

# **Dr. Panjabrao Deshmukh Krishi Vidhyapeeth,**

## **Syllabus for the post of Programme Assistant (Lab Technician) for KVK**

The details of the Online Written Test to be conducted will be as under :

- 1) The question paper will contain 200 ) Multiple Choice Questions (MCQs) of 1 Mark each having total 200 Marks
- 2) The Medium of Examination will be English except Marathi Subject.
- 3) The question paper of 200 marks will consist of sets of questions of following subjects :

<b>S.N.</b>	<b>Subject</b>	<b>Syllabus</b>	<b>Marks</b>
1	Marathi	The standard of questions of Marathi subject will be equivalent to Higher Secondary School Examination (XII standard) Marathi Subject includes Grammar, Sentences and usage of words etc. (25 Questions)	25 x1=25
2	English	The Question will be based on Spelling, Grammar, English Transformation & Sentences and use of words, Vocabulary etc. equivalent to Higher Secondary School Examination (XII standard) (25 Questions)	25 x1=25
3	General Knowledge	The subject includes day to day Events & Experiences, Religion, Indian Constitution & Politics, Science & Technology, Social and Industrial Reforms, Literature & Culture, Sports & Games, History & Geography of India Specially Maharashtra, Renowned (Great) Personalities and their Contributions, Administration and Rural Development, Indian Economy. (25 Questions)	25 x1=25
4	Aptitude Test	Questions will be asked to judge the candidate for Reasoning and promptness of the candidate in giving correct answers ( 25 Questions)	25 x1=25
5	Agriculture	100 Questions will be asked on the basis of syllabus of the four year degree programme with equal weightage to each degree. 1. B.Sc, (Agri.) - 25 Marks 2. B.Sc. (Horti.) - 25 Marks 3. B.Sc. (Forestry) - 25 Marks 4. B.Tech. (Agril. Engg.) – 25 Marks	100x1=100
		<b>Total Marks</b>	<b>200 Marks</b>

The standard for the Online written test will be at par with Graduate Level excluding Marathi & English Subjects. The duration for the examination will be of 2 Hours. Multiple Choice Questions (MCQs) will be asked in the said online exam.



# **KRISHI VIDYAN KENDRA**

***SYLLABUS FOR THE POST OF***

***PROGRAMME ASSISTANT***

***(LAB. TECH.)***

**SYLLABUS FOR THE POST OF PROGRAMME ASSISTANT  
(LAB. TECH.)**

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# 1. AGRICULTURE

Meaning and scope of Agronomy, Relationship with other sciences, Role of Agronomist National and international agricultural research institutes and SAU's in India, agricultural research stations/centres in Maharashtra. Agro-climatic zones of India and Maharashtra. Soil - Definition, classification, properties, factors affecting soil properties, soil fertility and productivity. Tillage and tilth - Definition, objectives, types of tillage, implements used, modern concepts of tillage, tilth and characteristics of ideal tilth, classification of crops Seeds and sowing - quality of seed, seed testing, seed multiplication, seed treatment, sowing methods, crop stand establishment, planting geometry and its effect on growth and yield - sole, paired and skipped row planting. Manures and fertilizers - Plant nutrients and their role in crop production, classification of manures and fertilizers and green manuring. Weed - Definition, characteristics, harmful and beneficial effects. Cropping systems - Definition, types, advantages and disadvantages, precision, farming, harvesting signs of maturity, methods of harvesting.

Agricultural meteorology, its importance in Agriculture Weather and climate, weather elements and factors affecting them. Earth's atmosphere, composition and structure of atmosphere. Solar radiation - nature, properties, depletion, factors affecting solar radiation, solar constant and energy balance. Atmospheric temperature - factors affecting temperature, importance of air temperature, horizontal and vertical distribution and variations in temperature and global warming Wind - Types, classification, importance of wind in Agriculture, forces acting to produce wind, cyclones, anticyclones and general circulation system of earth. Atmospheric humidity - saturated and actual vapour pressure, specific and relative humidity, diurnal variation of humidity. Process of condensation, formation of dew, fog, frost, mist, snow, rain and hail. Cloud - types, formation and classification. Precipitation - hydrologic cycle, types of rain - thunder and hail storms, types of monsoon, agricultural seasons. Drought - its classification, strategy to mitigate drought. Microclimate, Weather forecasting - Basics, types and importance of weather forecasting. Remote sensing and introduction to crop modelling.

Art, Science and business of crop production, Basic elements of crop production; Factors affecting crop production; History of Agricultural Development; Ancient India Agriculture in Civilization Era, Chronological Agricultural Technology development in India. Indian Agriculture, balance sheet, liabilities; Assets and Contrasting trends (DATA), Agril; growth, contrasting food chains, Diversity in physiographic, Soil groups, marine, livestock and water, Liabilities: Soil factors, weather factors, Economic ecology, dry and irrigated agriculture, Farming Systems approach, value addition, requirements in new technology; Women in Agriculture: multifaceted roles and tasks, work stress factors, Nutritional and rural life standards, role in house hold design making, drudgery reduction for farm women, women friendly agricultural technology; Empowerment of women; Group dynamics for farm women, rural women; The nucleus of Agricultural Extension and Training.

Irrigation: Definition and objectives, Water resources and irrigation development in India and Maharashtra Soil water relationships - physical properties of soil, volume mass relationship, classification of soil water, soil moisture constants, water availability, forces acting on water movement and retention. Plant water relationship - Role of water in plant, plant structure, water absorption, factors affecting absorption and transpiration, rooting characteristics, moisture extraction pattern of crop, soil water plant atmospheric continuum (SPAC) relationship. Methods of soil moisture estimation Evapotranspiration-Evaporation, transpiration, evapotranspiration, factors influencing ET. Crop water requirement - water

requirement, irrigation requirement, methods of estimation of water requirement and factors affecting water requirement. Effective rainfall - Definition, methods for estimation, factors affecting effective rainfall. Scheduling of irrigation - Approaches of irrigation scheduling, frequency and depth of irrigation, measurement of irrigation water. Methods of irrigation Surface, surge, subsurface, sprinkler, raingun, micro-irrigation (Drip and micro-sprinkler) components, merits and demerits, Fertigation - Definition and advantages. Irrigation efficiency - concepts and estimation. Water use efficiency and measures to improve it. Conjunctive use of water Irrigation water quality and its management- water quality parameters, management strategies for utilization of poor quality water. Water management of different crops - cereals, oilseeds, pulses, commercial, vegetable and fruit crops. Agricultural drainage - Definition, causes of water logging, effects of bad drainage on soil and crop, types, measures to improve bad drainage.

Origin, geographic distribution, economic importance, soil and climatic requirement, varieties, cultural practices and yield of kharif crops. Cereals : Rice, Maize, Kharif Sorghum, Pearl Millet and Minor Millets. Pulses: Pigeonpea, Mungbean, Uridbean, Horsegram, Mothbean, Cowpea. Oilseeds: Groundnut, Sesame, Soybean, Castor and Niger. Fibre Crops: Cotton, Jute. Green Manuring Crops: Sunhemp and Dhaincha. Forage Crops: Sorghum, Pearlmillet, Maize, Cowpea, Cluster Bean, Rainfed and Irrigated Grasses.

Origin, geographical distribution, economic importance, soil and-climatic requirements, varieties, cultural practices and yield of rabi crops, Cereals: Wheat, Barley, Rabi Sorghum. Pulses: Chickpea, Lentil, Peas, French Bean Oilseeds: Safflower, Sunflower, Linseed, Rapeseed and Mustard. Sugar Crops: Sugarcane and Sugarbeet. Medicinal And Aromatic Crops : Mentha, Lemon Grass, Citronelia, Palma Rosa, Isabgol And Posta Commercial Crops : Potato And Tobacco. Forage Crops : Maize, Berseem, Lucerne and Oat.

Weeds: Introduction, harmful and beneficial effects, classification, propagation and dissemination, Weed biology and ecology, crop weed association, crop weed competition and allelopathy. Concept of weed prevention, control and eradication, Methods of weed control: Physical, cultural, chemical and biological methods. Integrated weed management Herbicides: Definition, advantages and limitation of herbicide usage in India Herbicide: classification, formulations, methods of application Introduction to Adjuvants: their use in herbicides. Mode of action of herbicide: Translocation and absorption, persistence and fate of herbicides. Introduction to selectivity of herbicides, Compatibility of herbicides with other agro-chemicals. Weed management in major field and horticultural crops. Shift of weed flora in cropping systems, Aquatic, parasitic and problematic weeds and their control.

Farming systems - Definition, scope, classification and components. Integrated farming system (IFS), models for irrigated and rainfed situation. Cropping systems - Indices for evaluation of cropping systems. Organic farming - Definition, principles and components. Sustainable agriculture - Introduction, Definition, goal and current concepts, Factors affecting ecological balance and ameliorative measures. Land degradation and conservation of natural resources - low external input agriculture (LEIA) and high external input agriculture (HEIA). Irrigation problems Waste lands and their development.

Organic farming - Introduction, concept, relevance in present context, organic production requirements. Biological intensive nutrient management - organic manures, vermicomposting, green manuring, recycling of organic residues, biofertilizers Soil improvement and amendments. Integrated diseases and pest management - use of biocontrol agents, biopesticides pheromones, trap crops, bird perches Weed management. Quality considerations - certification, labeling and accreditation process, marketing, and export. Rainfed farming - meaning importance and problems, soil and climatic characteristics of rainfed areas; rainfall and its distribution and effectiveness Concept of watershed. Technique

of soil and water conservation, in situ moisture conservation, harvesting and recycling of runoff water. Management practices for rainfed crops. Drought management. Crop diversification - cropping systems Crop substitution - sequence/intercropping and their importance in rainfed farming Contingency planning for aberrant weather situations, alternate land use systems. Improved agronomic practices for raising rainfed crops.

Environmental Science-Definition, scope and importance Natural resources-Definition, classification - renewable and non-renewable. Importance and uses and overexploitation of forest, water food and energy resources Ecosystem - Definition, concept, structure and function study of producers, consumers and decomposers of an ecosystem. Food chain and food web and ecological pyramids Types of ecosystem- introduction, types, characteristic features, structures and function of forest. Grassland desert and aquatic ecosystem Biodiversity- Definition, classification, threats to biodiversity and its conservation Environmental pollution-causes, effects and control of air, water, soil, thermal, noise and marine pollution. Study of causes, effects and management of soil, nuclear and industrial wastes. Disaster management- foods, earthquakes, cyclones and land slide. Social issues and the environment, unsustainable to sustainable development. The environment protection act, the air Protection act, the water protection act, and the wild life protection act and forest conservation act.

Definition of genetics, History and role of genetics in Agriculture, relation of Genetics with other of science. Ultra structure of cell and cell organelles and their functions. Study of chromosome structure, morphology, number and types, Karyotype and ideogram, Chromosome number - somatic and gametic number,, chromosome size, chromatid, centromere, telomeres, chrdmonema, matrix. Special types of Chromosome, Lampbrush, Giant Charosome, B Chromosome, Functions of chromosome. Mitosis stages, importance. Meiosis Stages, importance, their significance and difference. Genetics and its importance, Mendels law of inheritance, monohybrid. Mendels laws of inheritance: Law of segregation: Law of independent assortment. Exceptions to the laws (Gene interaction). Multiple alleles, its characteristics and pseudoalleles. Pleiotropism, xenia, penetrance-complete and incomplete, expressivity, Atavism with examples. Multiple factor hypothesis with example-ear length in maize. Cytoplasmic inheritance-its characteristics features; Examples of Cytoplasmic inheritance, difference between chromosomal and cytoplasmic inheritance. Linkage-definition, phases, linkage map, linkage group, number of linkage groups. Types of linkage, linkage value, detection of linkage, significance of linkage. Crossing over-types, theories, mechanism, factors affecting crossing over, coincidence and interference, calculation of crossing over percentage from test cross data, cytological basis of crossing over-experiment of Stern in Drosophillas. DNA & its structure, function, types, modes of replication and repair; Components of DNA, DNAdouble helix structure, forms of DNA-A, B, C, and Z form; modes of replication-theories of DNA replication-conservative, semi-conservative and dispersive, DNA repair direct repair of DNA, Excision repair of DNA, very short patch repair, short patch repair, long patch repair, functions of DNA. RNA and its structure, function and types; components of RNA, types and functions of RNA-rRNA, tRNA, mRNA. Transcription, Translation, Genetic code and outlying of protein central dogma, process of transcription, Genetics code- codon characteristics of Genetics code, process of translation protein synthesis ribosomes, process- initiation, elongation and termination. Gene expression, promoter gene, operator gene, operon constitutive gene, operon model, components of operon- Regulator, Promoter, operator and structural gene model -induction and repression, example of Lac operon; fine cistron, recon, muton. Mutation: introduction, types of mutation, characteristics of mutation, classification of mutations, induction of mutation physical and chemical mutagenesis classification of mutagenes, detection of mutations, CIB method and Attached X-chromosome technique, significance of mutations. Chromosomal aberration Numerical Polyploidy, characteristics of polyploidy, terminology, examples,. Evolution of wheat, tobacco tritcale, brassica, cotton, significance of polyploidy.

Definition, history of plant breeding, Aims and objectives of Plant breeding, classification of plants and Botanical description, floral biology Emasculation and pollination techniques in cereals, millets, pulses and oilseeds and fibers and plantation crops etc., Reproduction sexual and asexual, Apomixis and their classification, Significance in plant breeding, Pollination-modes of pollination, genetic consequences, difference between self and cross pollinated crops. Methods of breeding- Introduction and acclimatization, Selection-Mass selection, Johannsson's pureline theory, genetic basis, Pure line selection, Hybridization-aims, objectives and types of hybridization, Methods of handling of segregating generations- Pedigree method, Bulk method, Back cross method and various modified methods. Self incompatibility and male sterility-types and their utilization in crop improvement, Heterosis, In breeding depression, theories of heterosis, Exploitation of hybrid vigour, development of inbred lines, single cross and double cross hybrid, Population improvement programme, recurrent selection, Synthetics and composites, Methods of breeding for vegetatively propagated crops-clonal selection and hybridization, Mutation breeding, ploidy breeding, wide hybridization and significance in crop improvement.

Introduction, Definition, importance in agriculture. Growth and development, Definition. Determinate and indeterminate growth, measurement of growth, growth analysis, growth characteristics. Definition and mathematical formulae. Crop water relations : physiological importance of water to plants, water potential and its components, measurement of water status in plants. Transpiration: significance, transpiration in relation to crop productivity, water use efficiency (WUE) in C3, C4 and CAM plants, factor affecting WUE. Photosynthesis: energy synthesis, significance and C3, C4 and CAM pathway, relationship of photosynthesis and crop productivity. Photorespiration : factors affecting photosynthesis and productivity, photosynthetic efficiency, dry matter partitioning, Harvest index of crops. Respiration : respiration and its significance, brief account of growth respiration and maintenance respiration. Translocation: translocation of assimilates, phloem loading, apoplastic and symplastic transport of assimilates, source-sink concept. Nutriophsiology: Definition mengel's classification of plant nutrients-functions of plant nutrients-deficiency and toxicity symptoms of plant nutrients foliar nutrition-hydroponics. Photoperiodism and vernalisation: introduction of photoperiodism and vernalisation in relation to crop productivity-photoperiodism. Plant classification on basis of photoreponses-forigine concept in flowering of phytochrome in flowering process vernalization methods. Plant growth regulators: occurrence -biosynthesis -mode of action of auxins, gibberellins, cytokinins, commercial application of plant growth regulators in agriculture. Senescence and abscission Steilll Slioition classification physiological and biochemical' harvest physic climacteric . Senescence and abscission. Post chic changes, climacteric and non- Bning.

Definition, Breeding objectives and important concepts of breeding, self pollinated , cross pollinated and vegetatively propagated crops. Role of National and International Crop improvement Institutes and organizations. Study in respect of origin, Botanical names, family, Genus, Chromosome numbers, Distribution of species, Wild species and forms. Cereals (Sorghum, Bajra, Maize, Rice, Wheat, Ragi), Pulses (Tur, Gram, Mung, Udid, Soybean), Oilseeds (Ground nut, Soybean, Sunflower, Safflower, Sesame, Linseed), Fiber ( Cotton, Kenaf, Roselle, jute), Fruit (Mango, Aonla, Guava, Custard apple, Banana, Papaya), Vegetables (Tomato, Brinjal, Bhendi, Chilli, Cucumber), Flowers (Chrysanthemum, Rose, Galardia, Gerbera, Marigold), Major breeding procedures for development of hybrids/ varieties of various crops: Introduction, Merits and demerits, Procedure flowchart with modifications in short, Achievements. Self pollinated crops: Mass selection, Pureline selection, Pedigree selection, Bulk method, Backcross method, Progeny and Single Seed Descent method. Cross pollinated crops: Population Improvement, (Mass, Progeny selection and Recurrent selection) P Other methods: Clonal selection, Mutation, polyploidy, Distant hybridization plant genetic resources, their conservation and utilization in crop improvement: Germplasm Definition, landrace, Variety, cultivar, wild type, Gene pool concept, Genetic erosion, germplasm collection and conservation types and methods in short. Ideotype concept

in crop improvement: Concept, Types of ideotype, Characteristics of a ideotype, Major steps in ideotype breeding, Ideotype of rice, wheat, sorghum, cotton Merits and limitation of ideotype breeding. Breeding for stress resistance: Introduction, Types of stresses. Biotic stresses: History, Types of resistance, Variability in pathogens and pests, , mechanism of pathogen resistance, achievements, Abiotic stresses: Types, Drought and mineral toxicity resistance, achievements. Genetic basis of adaptability for unfavourable environments, salinity, drought, high and low temperature Biometrics: Definition of biometrics, assessment of variability Range, Arithmetic mean, Variance, S.D., S.E., C.V. Multiple factor hypothesis: Explanation of Yule hypothesis given by Nilsson-Ehle(1908),Components of genetic variance. Heterosis and Inbreeding depression. Combining ability analysis. Genotype x Environment interaction and influence on yield performance. Stability analysis. IPR and its related issues: History, Need of IPR, Full forms and head quarters of WTO, GATT, UPOV, TRIPs, FAO, WIPO etc , Acts: Need & Objectives: i. Registration and protection Act 1999 (Geographical Indications of goods) ii. PPV & FRs Act. 2001 iii. Biological diversity Act 2002. Programme, Grow out test plot, Various research stations, other institutions. Hybrids and improved varieties of field crops, forage crops, and horticulture crops. Achievements of stress breeding.

Concept of plant biotechnology, History of plant tissue culture and plant genetic engineering, Scope and importance of plant biotechnology in crop improvement, Totipotency and morphogenesis, Nutritional requirements of plant tissue culture, Techniques of in vitro culture, Test tube fertilization. Endosperm culture, Factors affecting on test tube fertilization and endosperm culture Applications and achievements and types of somaclonal variation, Somatic embryogenesis and synthetic seed production, Protoplast isolation and culture, Protoplast manipulation and fusion, Somatic hybrids and cybrids and their applications in crop improvement Concept of genetic engineering, Restriction enzymes and their uses, Concept of vectors and their types for gene transfer, Gene cloning, Direct method of gene transfer, Indirect method of gene transfer, Transgenic plant and their applications, Different type of blotting techniques, DNA finger printing, DNA based markers: RFLP, RAPD, SSR and DNA probes, Mapping of QTL and future prospects, MAS and its application in crop improvements. Plant tissue culture laboratory specifications and organization of equipments and their use, Different Sterilization techniques and aseptic manipulations, Preparation of tissue culture media and their composition. Preparation of explants (Banana I Sugarcane) establishment and maintenance of callus cultures from different explants, sub culture of callus, Regulation of morphogenesis from different explants, roots, stem, leaf, bud, Micropropagation with shoot apex culture in different plants (Banana / Sugarcane), Meristem culture, Anther and pollen culture, Embryo and endosperm culture, Somatic embryogenesis and artificial seed production, Isolation and culturing of protoplast, Isolation of genomic DNA, Gene transfer method: direct method, Gene transfer method: indirect method, Gel electrophoresis technique, Confirmation of genetic transformation.

Introduction to Seed Production, Importance of Seed Production Seed Policy, Seed demand forecasting and planning certified, foundation and breeder seed production, Deterioration of crop varieties, Seed quality, Different classes of seed, production of nucleus and breeders's seed, Maintenance and multiplication of pre-release and newly released varieties in self, and cross pollinated crops, Seed production, foundation and certified seed production (varieties, hybrids, synthetics and composites) in maize, rice, sorghum, bajra, cotton, sunflower, castor, tomato, brinjal, chilli, bhendi, onion, bottle gourd and ridge gourd. Seed certification, phases of certification, procedure for seed certification. Field inspection and field counts etc. Seed Act and Seed Act enforcement, Central Seed Committee, Central Seed Certification Board, State Seed Certification Agency. Central and State Seed Testing Laboratories, Duties and Powers of seed inspectors, offences and penalties. Seed control order, seed control order 1983, seed Act 2000 and other issues related to seed quality regulation. Intellectual property rights, patenting, WTO, plant breeders rights. Varietal identification through grow-out test and electrophoresis, Establishing a seed testing

laboratory. Seed testing procedures for quality assessment Seed treatment and Seed Processing, Seed processing plant, Seed packing and seed storage, Seed marketing.

Soil: Pedological and edaphological concepts, Origin of the earth, Earth crust; Composition : Rocks and minerals, Weathering, Soil formation factor and processes .Components of soils; Soil profile, Soil physical properties, So texture, Textural classes, Particle size analysis, Soil structure classification, Soil aggregates, significance, Soil consistency, Soil crushing, Bulk density particle density of soils and porosity, their significance and manipulation, Soil compaction, Soil colour, Elementary knowledge of soil classification and soils India; Soil water, Retention and potentials, soil Moisture constants, Movement of soil water, Infiltration, permeability, Drainage, Methods of determination of soil moisture Thermal properties of soils, Soil temperature, Soil air, Gaseous exchange, Influence of soil temperature and air on plant growth; Soil colloids, properties, nature, types and significance; layer silicate clays, their genesis and sources of charges, adsorption of ions, Ion exchange, Influence of soil temperature and air on plant growth; Soil colloids, properties, nature, types and significance; layer silicate clays, their genesis and sources of charges, adsorption of ions, Ion exchange, CEC and AEC, Factors influencing ion exchange and its Significance. Soil organic matter; composition, Decomposability Humus, Fractionation of organic matter, Carbon cycle, C:N ratio. Soil Biology, Biomass Soil Organism and their beneficial and harmful roles .Soil Survey, Soil Classification Soils in India and Maharashtra, Soil erosion, types .universal soil equation, control measures.

Soil as a source of plant nutrients, Essential and beneficial elements, criteria of essentially, forms of nutrients in soil, mechanisms of nutrients transport to plants, factors affecting nutrient availability to plants, Measures to overcome deficiencies and toxicities. Problem soils - acid, salt affected and calcareous soils, characteristics, nutrient availabilities. Reclamation - mechanical, chemical and biological methods. Fertilizer and insecticides and their effect on soil water and air. Irrigations water - quality of irrigations water ; and its appraisal. Indian standards for water quality. Use of saline water for agriculture. Soil fertility - Different approaches for soil fertility evaluation. Methods, Soil testing - chemical methods. Critical levels of different nutrients in soil. Plant analysis -DRIS methods, critical levels in plants. Rapid tissue tests. Indicator plants. Biological methods of soil fertility evaluation. Soil test based fertilizer recommendations to crops. Factors influencing nutrients use efficiency (NUE) in respect of N,P,K,S, Fe and Zn fertilizers. Source, method and scheduling of nutrients for different soils and crops grown under rainfed and irrigated conditions.

Introduction - Raw materials- Manures - Bulky and concentrated- FYM, Composts, - Different methods, Mechanical compost plants, Vermicompost, Green Manures, Oil cakes, Sewage and sludge-Biogas plant slurry, Plant and animal refuges. Fertilizers-classification, Manufacturing processes and properties of major nitrogen (ammonium sulphate, urea, calcium ammonium nitrate, ammonium nitrate, ammonium sulphate nitrate) phosphatic (single super phosphate, enriched super phosphate, enriched super phosphate, diammonium phosphate, ammonium poly phosphate). Potassic and complex fertilizers their fate and reactions in the soil, Secondary and micronutrients fertilizers, Amendments. Fertilizer Control Order, Fertilizer Storage; Biofertilizers and their advantages, Organic chemistry as prelude to agro-chemicals, Diverse types of agrochemicals, botanical insecticides (Neem), Pyrethrum, Synthetic pyrethroids. Synthetic organic insecticides, Major classes, Properties and uses of Some important insecticides under each class. Herbicides - Major classes - Properties and uses of 2, 4-D, atrazine, glyphosate, butachlor benthocarb; Fungicides - Major classes - Properties and uses of carbendazim, carboxin, captan, tridemorph and cropper oxychloride - Insecticides Act. Plant growth regulators.

History, scope and importance of biochemistry, structure and organelles of plant cell and their role., Biomolecules - Definition, types, structure, properties and their applications, Carbohydrates - Definition, classification, structure, properties and functions-Nucleotides and

nucleic acid - Definition, components and their structure. Amino acids, peptides and proteins - Definition, classification, structure and properties, Plant proteins and their quality, Essential, amino acids classification, structure, properties and their significance, Fatty acids- Definition, classification, structure and essential fatty acids, Biochemical energetic - Definition, free energy concept of chemical reaction, components of electron transport chain, energy rich compound. Enzymes- Definition, classification, factors affecting enzyme activity Enzyme immobilization (inactivation) and Its Industrial application in agro-industries, Vitamins and their coenzyme derivatives. Metabolic energy and its generation metabolism - glycolysis, citric acid cycle, pentose phosphate pathways, phosphorylation - Definition, cyclic non cyclic and substrate level phosphorylation, oxidative phosphorylation. Fatty acid oxidation-Beta-oxidation. Biosynthesis- carbohydrates, lipids protein, nucleic acids, Metabolic regulation-integration of carbohydrate, protein metabolism. Secondary metabolites - glycosides, tannins, Lignin's, and mucilage's -Definition, classification, properties and their physiological rates and application in food and pharmaceutical industries. Secondary metabolites-alkaloids, terpenoids - Definition, classification, properties and their physiological roles and application in food and pharmaceutical industries.

Definition of Horticulture, fruit science : scope, importance, area and production of fruit crops in Maharashtra and India. Export import scenario of fruit crops in India. Classification of fruit crops on Horticultural basis. Climate and soil. Selection of site, fencing, wind break and shelter belts. Planning, layout and planting systems. High density, planting and meadow orcharding. Methods of propagation in fruit crops. Use of rootstocks in fruit crops. Training and pruning of fruit crops. Use of bio-regulators in propagation and fruit production. Nutritional management of fruit crops. Irrigation management of fruit crops. Special horticultural practices : Bahar treatments, notching, ringing, bending, girdling, etc. Origin, B.N., family, area and production, soil and climate, commercial varieties. Propagation and planting, after cares (irrigation, weed management, nutritional requirement, use of PGR, physiological disorders, plant protection measures and special horticultural practices), Harvesting and yield of horticultural fruit crops : Mango, Banana, Citrus (Sweet orange, Mandarin, Acid lime), Guava and Sapota, Grape, Pineapple, Papaya, Pomegranate, Anonaceous fruits, Ber and fig, Aonla and Jackfruit, Apple. Brief cultivation in tabular form on following crops Strawberry, Cherry, Pear, Plum, Peach, Almond, Karonda, Phalsa and Bael, Recommendations of Joint Agresco (last five years).

Importance and scope of olericulture, Vegetable garden and vegetable classification, Origin, area, production, varieties, package of practices for vegetables: Fruit vegetables : Tomato, Brinjal, Chillies, Okra, Cucurbitaceous vegetables - Cucumber, Ridge gourd, Bottle gourd, Bitter gourd and Melons, Cole crops - Cabbage, Cauliflower and Knolkhol, Bulb crops - Onion and Garlic. Beans and Peas - French beans, Cluster beans, Dolichos beans, Peas and Cowpea. Tuber crops - Potato, Sweet Potato, Root crops - Carrot, Radish. Leafy vegetables \_Amaranthus, Palak, Methi. Importance of ornamental horticulture, Types and styles of ornamental gardens, Study of trees, shrubs, climbers, palms, indoor plants and seasonal flowers (Common name, botanical name, family, propagation method and uses), Package of practices for Roses, Jasmine, Chrysanthemum Gladiolus, Marigold and Tuberose.

Importance and cultivation technology of Spices - Ginger, Turmeric, Pepper, Cardamom, Nutmeg, Pimenta, Cinnamon Coriander, Cumin, Fenugreek, Aromatic. Crops - Lemon Grass, Citronella, Palmarose, Vetiver, Geranium, Dawana; Plantation crops - Coconut, Arecanut, Betelvine, Cashew, Cocoa, Coffee, Tea, Oilpalm; Medicinal plants - Dioscoria, Rauwolfia, Opium, Ocimum, Perwinkle, Aloe, Guggul, Belladonna, Nux vomica, Solanum khasianum. Aonla, Senna, Plantago, Stevia, Cals and Acmrs, Hida. Behada, Arjun, Mahua, Adulsa, Safed. Musali, Gulwel, and Satap.

Importance of post harvest technology in horticultural crops. Maturity, Maturity indices, harvesting and post harvest handling of fruits and vegetables. Ripening, changes

during ripening and factors affecting ripening of fruits and vegetables. Pre-harvest factors affecting quality on post-harvest shelf life of fruits and vegetables. Factors responsible for deterioration of harvested fruits and vegetables. Chemicals used for hastening and delaying ripening of fruits and vegetables. Methods of storage, pre-cooling, pre-storage treatments, low temperature storage, controlled atmospheric storage, hypo-baric storage, irradiation and low cost storage structures. Various methods of packing, packaging and cushioning materials and transport. Importance and scope of fruits and vegetables preservation in India. Unit layout - Selection of site and precaution for hygienic conditions of the unit. Principles and methods of preservation by heat, low temperature, chemicals, fermentation, canning, bottling, ultra-violet and ionizing radiation. Spoilage of canned products, biochemical, enzymatic and microbial spoilage.

Economics: Meaning, Definition, Subject matter Division of Economics (production, Exchange, Distribution, Market supply), importance of Economics. Agricultural Economics; Meaning, Definition Basic Concepts: Goods, Service, Utility, Value, Price, Wealth, Welfare. Wants: Meaning, Characteristics, Classifications of Wants, Importance. Theory of consumption: Law of Diminishing Marginal utility Meaning, Definition, Assumption, Limitations, Importance. Consumer's surplus: Meaning, Definition, Importance. Demand: Meaning, Definition, Kinds of Demand, Demand schedule, Demand Curve, Law of Demand, Extension and Contraction Vs Increase and Decrease in Demand. Elasticity of Demand: Types of Elasticity of Demand, Degrees of price elasticity of Demand, Methods of Measuring Elasticity, Factors influencing elasticity of Demand, Importance of Elasticity of Demand. Supply: Meaning, Definition, Kinds of Supply, Supply schedule, Supply Curve, Law of supply, Extension and Contraction Vs Increase and Decrease in Supply, Elasticity of Supply: Types of Elasticity of Supply, Degrees of price elasticity of Supply, Methods of Measuring Elasticity Factors influencing elasticity of Supply Importance of Elasticity of Supply. Welfare Economics: Meaning, Pareto's optimality. National Income: Concepts, Measurement. Public Finance: Meaning, Principles. Public Resource: Meaning, Service Tax, classification of Taxes, Canons of Taxation. Public expenditure: Meaning, Principles. Inflation: Meaning, Definition, Kinds of inflation.

Definition of Statistics, its use, limitations; Frequency Distribution and Frequency Curves, Measures of Central Tendency, Characteristics of Ideal Average. Arithmetic Mean, Median, Mode and their Merits and Demerits; Measures of Dispersion. Standard Deviation, Variance and Coefficient of Variation; Probability. Definition and concept of probability. Normal Distribution and its properties; Introduction to Sampling. Random Sampling; the concept of Standard Error, Tests of Significance Types of Errors, Types of Hypothesis, Level of Significance and Degrees of Freedom, Steps involved in testing of hypothesis, Large Sample Test SND test for Means, Single Sample and Two Samples and Paired t-test F-test; Chi-square Test in 2 X 2 Contingency Table, Yates' Correction for continuity, Correlation; Types of Correlation, Scatter Diagram, Computation of Correlation Coefficient r and its testing, Linear Regression: of Y on X and on Y. Inter-relation between V and regression coefficients. Experimental Designs; Basic Principles, Completely Randomized Design (CRD), Layout and analysis with equal and unequal number of observations, Randomized Block Design (RBD), Layout and analysis, Latin Square Design (LSD), Layout and analysis.

Production Economics: Meaning, Definition Nature and Scope of Agricultural Production Economics. Basic concepts and terms. Concepts Production. Production Functions: Meaning, Definition, Types. Laws of returns: Increasing. Constant and decreasing. Factor Product Relations. Determination , optimum input and output Factor relations ,p. Product relationship. Types of enterprise relationships. Returns to scale: Meaning. Definition, Importance. Farm Management: Economic principles applied to Organizations of farm business. Types and systems of farming, Farm planning and budgeting, Risk and uncertainty, Farm budgeting. Linear programming: Assumption, Advantages and Limitations of Linear programming.

Agricultural finance: Nature and scope. Time value of money, Compounding and Discounting. Agricultural credit: meaning, Definition, need, classification, Credit analysis: 3R's 5C's and 7P's of credit, repayment plans. History of financing agriculture in India. Commercial banks, nationalization of commercial banks. Land bank scheme, regional rural banks, scale of finance. Higher financing agencies, RBI, NABARD, AFC, Asian Development Bank, World Bank, Insurance and Credit Guarantee Corporation of India. Assessment of crop losses, determination of compensation. Crop insurance, advantages and limitations in application. Estimation of crop yields. Agricultural cooperation; philosophy and principles. History of Indian cooperative Movement, pre-independence and post independence periods, cooperation in different plan periods, cooperative credit structure; PACS, FSCS. Reorganization of cooperative credit structure in Maharashtra and Single Window System, Successful cooperative systems in Gujarat, Maharashtra, etc.

Agricultural Marketing: Concepts and Definition, Scope and subject matter, Market and Marketing: Meaning, Definitions, Components of a market, classification. Market structure, Conduct, performance. Market functionaries or agencies, Producer's surplus: Meaning, Types of producers surplus, marketable surplus. Marketed surplus, importance, Factors affecting Marketable surplus. Marketing channels: Meaning, Definition, Channels for different products. Market integration: Meaning, Definition, Types of Market Integration. Marketing efficiency: Meaning, Definition, Marketing costs, Margins and price spread, factors affecting the cost of marketing costs. Theories of International Trade: Domestic Trade, Free trade, International Trade, GATT, WTO, Implications of AOA. Market access, Domestic support, Export subsidies, EXIM-Policy and Ministerial conferences. Cooperative Marketing. State Trading. Mre Housing CoipoxatitMi Central and State. Objectives, Functions, Advantages. Food Corporation of India: Objectives and Functions. Quality Control, Agricultural Products, Characteristics of agricultural produce and commodity exchange, AGMARK. Price: Meaning, Need for Agricultural Price Policy. Risk in Marketing: Meaning and importance, Types of Risk in Marketing. Speculations and Hedging, Futures trading, Contract farming.

Agribusiness: Meaning, Definition, structure of Agribusiness, (Input, Farm, Product Sectors). Importance of Agribusiness in the Indian Economy, Agricultural Policy. Agribusiness Management, Distinctive features, Importance of Good Management, Definitions of Management. Management Functions. Planning: Meaning, Definition, Types of Plans (Purpose or Mission, Goals or Objectives, Strategies, Policies, Procedures, rules, programmes, Budget) characteristics of sound plan. Steps in planning: Organization, Staffing, Directing, Motivation, Ordering, Leading, Supervision, Communication, control. Capital and Financial Management of Agribusiness: Importance of Financial Statements, Balance sheet, Profit and Loss Statement, Analysis of Financial statements. Agro-based Industries: Importance and Need, classification of Industries, Types of Agro based Industries, Institutional arrangement, Procedure to set up agro- based industries, Constraints in establishing agro-based industries. Marketing Management: Meaning Definitions, Marketing Mix, 4Ps of Marketing. Mix, market segmentation, Methods of Market, Product life cycle. Pricing policy: Meaning, pricing method. Prices at various stages of Marketing. Project: definitions, project cycle, identification, Formulation, Appraisal, Implementation, monitoring and evaluation, Appraisal and Evaluation techniques, NPV, BCR, IRR, N/K ratio, sensitivity analysis, characteristics of agricultural projects, preparation of project reports for various activities in agriculture and allied sectors: Dairying, poultry, fisheries, agro- industries etc.

History of Entomology in India. Factors for insects' abundance, classification of phylum Arthropoda upto classes. Relationship of class Insecta with other classes of Arthropoda. Morphology : Structure and functions of insect cuticle and moulting. Body segmentation, structure of head, thorax and abdomen, Structure and modification of insect antennae, mouth parts and legs. Wing venation, modifications and wing coupling apparatus.

Structure of male and female genitalia, Sensory organs. Metamorphosis and diapause in insects. Types of larvae and pupae. Structure and functions of digestive, circulatory, excretory, respiratory, nervous, secretory (Endocrine) and reproductive system in insects. Types of reproduction in insects. Systematics: Taxonomy - importance, history and development and binomial nomenclature. Definitions of Biotype, Sub-species. Species, Genus, Family and Order. Classification of class Insecta upto Orders. Orthoptera (Acrididae), Dictyoptera, Mantidae, Odonata, Isoptera (Termitidae), Thysanoptera (Thripidae), Hemiptera (Pentatomidae, Coreidae, Pyrrhocoridae, Lygaeidae, Cicadellidae, Delphacidae, Aphididae, Aleurodidae, Coccidae, Pseudococcidae), Neuroptera (Chrysopidae), Lepidoptera (Noctuidae, Sphingidae, Pyralidae, Gelechiidae, Arctiidae), Coleoptera (Coccinellidae, Chrysomelidae, Cerambycidae, Curculionidae, Bruchidae, Scarabaeidae), Hymenoptera (Tenthredinidae, Apidae, Trichogrammatidae, Ichneumonidae, Braconidae), Diptera (Cecidomyiidae, Trypetidae, Tachinidae, Agromyzidae).

Introduction, Environment and its components. Effect of abiotic factors temperature, moisture, humidity, rainfall, light, atmospheric pressure and air currents. Effect of biotic factors - food competition, natural and environmental resistance. Concepts of Balance of life in nature, biotic potential and environmental resistance and causes for outbreak of pests in agro-ecosystem. Pest surveillance and pest forecasting. Categories pests IPM, Introduction, importance, concepts, principles and tools of IPM-Host plant resistance. Cultural, Mechanical, Physical, Legislative, Biological (parasites, predators & insect pathogens such as bacteria, fungi and viruses). Methods of control. Chemical control, Importance, advantages and disadvantages, classification of insecticides, toxicity of insecticides and formulations of insecticides. Botanical insecticides, Organochlorines, Cyclodienes Organophosphates, Carbamates, Synthetic pyrethroids, Neo nicotinoides, Novel insecticides, Chitin synthesis inhibitors, Phenyl pyrazoles, Avermectins, Macrocyclic lactones, Oxadiazines, Thiourea derivatives, pyridine azomethines, pyrroles, etc. Nematicides, Rodenticides, Acaricides and fumigants. Recent methods of pest control, repellents, antifeedants, hormones, attractants, gamma radiation and genetic control. Insecticides Act, 1968 - Important provisions. Application techniques of spray fluids. Phytotoxicity of insecticides. Symptoms of poisoning, first aid and antidotes. Beneficial insects. Parasites and predators used in pest control and their mass multiplication techniques. Important groups of microorganisms, bacteria, viruses and fungi used in pest control and their mass multiplication techniques. Important species of pollinators, weed killers and scavengers, their importance. Non insect pests - mites, nematodes, rodents and birds. Vermiculture.

Stored grain pests: Coleopteran and Lepidopteran pests, their biology and damage, preventive and curative methods. Distribution, biology, nature and symptoms of damage, and management strategies of insect and non insect pests of rice, sorghum, maize, ragi (*Eteucre coracarta*), wheat, sugarcane, cotton, mesta, sunhemp, pulses, groundnut, castor, ginger, safflower, mustard, brinjal, bhendi, tomato, cruciferous and cucurbitaceous vegetables, potato, sweet potato, colacasia, moringa, amaranthus, chillies, mango, citrus grapevine, cashew, banana, pomegranate, guava, sapota, ber, apple, coconut tobacco, coffee, tea, turmeric, betelvine, onion, coriander, garlic, curry leaf, pepper, ginger and ornamental plants.

Introduction. History of Phytonematology, Economic importance, General Characteristics of Plant Parasitic Nematodes. Nematode - general morphology and biology. Classification of nematodes up to family level with emphasis on groups containing economically important genera, classification of nematodes by habitat, identification of economically important plant parasitic nematode upto generic level with the help of keys and descriptions. Symptoms caused by nematodes with examples. Interaction between plant parasitic nematodes and disease causing fungi, bacteria and viruses. Different methods of nematode management. Cultural methods (crop rotation, fallowing, soil amendments, other land management techniques). Physical methods (soil solarization, hot water treatment).

Biological methods. Chemical methods (Fumigants and non fumigants) Resistant varieties. IDM.

Introduction, History of Plant Pathology: History and development of Plant Pathology in ancient, dark, premodern, modern and present eras, Contribution made by different scientists, Definitions and objectives of Plant Pathology: Concepts of disease, Disease triangle, Important plant pathogenic organisms: Different groups like fungi, bacteria, fastidious vesicular bacteria and phytoplasma with examples of diseases caused by them, Morphology and reproduction: of spiroplasmas, viruses, viroids, algae, protozoa and phanerogamic parasites with examples of diseases caused by them, Prokaryotes - classification of prokaryotes according to Bergey's manual of Systematic bacteriology, General characters of fungi: mycelium (septate and non-septate), nutrition of fungi – (saprophytes, parasites and symbiosis), Definition of fungus, somatic structures, types of fungal thalli, fungus tissues, modification of thallus, reproduction in fungi (asexual and sexual) - spores (asexual and sexual), spore fruits (asexual and sexual), Asexual reproduction: fission, budding, and fragmentation; Sexual reproduction: plasmogamy, karyogamy and meiosis, Method of reproduction: planogametic copulation, gametangial contact, gametangial copulation, spermatization, dikaryotization; Nomenclature: binomial system of nomenclature, rules of nomenclature; classification of fungi -upto genus

History of Microbiology: Spontaneous generation theory, Role of microbes in fermentation, Germ theory of disease, Prokaryotic and eucaryotic microorganisms. Morphology, cytology and other characters of bacteria, fungi, algae, actinomycetes and mycoplasma. Bacteriophages, structure and properties of bacterial viruses : Lytic and Lysogenic cycles; viroids, prions. Metabolism in bacteria: ATP generation, chemoautotrophy, photoautotrophy, respiration, and fermentation. Bacterial genetics: Gene expression, Genetic recombination: transformation, conjugation and transduction, genetic of bacteria by Pour plate method and Spread plate method, 'eaching Schedule: Theory: engineering, plasmids, episomes, genetically modified organisms. Protection against infections. Plant - Microbe interactions. Applied areas of Microbiology. Soil Microbiology: Microbial groups in soil, microbial transformations of carbon, nitrogen, phosphorus and sulphur, Biological nitrogen fixation. Microflora of rhizosphere and phyllosphere microflora, microbes in composting. Microbiology of Water: potable, irrigation, sewage water and water purification systems. Microbiology of food: microbial spoilage of food and principles of food preservation. Beneficial microorganisms in Agriculture: Biofertilizer (bacterial cyanobacterial and fungal). Methods of application and quality norms of biofertilizers. Microbial insecticides. Microbial agents for control of plant diseases. Biodegradation, Biogas production.

Terms and concepts, survival and dispersal of plant pathogens: Survival - mode of perpetuation of pathogen, facultativism by dormant mycelium and sclerotia; perpetuation on alternate and collateral hosts; heteroecism, autocism, polymorphism, physiological specialization, Dispersal: continuous dissemination - autonomous dissemination, Role of air, wind, water, animals, birds, insects, nematodes and mites in dissemination of plant pathogens, Discontinuous dissemination - man, seed, soil and agricultural operations, Phenomenon of infection: pre-penetration, penetration and post penetration, Mechanism of infection and avenues of penetration, direct and indirect penetration, Pathogenesis: role of enzymes, toxins, growth regulators and polysaccharides, Defense mechanisms in plant: structural and biochemical (pre and post infection), Plant disease epidemiology and disease forecasting: remote sensing, Epidemiology - Definition, simple interest and compound interest diseases, essential conditions for epiphytotic, decline of epidemics, Plant disease forecasting: methods of disease forecasting, survey and surveillance, forecasting models, satellite imaginary forecasting; General principles of plant disease management: importance, principles - avoidance, exclusion, eradication, protection and resistance remote sensing laboratory, Soil solarization, Handling of plant protection equipments.

Economic importance, symptoms, cause, epidemiology and disease cycle and integrated management of diseases of rice, sorghum, bajra, maize, wheat, sugarcane, ragi, finger millet, turmeric, ginger tobacco, groundnut, sesamum, sunflower, safflower, linseed, castor, cotton, red gram, Bengal gram, black gram, green gram, soybean.

Economic importance, symptoms cause disease cycle and integrated management of diseases of citrus, mango, banana, grapevine, pomegranate, papaya, guava, sapota, custard, apple, ber, fig, strawberry cashes aonla, jamun. cocum, arecant, coconut, apple, chilli, brinjal, lady finger, potato crucifers, cucurbits, tomato, beans, onion, garlic, leafy vegetables, betelvine, mulberry, coffee, tea, oil palm, rose, chrysanthemum jasmine, aster marigold, gladiolus, carnation, tuberose and gerbera. Study of symptoms, etiology host-parasite relationship and specific control measures of diseases of citrus, mango, banana, grapevine, pomegranate, papaya, guava, sapota, custard apple, bee fig, strawberry cashew aonla, jamun, cocum, arecanit, coconut, apple, chili, brinjal, ladyfinger, potato, crucifers, cucurbits, tomato, beans, onion, garlic, leafy vegetables, betelvine, mulberry, coffee, tea, oil palm, rose, chrysanthemum and jasmine, aster marigold, gladiolus, carnation, tuberose, gerbera. Field visits at appropriate time during the semester. Survey and collection of disease samples of above crops and their preservation.

Surveying : survey equipment, chain survey, cross staff survey, calculations of area of regular and irregular fields. Plane table survey, Levelling- levelling equipment, terminology, methods of calculation of reduced levels, types of levelling, contouring. Water lifting devices-pumps (for open and tube well), discharge, head and power calculations, Irrigation water measurement through weirs, flumes and orifices. Soil and Water conservation - soil erosion, types of engineering control measures, run off estimation, watershed development.

Introduction to Computers, Anatomy of Computers, Input and Output Devices, Units of Memory, Hardware, Software and classification of Computers., booting of computer, warm and cold booting, Computer Viruses, Worms and Vaccines, Operating System - WINDOWS. Disk Operating System, Some fundamental DOS Commands, FORMAT, DIR, COPY, PATH, LABEL, VOL, MD, CD, DEL, TREE and DEITREE, Rules for naming files in DOS and "types of files. WINDOWS : GUI, desktop and its elements, V\forking with files and folders using WINDOWS Explorer; setting time and date. Anatomy of a WINDOW, Title Bar, Minimize, Maximize and Close Buttons, Scroll Bars, Menus and Tool Bars. Features of word-processing packages. Creating, Editing, Formatting and Saving a document; Electronic Spreadsheets, concept, Creating, Editing and Saving a spreadsheet. Concept of ceil range and cell reference. Use of in-built Statistical functions : SUM , Average, LN , LOG, SORT, MEAN , MEDIAN GEOMEAN, ASIN ,STDEV, CORREL. Use of data analysis tools, correlation and regression, t-test for two samples and ANOVA with one and two way classification (RBD & CRD). Creating Graphs, Features of slide presentation package. Concept of Database (RDBMS), creating updating database. Internet: World Wide Web (WWW), Concepts, Web Browsing and Electronic Mail.

Farm power in India : Sources, I.C. engines, working principles, two stroke and four stroke engines. I.C. engine terminology, different systems of I.C. engine. Tractors. Types, Selection of tractor and cost of tractor power tillage implements. Primary and secondary tillage implements, Implements for intercultural operations seed drill, paddy trans-planters, plant protection equipment and harvesting equipment: Equipment for land development and soil conservation.

Green house technology, Introduction, Types of Green Houses, Plant response to Green house environment, Planning and design of greenhouses, Design criteria of greenhouse for cooling and heating purposes. Materials of construction for green houses, Irrigation systems used in greenhouses, Choice of crops for cultivation under greenhouses, Growing

media, soil culture, type of soil required, drainage, flooding and leaching soil pasteurization in peat moss and mixtures, rock wool and other inert media. Drying, grain drying, types of drying, types of dryers, Storage, grain storage, types of storage structures, Cleaning machinery, Grading, methods of grading, equipment for grading of fruits and vegetables, Size reduction, equipment's for size reduction, Seed processing cleaning and grading, Separators, Storage structures, Quality standards FAQ, ASTA, FPO, FDA.

Sociology- Meaning, Definition. Rural Sociology- Meaning. Definition, scope, importance of rural sociology agricultural extension and interrelationship between Rural sociology & Agricultural extension. Indian Rural Society- Important characteristics, differences and relationship between Rural and Urban societies. Social Groups- Meaning, Definition, classification, factors considered in formation and organization of groups, motivation in group formation and role | of social groups in Agricultural Extension. Social Stratification - Meaning, Definition, functions, basis for stratification, forms of social stratification characteristics and differences between class & caste system. Cultural concepts- Culture, Customs, Folkways, Mores, Taboos, Rituals and Traditions- Meaning, Definition and their role In Agricultural Extension. Social Values and Attitudes- Meaning, Definition, types and role of Social Values and Attitudes in Agricultural Extension. Social Institution: Meaning, Definition, major institutions in rural society: Marriage, family and religion, functions and their role in Agricultural Extension Social Organizations- Meaning, Definition, types of organizations and role of social organizations in Agricultural Extension. Social Control- Meaning, Definition, need of social control and means of social control Social Change- Meaning, Definition, nature of social change, dimensions of social change and factors of social change. Leader- Meaning, Definition, types and their role in Agricultural Extension. Psychology and Educational Psychology - Meaning, Definition, scope, any importance of Educational Psychology in Agricultural Extension.-' intelligence - Meaning, Definition, types, factors affecting intelligence. Personality- Meaning, Definition, types, factors influencing personality. Teaching - Learning Process- Meaning and Definition of Teaching, Learning Learning Experience and Learning Situation, Elements of Learning Situation and its Characteristics. Principles of Learning and their implication for Teaching. Perception and Motivation.

Education -Meaning, Definition, Types- Formal, Informal and Non-formal education and their characteristics. Extension Education- Meaning, Definition, concepts, objectives and principles Agricultural Extension- Meaning and Definition. Rural Development- Meaning, Definition, concepts, objectives, importance and problems in Rural Development. Developmental programmes of Pre-independence era- Sriniketan, Marthandam. Gurgaon Experiment and Gandhian Constructive programme Development programmes of Post Independence era- Firka Development, Etawah-Pilot Project and Nilokheri Experiment. Community Development Programme - Meaning, Definition, concepts, philosophy, principles, objectives, differences between Community Development and Extension Education. National Extension Service. Panchayati Raj system - Meaning of Democratic Decentralization and Panchayati Raj. Three tiers of Panchayati Raj system, powers, functions and organizational set up. Agricultural Development programmes with reference to objectives & salient features- intensive Agricultural District Programme (IADP), High Yielding Varieties Programme (HYVP) Institution Village Linkage Programme (IVLP), Watershed Development Programme (WDP), National Agricultural! Technology Project (NATP), ATMA, ATIC, NHM and NAIP. Social Justice and Poverty Alleviation Programmes- Integrated Tribal Development Programme (ITDP), Integrated Rural Development Programme (IRDP), Swarna Jayanthi Gram Swarojgar N6jana (SGSY), Prime Minister Employment Yojana (PMEY). New Trends in Extension-Privatization. Women Development Programmes - Development of Women and Children in Rural Areas (DWCRA), Integrated Child Development Scheme (ICDS) and Mahila Samridhi Yojana (MSY), Mahila Arthik Vikas Mahamandal (MAVIM). Reorganized Extension System (T & V System)- Salient features, fort-nightly meeting,

monthly workshops, linkages, merits and demerits, Single Window System of Extension in Maharashtra. Broad Based Extension (BBE): Meaning and genesis.

Communication — Meaning, Definition, models, elements and their characteristics. Barriers in communication. Transfer of Technology: Meaning and Definition. Extension Programme Planning - Meaning Definition of planning, programmes and project, importance, principles and steps in programme planning process. Monitoring - Meaning and Definition. Evaluation - Meaning, Definition, types, differences between monitoring and evaluation. Extension Teaching Methods- Meaning, Definition, functions and classification. Individual contact methods- Farm and Home visit, Result Demonstration, Field trials- - Meaning, objectives. steps, merits and demerits. Group contact methods- Group discussion, Method demonstration, Field trips- Meaning, objectives, steps, merits and demerits. Group discussion techniques- Lecture, Symposium, Panel, Debate, Forum, Buzz group, Workshop, Brain Storming. Seminar and Conference. Mass contact methods- Campaign, Exhibition, Farmers Rally, Radio & Television, Community Radio Stations (CRS). Factors influencing the selection of Extension Teaching Methods and Combination (Media Mix) of teaching methods. Advanced Information Sources- Internet, Cyber Cafe, Video and Tele conferences, Kisan Call Centers, Consultancy clinics. Agricultural Journalism- Meaning, scope and importance News- Definition, meaning, sources of news, types merits and limitations Diffusion and Adoption of Innovations- Meaning, Definition, Innovation- Decision Process- adopters categories and their characteristics, factors influencing adoption process. Capacity Building of Extension Personnel and Farmers- Meaning, Definition, training process (steps) types of training, training to extension personnel, farmers, farm women and rural youth, FTC and KVK.

Entrepreneur: Meaning, Definition, characteristics and role, demands of entrepreneur, identifying potential entrepreneurs, functions. Entrepreneurship Development- Concept of entrepreneurship, process of entrepreneurship development, motivation and entrepreneurship development, importance of planning, monitoring and follow-up, managing competition, entrepreneurship development programmes. Current Status of Indian Agricultural Processing and Export Industries. SWOT analysis generation, incubation and commercialization of ideas and innovations. Agri. Partnership -Definition, Importance, agri. Clinics & agri. business centers Entrepreneurial Behaviour- Concept, dimensions, factors affecting entrepreneurial behaviour Government schemes and incentives for promotion of entrepreneurship, Government policy on small and Medium Enterprises (SMES)/ Small Scale Industries (SSIs). ICT's in rural enterprises. Market survey, formulation of project, financial analysis of project. Communication skills: Communication - Meaning and process of communication. Advertisements- Meaning, types, forms and functions Writing Skill: Business letters, Letters of inquiry, quotation orders and tenders complaints letter. Constraints perceived by rural entrepreneur.

Place of livestock in the national economy, different livestock development programmes of Govt, of India. Terminologies used in livestock and poultry management. Important exotic and Indian breeds of cattle, buffalo and swine. Male and female reproductive system of Cattle. Measures and factors affecting fertility in livestock, reproductive behavior like oestrus, parturition, etc. Milk secretion, milking of animals and factors affecting milk yield and composition. Feeding and management of calves, growing heifers and milch animals and other classes and types of animals, housing principles and space requirements for different species of livestock. Disease control measures, sanitation and care, breeding, feeding and production records. Breed characteristics of poultry, their' methods of rearing, breeding, feeding and management, incubation, hatching and brooding, vaccination and prevention of diseases, preservation and marketing of eggs, its economics and keeping quality. Cost of production of milk, economical units of cattle, buffalo and swine.

History and concept of Animal Breeding. Cell and cell division. Gene: Functions and role in Animal Genetics, Gene actions, Gene and Genotypic frequencies Gene expression and

mutation. Mendelian principles and Hardy Weinberg law. Chromosomes and its abnormalities. Laws of probabilities and Animal breeding. Variations in economic traits of farm animals. Methods of selection. Quantitative and qualitative traits. Composition of plant and animal body, classification of feeds and fodders. Important food ingredients and their functions in animal body. Digestive system, digestion and absorption of different nutrients in ruminants and non-ruminants. Feed supplements and feed additives, method of measuring food values. Feeding standard & their principles. Concept of preparation of complete feed block.

Present status of Dairy Industry in Maharashtra and India. Definition and composition of milk. Physico-chemical properties of milk. Microbial quality of raw milk. Factors affecting composition of milk. Physico-chemical and microbial standards for different types of milk. Nutritional importance of milk and its constituents. Reception and processing (Platform test, Chilling? Standardization, Homogenization, Pasteurization, Storage, Marketing) of milk, classification and composition of milk products (Heat coagulated, Heat and acid coagulated, Evaporated, Fermented Frozen and Fat riched products). IS PFA and Agmark standards for milk products. International requirement for export of milk. Preservation of milk and milk products by-Bio, Herbal, Chemical and physical preservatives in use. Utilization of dairy by-product: whey and high acid milk. Packaging of milk and milk products with modern techniques.

Importance of Sheep and Goat production in national economy. Important Indian and Exotic breeds of Sheep and Goat. Housing requirement of Sheep and Goat. Breeding seasons for Sheep and Goat. Methods of breeding Sheep and Goat. Feeding practices for Sheep and Goat. Flushing of ewes and does. Care and Management of pregnant ewes I does. Care and Management mbs ws and rams / bucks. Composition and utilization of Sheep and Goat Uak Grading and marketing of wool. Marketing of Sheep and Goat. Cooling help an Goat. Preparation of animal tor slaughter and different me hods (slaughter. Dressing percentage and Meat bone ratio. Different Meat cut and edible and non-edible offal's. Study of common ailments and control sites in Sheep and Goat. Preventive measures (vaccination) against were, diseases of Sheep and Goat. Systems of rearing of sheep and goat. Insurance of sheep and goats.

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## 2. AGRICULTURAL ENGINEERING

Differential calculus: Taylors & Maclaurins expansions, indeterminate form, curvature, asymptotes, tracing, function of two or more independent variables, partial differentiation homogeneous functions and Euler's theorem, Composite functions, total derivatives, derivative of an implicit functions, change of variable, maxima and minima, integral calculus reduction formulae, rectification of standard curve, double and triple integrals, change of order of integration, gamma and beta functions. application of double and triple integral to find area, ordinary differential equation exact and Bernoulli's differential equation, equation reducible to exact form by integrating factors, equation of first order and higher degree. Clairauts equations, differential equations of higher orders, method of finding complimentary function and particular integrals, method of variation of parameters, Cauchy and Legendres linear equations, simultaneous linear differential equation with constant coefficients, series solution techniques, Vector calculus: differentiation of vectors, scalar and vector point functions, vector differential operator Del, Gradient of scalar point function, Divergence and curl of a vector point function, identities involved in Del, second order differential operator lines, surface and volume integrals, stokes, divergence and Greens theorems (without proofs).

Surface tension Capillarity, surface tension by capillary rise method and Jaegers method, Viscosity Flow of liquids. Laminar flow/streamline flow, turbulent flow, critical velocity, Viscosity, coefficient of viscosity, poiseuille's equation for flow of liquid through pipes, Bernoulli's theorem, Semiconductor Distinction between metals, insulators and semiconductor intrinsic and extrinsic semiconductor. Determination of Energy band gap in, Semiconductor Donor & acceptor levels, LASER: Spontaneous and stimulated emission. A & B Einsteins coefficient, population inversion, He-Ne & Ruby laser, Ammonia and Ruby MASER, Holography-Note, Illumination: law of illumination, luminous flux, illumination intensity, candle power, brightness, Optic Fiber: Physical structure, basic theory, mode type, put out put characteristics of optic fiber and applications, Introduction to dia, para and (ferromagnetism, classification, Quantum mechanics Wave particle duality, debroglies concept, uncertainty principle, wave function, time dependent and time independent Schrodinger wave equation, introduction to superconductivity, Meissner effect, Isotope effect, Type-I and II superconductors, Josephson's effect DC and AC, Squids.

Introduction to High Level Languages *i.e.* "C" language, Primary Data types, U defined data type, variable, operator, building & evaluating expression, standard libra function, managing input and output, decision making, branching, looping, array, defined function, passing the argument and returning the value, recursion, string functioning structure and union, pointer, stack, push/pop operation, queue, insertion deletion operation linked list.

Matrices: elementary transformation,, rank of matrix, reduction to normal forms, Gauss Jordon method to find inverse of a matrix, consistency and solutions of Linear equations, eigen values and eigen vectors, Cayley-Hamilton theorem, linear transformation, orthogonal transformation, diagonalization of matrixes, bilinear and quadratic forms, function of complex variable: limit, continuity and derivative of complex functions, analytic function, Cauchy-Reimann equation, conjugate functions, harmonic function. Fourier series, infinite series and its convergence, periodic functions, Eulers formulae, Dirichlet conditions, function having arbitrary period, even and odd functions, half range series, Harmonic analysis, partial differential equation: formation of partial differential equations.

Basic database concept, DBMS Concept, introduction to RDBMS, Concept of normalization, SQL command, DML, DDL, select command, join and function, group function, set function, basic of HTML, developing the web page using meta tag, static and dynamic page, interlinking the web pages, project.

Numerical analysis, finite differences various difference operators and there relationship, factorial notation interpolation with equation interval, Newton's forward and backward interpolation formulae, Newton's divided difference formula, Lagrange's interpolation formula, numerical differentiations: differentiation based on equal interval interpolations, first and second order derivative by using Newton's forward and backward maxima and minima of a tabulated functions, numerical integration by Trapezoidal Simpson's rules, difference equations: order of a difference equations, solution of linear difference equations, rules for finding complementary functions and particular integral numerical solution of a ordinary differential equations by Picard's methods, Taylor series method, Euler's method, modified Euler's method, Laplace transforms: definition of Laplace transform, Laplace transform of elementary functions, properties of Laplace transform inverse Laplace transform, transform of derivative, integrals, transform of function multiplied by  $t$ , transform of function divided by  $t$ . Convolution theorem application of Laplace transform to solve ordinary differential equation and simultaneous differential equation Laplace transform of unit step function, unit impulse function, periodic function. One credit for tutorial is to be utilized for practice of solving example on the guidelines of illustrative examples, (Preferably the first and second illustrative examples on above article) given in the textbooks.

Statistics, Scope, population parameter and Estimates. Measures of Central Tendency: Arithmetic, Weighted, Geometric and Harmonic means, median and Mode for grouped and ungrouped data. Measures of Dispersion: Mean Deviation Variance, Standard Deviation and Coefficient of Variation. Concepts of probability, compound events, Additive, multiplicative, Theorems, independent Events, Discrete and continuous Theoretical Probability Distributions, Density functions, Binomial, Poisson, Normal, Chi-square,  $t$ ,  $F$  distributions. Simple, partial, multiple correlations Theory of regression, Multiple Regression models and orthogonal polynomials. Tests of significance Null and Alternative hypotheses Critical Region, Level of significance, Degrees of freedom, Types of Errors, Confidence intervals.

General-Workshop terminology, Ferrous and non ferrous metals, Steels and Alloy steels, alloys, Non ferrous heavy metals, corrosion, plastic, Glue, Grease, Paints, Varnish and Carpentry-Timber classification, defects in timber, description and use of tools in carpentry, seasoning and preservation of timber. Smithy-Nature of work in smith's furnace, tools and their uses, safety precautions in smithy and cold working of metals, forging drawing and spinning etc. Fitting-Description and use of files chisels, hacksaw, vices, hammers and other measuring marking tools, precision measuring tools, dial gauges and inspection gauges. Welding shop-types of welding, oxy-acetylene gas welding, electric arc welding, argon arc welding, MIG and TIG welding, Resistance welding, Brazing and soldering, use of fluxes. Sheet metal shop- Description and uses of tools and equipments used in sheet metal different joints, riveting Lacquers.

Construction and use of scale, lettering, construction of plane, geometrical figures parabola, hyperbola and ellipse and special plane curves, cycloid, epicycloids, hypocycloid, involutes and spirals, helix and simple loci, orthographic projection of points, lines, their traces and inclinations, projections of solids like prism, cylinder, cone, pyramid, sections of solid and development of surfaces Construction of isometric scales, isometric and orthographic projections of simple objects.

Iron Carbon phase diagram, lattice type of lattice, ferrous non ferrous metals and

their alloys, introduction to welding, types of welding oxyacetylene gas welding, types of flames, welding techniques and equipment. Principle of arc welding, equipment and tools. Casting processes. Classification, constructional details of center lathe, Main accessories and attachments, Main operations and tools used on center lathes. Types of shapers, Constructional details of standard shaper. Work holding devices, shaper tools and main operations. Types of drilling machines. Constructional details of pillar types and radial drilling machines. Work holding classification. Constructional details and principles of operation of column and knee type universal milling machines. Plain milling cutter. Main operations on milling machine.

Machine Drawing: Methods of projection, preparation of working drawing from models and is a metric views, Drawing of missing views, methods of dimensioning, concept of sectioning revolved and oblique section. Sectional views of machines parts. Types of rivets and revolved and oblique section. Sectional views of machine parts. Types of rivets and riveted joints, leak proof joints. Welded joints, Threads ( nomenclature, single start, multi start threads, nuts, and bolts, screwed fasteners, shaft coupling and shaft bearings). Machine Graphics: Graphic standards, primitives graphic software, points, lines and polygons, co- ordinate systems, geometric modelling, wire frame modelling, solid modelling, surface modelling, preparation of computerized drafting by drafting software. Introduction to Auto CAD, Pro-E, workbench Ansys, 3-D software or any other available drafting software.

Elements, links, pairs, kinematics chain, and mechanisms. Classification of pairs mechanisms Lower and higher pairs. Four bar chain, slider crank chain and their invers Determination of velocity and acceleration using graphical (relative velocity acceleration) method. Instantaneous centers. Types of gears. Law of gearing, velocity sliding between two teeth in mesh. Involute and cycloidal profile for gear teeth. Spur gear nomenclature, interference and undercutting. Introduction to helical, spiral, bevel and worm gear. Simple, compound, reverted, and epicyclic trains. Determining velocity ratio by tabular method. Turning moment diagrams, co-efficient of fluctuation of speed and energy, weight of flywheel, flywheel applications. Belt drives, types of drives, belt materials. Length of belt power transmitted, velocity ratio, belt size for flat and V belts. Effect of centrifugal tension creep and slip on power transmission, Chain drives. Types of friction, laws of dry friction Friction of pivots and collars. Single disc, multiple disc, and cone clutches. Rolling friction. anti friction bearings. Types of governors, constructional details and analysis of Watt, Porter, Proell governors. Effect of friction, controlling force curves. Sensitiveness, stability, hunting isochronism, power and effort of a governor. Static and dynamic balancing. Balancing of rotating masses in one and different planes. Partial primary balancing of reciprocating masses.

Sources of farm power conventional & non-conventional energy sources Classification of tractors and IC engines. Review of thermodynamic principles of IC (CI & SI) engines and deviation from ideal cycle. Study of engine components their construction. operating principles and functions. Engine systems: valves & valve mechanism. Fuel & air supply, cooling, lubricating, ignition, starting and electrical systems. Study of constructional details, adjustments & operating principles of these systems. IC engine fuels - their properties & combustion of fuels, gasoline tests and their significance, diesel fuel tests and their significance, detonation and knocking in IC engines, study of properties of coolants, anti freeze and anti-corrosion materials, lubricant types & study of their properties Engine governing systems.

Objectives of farm mechanization. Classification of farm machines. Materials of construction & heat treatment. Principles of operation and selection of machines used for production of crops. Field capacities & economics. Tillage; primary and secondary tillage

equipment. Forces acting on tillage tools. Hitching systems and controls. Draft measurement of tillage equipment: Earth moving equipment - their construction & working principles viz Bulldozer, Trencher, Elevators etc.; sowing, planting & transplanting equipment calibration and adjustments. Fertilizer application equipment. Weed control and Plant protection equipment their sprayers and dusters, their calibration, selection, constructional features of different components and adjustments.

Study of transmission systems, clutch, gear box, differential and final drive mechanism Familiarization of brake mechanism. Ackerman and hydraulic steering and hydraulic systems. Tractor power outlets: PTO, belt pulley, drawbar, etc. Tractor chassis mechanics and design for tractor stability. Ergonomic considerations and operational safety.

Principles & types of cutting mechanisms. Construction & adjustments of shear & impact-type cutting mechanisms. Crop harvesting machinery: mowers, windrowers, reapers, reaper binders and forage harvesters. Forage chopping & handling equipment. Threshing mechanics & various types of threshers. Threshers, straw combines & grain combines, maize harvesting & shelling equipment, Root crop harvesting equipment - potato, groundnut etc., Cotton picking & Sugarcane harvesting equipment. Principles of fruit harvesting tools and machines. Horticultural tools and gadgets. Testing of farm machine. Test codes & procedure. Interpretation of test results. Selection and management of farm machines for optimum Topic performance.

Meaning of design, Phases of design, design considerations. Common engineering materials and their mechanical properties. Types of loads and stresses, theories of failure, factor of safety, selection of allowable stress. Stress concentration. Elementary fatigue and creep aspects. Cotter joints, knuckle joint and pinned joints, turnbuckle. Design of welded subjected to static loads. Design of threaded fasteners subjected to direct static loads, bolted joints loaded in shear and bolted joints subjected to eccentric loading. Design of shafts under torsion and combined bending and torsion. Design of keys. Design of muff, sleeve and rigid flange couplings Design of helical and leaf springs. Design of flat belt and V-belt drives and pulleys. Design of screw motion mechanisms like screw jack, lead screw, etc. Selection of anifricion bearings. Design of curved beams; Crane hooks, circular rings, etc.

Introduction to various systems of a tractor viz. fuel, lubrication, cooling, electrical, transmission, hydraulic & final drive system. Familiarization with tractor controls & learning procedure of tractor starting and stopping. Driving in forward and reverse gears. Driving safety rules. Hitching, adjustments, settings and field operation of farm machinery. Familiarisation with different makes & models of 4-wheeled tractors. Starting &stopping practice of the tractor. Familiarisation with instrumentation panel & controls; Road signs, traffic rules, road safety, driving & parking of tractor; Tractor driving practice forward & reverse driving practice; Tractor driving practice with two wheeled tractor trailer forward & reverse; Study and practicing the hitching and dehitching of implements; Study operation and field adjustments of MB plough & disk plough; Field operation of trailing & mounted disk harrow; Field operation and adjustments of seed drill/planter/sprayer.

Definition and scope of Agronomy. Classification of crops. Effect of different weather parameters on crop growth and development. Principles of tillage. Tilt and its characteristics. Tillage implements. Water requirement of crops and irrigation scheduling, crop rotation, cropping systems, mono double and multiple cropping. Relay cropping and mixed cropping Cultivation practices of important field crops, improved varieties, seed rate, time and method of sowing, mannuring, fertilization. Concept of dry farming.

Scope of horticultural and vegetable crops. Soil and climatic requirements for fruits vegetables and floriculture crops, improved verities Criteria for site selection. Layout a planting methods Nursery raising, macro and micro propagation methods. Plant growing structures, pruning and training, fertilizer application, fertigation. Irrigation meth traditional and modem methods. Harvesting, harvest practices, grading and packaging Postharvest

practices. Garden tools. Management of orchard. (Construction and management of green house) Extraction and storage of vegetable seeds/Layout of lawns and kitchen gardens. Preparation of different fruits and vegetable products, Fruits Citrus, Mango, Gauva, Grapes, banana, sapota, pomegranate, ber, papaya Vegetables Tomato, chilli, brinjal, onion bhendi, cabbage, cauliflower, cucurbit crops. Flowers: Rose, chrysanthemum, jasmine, tuber rose, gaillardia, marigold, gladiolus, and aster.

Importance of livestock in agriculture, Basics of anatomy and physiology of Cattles, Buffalo, Sheep, Goat, poultry and their important species and breeds. General principles of breeding. Care and management of livestock and poultry. Artificial insemination, semen preservation. Space and shelter layout and requirement for farm animals, poultry and fish General principles of feeding, processing, preservation and storage of feed and fodder Milking and clean milk production. Livestock products- handling, marketing, economics, ongoing efforts in the country and recent trends in livestock husbandry, poultry and fish production and processed products aspects needing engineering consideration. Draft potential of various breeds of livestock for farm operations.

Soils: Nature and origin of Soil: Soil forming rocks and minerals, their classification and composition, soil forming processes, classification of soils, soils taxonomy, orders important soil physical properties; and their important soil particle distributions; soil inorganic colloids - their composition, properties and origin of charge, ion exchange in soil and nutrient availability, soil organic matter- its composition and decomposition, effect of soil fertility, soil reaction acid, saline and sodic soil, quality or irrigation water, essential plants nutrient their functions and deficiency symptoms in plants, important inorganic fertilizers and their reactions in soils.

Basics of agri-business management. Planning; organizing, controlling, Leading; Forecasting for Agril. Business; Location and layout of Facilities: Work force management; Quality management, Maintenance; Financial Analysis of Agribusiness process Strategy; Inventory management.

Entrepreneur: Meaning, definition, characteristics and role demands of entrepreneur, identifying potential entrepreneurs, Entrepreneurship Development-Concept of entrepreneurship, process of entrepreneurship development, motivation and entrepreneurship development, importance of planning. monitoring and follow-up, managing competition, entrepreneurship development programmes. Characteristics of Indian Farm Machinery Industry. SWOT analysis, generation, incubation and commercialization of ideas and innovations. Entrepreneurial Behavior concept, dimensions, factors affecting entrepreneurial behavior. Government schemes and incentives for promotion of entrepreneurship. Government policy on Small and Medium Enterprises (SMEs) Small Scale Industries (SSIs), Market survey, formulation of project, financial analysis of project. Communication Skills: Communication - Meaning and process of communication Advertisements - meaning types, forms, functions Writing skill: Business letter, Letters of inquiry, quotation orders and senders, complaints letters.

Phase rule and its application to one and two components systems, Fuels: classification, calorific value, Colloids: Classification, properties, Corrosion: Definition of all types of corrosion, corrosion types and method of prevention. Corrosion control, Water: temporary and permanent hardness, disadvantages of hard water, scale and sludge formation in boilers, boiler corrosion, Lubricants: Properties, mechanism, classification and tests, Polymers: types of polymerization, properties, uses and methods for the determination of molecular weight of polymers.

p-n junction, V-I characteristics of p-n junction, diode as a circuit element, rectifier, clip clamper, voltage multiplier, capacitive filter, diode circuits for OR & AND (both

positive negative logic), Transistor as an amplifier CB, CE, CC, operating point, classification (A C) of amplifier, various biasing methods (fixed, self, potential divider), h-parameter of transistor, CE amplifier, phase shift oscillator, ideal OP-AMP characteristics, linear non-linear applications of OPAMP (Adder, subtractor, integrator, active rectifier comparator, differentiator, differential, instrumentation amplifier and oscillator), Zener diode voltage regulator, transistor series regulator, current limiting, OP-AMP voltage regulator Basic theorem of Boolean algebra, Combinational logic circuits (basic gates), binary ladder D/A converter, successive approximation A/D converter, generalized instrumentation, measurement of displacement, temperature, velocity, force and pressure using potentiometer resistance thermometer, thermocouples, Bourdon tube, LVDT, strain gauge and tachometer.

Average and effective value of sinusoidal and linear periodic waveforms. Independent and dependent sources, loop current and loop equations (Mesh current method), node voltage and node equations (Nodal voltage method), Network theorems: Thevenin's, Norton's, Superposition, Reciprocity and Maximum power transfer, Star-Delta conversion solution of DC circuit by Network theorems, Sinusoidal steady state response of circuits, Instantaneous and average power, power factor, reactive and apparent power, Concept and analysis of balanced polyphase circuits, Disadvantages of low power factor and power factor improvement, Various methods of single and three phase power measurement, Star case and Godown wiring.

Electromotive force, reluctance, laws of magnetic circuits, determination of ampere turns for series and parallel magnetic circuits, hysteresis and eddy current losses Transformer principle of working, construction of single phase transformer, EMF equation transformer on load, equivalent circuit, voltage regulation, power and energy efficiency, open circuit and short circuit tests, principles, operation and performance of DC machines (generator and motor), EMF and torque equations, armature reaction, commutation, excitation of DC generator and their characteristics, DC motor characteristics, starting shunt and series motor, starters, speed control methods- field and armature control, polyphase induction motor: construction, operation, effect of rotor, resistance, torque equation, starting and speed control methods, single phase induction motors: double field revolving theory. characteristics, phase split, shaded pole motors,

Classification of energy sources; Introduction to renewable energy sources; characterization biomass; types, construction, working principle, uses safety/environmental aspects different renewable plants, passive energy, ocean energy, briquetting of biomass, biomass combustion, biodiesel preparation and energy conservation in agriculture.

Surveying: Introduction, classification and basic principles, Linear measurement Chain surveying. Compass survey. Errors in measurements, their elimination and correction Plane table surveying. Levelling, Contouring, Computation of area and volume. Theodolite traversing. Introduction to setting of curves.

Introduction of soil mechanics, field of soil mechanics, phase diagram physical and index properties of soil classification of soils, general classification based on particle size, textural classification and I.S. soil classification system stress condition in soils, effective and neutral stress, Permeability and seepage, Shear strength Mohr stress circle, theoretical relationship between principal stress circle, theoretical relationship between principal stress Mohr-Coulomb failure theory, effective stress principle. Determination of shear parameters by direct shear test, Mohr circle, theoretical test. Numerical exercise based on various types of tests. Compaction composition of soils standard and modified Proctor test, dry density compaction and Jolipour mini compaction test field compaction method and control. Consolidation of soil: Consolidation of soils, one dimensional consolidation spring analogy, Terzaghi's theory Laboratory consolidation test, calculation of void ratio and

coefficient of volume change, Taylor's and Casagrand' s method, determination of coefficient of consolidation. Earth pressure: Plastic equilibrium in soils Active and passive states, Rankine's theory of earth pressure active and passive earth pressure for cohesive soils, simple numerical exercise. Stability of slopes: Introduction to stability Analysis of infinite and finite slopes friction circles method Taylor's stability number.

Introduction, hydrologic cycle; precipitation forms, rainfall measurement, ma curve, hycograph, mean rainfall depth, frequency analysis of point rainfall, plotting posit estimation of missing data, test for consistency of rainfall records; interception; infiltration evaporation, evapo-transpiration estimation and measurement, geomorphology o watersheds - stream number, stream length, stream area, stream slope and Horton's law runoff factors affecting, measurement; stage and velocity, rating curve, extension of rating curve; estimation of peak runoff rate; rational method, Cook's method, SCS method and volume by Curve number method; hydrograph; components, base flow separation, unit hydrograph theory unit hydrograph of different durations, dimensionless unit hydrograph distribution hydrograph, synthetic unit hydrograph, uses and limitations of unit hydrograph, head water flood control methods, flood routing - graphical methods of reservoir flood routing, hydrology of dry land areas - drought and its classification; introduction to watershed management and planning.

Introduction, soil erosion causes, types and agents of soil erosion; water erosion. forms of water erosion, mechanics of erosion, gullies and their classification, stages of gully development, soil loss estimation - universal soil loss equation and modified soil loss equation, determination of their various parameters; erosion control measures - agronomical measures - contour cropping, strip cropping, mulching; mechanical measures - terraces level and graded broad base terraces and their design, bench terraces & their design, layout procedure, terrace planning, bunds - contour bunds, graded bunds and their design; gully and ravine reclamation - principles of gully control - vegetative and temporary structures; wind erosion factors affecting wind erosion, mechanics of wind erosion, soil loss estimation. wind erosion control measures - vegetative, mechanical measures, wind breaks & shelter belts, sedimentation - sedimentation in reservoirs and streams, estimation and measurement, sediment delivery ratio, trap efficiency; characteristics of contours and preparation of contour maps; land use capability classification; grassed water ways and their design; introduction to water harvesting techniques; introduction to stream water quality and pollution.

Introduction, classification of structures, functional requirements of soil erosion Control structures, flow in open channels-types of flow, state of flow, regimes of flow, energy momentum principles, specific energy and specific force, hydraulic jump and its plication, type of hydraulic jump, energy dissipation due to jump, jump efficiency, relative of energy, runoff measuring structures-parshall flume, H- flume and weirs, drop way-general description, functional use, advantages and disadvantages, structural parts functions, components of spillway, hydrologic and hydraulic design, free board and e tree board, structural design of a drop spillway- forces on retaining wall, determination of saturation line, seepage under the structure, uplift pressure estimation, safety against ng over turning, crushing and tension; chute spillway general description and its components, hydraulic design, energy dissipaters, design criteria of a SAF stilling basin and its limitations, drop inlet spillway- general description, functional use, design criteria; design diversions, small earth embankments-their types and design principles, farm ponds and reservoirs, cost estimation of structures.

Watershed management - problems and prospects; watershed based land use planning, watershed characteristics physical and geomorphologic, factors affecting watershed management, hydrologic data for watershed planning, watershed delineation, delineation of priority watershed, water yield assessment and measurement from a

watershed; hydrologic and hydraulic design of earthen embankments and diversion structures; sediment yield estimation and measurement from a watershed and sediment yield models; rainwater conservation technologies - in-situ and storage, design of water harvesting tanks and ponds; water budgeting in a watershed; effect of cropping system, land management and cultural practices on watershed hydrology; evaluation and monitoring of watershed programmes; people's participation in watershed management programmes; planning and formulation of project proposal; cost benefits analysis of watershed programmes; land use models; case studies.

Basic concepts, Force systems, Centroid, Moment of inertia. Free body diagram and equilibrium of force. Frictional forces. Analysis of simple framed structures using methods of moment diagrams. Stresses in beams. Torsion. Analysis of plane and complex stresses.

Stones: Properties of stones, Classification quarrying of stones. Bricks: Constituents, winning, moulding drying and burning of bricks, types of bricks, Cement: Composition of ordinary cement, functions of cement ingredients, harmful constituents of cement, settling action of cement, field and laboratory tests, storage, uses various types of cements, Mortars: Types of mortars and mortar mill, Concrete: Types, properties of concrete, aggregate, water cement ration, Measurement of material properties of concrete workability, consolidation and curing. Tiles: Types, tile making process, properties of tiles. Timber: Classification, structures, defects, qualities, decay preservation, seasoning. conversion and market forms, plywood and other timber substitutes.

Slope and deflection of beams using integration techniques, moment area theorems and conjugate beam method Columns and struts. Riveted and welded connections. Stability of masonry dams. Analysis of statically intermediate beams. Propped beams. Fixed and continuous beam analysis using superposition, three moment equation and moment distribution method.

Planning and layout of farmstead Physiological reaction of livestock to solar radiation and other environmental factors, livestock production facilities. BIS Standards for dairy, piggery, poultry and other farm structures. Design, construction and cost estimation of farm structures; animal shelters, compost pit, silo, fencing and implement sheds. Design and construction of rural grain storage system and development of rural roads, their construction cost and repair and maintenance. Sources of water supply, norms of water supply for human being and animals, drinking water standards and water treatment suitable to rural community. Sewage system its design, design of septic tank for small family. Scope, importance and need for environmental control for protected agriculture/precision farming.

Loads and use of BIS Codes. Design of connections. Design of structural steel members in tension, compression and bending. Design of steel roof truss. Analysis and design of singly and doubly reinforced sections, Shear, Bond and Torsion. Design of Flanged Beams, Slabs, Columns, Foundations, Retaining walls and Silos.

Thermodynamics properties. Closed and open system. Flow and non-flow processes. Gas laws, Laws of thermodynamics. Internal energy. Application of first law in heating and expansion of gases in non-flow processes. First law applied to steady flow processes. Kelvin Planck and Clausius statements. Entropy, Physical concept of entropy, Change of entropy of gases in thermodynamics processes. Difference between gas and vapour, Change of phase during constant pressure process. Generation of steam, triple point and critical point. Internal energy and entropy of steam. Use of steam tables and Mollier chart, heating and expansion of vapour in non-flow processes, measurement of dryness fraction. Classification of steam. boilers, Cochran, Lancashire, locomotive and

Babcock-Wilcox boilers. Boiler mountings and accessories.

Importance of engineering properties of biological materials. Study of different physical and thermal characteristics of important biological materials like shape, volume, density, roundness, sphericity, surface area, specific heat, thermal conductivity thermal diffusivity, etc. measurement of colour, flavour, consistency, viscosity, texture and their relationship with food quality and composition. Rheological characteristics like stress, strain time effects, rheological models and their equations. Aerodynamic characteristics and functional properties. Application of engineering properties in handling processing machine and storage structures. Concept, objectives and need of quality, quality control, methods of quality control, sampling, purpose, sampling techniques, requirements and sampling procedures for liquid, powdered and granular materials, sensory quality control, pane selection methods, interpretation of sensory results in statistical quality control, TQM and TQC, consumer preferences and acceptance.

Introductory concepts, Modes of heat transfer. Thermal conductivity of materials measurement General differential equation of conduction One dimensional steady state action through plane and composite walls, tubes and spheres Electrical analogy insulation materials, critical thickness of insulation. Free and forced convection. Newton's of cooling, heat transfer coefficient in convection Dimensional analysis of free connection Laminar forced convection on a flat plate and in a tube. Combined free and od connection. Introduction. Absorptivity, reflectivity and transmissivity of radiation Flack body and monochromatic radiation, Planck's law, Stefan-Boltzman law, Kirchoff s grey bodies and emissive power, solid angle, intensity of radiation. Types of heat angers, fouling factor, log mean temperature difference. at exchanger analysis restricted to parallel and counter flow heat exchangers. Steady state molecular diffusion in fluids at rest and in laminar flow, Fick's law, mass transfer coefficients Types of mass transfer.

Scope and importance of food processing, principles and methods of food processing. Processing of farm crops: cereals, pulses, oil seeds, fiber crops, fruits and vegetables and their products for food and feed. Principal of size reduction, grain shape, size reduction machines; crushers, grinders, cutting machines etc. operation, efficiency and power requirement - Rittinger's, Kick's and Bond's equation, fineness modulus. Theory of mixing, types of mixtures for dry and paste. materials, rate of mixing and power requirement, mixing index. Theory of separation, size and un-sized separation, types of separators, size of screens, sieve analysis, capacity and effectiveness of screens, pneumatic separation. Scope & importance of material handling devices. Study of different types of material handling systems; belt, chain and screw conveyor, bucket elevator, pneumatic conveying, Design consideration, capacity and power requirement.

Dairy development in India, Engineering, thermal and chemical properties of milk and milk products. Unit operations of various dairy and food processing systems. Process flow charts for product manufacture. Material and energy balances. Working principles of equipments for receiving, pasteurization, sterilization, homogenisation, filling & packaging Dairy plant design and layout. Composition and proximate analysis of food products. Deterioration in products and their controls. Physical, chemical and biological methods of food preservation, changes undergone by the food components during processing, evaporation, drying, freezing juice extraction, filtration, membrane separation, thermal processing. Food packaging. Plant utilities requirement.

Moisture content and methods for determination. Importance of EMC and methods of determination, EMC curve and EMC model. Principle of drying. Theory of diffusion, Mechanism of drying falling rate, constant rate, thin layer, deep bed and their analysis. Critical moisture content. Drying models, calculation of drying air temperature and air flow rate. Air pressure, within the grain bed, Shedd's and Hukill's equation. Different

methods of Jing including puff drying, foam mat drying, freeze drying, etc. Study of different types of dryers- performance, energy utilization pattern and efficiency. Study of drying and dehydration of agricultural products.

Types and causes of spoilage in storage. Conditions for storage of perishable products, Functional requirements of storage. Air movement inside the storage, Storage of grains. Destructive agents, Respiration of grains, Moisture and temperature changes in stored grains. Conditioning of environment inside storage through natural ventilation, mechanical ventilation. Artificial drying, Grain storage structures including Silo, CAP, Warehouse Storage of grains and their products, Storage of seeds, hermetically sealed and air-cooled storages-refrigerated. Control of temperature and relative humidities inside storage. Modified atmospheric storage and Control of its environment, Controlled atmosphere, modified atmospheric and frozen storages. Storage condition for various fruits and vegetables under cold and CA storage system. Economic aspects of storage.

Principles of refrigeration. Second law of thermodynamics applied to refrigeration. Reversed Camot cycle. Coefficient of performance, Unit of refrigeration. Refrigeration in food industry, Types of refrigeration system, Mechanical vapour compression, Vapour absorption system. Components of mechanical refrigeration, refrigerant, Desirable properties of ideal refrigerant, steam jet refrigeration systems, Thermoelectric refrigeration systems, Vertex tube refrigeration systems. Cold storages. Insulation material, design of cold storages, defrosting. Thermodynamic properties of moist air. Perfect gas relationship for approximate calculation, adiabatic saturation process, wet bulb temperature and its measurement, psychometric chart and its use, elementary psychometric process. Air conditioning, principles, type and functions of air conditioning, physiological principles in air conditioning, air distribution. Fundamentals of design of complete air conditioning systems, humidifiers and dehumidifiers, cooling and calculations, types of air conditioners, applications.

Properties of fluids: Ideal and real fluid. Pressure and its measurement, Pascal's law, pressure forces on plane and curved surfaces, centre of pressure, buoyancy. metacentre and metacentric height, condition of floatation and stability of submerged and floating bodies, Kinematics of fluid flow: Lagrangian and Eulerian description of fluid motion, continuity equation, path lines, streak lines and stream lines, stream function, velocity potential and flow net. Types of fluid flow, translation, rotation, circulation and vorticity, Vortex motion; Dynamics of fluid flow, Bernoulli's theorem, venturimeter, orifice meter and nozzle, siphon, Flow through notches, weirs and open channel; Laminar flow. Stress-strain relationships, flow between infinite parallel plates - both plates fixed, one plate moving, discharge, average velocity, shear stress and pressure gradient, Laminar and turbulent flow in pipes, general equation for head loss-Darcy, Equation, Moody's diagram, Minor and major hydraulic losses through pipes and fittings, flow through network of pipes, hydraulic gradient and energy gradient, power transmission through pipe; Dimensional analysis and similitude: Rayleigh's method and Buckingham's 'Pi' theorem, types of similarities, dimensional analysis, dimensionless numbers. Introduction to fluid machinery.

Irrigation Engineering Irrigation, impact of irrigation on Human Environment, some major and medium irrigation schemes of India, purpose of irrigation, sources of irrigation water, present status of development and utilization of different water resources of the country. Measurement of irrigation water: weir, notches, flumes and orifices and other methods; water conveyance, design of irrigation field channels, underground pipe conveyance system, irrigation structures, channel lining, land grading, different design methods and estimation of earth work and cost; soil water plant relationship, soil water movement, infiltration and its equations, evapo-transpiration, soil moisture constants, depth irrigation, frequency of irrigation, irrigation efficiencies, surface irrigation methods

of water application, border, check basin, furrow and contour irrigation.

Occurrence and movement of ground water, aquifer and its types, classification wells, steady and transient flow into partially, fully and non-penetrating and open well, familiarization of various types of bore wells common in the state, design of open well, groundwater exploration techniques, methods of drilling of wells, percussion, rotary, reverse rotary, design of assembly and gravel pack, installation of well screen, completion and development of well, groundwater hydraulics-determination of aquifer parameters of wells, by different method such as Theis, Jacob and Chow's etc. Theis recovery method, well interference, multiple well systems, surface and subsurface exploitation and estimation of ground water potential, quality of ground water, artificial groundwater recharge planning. modelling, ground water project formulation. Pumping Systems: Water lifting devices, different types of pumping machinery, classification of pumps, component parts of centrifugal pumps; pump selection, installation and trouble shooting, design of centrifugal pumps, performance curves, effect of speed on head capacity, power capacity and efficiency curves, effect of change of impeller dimensions on performance characteristics, hydraulic ram, propeller pumps, mixed flow pumps and their performance characteristics; priming, self priming devices, rotodynamic pumps for special purposes such as deep well turbine pump and submersible pump.

Drainage, objectives of drainage, familiarization with the drainage problems of the state. Surface drainage, drainage coefficient, types of surface drainage, design of open channel, sub-surface drainage purpose and benefits, investigations of design parameters, hydraulic conductivity, drainable porosity, water table etc, drainage criteria, types and of subsurface drainage system, Design of surface drains, interceptor and relief drains. Derivation of ellipse (Hooghoudt's) and Ernst's drain spacing equations Steady and unsteady state groundwater condition, dynamic equilibrium concept, Design of subsurface drainage system. Drainage materials, drainage pipes, drain envelope Layout, construction and installation of drains. Drainage structures. Vertical drainage. Bio- drainage. Tile Drains. Drainage of irrigated and humid areas. Salt balance, reclamation of saline and alkaline soils. Leaching requirements, conjunctive use of fresh and saline waters Economic aspects of drainage.

Pasi, present and future need of micro-irrigation systems, Role of Govt. for the promotion of micro-irrigation in India, Merits and demerits of micro-irrigation system, types and components of micro-irrigation system, Basic variables involved in design irrigation methods. Sprinkler Irrigation: system types, planning for design, uniformity and efficiency. out of set sprinkler system, lateral, manifold and main delivery system. Pressure requirement and pump power unit selection. Economical pipe selection and system economics, rain gun irrigation system. Tickle Irrigation: Different types of trickle, components of trickle system, planning the trickle system and design strategy Selection and design criteria for emitters. Lateral/ manifold and main pipe system design. Clogging, filtration, fertigation and chemigation. Maintenance and upkeep of trickle Irrigation. Cost economics of the system.

Major, medium and minor irrigation projects their comparative performance, development and utilization of water resources. Basic concepts of command area - definition, need and scope: historical perspective, command area development Interaction/collaboration of irrigation water use efficiency and agricultural production. Farmers participation in command area development. Description of components of irrigation canal system, their functions, planning and layout of canal irrigation system, preliminary design procedure for irrigation project and command area, crop water requirement, duty and delta, specific discharge of canal, design of canal by Kennedy and Lacey's theory and tractive force approach, Canal seepage and lining of canal, design of lined and economics. Diversion head works and canal head regulators, hydraulic jump and

its usefulness in the design of irrigation structures, theories of seepage, cross drainage works, canal falls, irrigation structures on distributory and minor, regulator and modules, operation maintenance of canal.

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### 3. FORESTRY

Definition of forest and forestry. Classification of forest and forestry, branches of forestry and their relationships. Definition, objectives and scope of Silviculture. Status of forests in India and their role. History of forestry development in India. Site factors - climatic, edaphic, physiographic, biotic and their interactions. Classification of climatic factors. Role played by light, temperature, rainfall, snow, wind, humidity and evapo-transpiration in relation to forest vegetation. Bioclimate and micro climate effects. Edaphic factors - influence of biological agencies, parent rock, topography on the soil formation. Soil profile - physical and chemical properties, mineral nutrient and their role, soil moisture and its influence on forest production. Physiographic factors - influence of altitude, latitude, aspect and slope on vegetation. Biotic factors - influence of plants, insects, wild animals, man and domestic animals on vegetation. Impacts of controlled burning and grazing. Influence of forests on environment. Trees and their distinguishing features. Growth and development. Forest reproduction - flowering, fruiting and seeding behaviour. Natural, artificial and mixed regeneration. Natural regeneration - seed production, seed dispersal, germination and establishment. Requirement for natural regeneration. Dieback in seedling with examples. Plant succession, competition and tolerance. Forest types of India and their distribution.

Introduction, definition, objectives and scope of forest mensuration. Scales of measurement (nominal, ordinal, interval and ratio scale). Units of measurement, standards of accuracy implied in their expression. Measurement of single tree - objectives, standard rules governing measurement at breast height. Measurement of tree diameter and girth using rulers, callipers and tapes. Comparison between tape and calliper measurements. Measurements of upper stem diameter and instruments such as Ruler, Finish Parabolic Calliper, Relaskop, Pentaprism. Bark measurements - objectives, thickness, surface area and volume. Crown measurements - objectives, diameter, height, surface area and volume. Height measurements - direct and indirect methods. Height measurement employing geometric and trigonometric principles, height measuring instruments, errors in height measurement. Measurement of cross sectional area, basal area, bole surface area, leaf area. The tree stem form, taper and classification of form factors and form quotient. Volume estimation of felled and standing trees and formulae involved. Volume tables-definition and their classification, (general, regional and local volume tables), merchantable volume tables. Preparation of volume tables. Stand growth, site quality, site index, stand structure, yield tables and preparation of yield tables. Biomass measurement. Determination of age of trees. Tree growth measurements, objectives increment, determination of increment, stump analysis, stem analysis and increment boring. Measuring tree crops - objectives, diameter, diameter and girth classes, height measurement of crop, crop age and crop volume. Stand tables. Forest inventory-definition, objectives, kinds of enumeration. Sampling - definition, advantages, kinds of sampling, random sampling: (simple, stratified, multistage and multiphase sampling). Non random sampling (selective, systematic and sequential sampling) sampling design, size and shape of the sampling units. Point sampling - horizontal and vertical point sampling. Introduction to remote sensing and its application in forestry.

Propagation concept, definition, methods and importance. Site selection, planning and layout of nursery area. Types of nursery, types of nursery beds, preparation of beds. Pre-sowing treatments. Methods of seed sowing. pricking. watering methods, weeding, hoeing, fertilization, shading, root culturing techniques, lifting windows, grading, packaging. Storing and transportation. Type and size of containers. Merits and demerits of containerized nursery. Preparation of ingredient mixture. Vegetative propagation techniques - macro and micropropagation. Study of important nursery pests and diseases and their control measures. Nursery practices for some important tree species.

Origin, distribution, general description, phenology, silvicultural characters, regeneration methods, silvicultural systems and economic importance of the following conifer and broadleaved tree species of India. Geographical distribution of important Indian trees, native trees, exotic trees, endemism. Conifers: *Abies pindrow*, *Picea smithiana*, *Cedrus deodara*, *Pinus roxburghii*, *Pinus wallichiana*, *P. gerardiana* and *Juniperus macropoda*. Broad leaved species: *Tectona grandis*, *Shorea robusta*, *Acacia* spp., *Dalbergia sissoo*, *D. latifolia*, *Quercus* spp. *Robinia pseudoacacia*, *Alnus* spp. *Anogeissus* spp. *Populus* spp, *Eucalyptus* spp, *Casuarina equisetifolia*, *Terminalia* spp., *Santalum album*, *Swietenia mahagony*, *Albizia* spp, *Prosopis* spp. *Pterocarpus santalinus*, *Azadirachta indica*, *Diospyros melanoxylon*, *Madhuca indica*, *Pongamia pinnata*, *Leucaena leucocephala* and *Bamboos*.

Geographical distribution of forests and their classification. Critical examination of the world forest sources, productivity potential and increment of world forests. Forest resources and forestry practices in different regions of the world – North and South America, Europe, Africa, China, Japan, Russia, South-East Asia and Australia. Forest development and economy – forest based industries of the world. Recent trends in forestry development in the world. International forestry organizations.

Silvicultural system - definition, scope and classification. Even aged and uneven aged forests and their crown classes. Detailed study of the silvicultural systems: Clear felling systems including clear strip, alternate and progressive strip systems. Shelterwood system – Uniform system, Group system, Shelterwood strip system, Wedge system, Strip and group system, Irregular shelterwood system, Indian irregular shelterwood system. Seed tree method. Selection system and its modifications. Accessory systems. Coppice system – Simple coppice system, Coppice of the two rotation system, Shelterwood coppice system, Coppice with standard system, Coppice-with- reserve, Coppice selection system, Pollard system. Conversion and its implications. Choice of silvicultural system. Dauerwald concept. Culm selection system in Bamboo. Tending operations - weeding, cleaning, thinning, definitions, objectives and methods, increment felling and improvement felling. Pruning and lopping. Control of climbers and undesirable plants.

Definition, scope and impediments. Plantation forests - planting plan, plantation records, maps. Plantation establishment -legal title of land, survey, site selection. Site preparation - purpose and methods. Planting - layout, time of planting, planting pattern, spacing, gap filling, planting methods, direct seedling. Choice of species on ecological aspects - afforestation of dry land, wetland, other adverse sites and taungya. Enrichment planting, nurse and cover crops. Intercultural operations. Plantation maintenance - weed control, climber cutting, staking, singling and pruning. Thinning - definition, objectives. Effects of thinning - physiological and mensurational. Effect of methods of thinning on stand development. Energy and industrial plantation - definition, scope, species, establishment, management and impact on environment. Plantation economics.

Environment: introduction, definition and importance. Components of environment - interactions with organisms. Global and Indian environment - past and present status. Environmental pollution and pollutants. Air, water, food, soil, noise pollution - sources, causes and types. Smog, acid rain, global warming, ozone hole, eutrophication, sewage and hazardous waste management. Impact of different pollutions on humans, organisms and environment. Introduction to biological magnification of toxins. Deforestation - forms and causes, relation to environment. Prevention and control of pollution - technological and sociological measures and solutions - Indian and global efforts. India, international and voluntary agencies for environmental conservation - mandates and activities. International conferences, conventions and summits-major achievements. Environmental policy and legislation in India. Introduction to environmental impact assessment. Causes of

environmental degradation - socio-economic factors. Human population growth and lifestyle.

Indian agriculture - its structure and constraints. Land use definition, classification and planning. Agroforestry - definition, aims, objectives and need. Traditional agroforestry systems: Taungya system, Shifting cultivation, wind break, shelterbelts, Homestead gardens. Alley cropping, high density short rotation plantation systems, silvicultural woodlots/energy plantations. Classification of agroforestry system -structural, functional, socio-economic and ecological basis. Multipurpose tree species and their characteristics. Tree architecture, canopy management - lopping, pruning, pollarding and hedging. Diagnosis and design. Agroforestry systems in different agroclimatic zones, components, production and management techniques. Nutrient cycling, soil conservation, watershed management and climate change mitigation. Economics of agroforestry systems. People participation, rural entrepreneurship through agroforestry and industrial linkages. Analysis of fodder and fuel characteristics of tree/shrubs. Financial and socio-economic analysis of agroforestry systems. Tree crop Interaction Allelopathy with respect to forest trees.

Introduction – importance and scope of dendrology, Morphology of woody plants and range of variation. Principles and systems of classification of plants. Bentham and Hooker's, Engler and Prantles, and Hutchinson's Systems. Plant Nomenclature – objectives, principles and International Code of Botanical Nomenclature. Role of vegetative morphology in identification of woody forest flora. Peculiarities of tree stems, twigs, general form of woody trunk and deviations like buttresses, flutes, crooks, etc. Morphology and description of barks of common trees. Characteristics of blaze on bark, colour, gums, latex, etc. Morphology of leaf, description of different types of leaves, colour of young and old leaves in some species as (regular) features of identification. Reproductive morphology of plants with reference to description and identification of reproductive parts. Floristics and procedures; herbarium techniques, collection, processing and preservation of plant material. General study of herbarium, arboretum and xylarium. Description of the plant in scientific terms, study of sport characteristics of plants, naming and classifying based on adopted system. Study of families, as survey of forest resources: Magnoliaceae, Rhizophoraceae, Ebenaceae, Sapotaceae, Caesalpiniaceae, Santalaceae, Mimosaceae, Elaeagnaceae, Papilionaceae, Meliaceae, Salicaceae, Apocynaceae, Betulaceae, Verbenaceae, Fagaceae, Compositae, Moraceae, Poaceae, Tiliaceae, Liliaceae, Euphorbiaceae, Pinaceae, Dipterocarpaceae, Cupressaceae, Guttiferae, Taxaceae, Myrtaceae, Rubiaceae and Combretaceae.

Historical development of ecology as a science. Concept of levels of biological organization. Ecosystem – classification and distribution. Forest environment- Major abiotic and biotic components and their interaction, Nutrient cycling, trophic levels, food webs, ecological pyramids and energy flow. Population ecology - definition, population dynamics and carrying capacity, preparation of life table and its importance in forest management. Community ecology - Species interaction, Ecological succession, terminology, basic concepts, climax vegetation types, Methods to study effects of forest management on succession. Biogeography. Autecology of important tree species at Akola/ Dapoli. Biodiversity and conservation – definition, levels of study, distribution of diversity in life forms, hotspots of biodiversity, measurement of diversity and diversity indices. Principles of conservation biology, Ex situ and In situ methods of conservation, Genetically and evolutionary principles in conservation. Biosphere concept. Conservation – efforts in India and worldwide.

Tree structure, growth, development, differentiation and reproduction. Plant growth functions and growth kinetics, Physiological functions and processes in trees. Environmental effects on growth and development. Productivity of tropical deciduous and evergreen forests. Light use efficiency in forest species, canopy structure, plant phyllotaxis and its importance in translocation. Plant light relationship environment. Branching in isolated plants. Monoculture and mixed tree communities. LAI, Photosynthetic efficiency and

respiratory losses, source sink relationship, Factors affecting photosynthesis. Radiation interception, absorption of water, ascent of sap and water balance. Transport processes with special reference to long distance transport in trees and its impact on plant water relations and photosynthesis. Development of seeds and seedlings. Biocides and growth regulators in forest ecosystems. Senescence and abscission. Role of trees in pollution control.

Introduction, history and development of tree improvement, its relation to other disciplines for forest management. Reproduction in forest trees – anthesis and pollination – their importance in tree breeding. Quantitative inheritance, heritability, genetic advance, genetic gain, combining ability and their application. Genetic, environmental and phenotypic expression of trees. Genetic basis of tree breeding and selection practices in forest trees. Patterns of environmental variation- species and provenance trials in forest trees. Seed stands (seed production areas) Plus tree selection, progeny trials and establishment of seed orchard. Genetic consequences of hybridization. Back cross breeding, heterosis breeding, breeding for resistance to insect pest, diseases, air pollution and for wood properties. Conservation of forest tree germplasm. Recent techniques in tree improvement. Vegetative propagation and tree improvement.

Introduction – Seed and its importance – afforestation activity and seed requirements in India. Role of seed technology in nursery stock production. Production of quality seed, identification of seed collection areas-seed orchards – maintenance of genetic purity-isolation and rouging, seed source provenance and stands. Selection of seed tree, genotypic and phenotypic selection, plus tree – pure stands, elite seed tree, isolated tree and their location. Locality factors. Seed Collection – Planning and Organization, Collection methods, Factors affecting seed collection, Seed maturity and tests. Seed processing – Seed extraction, drying, blending, cleaning, grading, treating, bagging, labeling and storage. Storage – orthodox and recalcitrant seeds, precautions of handling of recalcitrant seeds, natural longevity of tree seeds, factors affecting longevity – storage conditions, methods and containers. Seed testing, sampling, mixing and dividing, determination of genuineness, germination, moisture, purity, vigour, viability, seed dormancy and breaking of seed dormancy. Different viability and vigour tests, seed pelleting, seed health. Classes of tree seeds, certification procedures of tree seeds.

Definition of wildlife, free living, captive, domesticated and feral animals Justification of wildlife conservation, uses, values and negative impact of wildlife. Zoogeographic regions and biomes of the world. India's uniqueness in biodiversity, reasons and causes of wildlife depletion. Biogeographic classification of India. Status and distribution of wildlife in India. Scientific and common names of important mammals, birds and reptiles. Rare, endangered and threatened species of mammals, birds and reptiles of India. Agencies involved in wildlife conservation, Govt. and NGO' s. BNHS, WWF, Indian Board for wildlife, CITES. Biological basis of wildlife management. Basic requirements of wildlife– food, water, cover and space, limiting factors. Wildlife ecology: Relevance of basic ecological concepts such as food-chain, food-web, ecological pyramids, habitat, ecological niche, carrying capacity, density, prey-predator relations and population dynamics.

History and importance of forest pathology in India and the world. Relation of plant pathology with forest pathology and other sciences, classification of tree diseases. Role of microbes and fungi in a natural forest ecosystem. Broad classification of different pathogens causing tree diseases. General characteristics of fungi, bacteria, viruses, phytoplasma and phanerogames. Important characters of ascomycetes and basidiomycetes. Important orders and families of Hymenomycetes with a special reference to Aphyllphoraeae and Agaricaceae that contain members causing tree diseases. Growth and reproduction of plant pathogens, infection and factors influencing disease development. Dissemination and survival of plant pathogens. Distribution, economic importance, symptoms, etiology and management of the following. Diseases of important tree species

like teak, *Dalbergia* sp., *Acacia* spp., Neem, Cassia, Sal, *Albizia*, *Terminalia*, Mango, Jackfruit, Pines, Deodar, Eucalyptus, Bamboo, Casuarina, Rubber, Sandal wood, medicinal and aromatic plants grown in different agroforestry systems. Biodegradation of wood in use. Types of wood decay, gross characters of decay, sapstain, different types of rots in hardwoods, softwoods and their prevention. Graveyard test and decay resistant woods. Principles of forest disease management. Definition and scope of disease management in forestry. Importance of disease cycle and economic threshold in disease management. Principles of disease management such as exclusion, cultural, chemical, biological and immunization. Nature of disease resistance. Fungicides and their use in nurseries and plantations. Integration of cultural, chemical, biological and host resistance in disease management, Meristem and tissue culture techniques in disease management. Nursery diseases of important forest species.

History of wildlife management and conservation in India; cultural background. Habitat management: Purposes, principles, practices and tools-fire, cutting, grazing. Habitat interspersation and edge effect. Provision of water, saltlicks and food. Zoning – core, buffer, tourism and multiple use in protected areas. Wildlife damage control : Mitigating human – wildlife conflict: fences, trenches, walls, lure crops, repellents, translocation and compensation. Captive wildlife : Zoos and safari parks. Captive breeding for conservation. Central Zoo Authority of India. Wildlife census : Purpose, techniques. Direct and indirect methods of population estimation. Sample and total counts, indices, encounter rates and densities. Wildlife (Protection) Act, 1972. Protected areas – Sanctuary, National Park and Biosphere Reserves. Special projects for wildlife conservation. Project Tiger and Musk Deer Project. Introduction and reintroduction of species. Wildlife corridors. MAB, Red Data Book, Category of threat, CITES. Conservation : Meaning, principles and strategies, in-situ and exsitu conservation, conserving biodiversity. Politics- socioeconomics, role of education and extension.

Definition, importance and scope of Entomology. Definition of insect and its position in the Animal Kingdom. Important characters of phylum arthropoda and class insecta. External morphology of generalized insect. Insect growth and development, Reproduction in insects, immature stages (Egg. Larvae/Nymph and Pupae); metamorphosis in Insects Taxonomic classification of class Insecta, diagnostic characters of the orders and major families of economic importance. History and importance of Forest Entomology in India. Methods and principles of pest control: Mechanical, physical, silvicultural, legal, biological and chemical. Principles and techniques of Integrated Pest Management in forests. Classification of forest pests : types of damages and symptoms; factors for outbreak of pests. Nature of damage and management: Insect pests of forest seeds, forest nursery and standing trees of timber yielding species of natural forest(*Tectona*, *Dalbergia* sp., Sal, *Gmelina*, Pines); Plantation forest species (Eucalyptus, Bamboo, Casuarina, ). Insect pests of freshly felled trees, finished timbers and their management. Morphology of plant parasitic nematodes, brief classification of important genera of nematodes. Important diseases caused by different genera and their management practices.

Definition and scope of ethnobotany. Man and biological resource of earth with respect to plants. Terms employed in relation to ethnobotany and its relationship with man and domestic animals. Ethnic - people and their contribution in therapeutic and ethnobotanical knowledge especially with respect to medicinal and allied aspects. Important plants and their folk uses for medicines, food, dyes, tans, etc. Symbolic relationships including mythology mainly from the following families. Guttiferae (*Clusiaceae*), Rosaceae, Malvaceae, Fabaceae, Mimosaceae, Caesalpinaceae, Combretaceae, Umbelliferae (*Apiaceae*), Rubiaceae, Asteraceae, Ebenaceae, Apocynaceae, Asclepiadaceae, Euphorbiaceae, Lauraceae, Palmaceae, Poaceae, Liliaceae, Coniferae, Santalaceae, Thymeliaceae.

Introduction to Wood Anatomy. The plant body – Cell and organelles, meristems,

promeristem, primary meristem, secondary meristem, apical and intercalary meristems. Simple tissues- parenchyma, collenchyma, sclerenchyma. Complex and vascular tissues. Anatomy of stems and roots of dicots and monocots. The secondary growth in woody plants. Mechanism of wood formation. Formation of early and late wood, growth rings, transformation of sapwood to heartwood. The macroscopic features of wood, bark- sapwood, heartwood, pith, growth rings, wood rays, resin or gum-canals. Cell inclusions. Physical properties of wood; colour, hardness, weight, texture, grain, lusture, etc. Abnormalities in wood -- deviation from typical growth form (leaning, bending, crook, fork, buttress), grain deviation, false and discontinuous growth rings. Reaction wood-compression and tension wood. Disruption of continuity of inner wood, shakes, included bark, resin pockets, pith flecks, knots (live and dead).

Definition and scope of logging, logging plan and execution. Location and demarcation of the area for logging and estimation of produce available for extraction. Implements used in logging operation- traditional and improved tools. Felling rules and methods. Conversion, measurement and description of converted material. Means of transport of timber- carts, dragging, skidding, overhead transport, ropeways, skylines. Transport by road and railways. Transport by water- floating, rafting and concept of booms. Grading and Storage of timber in the depots for display and disposal, temporary and final storage. Timber Depots- types, lay out and management. Systems of disposal of timber. Size of material in logging operation. Ergonomics: definition, components and provision of energy. Requirement of energy and rest periods. Effect of heavy work, posture, weather and nutrition. Personal protective equipments, safety helmets, ear and eye protections. Accidents: causes, statistics, safety rules and first aids. Plants, animals and insect infestations; diseases and their prevention.

Wood as raw material, kinds of woods– hardwood, softwood; bamboos and canes. Merits and demerits of wood as raw material. The physical features of wood. Mechanical properties of wood like tension, compression, bending, shearing cleavage, hardness, impact resistance, nail and screw holding capacities. Suitability of wood for various uses based on mechanical and physical properties. Electrical and acoustic properties of wood. Wood water relationship – shrinkage, swelling, movement, fibre saturation, equilibrium moisture content. Wood seasoning – merits, principles and types – air seasoning, kiln seasoning and chemicals seasoning. Refractory classes of timbers, kiln schedules. Seasoning defects and their control. Wood preservation – principles, processes, need, types of wood preservatives (Water soluble, oil based, etc.), Classification of timbers based on durability. General idea about fire retardants and their usage. Non-pressure methods – steeping, dipping, soaking open tank process, Boucherie process. Pressure methods – full cell process, empty cell process (Lowry and Rueping). Wood machining. Sawing – techniques, kinds of saws – cross cut, edging, cudless, hand, circular and bow saws. Wood working, tools used in wood working (parting, slicing, shaping, measuring and marking tools). Various stages in wood working. Dimensional stabilization of wood by surface coating method, bulking method, impregnation of resins and polymers.

Pulp and paper industry. Introduction and raw material; pulping-mechanical, chemical, semi chemical and semi-mechanical; pulp bleaching; stock preparation and sheet formation; types of paper; manufacture of rayon and other cellulose derived products. Manufacture, properties and uses of Composite wood- plywood, fiberboard, particleboard and hard board. Adhesives used in manufacture of composite wood. Improved wood-definition, types (impregnated wood, heat stabilized wood, compressed wood, and chemically modified wood). Destructive distillation of wood. Saccharification of wood. Production of wood molasses, alcohol and yeast. Specialized wood products.

History, scope, opportunities and constraints in the cultivation and utilization of medicinal and aromatic plants in India. Importance, origin, distribution, area, production,

climatic and soil requirements, propagation and nursery techniques, planting and aftercare, training and pruning, nutritional and water requirements. Plant protection, harvesting, processing and economics of under mentioned important medicinal and aromatic plants. Medicinal Plants : Amla, Bel, Chandan, Ashwagandha, Tinospora, Abrus, Gymnema, Guggal, pepper, cardamom, clove, ginger, turmeric, betelvine, periwinkle, *Rauvolfia*, *Dioscorea*, isabgol, pyrethrum and other species relevant to local conditions. Aromatic Plants : Citronella grass, khus grass, geranium, patchouli, bursera, *Mentha*, *Ocimum* and other species relevant to the local conditions. Endangered medicinal and aromatic plants of India and their conservation. Study of chemical composition of a few important medicinal and aromatic plants, their extraction and use. Therapeutic and pharmaceutical uses of important species.

Introduction, methods of collection, management and importance of Non-Timber Forest Products(NTFP). Fodder (grasses and tree leaves), canes and bamboos. Essential Oils - methods of extraction, classification, storage and uses. Non-essential oils – nature, occurrence, methods of extraction, classification and uses. Important fixed oil yielding trees. Gums and resins –definition, classification, sources, collection and uses. Factors affecting gum formation. Important gum yielding plants. Resins and Oleoresins, their formation in plants and classification of resins. Tans- nature, classification, uses and important tannin yielding plants. Dyes – classification and sources of dyes. Beedi leaves – sources, collection and processing. Fibers and flosses. Katha and Cutch –sources, extraction and uses. Drugs, wild fruits, spices, poisons and bio-pesticides.

Nature and scope of economics and its relationship with other sciences. Theory of consumption. Marshallian theory of utility, equimarginal utility and Hicks-Allen approach for determining consumer equilibrium. Concept and types of demand, laws of demand and factors affecting demand of commodities. Elasticity – its kinds, measurement and factors affecting it. Factors of production, their definition and characteristics, Law of diminishing marginal returns. Supply – definition, law and elasticity. Market – its classification and price determination under different market situation. Introduction to distribution theories with particular reference to Ricardian Theory of Rent. Marginal productivity theory of wages, Liquidity preference theory of interest, Marginal Productivity theory, risk taking and uncertainty bearing theories of profit. National Income and its concepts. Concept and types of inflation.

Introduction; Forest soils Vs. cultivated soils. Properties of soils under different forest ecosystems. Soil colloids and exchange phenomenon. Essential nutrient elements-occurrence, availability and their functions. Diagnosis of nutrient deficiencies-visual symptoms, soil fertility evaluation methods. Site productivity and nutrient cycling in forest soils. N,P and K, Macro and micronutrient fertilizers and their uses. Brief history of Microbiology. Forest soil environment- distribution of various microorganisms in soil ecosystem and their interaction effects. Mineral Transformation-carbon cycle with reference to organic matter decomposition and humus formation, Microbial degradation of cellulose & lignin. Bio-fertilizers – their importance. Nitrogen fixation-Rhizobium-tree legume symbiosis, Frankia X non-legume symbiosis, asymbiotic and associative N<sub>2</sub> fixation. Nitrification and denitrification in forest ecosystems. Microbial transformation of phosphorous, sulphur and micro nutrients. Mycorrhizae: types,biology and importance with specific relevance to tree crops and mobilization of phosphorus and micro-nutrients. Rhizosphere and phyllosphere concept.

Engineering survey, scope and types of surveying, chain surveying, types and instruments used; Traversing, triangulation, survey stations, base line, check and tie lines; ranging of survey lines; offsets and their types; chain of sloppy grounds, chaining across obstacles; cross staff surveying, compass surveying, chain and compass traversing, magnetic and true bearings, prismatic compass, local attraction. Computation of interior angles and

balancing of closed traverse. Plane table surveying; plane table and its accessories, methods of plane table surveying. Leveling: terms used, types of levels, dumpy level and its adjustments, booking of staff readings, calculation of reduced levels. Theodolite and its uses. Contour surveying. Building materials – types, strength and characteristics, site selection for building construction. Forest roads – alignment, construction and drainage; retaining walls, breast walls, waterways and culverts; bridges – types, selection of site, simple wooden beam bridges, check dams, spurs, farm ponds, earth dams.

Methods of soil survey, types of soil survey. Land use classes and planning. Soil sampling methods, Soil mapping unit, soil survey interpretation, soil survey report. Scope and objective; soil survey, sampling methods; planning, inventory, permanent sample plots; sample size allocation, land use classes and planning. Aerial photography and remote sensing-definition, meaning, scope, merits and brief history. Electromagnetic spectrum; radiations, differential reflections by surfaces, active and passive remote sensing, earth observation satellites. Equipment and materials-aerial bases, cameras, filters, stereoscopes, computers, radars. Photogrammetry: Vertical and oblique photography. Photographs and images, scales, resolution, photo interpretation, photogrammetry, image analysis, mapping. Agencies involved in remote sensing and acquiring information from them. Remote sensing; principles, uses in forestry, status monitoring, fire, vegetation/cover classification and mapping, species identification, height and volume – estimation. Identification of tree species and their form stand delineation. Interpretation of land forms and soils; use of micro-level survey of farm forests, large scale photos in forest inventory, site selection. Imagery and image analysis – video satellite, computer and radars. Geographic Information systems-Computer softwares used.

Anthropology – definitions, nature and scope of Anthropology. Branches of Anthropology & methods of anthropological study, Concepts of Culture, Society, Community, Groups and Institutions. Race – concept criteria of racial classification, major races of India and the world. Social Institutions: Family – forms and functions, Marriage – forms and functions, Kinship – decent, residence, Systems terminology and usages, Tribal Economy, Tribal religion. Meaning, definitions and characteristics of Tribes. History of Indian Tribes. Tribal Demography. Tribal - Social and Political organization. Tribal Law and Justice. Tribal taboo and Totem. Socio-cultural and socio-economic problems of tribes with special reference to indebtedness, land alienation, shifting cultivation, migration, depopulation, un-employment, impact of urbanization and industrialization, education and forest problems. Social and cultural change – its meaning and characteristics and difference between social & cultural change and recent changes among the tribals. Forest and Tribes – their relationship-forest ecosystem and cottage industries. Role of Tribals in Forest protection, development & conservation. Tribal welfare and social forestry, Tribals and Co-operative movements. History of tribal welfare and administration - the Constitutional safeguards for the scheduled tribes. Policies, plans and programmes of tribal development and their implementations. The role of anthropology in tribal development.

Introduction and definition. Relationship with other disciplines. History and development Types and distribution around world. Grasses: characters and classification. Characteristics of rangelands: components of vegetation, nutrient value of forages and environmental factors. Importance of rangelands. Indian rangelands: origin, distribution, characteristics, status and management. Ecology in relation to grazing – Ecological concepts relevant in rangeland management, animal – plant interactions, effect on vegetation and plant succession. Plant morphology and physiology in relation to grazing factors – factors influencing food synthesis and reproduction. Range inventory – mapping, methods of sampling and evaluation, purposes and principles, Carrying capacity. Range utilization. Intensity and frequency of use. Range management – topography, animal species, forage preference, density. Grazing – grazing intensity, season of grazing, types – their merits and demerits. Animal unit (A.U.). Fire – controlled burning, effect of fire on vegetation and

fauna. Weed control – types, their characteristics, chemical and biological control. Range improvement– range seeding, introduction of grasses and legumes, fertilization, soil and water conservation strategies. Multiple use.

Nature and scope of forest economics, importance of forestry in economic development Concepts of demand, derived demand and supply with special reference forestry outputs. Basics of marginal analysis and its applications in economic analysis of forestry production systems. Basics of Linear Programming. Financial and economic rotations. Fundamentals of project planning and evaluation and network scheduling techniques. Valuation of timber and non-timber forest products.

Introduction: definition and scope. Peculiarities of forest management. Principles of forest management and their applications. Objects of management, purpose and policy. Sustained and progressive yield concept and meaning. General definitions – management and administrative units, felling cycle, cutting section. Rotations: definition, kinds of rotations, choice of rotations, length of rotations and conversion period. Normal forest: definition and concept. Even aged and uneven aged models. Estimation of growing stock, density, quantity and increment. Yield regulation – general principles of even aged and uneven aged forest crop. Yield regulation based on area, volume, area and volume, increment and number of trees. Working Plan – definition, objects and necessity. Forest Policy: definition, necessity and scope. Legal and institutional approaches to forest resource management. National Forest Policies. Forest Law: legal definition. Objects of special forest law. Indian Forest Act. Detailed study of IFA, 1927. Maharashtra State Forest Acts and Rules.

Nature and Function of money. Finance – Definition, Aims, and objectives need and importance. Role of capital in forestry. Classification and sources of credit. Principles of financial management, Economic feasibility test for credit, three R's and three C's credits. Role of different agencies in supplying credit. Co-operative credits structure in India. Regional rural banks and NABARD – Objectives, working and functions. Concepts of supervisory credits and its organization, problems of overdues and recoveries. Forest credit policy. Credit squeeze and its effect. Balance sheet and its role in financial management. Business management – meaning scope and principles of management. Tools and steps involved in business management.

Nature and scope of marketing. Approaches to marketing and the study of marketing functions with special reference to forestry. Classification of market, market structure and conduct of important timber and non-timber markets. Marketing channels, costs, margins and price spread – concepts and applications. Concepts of market integration and marketing efficiency. Role of public and private agencies in marketing of forest produce. Market inefficiencies in the trade of forest produce and measures to check the same. Fundamentals of international trade. Domestic and international trade in timber and non-timber forestry outputs. Demand forecasts – concept and methods. WTO – background, structure, functions and decision making process. IPRs and their implications for forestry and allied sectors in the country.

Composition of earth' s crust, soil as a natural body-major components by volume-pedology, rocks- types- Igneous-sedimentary and metamorphic-classification-soil forming minerals definition- classification-silicates-oxides carbonates – sulphides - phosphates-occurrence. Weathering of rocks and minerals-weathering factors-physical-chemical-biological agents involved, weathering indices-factors of soil formation, land forms-parent material-climate organism- relief-time- soil forming processes-eluviations and illuviation-formation of various soils. Problem soils: salted soils, permeable, flooded, sandy soils properties. Physical parameters; texture-definition-methods of textural analysis-Stock' s law-assumption limitations- textural classes-use of textural triangle, absolute specific gravity-

definition apparent specific gravity/bulk density-factors influencing-field bulk density. Relation between BD. PD-Practical Problem. Pore space-definition-factors affecting capillary and noncapillary porosity-soil colour- definition-its significance-colour variable-hue, value, chroma, Munsell colour chart-factors influencing-parent material-soil moisture-organic matter, soil structure-definition-classification-clay prism like structure-factors influencing genesis of soil structure, soil consistency plasticity- Atterberg's constants. Soil air-air capacity-composition factors influencing-amount of air space-soil air renewal, soil temperature-sources and distribution of heat-factors influencing-measurement, chemical properties-soil colloids organic- humus-inorganic-secondary silicate-clay-hydrous oxides. Soil organic matter decomposition-pH-nutrient availability-soil buffering capacity, soil water-forms- hygroscopic capillary and gravitational-soil moisture constants-hygroscopic coefficient-wilting point- field capacity-moisture equivalent, maximum water holding capacity, energy concepts-pF scale measurement- gravimetric-electric and tensiometer methods-pressure plate. and pressure membrane apparatus-Neutron probe-soil water movement-saturated and unsaturated infiltration and percolation-soil survey – classification– aerial photography–satellite–their interpretation, soil orders- land capability-classification, soils of different eco-systems and their properties; water quality parameters and assessment.

Agrometeorology-definition, aim and scope. Factors and elements of weather and climate. Composition and structure of atmosphere. Air and soil temperature regimes, atmospheric humidity, types of clouds and precipitation, hails and frost. Cyclones, anticyclones and thunderstorms. Solar radiations-components and effect on plant growth. Wind as a source of energy. Effect of weather and climate on the growth and development of crops. Climatic normals for crops. Agroclimatic zones of India and Himachal Pradesh. Evaporation and transpiration. Use of remote sensing techniques in agrometeorology. Agriculture weather forecasting.

History of genetics and hypothesis-theories. Physical basis of heredity, cell reproduction – mitosis - meiosis and its significance. Gametogenesis and syngamy in plants. Mendel's principles of heredity, deviation from Mendelian inheritance, pleiotropy, threshold characters, co-dominance penetrance and expressivity. Chromosome theory of inheritance, gene interaction: modification of monohybrid and dihybrid ratios. Multiple alleles, quantitative inheritance, linkage and crossing over, sex determination - theories, sex linked inheritance and characters. Cytoplasmic inheritance and maternal effects. Chemical basis of heredity: Structure of DNA and its replication. Evidences to prove DNA as genetic material. Mutation and its classification. Chromosomal aberrations: Changes in chromosome structure and number.

Water relations in plants: role of water in plant metabolism, osmosis, imbibition, diffusion, water potential and its components, absorption of water, mechanisms of absorption, ascent of sap. Stomata, structure, distribution, classification, mechanisms of opening and closing of stomata, guttation, transpiration, factors affecting transpiration. Different types of stresses: water, heat and cold tolerance, mechanism of tolerance. Plant nutrition: essentiality, mechanism of absorption, role in plant metabolism, Photosynthesis, importance of photosynthesis, Structure and function of chloroplast, dark and light reactions, CO<sub>2</sub> fixation, C<sub>3</sub>, C<sub>4</sub> and CAM, advantages of C<sub>4</sub> pathway, photorespiration and its implications. Factors affecting the photosynthesis. Respiration, glycolysis, TCA cycle and Electron transport chain, ATP synthesis and factors affecting the respiration. Photohormones, physiological role in controlling plant process. Environmental stimuli for plant development.

Economic importance and classification of horticultural crops and their culture and nutritive value, area and production, exports and imports, fruit and vegetable zones of India and of different states, nursery management practices, soil and climate, vegetable gardens, nutrition and kitchen garden and other types of gardens – principles, planning and layout, management of orchards, planting systems and planting densities. Production and practices

for fruit, vegetable and floriculture crops, nursery techniques and their management. Principles and methods of pruning and training of fruit crops, types and use of growth regulators in horticulture, water management, weed management, fertility management in horticultural crops, cropping systems, intercropping, multi-tier cropping, mulching, bearing habits, factors influencing the fruitfulness and unfruitfulness. Rejuvenation of old orchards, top working, frame working, principles of organic farming.

Definition and importance of Hydrology, Hydrological cycle, weather and hydrology, rainfall measurement and analysis, hydrologic properties, infiltration, runoff, water holding capacity of soils, free water, capillary water, hygroscopic water, ground water, evapotranspiration, water yield, interception by stemflow through fall, study of hydrographs. Recharging of water wells and springs. Wasteland Management: Objectives, components, runoff, factors affecting runoff, stream flow and stream gauging. Sedimentation, factors affecting sedimentation, flood and its control measures. Afforestation and forest management in wasteland areas. Soil erosion, universal soil loss equation, soil and water conservation practices and soil conservation structure like contour and graded bunding. Bench terracing and bench bank stabilization. Waterways their design, layout, construction, stabilization and maintenance. Methods of land leveling, its cost estimation, their location and design. Water harvesting structures and farm ponds. Irrigation Source: Water wells, aquifers, water application methods; surface, subsurface, drip and sprinkler irrigation system. Drainage: types of drainage systems, their selection, design, installation and maintenance.

Important breeds of cattle, buffalo, sheep and goat. Breeding and reproductive management for higher productivity – breeding systems, estrous cycle, heat detection and artificial insemination. Feeding management – types of feedstuffs available for feeding livestock. Feed nutrients and their functions in animal body. Assessing nutritive value of feed – estimation of feed nutrients by proximate and Van Soest methods, estimation of digestible nutrients and energy in feedstuffs. Principles of rationing. Milk – definition, composition and nutritive value. Factors affecting quantity and quality of milk. Prevention and control of diseases.

Basic concepts: Variable statistics, types and sources of data, classification and tabulation of data, construction of frequency distribution, tables, graphic representation of data, simple, multiple component and percentage, bar diagram, pie diagram, histogram, frequency polygon and frequency curve average and measures of location, mean, mode, median, geometric mean, harmonic mean, percentiles and quadriles, for raw and grouped data. Dispersion: Range, standard deviation, variance, coefficient of variation for raw and grouped data. Probability: Basic concept, additive and multiplicative laws. Theoretical distributions, binomial, poisson and normal distributions, sampling, basic concepts, sampling vs. complete enumeration parameter and statistic, sampling methods, simple random sampling and stratified random sampling. Tests of Significance: Basic concepts, tests for equality of means, and independent and paired t-tests, chi-square test for application of attributes and test for goodness of fit of mendelian ratios. Correlation: Scatter diagram, correlation co-efficient and its properties, regression, fitting of simple linear regression, test of significance of correlation and regression coefficient. Experimental Designs: Basic concepts, completely randomized design, randomized block design, latin square designs, factorial experiments, basic concepts, analysis of factorial experiments up to 3 factors – split plot design, strip plot design, long term experiments, plot size, guard rows.

Introduction to computer, Anatomy of Computers, Input and Output Devices. Memory, Hardware, Software and Classification of Computers. Classification of Computer applications. Generation of Computers. Computer Viruses. Number Systems. Operating Systems- DOS and Windows. Disk Operating System (DOS), Fundamental DOS Commands- FORMAT, DIR, COPY, PATH, LABEL, VOL, MD, CD, DEL, TREE. Rules for naming the file in DOS and types of Files. Windows: - GUI, Desktop and its elements,

Windows Explorer, working with files and folders; setting time and date, starting and shutting down Windows. Anatomy of Windows, Title bar, Minimize, Maximize and Close buttons, Scroll bars, Menus and Tool bars. Programming Concepts - Flow Charts and Algorithm, executing simple programs in C- language. Applications:- MS-Word, Processing and units of document, feature of word processing package. Editing, formatting and saving a document in MS-Word. Mail- Merge in Microsoft Word. MS-Excel:- Introduction of Spreadsheet, concept, packages. Creating, editing and saving spreadsheet in MS- Excel. Creating Graphs. MS-Power Point: - Features of Power Point package. MS-Access :- Concept of Database, SQL commands, database creation, form designing, query and report designing. Safeguards for Data security. Computer Network-LAN and its components, WAN, MAN, Network protocols- TCP/IP, HTTP and other. Internet- World Wide Web (WWW), WebBrowsing and Electronic Mail.

Extension education: meaning, definition, nature, scope, objectives, principles, approaches and history. Forestry extension: process, principles and selected programmes of leading national and international forest institutes. People's participation in forestry programmes. Motivation of women community, children, youth and voluntary organizations for forestry extension work. Rural Development: meaning, definition, objectives and genesis. Transfer of technology programmes like lab to land programme (LLP) national demonstration (ND), front line demonstration (FLD) Krishi Vigyan Kendras (KVK), Technology Assessment and Refinement Programme (TARP) etc. of ICAR. Communication: meaning, definition, elements and selected models. Audio – visual aids: importance, classification and selection. Programming planning process – meaning, scope, principles and steps. Evaluation: meaning, importance and methods. Scope and importance of Participatory Rural Appraisal (PRA) & Rapid Rural Appraisal (RRA). Management and administration: meaning, definition, principles and functions. Concepts of human resource development (HRD), rural leadership.

Entrepreneurship Development: Assessing overall business environment in the Indian economy. Overview of Indian social, political and economic systems and their implications for decision making by individual entrepreneurs. Globalization and the emerging business / entrepreneurial environment. Concept of entrepreneurship; entrepreneurial and managerial characteristics; managing an enterprise; motivation and entrepreneurship development; importance of planning, monitoring, evaluation and follow up; managing competition; entrepreneurship development programs; SWOT analysis, Generation, incubation and commercialization of ideas and innovations. Government schemes and incentives for promotion of entrepreneurship. Government policy on Small and Medium Enterprises (SMEs) / SSIs. Export and Import Policies relevant to forestry sector. Venture capital. Contract farming and joint ventures, public-private partnerships. Overview of forestry inputs industry. Characteristics of Indian forestry processing and export industry. Social Responsibility of Business. Communication Skills: Structural and functional grammar; meaning and process of communication, verbal and non-verbal communication; listening and note taking, writing skills, oral presentation skills; field diary and lab record; indexing, footnote and bibliographic procedures. Reading and comprehension of general and technical articles, précis writing, summarizing, abstracting; individual and group presentations, impromptu presentation, public speaking; Group discussion. Organizing seminars and conferences. \*\*\*\*\*

## 4. HORTICULTURE

Economics, importance, area and production of Horticultural crops, Export-import scenario of Horticultural crops, Classification of Horticultural crops, Agroclimatic zones of India for fruit and vegetables cultivation, Soil and climatic requirements of Horticultural crops, Vegetable gardens-Nutrition, garden, kitchen garden and other types, Ornamental gardens, Selection of site for establishing orchard, Layout and planting of an orchard, Planting systems and planting densities, Management of orchards, Special horticultural practices, Principles and methods of training and pruning of fruit crops, Classification of bio-regulators and their uses in Horticulture, Water management, weed management, mulching and nutritional management of Horticultural crops, Cropping systems-inter cropping, mixed cropping, mixed farming and multistoried cropping, Bearing habits in fruit crops, Fruitfulness, unfruitfulness; factors affecting unfruitfulness and remedies, Rejuvenation methods- top working, crown working, bridge grafting, etc, Canopy management of fruit crops, Organic farming – Definition and principles.

History importance and scope of ornamental gardening, Types of gardens, Ornamental industry: Area, production and industrial importance, Principles of gardening, Garden components and adornments, Types of lawn grasses and methods of lawn making, Rockery and methods of designing rockeries, Water Garden and methods of designing water gardens, Special types of garden (Japanese, English, Mughal ), Walk, paths, bridges, constructed features etc, Types of trees, their propagation and their planting, Types of shrubs and herbaceous perennials and planting, Types of climbers, creepers, cacti and succulents, Flower arrangement and Ikebana, Bioasthetic planting, its importance, urban planning, beautifying railway station, residential colonies etc, Bonsai and bonsai culture.

Composition of earth's crust, soil as a natural body – major components. Eluviations and illuviation formation of various soils. Problem soils; salt soils, permeable, flooded, sandy soil properties. Physical parameters; texture – definition, methods of textural analysis, Stock's law, assumption, limitations, textural classes, use of textural triangle; absolute specific gravity, definition, apparent specific gravity density – factors influencing, field bulk density. Relation between BD (bulk density), PD – practical problems. Pore space – definition. Factors affecting capillary and non-capillary porosity, soil colour – definition, its significance, parent material, soil moisture, organic matter, soil structure, definition, classification, clay prism like structure, factors influencing genesis of soil structure, soil consistency, plasticity, Atterberg's constants. Soil air, air capacity, composition, factors influencing, amount of air space, soil air renewal. Soil temperature, sources and distribution of heat, factors influencing, measurement, chemical properties, soil colloids, organic, humus, inorganic, secondary silicate, clay, hydrous oxides. Ion exchange, cation-anion importance soil organic matter decomposition, pH and nutrient availability, soil buffering capacity, soil, water, forms, hygroscopic, capillary and gravitational, soil moisture constants, hygroscopic coefficient, wilting point, field capacity, moisture equivalent, maximum water holding capacity, energy concepts, PF scale, measurement, gravimetric – electric and tensiometer methods – pressure plate and pressure membrane apparatus – Neutron probe – soil water movement – classification – aerial photography – satellite of soil features – their interpretation; soil orders; land capability classification; soil of different eco-system and their properties, management of problem soils – soils environmental quality. Irrigation water quality, determination of quality parameters, empirics equation management of irrigation water.

Historical background of genetics, theories and hypothesis. Physical basis of heredity, cell reproduction, Mitosis, meiosis and its significance. Gametogenesis and

syngamy in plants. Mendelian genetics-Mendel's principles of heredity, deviation from Mendelian inheritance, pleiotropy, threshold characters, co-dominance, penetrance and expressivity. Chromosome theory of inheritance, gene interaction. Modification of monohybrid and dihybrid ratios. Multiple alleles, quantitative inheritance linkage and crossing over, sex linked inheritance and characters. Cytoplasmic inheritance and maternal effects. DNA and RNA – as genetic material. Mutations and their classification. Chromosomal aberrations, changes in chromosome structure and number.

Extension education – History, Meaning, definition, nature, scope, objectives, principles and approaches. Horticultural extension - Selected programmes of leading national and international Horticultural institutes. Peoples participation in Horticultural programmes. Motivation of women community, children, youth and voluntary organizations for Horticultural extension work. Rural Development - Meaning, definition and objectives. Transfer of technology programmes like Lab to Land Programmes (LLP), National Demonstration Schemes (NDS), Front Line Demonstration (FLD), Krishi Vigyan Kendras (KVK), Technology Assessment and Refinement Programme (TARP) of ICAR. Communication - Meaning, definition, elements and selected models. Audio-visual aids - Importance, classification and selection. Programme planning process – Meaning, scope, principles and steps. Evaluation- Meaning, Importance and methods. Scope and importance of Participatory Rural Appraisal (PRA) and Rapid Rural Appraisal (RRA). Management and Administration - Meaning, definition, principles and functions. Concepts of human resource development (HRD). Leader- Meaning, Definition, types and role in Horticultural Extension.

Nature and scope of economics, definition and concepts, divisions of economics, economic systems, approaches to the study of economics. Consumption – theory of consumer behaviour, laws of consumption, classification of goods. Wants – their characteristics and classification, utility and its measurement, cardinal and ordinal, law of diminishing marginal utility, law of equi-marginal utility, indifference curve and its properties, consumer equilibrium. Theory of demand, demand schedule and curve, market demand. Price, income and cross elasticities, Engel's law of family expenditure – consumer's surplus. Theory of firm, factors of production – land and its characteristics, labour and division of labour, theories of population. Capital and its characteristics – classification and capital formation. Enterprises – forms of business organization – merits and demerits. Laws of return – law of diminishing marginal return – cost concepts. Law of supply – supply schedule and curve elasticities. Market equilibrium, distribution – theories of rent, wage, interest and profit. Price determination and forecasting under various market structures.

Agricultural meteorology, its importance in Agriculture Weather and climate, weather elements and factors affecting them. Earth's atmosphere, composition and structure of atmosphere. Solar radiation – nature, properties, depletion, factors affecting solar radiation, solar constant and energy balance. Atmospheric temperature – factors affecting temperature, importance of air temperature, horizontal and vertical distribution and variations in temperature and global warming. Soil temperature – importance of soil temperature, variation of soil temperature. Air pressure – Variations, isobars and pressure gradients. Wind – Types, classification, importance of wind in Agriculture, forces acting to produce wind, cyclones, anticyclones and general circulation system of earth. Atmospheric humidity – saturated and actual vapour pressure, specific and relative humidity, diurnal variation of humidity. Process of condensation, formation of dew, fog, frost, mist, snow, rain and hail. Cloud – types, formation and classification. Precipitation – hydrologic cycle, types of rain – thunder and hail storms, types of monsoon, agricultural seasons. Drought – its classification, strategy to mitigate drought. Microclimate Weather forecasting – Basics, types and importance of weather forecasting. Remote sensing and introduction to crop modeling.

Introduction to Computers, Anatomy of Computers, Input and Output Devices. Units of

Memory, Hardware, Software and Classification of Computers. Personal Computers, Types of Processors, booting of computer, warm and cold booting. Computers Viruses, Worms and Vaccines. Operating System – DOS and WINDOWS. Disk Operating System (DOS): Some fundamental DOS Commands, FORMAT, DIR, COPY, PATH, LABEL, VOL, MD, CD and DELTREE, Rules for naming files in DOS and Types of files. WINDOWS: GUI, Desktop and its elements, WINDOWS Explorer, working with files and folders; setting time and date, starting and shutting down of WINDOWS. Anatomy of a WINDOW, Title Bar, Minimum, Maximum and Close Buttons, Scroll Bars, Menus and Tool Bars. Applications – MSWORD: Word, processing and units of document, features of word-processing packages. Creating, Editing, Formatting and Saving a document in MSWORD; MSEXCEL: ELECTRONIC Spreadsheets, concept, packages. Creating, Editing and Saving a spreadsheet with MSEXCEL. Use of in-built Statistical and other functions and writing expressions. Use of Data Analysis Tools, Correlation. Creating Graphs. MS Power Point: Features of Power Package. MSACCESS: Concept of Database, Units of database, creating database; Principles of Programming: Flow Charts and Algorithms, illustration through examples. Internet: World Wide Web (W W W), Concepts, Web Browsing and Electronic Mail.

History and Scope of Microbiology: The discovery of micro-organism, spontaneous generation conflict, germ theory of diseases, microbial degradation of organic and inorganic matter. Development of microbiology. Microscopy and Specimen Preparation: The bright field microscope, fixation, dyes and simple staining, differential staining. Composition of microbial world. Morphology and general characters of bacteria, fungi, algae, actinomycetes and related organisms. Difference between prokaryotic and eukaryotic cells. Prokaryotic cell structure and functions. Types of culture media and pre-culture techniques. Microbial growth: growth curve. Measurement of bacterial growth. General properties of viruses and brief description of bacteriophages. General principle of bacterial genetics, DNA as genetic material. Antibiosis, symbiosis, intra-microbial and extra-microbial association.

Propagation: Definition and potentialities for plant multiplication Sexual and asexual methods of propagation their advantages and disadvantages, different methods for breaking dormancy. Seed dormancy internal and external factors affecting seed dormancy different seed treatments. Apomixis, monoembryony, polyembryony, chimera etc. Propagation Structures:- Mist chamber, humidifiers, greenhouses, glasshouses, cold frames, hot beds, poly houses, etc. Use of growth regulators in (seed, vegetables, tissue culture) propagation. Methods and techniques of vegetative propagation - cuttings, layering, grafting and budding, Physiological and bio chemical basis of rooting, factors influencing rooting of cuttings and layering, factors affecting grafting, graft incompatibility. Anatomical studies of bud union. Selection and maintenance of mother trees. Collection, storage and transport of scion sticks, scion and root stock relationship. Bud wood certification. Techniques of propagation through specialized organs, such as bulbs, tubers, rhizomes, corms, runners. Suckers, etc. Micropropagation, hardening of plants in nursery. Selection of site for nursery. Features of nursery. Nursery registration act. Plant protection in nursery management.

Growth and development, definition, components growth, phases in Horticultural crops. Different stages of growth, growth analysis in Horticultural crops. Plant bioregulators auxin, gibberellin, cytokinin, ethylene, inhibitor and retardants: Basic functions and bio synthesis. Role of bio regulators in crop growth and development. Role of bio regulators flowering, fruit setting, fruit thinning, fruit drop, fruit ripening. Factors affecting flowering, physiology of flowering. Photoperiodism long day short day and neutral plants, utilization and its application in horticulture. Developmental processes like juvenility, senescence. Physiology of seed development and maturation. Seed dormancy and bud dormancy, causes and dormancy breaking methods in Horticultural crops. Physiology of fruit growth and development. Factors affecting fruit set and fruit development. Physiology of ripening of fruits climacteric and non climacteric fruits. Sex expression and its relationship.

Soil as medium for plant growth. Soil fertility and productivity, meaning & difference. Methods of soil fertility evaluation, Visual, chemical and biological methods. Essential plant

nutrients macro & micro nutrients forms, moment, their role and deficiency symptoms and Correction measures. Mechanism of nutrient uptake active & passive. Problematic soils : Saline, saline-sodic, sodic, acid and calcareous soils their reclamation and management. Green manuring types, advantages, disadvantages their method. Organic manures, sources, biogas slurry, sewage, sludge. Agro industrial and urban waste, sewage water. Organic manures, composition, role and importance in soil fertility. Organic and natural farming. Nitrogenous fertilizer, Classification, content and reaction in soil. Phosphatic & potashic fertilizers, classification Properties their behavior in soil. Mixed, Complex and Compound fertilizers. Fertigation. Slow release fertilizers. Biofertilizers, Classification, importance & role. Fertilizer management Rain fed & irrigated. Fertilizer use efficiency, improvement. Handling and storage of fertilizers. Integrated nutrient management Concept, Component & utility. Ecofriendly farming & sustainable agriculture. Soil pollution by agrochemicals.

Importance of water. Water resources in India. Irrigated area of different crops. Functions of water for plant growth. Effect of moisture stress and excess moisture on crop growth. Available and unavailable soil moisture, water budgeting. Distribution of soil moisture, classification of crops on the basis of rooting depth. Water requirement of horticultural crops. Use of pan evaporation, it's relation to requirement of water for plant growth. Critical stages of crop growth in respect of irrigation. Scheduling of irrigation – approach to fruit crops. Scheduling irrigation to vegetables. Methods of irrigation. Pressurized methods – Sprinkler and drip irrigation system. Merits and demerits along with suitability of irrigation system. Quality of irrigation water – it's role in horticultural crop production.

Plant Breeding as dynamic science, genetic basis of Plant Breeding- classical, quantitative and molecular, Plant Breeding in India – limitations major achievements, goal setting for future, Sexual reproduction (cross and self pollination ), asexual reproduction, pollination control mechanism (incompatibility and sterility and implications of reproductive systems on population structure). Genetic components of polygenic variation and breeding strategies, selection as a basis of crop breeding. Hybridization and selection – goals of hybridization, selection of plants; population developed by hybridization- simple crosses, bulk crosses and complex crosses. General and special breeding techniques. Heterosis- concepts, estimation and its genetic basis.

Water Relation in Plants: role of water in metabolism, osmosis inhibition, diffusion, water potential and its components, measurement of water potential in plants, absorption of water, mechanism of absorption and ascent of sap. Stomata: Structure, distribution, classification, mechanism of opening and closing of stomata. Osmotic pressure, guttation, from bleeding: transpiration methods and mechanism and factors affecting transpiration. Drought: Different types of stresses; water heat and cold tolerance; mechanism of tolerance. Plant Nutrition: Essentiality, mechanism of absorption and its role in plant metabolism. Photosynthesis, structure and function of chloroplast, dark and light reactions, cyclic and non-cyclic electron transfer, CO<sub>2</sub> fixation – C<sub>3</sub>, C<sub>4</sub> and C<sub>4</sub> metabolism, Advantages of C<sub>4</sub> pathway. Photorespiration and its implication, factors affecting photosynthesis. Phytohormones, physiological role in controlling plant process. Environmental stimuli for plant development.

Introduction to the science of phytopathology, its objectives, scope and historical background. Classification of plant diseases, symptoms, signs, and related terminology. Parasitic causes of plant diseases (fungi, bacteria, fastidious bacteria, viruses, phytoplasma, protozoa, algae and flowering parasitic plants), their characteristics and classification. Non-parasitic causes of plant diseases. Infection process - host pathogen relationship, avenues of penetration, parasitism. Survival and dispersal of plant pathogens. Plant disease epidemiology, forecasting and disease assessment. Principles and methods of plant disease management. Integrated plant disease management.

Definition, division and scope of entomology, classification of phylum Arthropoda and relationship of class insecta with other classes of Arthropoda. Importance of class insecta-

Harmful insects and beneficial insects, dominance of class Insecta. Body segmentation, structure of head, thorax and abdomen. Structure and functions of insect cuticle and moulting. Structure and modification of mouthparts (Chewing and biting, piercing and sucking, chewing and lapping, sponging). Structure and modifications of insect antenna. Structure and modifications of insect leg. Wing venation, modifications and wing coupling apparatus. Sensory organs. Anatomy of digestive system and circulatory system. Anatomy of excretory system. Anatomy of nervous system and endocrine system. Anatomy of male and female reproductive system. Postembryonic development – eclosion, metamorphosis, its types and diapause in insects. Classification of class insecta upto order. Distinguished characters and economic importance of orders (Lepidoptera, Coleoptera and Hemiptera). Distinguished characters and economic importance of orders (Hymenoptera, Diptera, Neuroptera, Orthoptera and Isoptera).

Definition of Statistics, its use, limitations; Frequency Distribution and Frequency Curves; Measures of Central Tendency; Characteristics of Ideal Average, Arithmetic Mean; Median, Mode and their Merits and Demerits; Measures of Dispersion;- Standard Deviation, Variance and Coefficient of Variation; Probability:- Definition and concept of probability; Normal Distribution and its properties; Introduction to Sampling:- Random Sampling; the concept of Standard Error, Tests of Significance – Types of Errors, Types of Hypothesis, Level of Significance and Degrees of Freedom, Steps involved in testing of hypothesis;- Large Sample Test – SND test for Means, Single Sample and Two Samples (all types); Small Sample Test for Means, Student's t-test for Single Sample, Two Samples and Paired t-test. F-test; Chi-Square Test in 2 X 2 Contingency Table, Yates' Correction for continuity; Correlation:- Types of Correlation, Scatter Diagram, Computation of Correlation Coefficient 'r' and its testing, Linear Regression: of Y on X and X on Y. Inter-relation between 'r' and regression coefficients. Experimental Designs:- Basic Principles, Completely Randomized Design (CRD), Layout and analysis with equal and unequal number of observations, Randomized Block Design (RBD), Layout and analysis, Latin Square Design (LSD), Layout and analysis.

Horticultural classification of fruits. Horticultural zones of India importance and scope of tropical and sub-tropical fruit crops, detailed study of area, production and export potential, varieties, climate and soil requirements, propagation techniques, planting density and systems, after care, training and pruning. Management of water, nutrient and weeds, special horticultural techniques including plant growth regulators, and use in commercial orchards. Physiological disorders. Post-harvest technology, harvest indices, harvesting methods, grading, packaging and storage of the following crops. Mango, banana, grapes, citrus, papaya, sapota, guava, pineapple, Litchi, fig. and pomegranate. Bearing habits in mango and citrus, causes and control measures of special production problems, alternate and bearing in mango and citrus, overcome, control measures., citrus decline and casual factors and their management. Bud forecasting in grapes, sex expression and seed production in papaya, latex extraction and crude papain production, economic of production.

Importance and scope of tropical and sub tropical vegetable and tuber crops, Area, production, export potential of tropical and sub-tropical vegetable and tuber crops, vegetable farming and its types. Climate and soil requirements, seed rate, land preparation, Raising of nursery, transplanting of vegetable crops and planting for directly sown/ transplanted vegetable crops. Spacing, planting systems, water and weed management; nutrient management, improved varieties and hybrids, deficiencies, physiological disorder use of growth regulators harvesting, grading, storage and yield economic crops and marketing of tomato, brinjal, chilli, capsicum okra, amaranthus, cluster beans, cowpea, lab-lab, snap bean, dolichos bean, cucurbits, moringa, curry leaf, agathi, portulaca and basella, sweet potato, colocasia, dioscorea, amorphophallus xanthosoma, tapioca.

Importance and present status of post harvest technology in horticultural crops in India and Maharashtra. Maturity, types of maturity and factors affecting maturity of horticultural crops. Maturity indices of fruits and vegetables Harvesting grading and handling of fruit, vegetables and cut flowers. Maturity indices of cut flowers, rose, gerbera,

carnation, anthurium, lily, tuberose, chrysanthemum. Harvesting, grading, handling of above cut flowers. Maturity indices, harvesting, grading, handling of medicinal and aromatic plants. Pre-harvest factors affecting post harvest quality of horticultural crops. Handling of commodity before packaging. Physiological and biochemical changes during ripening of fruits. Ripening of fruits, role of ethylene. Hastening and delaying ripening process. Post harvest treatments of horticultural crops to increase the shelf life. viz. disinfection treatments like VHT, Hot water treatment fungicidal chemical irradiation etc. Quality parameters & specification of fruits, vegetables and flowers for export. Methods of storage for local and export market. Packaging- importance, methods and types, cushioning.

History, scope and importance, area and production, uses, export potential and role of spices and condiments in national economy. Classification, soil and climate, propagation-seed, vegetative and micro-propagation systems and methods of planting. Nutritional management, irrigation practices, weed control, mulching and cover cropping. Training and pruning practices, role of growth regulators, shade crops and shade regulation. Harvesting, post-harvest technology, packaging, storage, value added products, methods of extraction of essential oil and oleoresins. Economics of cultivation, role of Spice Board and Pepper Export Promotion Council, institutions and research centers in R&D. Crops: Cardamom, black pepper, ginger, turmeric, clove, nutmeg, kokum, cinnamon, allspice, curry leaf, coriander, fenugreek, fennel, cumin, dill, celery, bishops weed, saffron, vanilla, thyme and rosemary.

History, scope of gardening aesthetic values Gardens in India, types of garden Landscaping, historical background and values of landscaping Principles, basic components and elements of landscape design Plant material for landscaping symbols, tools and implements used in landscape design Layout of formal gardens, informal gardens Special types of gardens (bog garden, sunken garden, terrace garden, rock garden) Special types of gardens trees their design and walk paths, bridges, constructed features Principles of gardening, garden components, adornment, lawn making, methods of designing rockery, water garden Floriculture industry, importance, area and production industrial importance in India Green house and lath house Propagation, planting shrubs and herbaceous perennials Importance, design values, propagation, planting climbers and creepers Propagation, planting palms, ferns, grasses, cacti and succulent Flower arrangement, importance production details, cultural operations and constraints Post harvest practices, bioaesthetic planning, definition need Country planning, urban planning Planting avenues, schools and villages Beautifying railway stations, dam sites, hydro electric stations, colonies, river banks Planting material for play grounds vertical gardens and roof gardens Culture of bonsai, art of making bonsai, parks and public gardens Landscape design for specific areas.

Weeds: Introduction, harmful and beneficial effects, classification, propagation and dissemination; Weed biology and ecology, crop weed association, crop weed competition and allelopathy. Concepts of weed prevention, control and eradication; Methods of weed control: physical, cultural, chemical and biological methods. Integrated weed management; Herbicides : definition, advantages and limitation of herbicide usage in India, Herbicide : classification, formulations, methods of application; Introduction to Adjuvants and their use in herbicides; Introduction to selectivity of herbicides; Mode of action of herbicide : translocation and absorption, persistence and fate of herbicides. Introduction of selectivity of herbicide, Compatibility of herbicides with other agro chemicals. Weed management in major horticultural crops, shift of weed flora in cropping systems. Aquatic and problematic weeds and their control.

Symptoms, etiology, mode of spread, epidemiology and integrated management of diseases of the following vegetables, ornamental and spice crops: tomato, brinjal, chili, okra, cabbage, cauliflower, radish, knol-khol, broccoli, pea, beans, beet root, onion, garlic, fenugreek, and other leafy vegetables, ginger, potato, turmeric, pepper, cumin, cardamom,

nutmeg, coriander, clove, cinnamon, jasmine, rose, gerbera, crossandra, tuberose, carnation, chrysanthemum, marigold, gladiolus, geranium. Important post-harvest diseases of vegetables and ornamental crops and their management.

Carbohydrates : Occurrence, classification and structure, physical and chemical properties; isomerism, optical activity, reducing property reactions with acid and alkalies , osazone formation. Lipids – definition, classification, important fatty acids , triglycerides, essential fatty acids. Physical and chemical properties of oil/ fat, rancidity , phospholipidsits types and importance Plant pigments – definition. Classification. Structure and function of chlorophyll and carotenoids Sterols : definition, classification, structure, role of brassinosterols in plant. Proteins : definition, classification, function, solubility, Amino acids classification, structure, essential amino acids, properties of amino acids, different reactions like colour reactions, amphoteric nature and isomerism. Structure of proteins – primary tertiary and quaternary proteins, their properties and reactions. Enzymes – definition, classification, mechanism of action and factors affecting enzymes action. Co-factor and co-enzymes; vitamins and minerals as coenzymes / co-factor Carbohydrate metabolism, glycolysis and TCA cycle Metabolism of lipids and fatty acid biosynthesis of fatty acids Electron transport chain, bioenergetics of glucose and fatty acid Nucleic acid replication, transcription and translation.

Fruit breeding - History, Centers of origin, importance of centre of origin and scope of fruits breeding, objectives of fruit and plantation breeding, modes of reproduction apomixes and its types, agencies of pollination, type of incompatibility, sterility distribution, domestication and adaptation of commercially important fruits, variability for economic traits, breeding methods in production, selection – clonal selection, mutation, polyploidy and hybridization in crop improvement policy manipulations *in vitro* breeding tools (important fruit mango, banana , papaya, citrus, grape, guava sapota, pomegranate, arecanut, cashew, coconut, coffee, cocoa, oil palm, rubber, tea, and annona, ber, onla, kokum.).

Definition, importance and scope, present status of Arid fruit crops, classification of Arid regions in the country, Problems and constraints in fruit production in arid regions. Soil and agro-climatic condition of the arid regions, Detail cultivation of Aonla, Tamarind, Annona, Ber, Karonda, Woodapple, Jamun and phalsa with respect to origin, botany, soil, climate, propagation, layout and planting, spacing, nutrition and irrigation management, interculture horticultural practices, varieties, harvesting, yield, grading and storage, important pest and diseases and their management, Brief information about cultivation on above aspects of Jamun, woodapple, Charoli, Marking nut, passion fruit, Loquat, Litchi, Phalsa, Jackfruit. special horticultural practices for arid and minor fruit crops such as training, pruning use to plant growth regulators and chemicals, mulching, terracing, intercropping. Handling and storage.

Importance and scope of cool season vegetable crops in nutrition and national economy. Area, production, export potential, description of varieties and hybrids, origin, climate and soil, production technologies. Marketing of cabbage, cauliflower, Knolkhol, Sprouting broccoli, Brussels sprout, Lettuce, Palak, Chinese cabbage, Spinach, Garlic, Onion, Leek, Radish, Carrot, Turnip, Beet root, Peas, Broad beans, Rhubarb, Asparagus, Globe artichoke and Potato.

Scope and importance of commercial floriculture in India and Maharashtra. Production techniques of floricultural plants like Rose, Chrysanthemum. Carnation, Gerbera, Gladiolus, Marigold, Gaillardia Tuberose, Jasmine, China Aster, Dehlia and Lily\*. Production of above crops for domestic and export market with special reference to maturity, packaging and transport needs. Production techniques of above floricultural crop under poly house and net house conditions. Post harvest management of cut flowers. Dehydrated flower trade in India. its scope and present status. Post harvest technology for loose flowers. Flower arrangement and value addition in Floriculture.

Introduction, concept, relevance in present context; Organic production requirements; Biological intensive nutrient management-organic manures, vermicomposting greenmanuring, recycling of organic residues, biofertilizers; Soil improvement and amendments. Integrated diseases and pest management - use of biocontrol agents, biopesticides pheromones, trap crops, bird perches; Weed management; Quality considerations, certification, labeling and accreditation process marketing and export.

Symptoms, etiology, modes of spread, epidemiology and integrated management of the diseases of fruits, plantation, medicinal and aromatic crops viz . mango, banana, grape, citrus, guava, sapota, papaya, jackfruit, pineapple, pomegranate, ber, apple, pear, each, plum, almond, walnut, strawberry, atoca nut, coconut, custard apple, fig, pineapple, jamun, aonla, oil palm, coffes, tea, cocoa, cashew, rubber, betelvine, senna, neem, hemp, belladonna, pyrethrum, camphor, costus, crotalaria, datura, dioscorea, mint; opium, Solanum khasianum and tephrosia. Important post-harvest diseases of fruit, plantation, medicinal and aromatic crops and their management.

History, scope and constraints in the cultivation and maintenance of medicinal and aromatic plants in India. Importance, origin and distribution, area, production, climate and soil requirements, propagation and nursery techniques, planting and after care, cultivation practices, training and pruning, nutritional and water requirement. Plant protection, haresting and processing of under mentioned important medicinal and aromatic plants, extraction, use and economics of drugs and essentials oils in medicinal aromatic plants. Therapeutic and pharmaceutical uses of important species. Medicinal Plants : Betelvine, periwinkle, rauvolfia, dioscorea, isabgol, belladonna, cinchona, ashwangandha, safed musali, stevia, aloevera, adulsa, panpimpili, asparagus, wild brinjal and other species relevant to local conditions. Aromatic plants : Citronella grass, palma rosa grass, lemon grass, khas grass, lavender, geranium, patchouli, menthe and other species relevant to the local conditions.

Farm management definition, nature, characteristics and scope. Farm management principles and decision making, production function, technical relationships, cost concept, curves and functions- factors, product, relationship factors relationship, product relationship, optimum conditions, principles of opportunity cost equi-marginal returns and comparative advantages, time value of money, economic of scale, returns to scale, cost of cultivation and production, break even analysis, decision making under risk and uncertainty. Farming systems and types planning meaning, steps and methods of planning, types of plan, characteristics of effective plans. Organizations - forms of Business organizations, organizational principles, division of labour. Unity of command, scalar pattern, job design, span of control responsibility, power authority and accountability. Direction - guiding, leading, motivating, Supervising, Coordination - meaning, types and methods of controlling evaluation. Control system and devices. Budgeting as a tool for planning and control. Record keeping as a tool of control. Functional areas of management operations management physical facilities, implementing the plan, scheduling the work, controlling production in terms of quantity and quality. Materials management - types of inventories, inventory costs. Managing the inventories, economic order quantity (EOQ), Personnel management-recruitment, selection training, job specialization. Marketing management-definition, planning the marketing programmes, marketing mix and four P's. Financial management – financial statements and rations, capital budgeting. Project management- project preparation evaluation measures.

Importance and scope vegetable breeding. History, Centres of origin, plant bio-diversity and its conservation. Methods of reproduction, agencies of pollination and mechanism in self and cross pollinated crops. Self-incompatibility and male sterility, its classification and application. in crop improvement objective of breeding of vegetable crops, exploitation of hybrid vigour, polyploidy breeding resistance breeding, mutation breeding. Breeding methods for crop improvement in Crops viz., Solanaceous vegetables, cole crops, cucurbits, bulb

crops, root crops, leafy vegetables, okra, leguminous crops, tropical tuber crops.

Importance and scope of temperate fruits and plantation crops. Classification of temperate fruits and plantation crops. Area and production of temperate fruit in India and Maharashtra. Export and import potential of temperate fruits and plantation crops. Role of temperate fruit crops and plantation crops in national economy, Uses and industrial importance. Propagation techniques in Apple, Pear, Peach, Apricot, Cherry, Persimmon, Strawberry, Kiwi, Almond, Walnut, Pecan nut, Coconut, Areca nut, oil palm, Cacao, Cashew nut, Coffee, Tea, and Rubber. Training, Pruning, Use of plant growth regulators, Nutrient and weed management, harvesting of above crops. Important insect pest and diseases and their control measures on above crops.

Definition, objectives and importance, integration, advantages and constraints. Distinction between agroforestry and social forestry. Status of Indian forests and role in India of agroforestry. Classification of agroforestry system, subsystem and practice : agri silviculture, silvipastoral, horti-silviculture, horti-silvipastoral, shifting cultivation, taungya, home gardens, alley cropping, intercropping, wind breaks, shelterbelts and energy plantations. Planning for agroforestry - constraints, diagnosis and design methodology, selection of tree crop species for agro-forestry. MPTS - their management practices, economics of cultivation - nursery and planting (*Acacia catechu*, *Dalbergia sissoo*, *Tectona*, *Populus*, *Morosa*, *Grewia*, *Eucalyptus*, *Quercus spp.* and bamboo, tamarind, neem etc.).

Importance and scope of protected cultivation, scope in India. Different types of protective cultivation.. Plant environment interaction. Crops for green house cultivation. Green house ventilation, cooling system, green house heating, CO<sub>2</sub> enrichment, light control. Irrigation and nutrient management. Disease and pest control of green house plant. Green house production, handling packaging and marketing of green produce. Recommendations of last five years Joint Agresco.

Environment: introduction, definition and importance. Components of environment - interactions with organisms. Global and Indian environment – past and present status. Environmental pollution and pollutants. Air, water, food, soil, noise pollution- sources, causes and types. Smog, acid rain, global warming, ozone hole, eutrophication, sewage and hazardous waste management. Impact of different pollutions and humans, organisms and environment. Introduction to biological magnification of toxins. Deforestation- forms and causes, relation to environment, Prevention and control of pollution – technological and sociological measures and solutions- Indian and global efforts. India, international and voluntary agencies for environmental conservation- major achievements. Environmental policy and legislation in India. Introduction to environmental impact assessment. Causes of environmental degradation – socio- economic factors. Human population growth and lifestyle.

General-economic classification of insects. Ecology and insect pest management with reference to fruit, plantation, medicinal and aromatic crops. Pest survey and monitoring and its importance in IPM. Distribution, host range, bio-ecology, injury integrated management of important pests affecting. Citrus : Major : Lemon butterfly, leaf miner, citrus psylla white fly and black fly, fruit sucking moth bark eating caterpillar. Minor : Aphid, Mealy bug and Nematodes. Mango : Major : Jassids/hoppers; fruit fly, stone weevil stem borer, mealy bugs, bark eating caterpillar. Minor : Scale, Red ants, shoot borer. Grapevine : Major : Flea beetle, Thrips, Mealy bug mites, Minor : Stem borer, cockchafer beetle. Pomegranate : Major : Fruit borer, Mealy bug, Thrips, Scale insects, white fly. Minor : Aphid, fruit sucking moth, mites, pin hole borer. Guava and fig : Major : Pest of Guava - fruit fly, spiraling, white fly, bark eating caterpillar. Minor: Scales, mealy bugs Fig Major : Jassids, scales, mealy bugs, Minor: Mite, stem borer. Banana, Papaya and Custard apple Banana Major: Root stock weevil, Aphid. Minor: Burrowing nematodes Papaya Major : Aphid, whitefly, Custard apple : Meal bug. Ber : Major : Ber fruit borer, ber fruit fly Minor : Hairy caterpillar, jassids, Sapota : Major: Chiku

moth, Seed borer I Minor: Mealy bugs. Cashewnut : Major : Tea mosquito, Minor: Leaf eating caterpillar Coconut, Arecanut and other palm trees and cashewnut Major: Rhinoceros beetle, Red palm weevil, Black headed caterpillar, Rat. Minor: Termite, mite, scales, mealy bugs. Tea , Coffee Apple, pear, peach, plum Beetle vine and Rubber Insect pests of stored fruits plantation of medicinal and aromatic plants and their management. IPM of stored fruits, plantation and medicinal and Aromatic Plants, Pests of Shatawari and Ashwaganda. Pests of Opium and Mentha, Pests of Wild brinjal and Sweet flag, Pests of Cinchona, Senna, belladonna, Pests Pachouli Isabgol and Dhatura. Pest of Rose, Pests of Vetivar and Davana. Pests of Kevara and Citronella. Pests of Geranium, Palmarose and lemongrass, Pests of Eucalyptus, Pests of Sandalwood, Pests of Neem, Tephrosia and Camphur, Insecticide residue problems in fruit plantation, medicinal and aromatic plants and their tolerance limits.

Studies on pests of potato : Tubber moth, cutworm, aphids. jassids, leaf eating caterpillar, epilachna beetle, mites. Sweet potato and Yam : - Sweet potato : Sweet potato leaf eating caterpillar, sweet potato weevil, Yam : Yam beetle, mealy bugs, scale insects, sawfly. Brinjal : Shoot and fruit borer, jassids, aphids, white fly, grey weevil, hadda beetle, mites.

Bell pepper-Thrips, mites, cutworm, fruit borer, whitefly capsicum. Onion and garlic: Onion thrips, cutworm, onion fly, Earwig. Toamto : Fruit borer, leaf eating caterpillar, white fly, mealy bugs, aphids, leaf miner. Okra : Shoot and fruit borer, leaf roller, jassids, aphids, mites, whitefly. Peas and beans : Pod borer, aphids, stem fly, pulse beetle, mites.

Cruciferous and root crops : Diamond back moth, mustard sawfly, aphids, (Cabbage, cauliflowers, radish, carrot) cabbage butterfly, leaf miner. Cucurbits : Fruit fly, pumpkin beetles, blister beetle, Hadda beetle. Leafy vegetables : Cutworm, leaf eating caterpillar, aphids, leaf miner, (Amaranthus, coriander, methi, spinach, radish, salad crops) leaf hopper, mustard sawfly. Roses : Aphids. jassids, thrips, mites scale insects, bud borer, leaf eating caterpillar, leaf cutting bees, Digger wasp, termites. Chrysanthemum & marigold : Aphids, thrips, white fly, jassids, leaf miner, lace bug, mites, bud borer, leaf miner, slugs. Jasmin & Tuberose : Bud worm, gallary worm, tingid bug, mites, scales, rose bud borer, aphids thrips, mites. Aster : Leaf hopper, black blister beetle, leaf miner, aphids, mites. Gladiolus : Seed corm maggot, aphids, thrips, mites, cutworm. Gerbera & : White fly, leaf miner, mites, leaf eating caterpillar, rose bud borer. Carnation : Red spider mite, aphids, thrips, rose bud borer. Studies on pest of lily, anthurium and orchids. Integrated pest management in polyhouse. Studies on pests of black pepper. Clove. Cinnamon I Cardamom Nutmeg and Mace Curry leaf Coriander, Cumin and Fennel Turmeric and Ginger, Chilli - Thrips, mites, cutworm, aphids, termites, white fly. Studies on polyphagous pests. Studies on non-insect pests and their management.

Sources of farm power in India Human, Animal, Mechanical, electrical, Wind Power, Scope of Mechanization, Principle of operation of I.C. engine I.C. engine working principles, Two and Four stroke engine, Engine terminology and examples, I.C. Engine systems Fuel supply system, cooling system, Air cleaner, Tractor Tractor types and their selection, fixed and operating cost of tractors with examples, Tillage Tillage, objectives of tillage, classification and types of tillage, Tillage implements, Primary tillage implements M. B. plough and Disc plough with examples, ploughing of land and method of ploughing, Secondary tillage implements Harrows, cultivators and examples, Seed drills Sowing methods, seed drill, components of seed drill, seed metering mechanism, types of furrow openers, calibration of seed drill, examples, Study of planter Planter, Functions, seed metering devices, type of planters, Plant protection equipments Classification, types of spraying and types of dusting machines, Harvesting and threshing equipments Definition of harvesting and threshing, harvesting/threshing methods, implements and combine harvester-thresher, Equipment for land development and soil conservation Clod crusher, leveler, bund former, animal drawn scoop, earth moving machinery.

History of improvements of ornamental plants, objectives and techniques in ornamental plant breeding. Introduction, selection, hybridization, mutation and biotechnological technique for improvement of ornamental plants. Breeding for disease resistance. Development of promising cultivars of important ornamentals. Role of heterosis and its exploitation, production of FI hybrids and utilization of male sterility, production of open pollinated seed. Harvesting

processing and storage of seeds, seed certification.

History of seed industry in India. Definition of seed.. Importance and scope of vegetable seed production in India. Principles of vegetable seed production. Role of temperature, humidity and light in vegetable seed production. Isolation distances in vegetables and agencies of pollination. Methods of seed production of cole crops, root vegetables, solanaceous vegetables, cucurbits, leafy vegetables, bulb crops, leguminous vegetables, okra. Seed testing and purity analysis. Field and seed standards. Seed processing, drying and extraction. Seed act.

Importance and scope, current status, future prospects and problems of protected cultivation. Protected structures, designs and fabrication. Classification of green houses and factors affecting the construction of green house. Environment control in green house viz. Temperature, light, relative humidity (RH), CO<sub>2</sub> enrichment and ventilation or air circulation. Production system and media for protected cultivation. Drip irrigation and fertigation in protected vegetable cultivation. Production of green house Capsicum, Cucumber, Melons, Tomato, Cherry Tomato. Production of vegetables under net houses (Capsicum, Beans, Tomato, Coriander, Methi) and offseason cultivation of vegetables under plastic low tunnels. Disease management and pests management of vegetable crops under protected cultivation. Grading, packaging, transport technology of Vegetables. Constraints in green house vegetable cultivation.

Importance and scope of fruit and vegetable preservation industry in India, Post harvest losses. Principles and guide lines for processing unit. Principles and methods of preservation viz., heat, pasteurization, canning and bottling. Preservation by sugar and chemicals. Fruit Beverages. Preparation and preservation of unfermented fruit beverages viz., juices, squash, syrup and cordial etc. Fermented beverages-nira, wine, Cider. Preparation of jam jelly and marmalade. Preserve, candied and crystallized fruits. Preservation with salt and vinegar. Preparation of chutneys and sauces/ ketchups. Mushroom processing. Processing of Plantation crops. Spoilage in Processed foods. Quality control of Processed products, Govt. policy on import and export of Processed fruits, food laws. Recommendations of JOINT AGRESCO of last five years.

History, scope and importance of biotechnology, organogenesis and effect of plant growth regulators, somatic embryogenesis and artificial seeds, callus culture and single cell culture, suspension culture and secondary metabolites, micropropagation, meristem culture and production of disease free plants, anther and pollen culture, embryo culture and embryo rescue technique, somaclonal variation, protoplast isolation and protoplast culture and protoplast fusion, somatic hybridization and cybridization, methods of plant transformation, transgenic plants and their application, molecular markers and their application, cryopreservation.

History of development of Nematology- Definition, economic importance. General characteristics of plant parasitic nematodes. Nematode general morphology, taxonomy and biology. Classification of nematodes. Symptomatology. Control of important plant parasitic nematodes of fruit crops : Pomegranate, Grapes, Fig, Citrus, strawberry, Cashewnut. Vegetable crops : Tomato, Brinjal, Okra, Chilli and Cucurbit etc. Tuber and bulb crops : Potato, Sweet potato, Carrot, Radish, and Onion. Ornamental crops : Chrysanthemum, Rose, Tuberose, Gladiolus, Carnation and Gerbera. Spices : Turmeric, Ginger, Cardamom and Clove. Plantation crops : Banana, Arecanut and Coconut.

Entrepreneur: Meaning, definition, characteristics and role, demands of entrepreneur, identifying potential entrepreneurs. Entrepreneurship development - Concept of entrepreneurship, process of entrepreneurship development, motivation and entrepreneurship development, importance of planning, monitoring and follow-up, managing competition, entrepreneurship development programmes. Characteristics of Indian Horticultural Processing and Export Industry. SWOT analysis, Generation, incubation and commercialization of idea and innovations. Entrepreneurial behavior-Concept, dimensions, factors affecting entrepreneurial behaviour. Government schemes and incentives for promotion of

entrepreneurship Government policy on Small and Medium Enterprises (SMEs)/ SSIs. Market survey, formulation of project, financial analysis of project. Communication skills : Communication - Meaning and process of communication. Advertisements - Meaning, types, forms, functions. Writing Skill : Business letter, Letters of inquiry, quotation orders and tenders, complaints letters

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