental programmes. Concept and
elements of diffusion and adoption for social change. Diffusion process, adoption process, models of
diffusion and adoption, adopter categories and their characteristics. Factors influencing adoption and
attributes of innovations. Concept and stages of Innovation decision process, consequences of innovations.

Unit 7: Extension Management


Unit 8: Entrepreneurial Development

Concept, Significance and scope. Programmes and agencies promoting entrepreneurship. Types and techniques of training for developing entrepreneurial activities in various areas. Self Help Groups concepts, organization, mobilization, micro-finance and functioning of SHGs for empowerment and sustainability. Agripreneurship - Agri-clinics and agribusiness centers. International cooperation in agriculture SAIC, commonwealth, FAO, USAID DFID and CGIAR system. Critical analysis of extension systems of SAARC, BRICS and other selected countries (USA, UK, Japan, Philippines, Israel etc.)

Unit 9: Developmental Strategies and Issues in Extension


Unit 10: Gender Sensitization and Empowerment

Gender and empowerment: meaning, gender related definitions and importance for empowerment women; need and focus on gender sensitization, gender in community diversity and its implication for empowerment. Gender perspectives in development of women, social characteristics, roles, responsibilities, resources, constraints, legal issues and opportunities; economical, educational and other parameters. Gender tools and methodologies: Dimensions and methodologies for empowerment; gender budgeting; gender analysis framework-context, activities, resources and programme action profile;
technologies and empowerment—gender specific technologies, household technology interface, socio-cultural interface and women as consumer of technologies. Gender issues and development; health and nutrition, violence, governance, education and media.

3) **AGRICULTURAL MICRO BIOLOGY**

**Unit 1: History of Microbial World**

**Unit 2: Microbial Ecology and Physiology**

**Unit 3: Soil Microbiology**

**Unit 4: Environmental Microbiology and Basic Microbiological Techniques**
Isolation and preservation of different types of microorganisms. Methods of sterilization and disinfection. Microscopy: Optical, phase contrast, fluorescent, dark field and electron. Microbial assay of vitamins, enzymes and antibiotics. Pollution of soil, water and air. Role of microorganisms in pollution, sources of pollution and their impact on environment, microbiology of sewage and industrial effluents and their safe disposal, management of solid and liquid organic wastes, composting, biogas, water purification, sewage treatment, water-borne diseases and effluent management.

**Unit 5: Microbial Biotechnology**
4) **AGRONOMY**

**Unit 1: Crop Ecology and Geography**
Principles of crop ecology, Ecosystem concept and determinants of productivity of ecosystem; Physiological limits of crop yield and variability in relation to ecological optima; Crop adaptation; Climate shift and its ecological implication; Greenhouse effect; Agro-ecological and agro climatic regions of India; Geographical distribution of cereals, legumes, oilseeds, fodders and forages, commercial crops, condiments and spices; Adverse climatic factors productivity; Photosynthesis, respiration, net assimilation, solar energy conversion efficiency and relative water content, light intensity, water and CO2 in relation to photosynthetic rates and efficiency; Physiological stress in crops; Remote sensing: Spectral indices and their application in agriculture, crop water stress indices and crop stress detection.

**Unit 2: Weed Management**
Scope and principles of weed management; Weeds classification, biology, ecology and allelopathy; Crop weed competition, weed threshold; Herbicides classification, formulations, mode of action, selectivity and resistance; Persistence of herbicides in soils and plants; Application methods and equipment; Biological weed control, herbicides: Integrated weed management; Special weeds, parasitic and aquatic weeds and their management in cropped and non cropped lands; weed control schedules in field crops, Role of GM crops in weed management.

**Unit 3: Soil Fertility and Fertilizer Use**
History of soil fertility and fertilizer use; Concept of essentiality of plant nutrients, their critical concentrations in plants, nutrient interactions, diagnostic techniques with special emphasis on emerging deficiencies of secondary and micro-nutrients; Soil fertility and productivity and their indicators; Fertilizer materials Including liquid fertilizers, their composition, mineralization, availability Water solubility of phosphate fertilizers; and their use for crop production; Integrated nutrient management and efficiency and recovery of applied plant schedules for cropping systems direct, related environmental problems nutrient management.

**Unit 4: Dryland Agronomy**
Concept of dryland farming; dryland significance and constraints of dryland delineation of dryland tracts; drylands; Rainfall anal syndrome, effect on plant growth, management; Crop Planning including cropping systems, conservation weather conditions; Techniques evapotranspiration, runoff and recycling concept, techniques and timely sowing, precision in seeding, and foliar application, aqua-fertigation; management in dryland areas.

**Unit 5: Crop Production in Problem Soils**
Problem soils and their distribution in India, acid, saline, waterlogged and mined soils; Response of crop to acidity, salinity, sodicity, excess water and nutrient imbalances; Reclamation of problem soils, role of amendments and drainage; Crop production techniques in problem soils-crops, varieties, cropping system and agronomic practices; Effects of water table fluctuation on crop growth; Degraded lands and their rehabilitation.

**Unit 6: Crop Production**
Crop production techniques for cereals, millets, legumes, oilseeds, fiber crops sugarcane, tobacco, fodder and pasture crops including origin, history, distribution adaptation, climate, soil, season, modern varieties, fertilizer requirements, intercultural operations, water requirement. Weed control, quality components industrial use, economics and post harvest technology.
Unit 7: Agricultural Statistics
Frequency distribution, standard error and deviation, correlation and regression analyses, coefficient of variation; Tests or significance - t, F and chi-square (X²); Data transformation and missing plot techniques: Design of experiments and their basic principles, completely randomized, randomized block, split plot, strip-plot, factorial and simple confounding designs; Efficiency of designs; Pooled analysis.

Unit 8: Sustainable Land Use Systems
Concept of sustainability; Sustainability parameters and indicators; Conservation agriculture; Alternate land use systems; Types, extent and causes of wasteland; Shifting cultivation; Agro forestry systems; Agricultural and agro-industrial residues and its recycling, safe disposal; Allelopathy and biomass production. Occurrence of groundwater; Analysis of hydrologic data and their use.

Unit 9: Basics of Soil and Water
Soil and water as vital resources for agricultural production. Occurrence of groundwater, groundwater aquifers, exploration groundwater; Hydrological cycle; Soil-plant water relationship; Fate of rain water received at the soil surface, runoff and infiltration reciprocity, factors affecting infiltration, means to enhance infiltrability of soil, mechanical and biological means to reduce runoff and soil loss; Water harvesting for crop lifesaving irrigations; watershed management; Soil and water conservation. Contingent crop plans and other strategies for aberrant weather conditions; Cropping patterns, alternate land use and crop diversification in rainfed areas; Analysis of hydrologic data and their use.

Unit 10: Soil Water Relationship
Soil water relations, water retention by soil, soil moisture characteristics, field capacity, permanent wilting point, plant available water and extractable water. Soil irrigability, classifications, factors affecting profile water storage. Determination of soil water content, computation of soil water depletion, soil water potential and its components, hydraulic head, Movement of soil water saturated and unsaturated water flow; Field water budget, water gains and water losses from deep percolation beyond root zone, capillary rise; Evapotranspiration (ET), scope for economizing water, measures for reducing direct evaporation from soil and crop canopies; Soil physical properties in relation to plant growth and development; Erodability of soils and their prevention.

Unit 11: Plant Water Relationship
Plant water relations: Concept of plant water potential, cell water relations, plant water potential and its components; Significance of osmotic adjustment, leaf diffusive resistance, canopy temperature, canopy temperature depression (CTD); Water movement through soil plant atmosphere systems, uptake and transport of water by roots; Development of crop water deficit, crop adaptation to water deficit, morpho-physiological effect of water deficit, Drought tolerance, mechanisms of drought tolerance, potential drought tolerance traits and their measurements. Management and Effect of excess water on plant growth and production; Types of droughts, drought indices.

Unit 12: Irrigation Water Management
Management of irrigation water; History of irrigation in India; Major irrigation projects in India; Water resources development; Crop water requirements; Concepts of irrigation scheduling, Different approaches of irrigation scheduling; Soil water depletion plant indices and climatic parameters; Concept of critical stages of crop growth in relation to water supplies; Crop coefficients, water production functions; Methods of irrigation viz. surface methods, overhead methods, drip irrigation and air conditioning irrigation, merits and demerits of various methods, design and evaluation of irrigation methods; Measurement of irrigation water, application and distribution efficiencies; Management of water resources (rain, canal and ground water) for agricultural production; Agronomic considerations in tile-design and operation of irrigation projects, characteristics of irrigation and Water quality, conjunctive use of water, irrigation strategies under different situation of water availability, optimum crop plans and cropping patterns in canal
command areas: Socio-economic aspects of on-farm water management; Irrigation water distribution, Irrigation efficiencies; Design of irrigation canals, design of irrigation structures, Interaction between irrigation and fertilizers.

5) **BIO-CHEMISTRY**

**Unit I: Basic Biochemistry and Biomolecules**
Scope and importance of biochemistry and molecular biology in plants. Structural and functional organization of prokaryotic and eukaryotic cells, viruses and bacteriophages, cell organelles function and their fractionation. Chemical bonding in biological systems, pH and buffers. Thermodynamics and bioenergetics concept of entropy, and free energy changes in biological reactions, Redox reactions, Role of high - concept of phosphates. Biomembranes, Classification structure, chemistry, properties and function of carbohydrates, proteins, lipids and nucleic acids. Components of immune system, Prostaglandins.

**Unit 2: Intermediary Metabolism**

**Unit 3: Enzymes, Vitamins and Hormones**

**Unit 4: Molecular Biology**
Unit 5: Techniques in Biochemistry
Principles of optical, phase contrast, fluorescence and electron spectrophotometry, UV and VIS, fluorimetry, turbidometry and atomic absorption spectrophotometry. Radioisotopic techniques - scintillation counters and autoradiography and their application in biological sciences. Electrophoresis general principles and application, gel electrophoresis, isoelectric focusing, pulsed field gel electrophoresis, immune electrophoresis. Chromatographic techniques paper, thin layer, column chromatography, GC and HPLC. Centrifugation-principles of sedimentation in various rotors, differential centrifugation, density gradient centrifugation and ultracentrifugation. Cell tissue and organ culture Cryopreservation, PCR and application of RFLP, RAPD, AFLP, microsatellite and mitochondrial and ribotyping techniques. Southern, Northern and Western blotting ELISA. Microarray and DNA chips. Preliminary methods of statistical analysis as applied to agricultural data standard deviation, standard error, ANOVA, correlation and regression.

Unit 6: Biochemistry of Food-grains, Fruits and Vegetables

Unit 7: Photosynthesis

Unit 8: Plant Metabolic Processes

Unit 9: Plant Molecular Biology

Unit 10: Plant Biotechnology / Genetic Engineering
improvement insect-pest resistance (insect, viral, fungal and bacterial diseases) Abiotic stress tolerance, herbicide resistance, storage protein quality improvement, increasing shelf-life, oil quality, Biosafety and IPR issues.

6) ENTOMOLOGY

Unit 1: Systematics
History and development of Entomology, Evolution of insects, position of insects in the animal world, characteristics of phylum Arthropoda, structural features of important arthropod groups such as Trilobita, Chelicerata and Mandibulata, structural features of important classes of phylum Arthropoda viz. Arachnida, Crustacea, Chilopoda, Diplopoda and Hexapoda. Classification of insects up to order level, habits, habitats and distinguishing features of different Order and important Families - Speciation, kinds and systems of classification and newer trends in systematics - Principles of binomial nomenclature, Law of priority, homonymy, synonymy, type concept in zoological nomenclature.

Unit 2: Morphology
Body wall, its structure, outgrowths, endoskeleton, Body regions, segmentation, sclerites and sutures. Head and head appendages, types of mouth parts, antennae, their structure and types. Thorax structure, thoracic appendages and their modification. Wings, their modification and venation, Abdomen; structure, abdominal appendages both in Pterygota and Apterygota. External genitalia, general structure and modification in important insect orders. Insect Pigmentation.

Unit 3: Embryology, Internal Anatomy and Physiology
Embryonic and post embryonic development, types of metamorphosis, physiology of ecdysis. General features and types of larvae and pupae. Structure, function and physiology of Digestive, Circulatory, Respiratory, Reproductive, Nervous and Excretory systems, Sense Organs; structure and types. Insect food and nutrition; minerals, carbohydrates, proteins and amino acids, lipids, vitamins and their role in growth and development, artificial diets- Muscular and glandular system.

Unit 4: Ecology

Unit 5: Biological Control
conservation, habitat management and augmentation. Mass multiplication techniques and economics. Effective evaluation techniques, Biocontrol organizations in world and India. Successful cases of biological control of pests-Microbial control & mode of Action of Entomopathogenic microbes. Principles of biological control of weeds; Natural enemies on artificial diet; Quarantine regulations in biological control. Role of biotechnology in biological control; Semiochemicals in biological control.

Unit 6: Chemical Control and Toxicology

Unit 7: Host Plant Resistance

Unit 8: Innovative Approaches in Pest Control

Unit 9: Integrated Pest Management
History, concept and principles of IPM. Components of IPM: Host plant resistance, agronomic manipulations, mechanical and physical methods, chemical methods, biocontrol agents utilization, genetic and behavioral control strategy etc. IPM strategies for field and horticultural crops. IPM case histories. Concept of damage levels- Economic threshold levels (ETL), Economic injury levels (EIL) and their determination. System approach, Agro ecosystem and cropping system vs. IPM. Constraints and Strategies of IPM implementation. Pest and pesticide risk analysis, partial budgeting and benefit cost ratio, push and pull technology and Area Wide Pest Management - AESA and P:D ratio - Root dip method - Root feeding and stem application methods.
Unit 10: Pesticide Application Equipments
Types of appliances: sprayers, dusters, fog generators, smoke generators, soil injecting guns, seed treating drums, flame throwers, etc. Power operated sprayers and dusters. Types of nozzles and their uses. Maintenance of appliances. Aerial application of pesticides, principles of aerial application, factors affecting the effectiveness of aerial application. Equipments for aerial applications. Advantages and disadvantages of aerial application.

Unit 11: Pests of Field Crops and their Management
Distribution, host range, biology and bionomics, nature of damage and management of arthropod pests of cereals, Oilseed, pulses and fibre crops, sugarcane and tobacco. Polyphagous pests: locusts, termites, hairy caterpillars, cut worms and white grubs. Management of non insect pest (mites, rodents, birds, wild boars etc.,)

Unit 12: Pests of Horticultural Crops and their Management
Distribution, host range, biology and bionomics, nature of damage and management of arthropod pests of vegetables, fruits and plantation crops, spices, condiments and ornamentals. Management of non insect pests (mites, rodents, birds, wild boars etc.,)

Unit 13: Pests of Stored Products and their Management
Fundamentals of storage of grains and grain products. Storage losses, sources of infestation/infection, factors influencing losses, insect and non-insect pests, their nature of damage and control. Microflora in storage environment and their control. Storage structures, bulk storage and bag storage, their relative efficacy and demerits. Grain drying methods and aeration. Non-insect pests (rodents, birds, mites) of stored products and their control. Integrated management of storage pests. Estimation of losses caused by stored grain insect pests; Methods for detection of hidden infestation in grain storage Recent trends in management of stored grain insect pests.

Unit 14: Arthropod Vectors of Plant Diseases

Unit 15: Honey Bees and Bee-keeping
Honey bees and their economic importance. Bee species, their behaviour, habit and habitats. Bee Keeping: bee pasturage, hives and equipments, seasonal management. Bee enemies including diseases and their control.

Unit 16: Silkworms and Sericulture

Unit 17: Lac Insect
Lac insect, its biology, habit and habitats. Host Trees: pruning, inoculation, lac cropping techniques, and harvesting. Enemies of lac insect and their control
Unit 18: Other Useful Insects
Pollinators, biocontrol agents of weeds, soil fertility improving agents, scavengers. Use of insects and insect products in medicines. Usefulness of insects in scientific investigations, insects as food.

Unit 19: Statistics and Computer Application
Frequency distribution, mean, mode and median. Standard, normal, bionomial and Poisson’s distribution. Sampling methods and standard errors. Correlation and regression: Partial and multiple, tests of significance; t, F, chi-square, Duncan’s multiple range tests. Design of experiments: Principles of Randomized block design, Latin square design, Split-plot designs. Probit analysis. Use of soft ware packages like SPSS, SAS, etc. for the above tests and designs of experiments for analysis.

Unit 20: Nematology
History and economic importance of plant parasitic nematodes - Classification of nematodes, general characters of plant parasitic nematodes Type of parasitism Complex diseases caused by plant parasitic nematodes Symptomatology and management of nematodes infesting paddy, cotton, groundnut, vegetables and fruit crops.

7) FARM MACHINERY AND POWER

Unit 1: Farm Mechanization and Equipment
Status of farm mechanization in India; power availability on farms; hand tools used for different kinds of farm operations and materials for construction. Functional requirement, principle of working, constructional features and operation of animal and power operated equipment for land development, tillage, sowing, planting transplanting, fertilizer application, intercultivation, plant protection, harvesting threshing, mowing, chaff cutting and baling, special equipment for crops such as sugarcane, cotton, groundnut, potato and plantation crops like coconut, areca nut, cashew nut etc.

Unit 2: Farm Machinery Design
Design and selection of machinery elements viz. gears, pulleys, chains and sprockets belts, bearings, couplings and springs and fasteners. Farm machine system characteristics and evaluation, dynamic balancing and stability of farm machines, force analysis on agricultural tools and implements, pull, draft, unit draft and power of farm equipment, design of soil working tools for sowing and planting; design of fertilizer applicators, intercultivation equipment, harvesters and threshers; pneumatic and hydraulic controls.

Unit 3: Farm Machinery Testing, Evaluation and Management
Calibration of seed drills, planters, plant protection equipment; methods of testing and performance evaluation of tillage equipment, seed drills and planters, fertilizer applicators, sprayers and dusters, harvesting and threshing equipment, grain and straw combines, and special equipment such as sugarcane, cotton, rice and potato planter; calculations of field capacity, efficiency and rates of seed fertilizer and chemical applicators; calculation of capacity, efficiency and losses in threshers harvesters and chaff cutters. Farm machinery selection and management for different soils, crops and operations; cost analysis of animal and tractor operated implements and tractors; matching power-implement system, estimation of energy and power requirements, reliability of farm machinery.

Unit 4: Engines and Tractor Systems
Engineering thermodynamics, power cycles, fuels; various systems of IC engines; operations, adjustment and trouble shooting of different systems; calculations of power, torque, speed, firing arrangement and intervals, heat load and power transmission from piston to the flywheel; tractor power transmission,
differential, final drives; power outlets such as P.T.O. and drawbar; recent trends in tractor design; emissions and control of pollutants; mechanical and power steering; tractor chassis mechanics, hitching systems, hydraulic controls for tractors, automatic position and draft control; tractor performance tests, operation and maintenance tractors and power tillers.

**Unit 5: Ergonomics and Safety**

Anthropometry in equipment design, physiological cost and effect of work on physiological responses, fatigue and comfort; ergonomics in design of farm tools; safety aspects of agricultural machinery; effect of noise and vibration on work performance; chemical hazards and control measures; operator's protective gadgets; design of tractor controls viz., hand and foot controls, visual range and limitations, seat design etc. Roll over protection system (ROPS) in tractor.

**Unit 6: Soil Dynamics in Tillage and Traction**

Dynamic properties of soil and their measurements; stress-strain relationships; theories of soil failure, mechanics of tillage tools; design parameters and performance of tillage tools. Introduction to traction devices, tyre function and size, their selection, mechanics of traction devices, traction theories, slippage and sinkage of wheels, evaluation and prediction of traction performance; soil compaction causes and methods for alleviating the effect on soil and crop responses.

**Unit 7: Energy in Agriculture**

Conventional and renewable energy sources in agriculture; solar radiation and its measurement; characteristics of solar spectrum; solar energy collection, storage and applications; solar photovoltaic conversion and SPV powered systems. Types of wind mills and their applications; thermo-chemical conversion of biomass, direct combustion, Pyrolysis and gasification, chemical conversion processes, carbonization, briquetting, pelletization and densification of biomass; bioconversion into alcohols, methyl and ethyl esters, organic acids, solvents of amino acids; types of biogas plants, biogas properties, uses and distribution, alternate fuels for IC engines.

Energy requirement in agricultural production systems, energy ratio and specific energy value, inflow and outflow of energy in unit agricultural operation, energy audit, accounting and analysis.

**Unit 8: Manufacturing Technology**

Specification of materials, surface roughness, production drawing, computer aided drawing heat treatment, workshop practices applied in prototype production, common tools and press operations, metal cutting and machining, jigs, fixtures and gauges, casting and die-casting processes; basic joining processes, welding processes, weldments testing and metallurgy.

**Unit 9: Instrumentation and Measurement Techniques**

Mechanical measurements, sensors and transducers, application of electrical strain gauges, signal transmission and processing, dynamic measurements; measurement of temperature, pressure, strain, force, torque, power vibrations etc.; determination of calorific value, fluid flow rates etc; signal conditioning and monitoring, data acquisition and storage.

8) **GENETICS AND PLANT BREEDING**

**Unit 1: General Genetics and Plant Breeding**

Unit 2: Economics Botany and Plant Breeding Methods
Origin, distribution, classification, description and botany of cereals (wheat, rice maize, sorghum, pearl millet, minor millets); pulses (pigeonpea, chickpea, black gram, green gram, cowpea, soyabean, pea, lentil, horse gram, lab-lab, rice bean, winged bean, lathyrus, Lima bean; oilseeds (groundnuts, sesame, castor, rapeseed mustard sunflower, Niger, linseed; fibers and sugar crops, fodder and green manures; Breeding methods for self-pollinated, cross-pollinated and clonally propagated crops.Component, recombinational and transgressive breeding. Single seed descent. Populations, their improvement methods and maintenance, Hybrid breeding and genetic basis of heterosis. Ideotype breeding. Mutation breeding.

Unit 3: Genome organization and Cytogenetics of Crop Plants

Unit 4: Quantitative and Biometrical Genetics

Unit 5: Genetic Engineering and Biotechnological Tools in Plant Breeding

Unit 6: Plant Breeding for Stress Resistance and Nutritional Quality
Genetic basis and breeding for resistance to diseases and insect-pests. Breeding for vertical and horizontal resistance to diseases. Genetic and physiological basis of abiotic stress tolerance. Breeding for resistance to heat, frost, flood, drought and soil stresses. Important quality parameters in various crops, their genetic basis and breeding for these traits. Role of molecular markers in stress resistance breeding: MAS, MARS and MABB.
Unit 7: Plant Genetic Resources and their Regulatory System; Varietal Release and Seed Production


Unit 8: Statistical Methods and Field Plot Techniques


9) HORTICULTURE - FRUIT SCIENCE

UNIT 1: TROPICAL AND DRY LAND FRUIT PRODUCTION

Commercial varieties of regional, national and international importance, ecophysiological requirements, recent trends in propagation, rootstock influence, planting systems, cropping systems, root zone and canopy management, nutrient management, water management, fertigation, role of bioregulators, abiotic factors limiting fruit production, physiology of flowering, pollination, fruit set and development, honeybees in cross pollination, physiological disorders - causes and remedies, quality improvement by management practices; maturity indices, harvesting, grading, packing, storage and ripening techniques; industrial and export potential, Agri. Export Zones (AEZ) and industrial supports. Crops: Mango and Banana, Citrus and Papaya, Guava, Sapota and Jackfruit, Pineapple, Annonas and Avocado, Aonla, Pomegranate and Ber, minor fruits of tropics.

UNIT 2: SUBTROPICAL AND TEMPERATE FRUIT PRODUCTION

Commercial varieties of regional, national and international importance, ecophysiological requirements, recent trends in propagation, rootstock influence, planting systems, cropping systems, root zone and canopy management, nutrient management, water management, fertigation, bioregulation, abiotic factors limiting fruit production, physiology of flowering, fruit set and development, abiotic factors limiting production, physiological disorders - causes and remedies, quality improvement by management practices; maturity indices, harvesting, grading, packing, precooling, storage, transportation and ripening techniques; industrial and export potential, Agri Export Zones (AEZ) and industrial support. Crops: Apple, pear, quince, grapes, Plums, peach, apricot, cherries, Litchi, loquat, persimmon, kiwifruit strawberry, Nuts-walnut, almond, pistachio, pecan, hazelnut, Minor fruits - mangosteen, carambola, bael, wood apple, fig, jamun, rambutan, pomegranate.

UNIT 3: BIODIVERSITY AND CONSERVATION

Biodiversity and conservation; issues and goals, centers of origin of cultivated fruits; primary and secondary centers of genetic diversity; Present status of gene centers; exploration and collection of germplasm; conservation of genetic resources - conservation in situ and ex situ. Germplasm conservation - problem of recalcitrancy - cold storage of scions, tissue culture, cryopreservation, pollen and seed storage; inventory of germplasm, introduction of germplasm, plant quarantine; Intellectual property rights, regulatory horticulture Detection of genetic constitution of germplasm and maintenance of core group; GIS and documentation or local biodiversity, Geographical indication.
Crops: Mango, sapota, citrus, guava, banana, papaya, grapes, jackfruit, custard, apple, ber, aonla, malus, Prunus sp, litchi, nuts, coffee, tea, rubbur, cashew, coconut, cocoa, palmyrah, arecanut, oil palm and betelvine.

UNIT 4. CANOPY MANAGEMENT IN FRUIT CROPS
Canopy management - importance and advantages; factors affecting canopy development; Canopy types and structures with special emphasis on geometry of planting, canopy manipulation for optimum utilization of light. Light interception and distribution in different types of tree canopies; Spacing and utilization of land area - Canopy classification; Canopy management through rootstock and scion; Canopy management through plant growth inhibitors, training and pruning and management practices; Canopy development and management in relation to growth, flowering, fruiting and fruit quality in temperate fruits, grapes, passion fruits, mango, sapota, guava, citrus and ber.

UNIT 5: BREEDING OF FRUIT CROPS
Origin and distribution, taxonomical status - species and cultivars, cytogenetics, genetic resources, blossom biology, breeding systems, breeding objectives, ideotypes, approaches for crop improvement - introduction, selection, hybridization, mutation breeding, polyploid breeding, rootstock breeding, improvement of quality traits, resistance breeding for biotic and abiotic stresses, biotechnological interventions, achievements and future thrust in the following selected fruit crops. Crops: Mango, banana and pineapple, Citrus, grapes, guava and sapota, Jackfruit, papaya, custard apple, aonla, avocado and ber, Mangosteen, litchi, jamun, phalsa, mulberry, raspberry, kokam and nuts, Apple, pear, plums, peach, apricot, cherries and strawberry.

UNIT 6: POST HARVEST TECHNOLOGY
Maturity indices, harvesting practices for specific market requirements, influence of pre-harvest practices, enzymatic and textural changes, respiration, transpiration; Physiology and biochemistry of fruit ripening, ethylene evolution and ethylene management, factors leading to post-harvest loss, pre-cooling; Treatments prior to shipment, viz., chlorination, waxing, chemicals, biocontrol agents and natural plant products. Methods of storage - ventiated, refrigerated, MAS, CA storage, physical injuries and disorders; Packing methods and transport, principles and methods of preservation, food processing, canning, fruit juices, beverages, pickles, jam, jellies, candies; Dried and dehydrated products, nutritionally enriched products, fermented fruit beverages, packaging technology, processing waste management, food safety standards.

UNIT 7: GROWTH AND DEVELOPMENT
Growth and development - definition, parameters of growth and development, growth dynamics, morphogenesis; Annual, semi-perennial and perennial horticultural crops, environmental impact on growth and development, effect of light, photosynthesis and photoperiodism vernalisation, effect of temperature, heat units, thermoperiodism; Assimilate partitioning during growth and development, influence of water and mineral nutrition during growth and development, biosynthesis of auxins, gibberellins, cytokinins, abscissic acid, ethylene, brassinosteroids, growth inhibitors, morphactins, role of plant growth promoters and inhibitors; Developmental physiology and biochemistry during dormancy, bud break, juvenility, vegetative to reproductive interphase, flowering, pollination, fertilization and fruit set, fruit drop, fruit growth, ripening and seed development; Growth and developmental process during stress - manipulation of growth and development, impact of pruning and training, chemical manipulations in horticultural crops, molecular and genetic approaches in plant growth development.

UNIT 8: BIOTECHNOLOGY OF FRUIT CROPS
Harnessing bio-technology in horticultural crops, influence of plant materials, physical, chemical factors and growth regulators on growth and development of plant cell, tissue and organ culture; Callus culture - types, cell division, differentiation, morphogenesis, organogenesis, embryogenesis; Use of bioreactors
and in vitro methods for production of secondary metabolites, suspension culture, nutrition of tissues and cells, regeneration of tissues, ex vitro, establishment of tissue cultured plants; Physiology of hardening - hardening and field transfer, organ culture - meristem, embryo, anther, ovule culture, embryo rescue, somaclonal variation, protoplast culture and fusion; Construction and identification of somatic hybrids and cybrids, wide hybridization, in vitro pollination and fertilization, haploids, in vitro mutation, artificial seeds, cryopreservation, rapid clonal propagation, genetic engineering and transformation in horticulture crops, use of molecular markers. In vitro selection for biotic and abiotic stress, achievements of biotechnology in horticultural crops.

UNIT 9. PROTECTED FRUIT CULTURE
Greenhouse - World scenario, Indian situation: present and future, Different agro-climatic zones in India, Environmental factors and their effects on plant growth; Basics of greenhouse design, different types of structures - glasshouse, shade net, poly tunnels - Design and development of low cost greenhouse structures; Interaction of light, temperature, humidity, 002, water on crop regulation - Greenhouse heating, cooling, ventilation and shading; Types of ventilation- Forced cooling techniques -Glazing materials - Micro irrigation and Fertigation; Automated greenhouses, microcontrollers, waste water recycling, Management of pest and diseases - IPM.

10) HORTICULTURE - VEGETABLE SCIENCE

UNIT 1: PRODUCTION TECHNOLOGY OF COOL SEASON VEGETABLE CROPS
Introduction, botany and taxonomy, climatic and soil requirements, commercial varieties / hybrids, sowing / planting times and methods, seed rate and seed treatment, nutritional and irrigation requirements, intercultural operations, weed control, mulching, physiological disorders, harvesting, post-harvest management, plant protection measures and seed production of: Potato, Cole crops: cabbage, cauliflower, knoll kohl, sprouting broccoli, Brussels sprout, Root Crops: carrot radish, turnip and beetroot, Bulb crops: onion and garlic, Peas and broad bean, green leafy cool season vegetables.

UNIT 2: PRODUCTION TECH. OF WARM SEASON VEGETABLE CROPS
Introduction, botany and taxonomy, climatic and soil requirements, commercial varieties/hybrids, sowing/planting times and methods, seed rate and seed treatment, nutritional and irrigation requirements, intercultural operations, weed control, mulching, physiological disorders, harvesting, post harvest management, plant protection measures, economics of crop production and seed production of : Tomato, eggplant, hot and sweet peppers, Okra, beans, cowpea and cluster bean, Cucurbitaceous crops, Tapioca and sweet potato, Green leafy warm season vegetables.

UNIT 3: BREEDING OF VEGETABLE CROPS
Origin, botany, taxonomy, cytogenetics, genetics, breeding objectives, breeding methods (introduction, selection, hybridization, mutation), varieties and varietal characterization, resistance breeding for biotic and abiotic stress, quality improvement, molecular market, genomics, marker assisted breeding and QTLs, biotechnology and their use in breeding in vegetable crops-Issue of patenting, PPVFR act. Potato and tomato, Eggplant, hot pepper, sweet pepper and okra, Peas and beans, amaranth, chenopods and lettuce, Gourds, melons, pumpkins and squashes, Cabbage, cauliflower, carrot, beetroot, radish, sweet potato and tapioca.

UNIT 4: GROWTH AND DEVELOPMENT
Cellular structures and their functions; definition of growth and development, growth analysis and its importance in vegetable production; Physiology of dormancy and germination of vegetable seeds, tubers and bulbs; Role of auxins, gibberellins, cytokinins and abscissic acid; Application of synthetic hormones, plant growth retardants and inhibitors for various purposes in vegetable crops; Role and mode of action of morphactins, antitranspirants, anti-auxin, ripening retardant and plant stimulants in vegetable
crop production; Role of light, temperature and photoperiod on growth, development of underground parts, flowering and sex expression in vegetable crops; apical dominance; Physiology of fruit set, fruit development, fruit growth, flower and fruit drop; parthenocarpy in vegetable crops; phototropism, ethylene inhibitors, senescence and abscission; fruit ripening and physiological changes associated with ripening; Plant growth regulators in relation to vegetable production; morphogenesis and tissue culture techniques in vegetable crops. Sex expression in cucurbits and checking flower and fruit drops and improving fruit set in Solanaceous vegetables; growth analysis techniques in vegetable crops.

UNIT 5: SEED PRODUCTION
Introduction; modes of propagation in vegetables; Seed morphology and development in vegetable seeds; Floral biology of these plant species; classification of vegetable crops based on pollination and reproduction behavior; steps in quality seed production; identification of suitable areas/locations for seed production of these crops; Classification based on growth cycle and pollination behavior; methods of seed production; comparison between different methods e.g. seed-to-seed vs. root-to-seed method in radish; seed multiplication ratios in vegetables; pollination mechanisms; sex types, ratios and expression and modification of flowering pattern in cucurbits; nursery raising and transplanting stage: Seed production technology of vegetables, viz. solanaceous, cucurbitaceous, leguminous, malvaceous, Cole crops, leafy vegetables, rood, tuber and bulb crops and spices; harvesting/picking stage and seed extraction in fruit vegetables; clonal propagation and multiplication in tuber crops e.g. Potato, sweet potato, colocasia, tapioca; seed-plot technique in potato tuber seed production; hybrid seed production; hybrid seed technology of vegetable crops, TPS (true potato seed) and its production technique; hybrids in vegetables; maintenance of parental lines; use of male sterility and self incompatibility in hybrid seed production, environmental factors related to flowering/bolting in vegetable crops; Share of vegetable seeds in seed industry; importance and present status of vegetable industry; intellectual property rights and its implications, impact of PVP on growth of seed industry.

UNIT 6: SYSTEMATICS OF VEGETABLE CROPS
Principles of classification; different methods of classification; salient features of international code of nomenclature of vegetable crops; Origin, history, evolution and distribution of vegetable crops, botanical description of families, genera and species covering various tropical. Subtropical and temperate vegetables; Cytological level of various vegetable crops; descriptive keys for important vegetables; Importance of molecular markers in evolution of vegetable crops; molecular markers as an aid in characterization and taxonomy of vegetable crops.

UNIT 7: PRODUCTION TECHNOLOGY OF UNDEREXPLOITED VEGETABLE CROPS
Introduction, botany and taxonomy, climatic and soil requirements, commercial varieties/hybrids, owing/planting times and methods, seed rate and seed treatment, nutritional and irrigation requirements, intercultural operations, weed control, mulching, physiological disorders, harvesting, post harvest management, plant protection measures and seed production of: Asparagus, artichoke and leek; Brussels sprout, Chinese cabbage, broccoli, kale and artichoke; Amaranth, celery, parsley, parsnip, lettuce, rhubarb, spinanch, basella, bathu (chenopods) and chekurmanis; Elephant foot yam, lima bean, winged bean, vegetable pigeon, pea, jack bean and sword bean; Sweet gourd, spine gourd, pointed gourd, Oriental picking melon and little gourd (kundru).

UNIT 8: POST HARVEST TECHNOLOGY OF VEGETABLE CROPS
Importance and scope of post harvest management of vegetables; Maturity indices and standards for different vegetables; methods of maturity determinations; biochemistry of maturity and ripening, enzymatic and textural changes, ethylene evolution and ethylene management, respiration, transpiration, regulation methods; Harvesting tools, harvesting practices for specific market requirements; post-harvest physiological and biochemical changes, disorders-chilling injury in vegetables, influence of pre-harvest practices and other factors affecting post harvest losses, packaging house operations, commodity
pretreatments—chemicals, wax coating, prepackaging and irradiation; packaging of vegetables, post harvest, diseases and prevention from infestation, principles of transport; Methods and practices of storage—ventilated, refrigerated, MA, CA storage, hypobaric storage, pre-cooling and cold storage, zero energy cool chamber; storage disorders.

11) HORTICULTURE - FLORICULTURE AND LANDSCAPING

Unit 1. BREEDING
Principles -- Evolution of varieties, origin, distribution, genetic resources, genetic divergence. Patents and Plant Variety Protection in India; Genetic inheritance -- of flower colour, doubleness, flower size, fragrance, post harvest life; Breeding methods suitable for sexually and asexually propagated flower crops and ornamental plants -- introduction, selection, domestication, polyploid and mutation breeding for varietal development, Role of heterosis, Production of hybrids, Male sterility, incompatibility problems, seed production of flower crops; Breeding constraints and achievements made in commercial flowers - rose, jasmine, chrysanthemum, marigold, tuberose crossandra, carnation, dahlia, gerbera, gladioli, orchids, anthurium, aster, heliconia, liliums, nerium; Breeding constraints and achievements made in ornamental plants - petunia, hibiscus, bougainvillea. Flowering annuals (zinnia, cosmos, dianthus, snap dragon, pansy) and ornamental foliages- Introduction and selection of plants for waterscaping and xeriscaping.

Unit 2. PRODUCTION TECHNOLOGY OF CUT FLOWERS:
Scope of cut flowers in global trade, Global Scenario of cut flower production, Varietal wealth and diversity, area under cut flowers and production problems in India- Patent rights, nursery management, media for nursery, special nursery practices, Growing environment, open cultivation, protected cultivation, soil requirements, artificial growing media, soil decontamination techniques, planting methods, influence of environmental parameters, light, temperature, moisture, humidity and CO₂ on growth and flowering; Flower production - water and nutrient management, fustigation, weed management, rationing, training and pruning, disbudding. special horticultural practices, use of growth regulators, physiological disorders and remedies, IPM and DM, production for exhibition purposes: Flower forcing and year round flowering through physiological interventions, chemical regulation, environmental manipulation; Cut flower standards and grades, harvest indices, harvesting techniques, post-harvest handling, Pre-cooling, pulsing, packing, Storage & transportation, marketing, export potential, institutional support, Agra Export Zones; Crops: Cut rose, cut chrysanthemum, carnation, gerbera, gladioli, tuberose, orchids, anthurium, aster, heliconia, liliums, nerium; Breeding constraints and achievements made in ornamental plants - petunia, hibiscus, bougainvillea. Flowering annuals (zinnia, cosmos, dianthus, snap dragon, pansy) and ornamental foliages.

Unit 3. PRODUCTION TECHNOLOGY FOR LOOSE FLOWERS
Scope of loose flower trade, Significance in the domestic market/export, Varietal wealth and diversity, propagation, sexual and asexual propagation methods, propagation in mist chambers, nursery management, pro-tray nursery under shadenets, transplanting techniques; Soil and climate requirements, field preparation systems of planting, precision farming techniques; Water and nutrient management, weed management, rationing, training and pruning, pinching and disbudding, special horticultural practices, use of growth regulators, physiological disorders and remedies IPM and IDM; Flower forcing and year round flowering, production for special occasions through physiological interventions, chemical regulation; Harvest indices harvesting techniques, post-harvest handling and grading, packing and storage, value addition, concrete and essential oil extraction, trasportation and marketing, export potential, institutional support, Agri Export Zones: Crops, Jasmine, scented rose chrysanthemum, marigold, tuberose, crossandra, nerium, hibiscus, barleria, celosia gomphrena, non-traditional flowers (Nyctanthes, Tabernaemontara, ixora, lotus, lilies tecoma, champaka, pandanus)
Unit 4. LANDSCAPING
Landscape designs, Styles of garden, formal, informal and free style gardens, types of gardens, English, Mughal, Japanese, Persian, Spanish, Italian, Vanams, Buddha garden; Urban landscaping. Landscaping for specific situations, institutions, industries, residents, hospitals, roadsides, traffic islands, damsites, IT parks, corporates; Garden plant components, arboretum, shrubbery, fernery, palmatum, arches and pergolas, edges and hedges, climbers and creepers, cacti and succulents herbs, annuals, flower borders and beds, ground covers, carpet beds, bamboo groves; Production technology for selected ornamental plants; Lawns, Establishment and maintenance, special types of gardens, vertical garden, roof garden, bog garden, sunken garden, rock garden, clock garden, colour wheels, temple garden, sacred groves; Bio-aesthetic planning, eco-tourism, theme parks, indoor gardening, therapeutic gardening, non-plant components, water scaping, xeriscaping, hardscaping;

UNIT 5. PROTECTED FLORICULTURE
Prospects of protected floriculture in India; Types of protected structures - Greenhouses, polyhouses, shade houses, rain shelters etc., Designing and erection of protected structures; Low cost/Medium cost structures - economics of cultivation, Location specific designs; Structural components; Suitable flower crops for protected cultivation; Environment control - management and manipulation of temperature, light, humidity, air and CO₂; Heating and cooling systems, ventilation, naturally ventilated greenhouses, fan and pad cooled greenhouses, light regulation; Containers and substrates, soil decontamination, layout of drip and fertigation system, water and nutrient management, weed management, physiological disorders 1PM and IDM; Crop regulation by chemical methods and special horticultural practices (pinching, disbudding, deshooting, deblossoming, etc); Staking and netting, Photoperiod regulation; Harvest indices, harvesting techniques, post-harvest handling techniques, Precooling, sorting, grading, packing, storage, quality standards.

Unit 6. VALUE ADDITION
Prospects of value addition, National and global scenario, production and exports, Women empowerment through value added products making, supply chain management; Types of value added products, value addition in loose flowers, garlands, veni, floats, floral decorations, value addition in cut flowers, flower arrangement, styles, Ikebana morebana, free style, bouquets, buttonholes, flower baskets, corsages, floral wreaths garlands, etc; Selection of containers and accessories for floral products and decorations; Dry flowers- Identification and selection of flowers and plant parts; Raw material procurement, preservation and storage; Techniques in dry flower making - Drying bleaching, dyeing, embedding, pressing; Accessories; Designing and arrangement - dry flower baskets, bouquets, pot-pourri, wall hangings, button holes, greeting cards, wreaths; Packing and storage; Concrete and essential oils; Selection of species and varieties (including non-conventional species), extraction methods, Packing and storage, Selection of species and varieties, Types of pigments, carotenoids, anthocyanin, chlorophyll, betalains; Significance of natural pigments, Extraction methods; Applications.

Unit 7. TURFING AND TURF MANAGEMENT
Prospects of landscape industry: History of landscape gardening, site selection, basic requirements, site evaluation, concepts of physical, chemical and biological properties of soil pertaining to turf grass establishment; Turf grasses - Types, species, varieties hybrids; Selection of grasses for different locations; Grouping according to climatic requirement-Adaptation; Turfing for roof gardens; Preparatory operations; Growing media used for turf grasses - Turf establishment methods, seeding sprigging/dibbling, plugging, sodding/turfing, turf plastering, hydro-seeding, astro-turfing; Turf management - Irrigation, nutrition, special practices, aerating, rolling, soil top dressing, use of turf growth regulators (TGRs) and micronutrients, Turf mowing - mowing equipments, techniques to minimize wear and compaction, weed control biotic and abiotic stress management in turfs: Establishment and maintenance of turfs for playgrounds, viz. golf, football, hockey, cricket, tennis, rugby, etc.
Unit 8. Computer Aided Designing (CAD) FOR OUTDOOR AND INDOORSCAPING

Exposure to CAD (Computer Aided Designing) - Applications of CAD in landscape garden designing, 2D drawing by AUTOCAD, 3D drawing by ARCHICAD, 3D drawing by 3D MAX software, Creating legends for plant and non-plant components, Basics of Photoshop software in garden designing; 2D drawing methods, AUTOCAD Basics, Coordinate systems in AUTOCAD LT 2007, Point picking methods, Toolbars and Icons, File handling functions, Modifying tools, Modifying comments, Isometric drawings Drafting objects; Using patterns in AUTOCAD drawing, Dimension concepts, Hyperlinking, Script making, Using productivity tools, e-transmit file, making sample drawing for outdoor and indoor garden by AUTOCAD 2D Drawing techniques, Drawing web format design, Making layout; 3D drawing methods, ARCHICAD file system, Tools and Infobox, modification tools, structural elements, GDL objects (Grid Dimensional Linking), Creation of garden components through ARCHICAD: ARCHICAD organization tools, Dimensioning and detailing of designs, Attribute settings of components Visualization tools for landscape preview, Data management, plotting and accessories for designing. Inserting picture using Photoshop. Making sample drawing for outdoor and indoor gardens.

12) HORTICULTURE - SPICES, PLANTATION, MEDICINAL & AROMATIC PLANTS

UNIT 1: PRODUCTION OF PLANTATION CROPS

Role of plantation crops in national economy, export potential, IPR issues, clean development mechanism, classification and varietal wealth. Plant multiplication including in vitro multiplication, systems of cultivation, multitier cropping, photosynthetic efficiencies of crops at different tiers, rainfall, humidity, temperature, light and soil pH on crop growth and productivity, high density planting, nutritional requirements, physiological disorders, role of growth regulators and macro and micro nutrients, water requirements, fertigation, moisture conservation, shade regulation. Weed management. Training and pruning, crop regulation, maturity indices, harvesting. Cost benefit analysis, organic farming, management of drought, precision farming. Crops: Coffee and tea, Cashew and cocoa, Rubber, palmyrah and oil palm, Coconut and arecanu, Wattle and betel vine.

UNIT 2: PRODUCTION TECHNOLOGY OF SPICE CROPS

Introduction, importance of spice crops-historical accent, present status – national and international, future prospects, botany and taxonomy, climatic and soil requirements, commercial varieties/hybrids, site selection, layout, sowing/planting times and methods, seed rate and seed treatment, nutritional and irrigation requirements, intercropping, mixed cropping, intercultural operations, weed control, mulching, physiological disorders, harvesting, post harvest management, plant protection measures and seed planting material and micro-propagation, precision farming, organic resource management, organic certification, quality control, pharmaceutical significance and protected cultivation of: Black pepper, cardamom, Clove, cinnamon and nutmeg, allspice, Turmeric, ginger and garlic, Coriander, fenugreek, cumin, fennel, ajowain, dill, celery, Tamarind, garcinia and vanilla.

UNIT 3: AGRONOMY OF MEDICINAL, AROMATIC AND UNDER-UTILIZED CROPS

Importance of medicinal and aromatic plants in human health, national economy and related industries, classification of medicinal and aromatic plants according to botanical characteristics and their uses, export potential and indigenous technical knowledge; Climate and soil requirements; cultural practices; yield and important constituents of medicinal plants (Mulbati, Isabgol, Rauwolfia, Poppy, Aloe vera, Satavar, Stevia, Safed Musli, Kalmegh, Asaphoetida, Nux vomica, Rosadle etc); Climate and soil requirements; cultural practices; yield and important constituents of aromatic plants (Citronella, Palmorosa, Mentha, Basil, Lemon grass, Rose, Patchouli, Geranium); Climate and soil requirements; cultural practices; yield of under-utilized crops (Fenugreek, Grain Amaranth, Coffee, Tea and Tobacco); Post harvest handling-
drawing, processing, grading, packing and storage, value addition and quality standards in herbal products.

UNIT 4: BREEDING OF PLANTATION CROPS AND SPICES
Species and cultivars, cytogenetics, survey, collection, conservation and evaluation, blossom biology, breeding objectives, approaches for crop improvement, introduction, selection, hybridization, mutation breeding, polyploidy breeding, improvement of quality traits, resistance breeding for biotic and abiotic stresses, molecular aided breeding and biotechnological approaches, marker-assisted selection, bioinformatics, IPR issues, achievements and future thrusts, Crops: Coffee, tea, cashew, cocoa, rubber, palmyrah palm, oil palm, coconut, arecanut, black pepper, cardamom, Ginger, turmeric, fenugreek, coriander, fennel, celery, carom (ajwain), nutmeg, cinnamon, clove and allspice.

UNIT 5: BREEDING OF MEDICINAL AND AROMATIC CROPS
Plant biodiversity, conservation of germplasm, IPR issues, Major objectives of breeding of Medicinal and Aromatic Crops, Scope for introduction; cytogenetic background of important Medicinal and Aromatic Crops, Scope for improvement of Medicinal and Aromatic Crops through selection, intro and interspecific hybridization, induced autotetraploidy, mutation breeding and biotechnological approaches; Breeding for yield and quality improvement in medicinal plants, Breeding for high herbage yield, essential oil and quality components secondary metabolites in medicinal and aromatic crops: Genetics of active principles and assay techniques useful in evaluation of breeder's material. Breeding problems in seed and vegetatively propagated medicinal and aromatic crops: achievements and prospects in breeding of medicinal crops, viz. Cassia angustifolia Catharanthus roseus. Gloriosa superb, Clocus, forskohlii. Stevia, withania somnifera, Papaver, somniferum, Plantago ovate, Dioscorea sp; prospects in breeding of medicinal crops, viz. Chlorophytum sp. Rauvolfia serpentine, Aloe vera, Ocimum sp, phyllanthus amanus, solanum s, Prospects in breeding of aromatic crops viz., Geranium, vettiver. Lemon grass, Palmarosa, citronella, Rosemary, Patchouli, Eucalyptus Artemisia and Mint.

UNIT 6. PROCESSING OF PLANTATION CROPS, SPICES, MEDICINAL AND AROMATIC PLANTS
Commercial uses of spices and plantation crops. Processing of major spices cardamom, black pepper, ginger, turmeric. chili and paprika. vanilla, cinnamon, clove, nutmeg, allspice coriander, fenugreek, curry leaf, Extraction of oleoresin and essential oils: Processing of produce from plantation crops, viz. coconut, areca nut cashew nut, oil palm, palmyrah palm, date palm, cocoa, tea, coffee and rubber, Processing of medicinal plants, viz. dioscorea, gloria stevia, coleus, ashwagandha, pulsi isabgol, safed musli, senna, aloe and catharanthus. Different methods of drying and storage, microbial contamination of stored product. Influence of temperature and time combination on active principles; Extraction and analysis of active principles using TLC / HPLC /GC. Distillation, solvent extraction from aromatic plants- davana, mint. rosemary, rose, citronella. lavender, jasmine, etc. Study of aroma compounds and value addition. Nano-processing technology in medicinal and aromatic plants.

UNIT 7: ORGANIC SPICE AND PLANTATION CROP PRODUCTION TECHNOLOGY
13) **PLANT PATHOLOGY**

**Unit 1: History and Principles of Plant Pathology**

**Unit 2: Laboratory and Analytical Techniques**

**Unit 3: Physiological and Molecular Plant Pathology**

**Unit 4: Mycology**

**Unit 5: Plant Bacteriology**

**Unit 6: Plant Virology**
Unit 7: Plant Disease Epidemiology

Unit 8: Phanerogamic parasites and Non-parasitic Diseases
Diseases caused by Phanerogamic parasites and their management. Diseases due to unfavourable soil environment, drought and flooding stress etc. Nutritional deficiencies. Primary/secondary air pollutants and acid rain.

Unit 9: Fungal Diseases of Crop Plants
Fungal diseases of cereals, millets, oilseeds, pulses, fruits, vegetables, plantation, fiber, spices and ornamental crops with special reference to etiology, disease cycle perpetuation, epidemiology and management. Post harvest diseases in transit and storage; aflatoxins and their integrated management.

Unit 10: Bacterial and Viral Diseases of Crop Plants
Crop diseases of cereals, pulses, oilseeds, vegetables, fruits, plantation and fiber crops caused by bacteria, viruses, viroids, phytoplasmas and other fastidious prokaryotes Mode of transmission and pathogen vector relationships. Epidemiology and management.

Unit 11: Management of Plant diseases
General principles of plant quarantine. Exotic pathogens and pathogens introduced into India. Sanitary and phytosanitary issues under WTO, TRIPS and PRA. Genetic basis of disease resistance and pathogenicity; gene for gene hypothesis; parasite mediated frequency-dependent selection concept of QTL mapping; breeding for disease resistance. Production of disease free seeds and planting materials. Seed certification. Chemical nature and classification of fungicides and antibiotics: their bioassy and compatibility with other agricultural chemicals; resistance to fungicides/antibiotics; effect on environment. Spraying and dusting equipments, their care and maintenances. Important cultural practices and their role in disease management, solarization, integrated disease management. Microorganisms antagonistic to plant pathogens in soil, rhizosphere and phyllosphere and their use in the control of plant diseases; soil fungistasis. Plant growth promoting Rhizobacteria.

14) CROP PHYSIOLOGY

Unit 1: Cell Organelles and Water Relations

Unit 2: Metabolic Processes and growth Regulation
Energy and work, free energy and chemical potential, redox reactions and electrochemical potential. Enzyme classification and mechanism of action, factors affecting enzyme action. Gene expression and protein turnover. Photosynthesis translocation and respiration as key processes regulating

Unit 3: Crop Productivity and Modeling

Unit 4: Abiotic Stress Responses in Plants

Unit 5: Plant Growth Regulators and Plant Development

**Unit 6: Mineral Nutrition**

**Unit 7: Climate and Climate Change**
Climate- cellulose, stable carbon, stable 18O-discrimination for hydrological changes. Likely changes in climate in future and its impact on crop and ecosystems. The greenhouse gases and global warning. CO as an important greenhouse gas, global carbon deposits, fluxes in the sinks and sources. Approaches to contain atmospheric CO₂ level. Effect of elevated CO₂ on plant growth and development. Methane as a greenhouse gas. Prediction on global warming, GCA models, effects on climate and biota. High temperature and CO₂ interaction on plant growth and productivity, ionising radiation UV-B chlorofluoro carbon (CFC) their impact on ozone layer- ozone hole and alteration in UV-B radiation. Effects of UV-B radiation on plant ecosystem, repair and acclimation to UV-B damage. Carotenoids and their role in membrane stabilization. Air pollution, SO₂, NO, methane, ozone perox acetyl nitrate and their effect on ecosystem. Industrial and domestic effluent their effect, on aquatic ecosystem, plant growth and development.

**Unit 8: Seed Physiology**

**Unit 9: Physiology of Flowering and Reproduction**
stress) etc. plant reproductive physiology. self-incompatibility responses (pollen-stigma interactions), seed and fruit development, seed and fruit abortion and means to overcome it. Molecular biology of seed development, Physiology of heterosis.

**Unit 11: Post-Harvest Physiology**

**Unit 12: Morphogenesis, Tissue Culture and Plant Transformation**
Morphogenesis; the cellular basis of growth and morphogenesis; polarity in tip growing cells and diffusive growing cells. Control of cell division and differentiation, phytochromes, different forms, physiological effects and gene regulation, and cellular totipotency, physiology and biochemistry of differentiation, in organ cell, tissue and cultures, micropropagation strategies, application of tissue culture in agriculture horticulture, forestry and industry: plant transformation; transformation vectors, concept of selectable and scorable markers. Agrobacterium mediated transformation, binary vectors, biolistics. Electroporation, selection of putative transgenic plants, genetic analysis. PCR, Southern analysis evaluation of transgenic plants.

15) **PROCESS & FOOD ENGINEERING**

**Unit 1: Heat and Mass Transfer**

**Unit 2: Farm Structures and Farmstead Planning**

**Unit 3: Storage Engineering**
Storage environment and its interaction with stored product. Factors/parameters influencing the shelf life of the stored product, climatograph and deterioration index. Modeling of metabolic activities and prediction of storage life, quality deterioration mechanisms and their control. Storage practices (including
fumigation) for food grains. Design of bulk storage and aeration system. Analysis of heat, moisture and gas transfer in bulk storage structures. Bag storage structures, their design and management. Storage of perishables in ventilated, refrigerated, controlled and modified atmosphere storage systems and their design, smart storage system. Quality analysis of stored produce. Storage structures for animal feed, silage etc. Chilling rooms, walk-in cooling rooms for perishables. BIS standards on practices and design of systems for food grains and other commodities, CAP storage, hermetic storage etc.

Unit 4: Material Handling Packaging and Transport

Unit 5: Post Harvest Operations
Grading, cleaning, washing, shorting, shelling, dehiscing, decortication, milling, polishing, pearling, drying (Osmotic, evaporative and freeze drying), pasteurization and sterilization of liquid foods, size reduction cryogenic grinding, granulation, crystallization, filtration, membrane processing, microfiltration, ultra filtration, nano-filtration, reverse osmosis, evaporation, distillation, mixing, clarification, coagulation, mechanical separation, sedimentation, pressing, expelling, leaching, extraction, palleting, extrusion and industrial fermentation.

Unit 6: Processing Technology and Processing Equipment Design
Pre-milling/conditioning treatments. Theory of grain drying, thin layer and deep bed drying, Process technology and machinery for cereals, pulses, oil seeds, fruits, vegetables, flowers, spices, condiments, plantation crops, animal products, sea-foods, fiber crops, animal feed, natural resins and gums, Bioprocess engineering, enzyme reaction kinetics, Industrial fermentation and processing, down-stream processing, bio-separation. Minimal processing of fruits and vegetables, high pressure processing, Ohmic heating, ultraviolet light, pulsed electric field, pulsed light field, micro and nano encapsulation of food ingredients, Food nanotechnology, Seed processing and technology, Agricultural byproducts/residue utilization, Waste disposal of food processing plants, different methods and equipment. Design of grain cleaners, graders, dryers, parboiling plants, size reduction machines, bioreactors, fermenters, centrifuges, cyclones, heat-exchanger, evaporators, filters, extrusion cookers. Computer aided design and analysis of machines and machine components. Materials, manufacturing processes, design of elements and selection of standard parts (pulley, chains, sprockets, bearings, belts, fasteners, hydraulic components, pipes hoses).

Unit 7: Engineering Properties & Quality of Biomaterials
Uniqueness of bio-materials and physical characteristics viz. size, volume, density, porosity, surface areas, friction, rolling resistance, angle of repose. Properties of bulk particulate solids viz. specific surface area, mean diameter, flow rate. Aerodynamics drag coefficient and terminal velocity. Pressure drop through packed beds. Thermal properties such as specific heat, thermal conductivity, thermal diffusivity. Dielectric properties viz. dielectric and microwave radiation, dielectric constant, energy absorption, heating. Optical properties and transmittance and reflectance. Rheological properties and stress-strain-time relationship, rheological models, visco-elasticity, Hertz’s theory of contact stresses. Food Quality and BIS specifications for quality of food materials, milling quality analysis, cooking and baking
qualities. Organoleptic and sensory evaluation of product quality. Determination of protein, oil content, carbohydrates, color, hardness, texture, nutritive value, bio-availability and microbial loads, non-destructive quality evaluation techniques. Measurement techniques and instruments for food quality determination, destructive and non-destructive quality evaluation, UV VIS NIR spectroscopy, X-ray, CT NMR, machine vision, Maturity, ripening stages and indices of fruits and vegetables.

**Unit 8: Agri-Project Planning and Management**

**Unit 9: Aquaculture Processing Technology & Structures Design**
Inland fish farming and associated considerations, Site selection for aquaculture design of dykes, sluice, channels etc, Fish Physiology and micro-climate considerations, Aeration & feeding systems, Design of fish rearing structures, Hatcheries, containers for live fish, fingerlings, fish seeds. Aquaculture in recirculatory systems, oxygen and aeration, sterilization and disinfection. Recirculation of water, Reuse systems, water exchange, Design of re-use systems. Inlet and outlet structures, water treatment plants.

**Unit 10: Dairy Engineering, Instrumentation and Process Control**


### 16) SOIL AND WATER ENGINEERING

**Unit 1: Ground Development, Wells and Pumps**
Unit 2: Open Channel Hydraulics
Hydraulics of open channel flow, energy and momentum principles, specific energy, Hydraulic jump and its classification. Design of different types of irrigation channels. Irrigation water measurement: using velocity area method, water meters, weirs, notches, flumes, orifices etc. Water conveyance and control. Conveyance losses and lining of irrigation channels. Irrigation water delivery and distribution.

Unit 3: Soil, Plant, Water and Atmosphere Relationship
Under limited water supplies. Contingent crop plans and other strategies for aberrant weather conditions. Cropping patterns, alternate land use and crop diversification in rain fed regions.

Unit 4: Hydrology and Soil and Water Conservation

Unit 5: Watershed Management

Unit 6: Irrigation Water Management
History of irrigation in India. Management of irrigation water. Major irrigation projects in India. Crop water requirements. Soil water depletion, plant indices and climatic parameters. Crop modeling, water production function. Methods of irrigation, surface methods, overhead methods, Pressurized irrigation system such as drip and sprinkler irrigation. Merits and demerits of various methods. Hydraulics and design of furrow, check basin and border irrigation, Hydraulics and design of pressurized irrigation systems. Irrigation efficiency and economics of different irrigation systems. Application and distribution

**Unit 7: Management of Degraded, Waterlogged and Other Problematic Soils and Water**


**17) SOIL SCIENCE & AGRICULTURAL CHEMISTRY**

**Unit 1: Pedology**

Concept of land, soil and soil science. Composition of earth crust and its relationship with soils; Rocks, minerals and other soil forming materials; Weathering of rocks and minerals; Factors of soil formation; Pedogenic processes and their relationships with soil properties; Soil development; Pedon, polypedon, soil profile, horizons and their nomenclature. Soil Taxonomy - epipedons, diagnostic subsurface horizons and other diagnostic characteristics, soil moisture and temperature regimes, categories of the system and their criteria; Interpretation of soil survey data for land capability and crop suitability classifications, Macro-morphological study of soils. Application and use of global positioning system for soil survey. Soil survey- types techniques. Soil series- characterization and procedure for establishing soil series benchmark soils and soil correlations. Study of base maps: cadastral maps toposheets, aerial photographs and satellite imageries. Use of geographical information system for preparing thematic maps.

**Unit 2: Soil Physics**

degradation; Identification, monitoring and management of waste lands; Land use land cover mapping and land use planning using conventional and remote sensing techniques; Concept of watershed- its characterization and management.

**Unit 3: Soil Chemistry**


**Unit 4: Soil Fertility**

Essential elements in plant nutrition; Nutrient cycles in soil; Transformation and transport of nutrients (Macro and micro nutrients) in soil; Nutrient use of efficiency-factors affecting-methods to enhance nutrient use efficiency. Site specific nutrient management. Critical Nutrient concept in soils and plants. Manures and fertilizers; Rate and reactions of Slow. release fertilizers and nitrification retarders: Quality control of fertilizers. Soil fertility evaluation soil testing, plant and tissue tests and biological methods mon soil test methods for fertilizer recommendation; Soil test-crop response correlations, Integrated nutrient management; Use of isotopic tracers in soil research; Nature, properties and development of acid, acid sulphate, saline and alkali and their management: Lime and gypsum requirements of soils: Irrigation water quality EC, SAR, RSC and specifications. Fertility status of major soil groups of India Pollution: types, causes, methods of measurement, standards and management. Heavy metal toxicity and soil pollution; Chemical and bio-remediation of contaminated soils; Soil factors in emission of greenhouse gases; Carbon sequestration in mitigating greenhouse effect: Radio-active contamination of soil.

**Unit 5: Soil Microbiology**


**Unit 6: Statistics**

Experimental designs for pot culture and field experiment; Statistical measures of central tendency and dispersion: Correlation and regression, Tests of significance t and F tests; Computer use in soil research.
18) **VETERINARY- ANIMAL NUTRITION**

**Unit 1: Energy and Proteins:**

**Unit 2: Minerals, Vitamins and Feed Additives**
Minerals: Classification of minerals, Physiological functions, Deficiency- symptoms and toxicity - Inter-relationships -Synergism and antagonism - Requirements - Different sources and bio-availability -Role of chelated minerals. Vitamins: Physiological functions and co-enzyme role -Deficiency symptoms, hypervitaminosis. Requirements, Sources and vitamin analogues - Antivitamins - Feed Additives: Nutritional role. Prebiotics - Prebiotics, phytochemicals other metabolic modifiers. Role of phyto-chemicals as growth promoters.

**Unit 3: Rumen eco-system and functions**

**Unit 4: Non-ruminant Nutrition**

**Unit 5: Nutrient Requirements**

**Unit 6: Forage Conservation and Evaluation**
Natural and cultivated forges-Their composition and nutritive values. Nutritive value Index. Forage quality evaluation in range animals -Role of indicator methods-Advances in silage and haymaking- Factors affecting quality of conserved forages- Quality criteria and grading of silage and hay under tropics-artificial drying of forages.

**Unit 7: Feed Processing and Technology**
Methods of feed processing - physical, chemical and biological effect of processing on nutritional quality and utilization. Pelleted and extruded feeds. Quality control of raw feedstuffs and finished feeds:

**Unit 8: Anti-metabolites and Toxic Principles**

**Unit 9: Elements of Research Methodology**
Principles of animal experimentation -Experimental designs in nutritional research. Modern methods of feed evaluation - In vitro, gas production and nylon bag techniques, Rumen simulation techniques - Rusitec Tracer techniques in nutrition research - Role of NIR Spectroscopy - Feed microscopy in quality evaluation of feedstuffs.

**Unit 10: Clinical Nutrition**
Role of nutrition to control digestive and metabolic disorders (milk fever, ketosis, ruminal acidosis-laminitis, bloat), metabolic profile tests. Role of nutrition in immunity, nutrition and reproduction, nutrients as antioxidants. Role of nutrition in management of GI parasites.

19) **VETERINARY - LIVESTOCK PRODUCTION AND MANAGEMENT**

**Unit 1: General**

**Unit 2: Breeding Management**
Basic principles of inheritance. Concept of heritability, repeatability and selection. Important methods of selection and systems of breeding in farm animals and birds. Importance of maintaining breeding records and their scientific interpretation.

**Unit 3: Feeding Management**

**Unit 4: Reproduction Management**
prevention in farm animals. Management factors affecting reproductive efficiency. Summer and winter management problems and their solutions.

Unit 5: Shelter Management
Housing systems, Selection of site and lay out of animal and poultry houses. Space requirement for livestock and poultry. Housing designs in different agro-climatic regions. Macro and micro-climatic changes affecting designs of animal and poultry houses. BIS (standards) for livestock and poultry housing. Construction of cheap animal and poultry housing utilizing local resources. Automation in livestock farming. Disposal of animal wastes under urban and rural conditions. Disposal of carcasses.

Unit 6: Health Management

Unit 7: Production and Management of Cattle and Buffalo

Unit 8: Production and Management of other Animals
Draft animals: Population dynamics of various categories of draft and work animals in India. Characteristics of draft animals. Estimating draft capacity of different species. Harness for various types of draft animals. Training of work animals. Feeding, care and management of draft animals. Management of camel with special reference to rearing, feeding and watering. Behavioral studies of various draft animals. Economics of draft animals vis-a-vis machine power.
Equine: Care and management of horses, feeding and breeding systems, shelter management, shoeing, preparation and management of race horses.
Rabbit: Economic importance. Important fur and meat type breeds. Housing, handling, feeding, watering, breeding, management, sanitation and health care of rabbits.

Unit 9: Wildlife Management
Unit 10: Forage Production and Conservation

Unit 11: Economics and Marketing of Livestock and Poultry and their Products

20) VETERINARY- AQUACULTURE

Unit-1: Aquaculture System
History and scope of Aquaculture; Aquaculture practices in different parts of the world; Global Aquaculture production, consumption scenario and emerging trends; Different systems of Aquaculture-traditional, extensive, intensive, semi-intensive, flow through and re-circulatory. Farming methods-ponds, lens, cages, raceway, raft, rope, monoculture, polyculture, mixed culture; Capture based Aquaculture and culture based Aquaculture, integrated multi-trophic Aquaculture (IMTA). Recirculation Aquaculture Systems (RAS, Integration of Aquaculture with agriculture and animal husbandry; sewage-fed farming, organic Aquaculture.

Unit-2: Species selection criteria for various culture practices
Criteria for candidate species selection, criteria for site selection for various culture practices; Aquaculture practices for freshwater fish (carps, catfishes, snake heads, feather backs, tilapia, murrels, mahsee; trouts, etc) freshwater prawn, brackishwater and marine shrimp and fish (seabass, milkfish, mullets, pearlspot, cobia, pompano, grouper, snappers, breams, other perches) lobsters, freshwater and marine ornamentals, exotics.

Unit-3: Broodstock Development and Management
Broodstock management and seed production technology-Natural seed collection, holding, packaging, transportation; Environmental, nutritional and endocrine control of reproduction, improvement of seed quality through stock upgradation induced breeding, synthetic hormones and its analogues and their application, layout and design of hatcheries, PIT tagging, canulation, hormonal and volitional spawning, incubation of eggs, cryopreservation of gametes, larval rearing, live feeds, microalgae, rotifers, Artemia, copepods, seed production of : carps, snakeheads, mahseer, trout, tilapia, pearlspot, ornamentals, Cobia, Grouper, Pompano, Tilapia, Mullets, Milkfish, Snappers, Breams, Shrimps (Penaeus monodon, P. indicus, P. semisulcatus, Litopenaeus vannamei) sand lobster, spiny lobster, mud crab (Scylla serrata) blue swimmer crab (Portunus pelagicus), giant freshwater prawn (Macrobrachium rosenbergii) mussel, edible oyster, pearl oyster. Larval transportation, bio-security principles, Specific pathogen Free (SPF) broodstock development, seed certification, quarantine and hatchery protocols, Nusery rearing, pre-stocking, stocking and post stocking management, feeding and nutrition management, health management, biofilm and its uses, probiotics, bioremediation, bioflok based nutrition.
Unit 4: Farm Design, Construction and Operational Management

Design and construction of aqua-farms: site selection, nutrient and soil quality, micro organisms and their roe, water supply and water circulation, soil and water quality management, liming, manuring and fertilization, bio-fertilization, poly houses, recirculatory system; construction of pens, cage design and construction, fixed cages, floating cages, semi-submerged and submerged cages, towing cages, flow through systems, race ways. Feed and nutrition management-Natural and formulated feeds, weaning to artificial feeds, feeding strategies, rations and feeding methods, manual and automatic feed dispersers, demand feeders, feed rationing, feeding protocols: Carrying capacity of aquafarms, use of biofilters, aerators; protocols in grow out systems.