

## COURSE CONTENTS

### Entrance Examination for Admission to Master's /PhD Programmes

S.No.	Course	Page No
1.	Syllabus for M.Sc. (Agriculture/Horticulture/ Food Science & Technology ) / MBA Entrance for Students having B.Sc. (Ag)/ B.Sc. (Honours) Agriculture degree	2
2.	Syllabus for M.Sc. (Agriculture/Horticulture/ Food Science & Technology) / MBA Entrance for students having B.Sc. Horticulture / B.Sc. (Honours) Horticulture Degree	10
3.	Syllabus for M.Sc. (Forestry) , M.Sc. (Agriculture/ Food Science & Technology) and MBA Entrance for students having B.Sc. (Forestry) / B.Sc. (Honours) Forestry Degree	12
4.	Syllabus for M.Tech. (Agril Engg) /MBA Entrance for students having B.Tech. Degree	24
5.	Syllabus for PhD Entrance	
i.	Agronomy	28
ii.	Agricultural Economics / Agricultural Economics & Farm Management	30
iii.	Entomology	33
iv.	Agricultural Extension and Communication/ Extension Education and Communication	36
v.	Genetics & Plant Breeding	38
vi.	Plant Pathology	41
vii.	Soil Science and Agricultural Chemistry	43
viii.	Horticulture - Fruit Science	46
ix.	Horticulture - Vegetable Science	47
x.	Plant Biotechnology / Molecular Biology & Biotechnology	49
xi.	Plant Physiology	51
xii.	Silviculture & Agro Forestry	54
xiii.	Food Science & Technology	59
xiv.	Farm Machinery and Power Engineering	66
xv.	Post Harvest Process and Food Engineering	67
xvi.	Soil and Water Engineering	69

**Syllabus for  
M.Sc. (Agriculture/Horticulture/ Food Science &  
Technology ) / MBA  
Entrance  
for  
Students having B.Sc. (Ag)/ B.Sc. (Honours)  
Agriculture Degree**

## **Agronomy**

General: Basic principles of crop production; cultivation of rice, wheat, chickpea, pigeon-pea, sugarcane, groundnut, rapeseed mustard and potato.

Principles of Agronomy, crop ecology and geography and Agricultural Meteorology: Agronomy – meaning and scope, National & International agricultural research institutes in India, Agro climatic zones of India, Tillage, crop stand establishment and planting geometry and their effect on crop, Organic farming, precision farming, integrated farming systems, principles of field experimentation. Climate shift and its ecological implications, Agro-ecological regions in India, Climatic factors and their effect on crop productivity, weather & climate, Earth's atmosphere, solar radiation, Atmospheric temperature and global warming. Crops and atmospheric humidity, weather forecasting.

Field crops : Origin, distribution, economic importance, soil and climatic requirement, varieties, cultural practices and yield of cereals (rice, wheat, maize, sorghum, pearl millet, minor millets, barley), pulses (chickpea, lentil, peas, pigeon pea, mungbean, urdbean), oilseeds (groundnut, sesame, soybean, rapeseed & mustard, sunflower, safflower, linseed), fiber crops (cotton, jute, sunn hemp), sugar crops (sugarcane), fodder & forage crops (sorghum, maize, Napier, berseem, Lucerne, oats), and commercial crops (potato, tobacco). Weed management : Principles of weed management, classification, biology and ecology of weeds, crop weed competition and allelopathy, concepts and methods of weed control, integrated weed management, classification, formulations, selectivity Application methods and equipments, special and problematic weeds and their management in cropped and non-cropped situations, weed management in field crops.

Water management : Principles of irrigation, water resources and irrigation development in India, water and irrigation requirements, concepts and approaches of irrigation scheduling, methods of irrigation, measurement of irrigation water, application distribution and use efficiencies, conjunctive use of water, irrigation water quality and its management, water management in major field, crops (rice, wheat, maize, groundnut, sugarcane) Agricultural drainage.

Soil fertility and fertilizer use : Essential plant nutrients and their deficiency symptoms, concept of essentiality of plant nutrients, indicators of soil fertility and productivity, fertilizer materials and their availability to plants, slow release fertilizers, nitrification inhibitors, principles and methods of fertilizer application, integrated nutrient management, site specific nutrient management.

Dryland Agronomy : Characteristics of Dryland farming and delineation of Dryland tracts, constraints of Dryland farming in India, Types of drought and their management, contingency crop planning and mid-season corrections for aberrant weather and its recycling. Watershed management.

Sustainable land use systems : Sustainable agriculture : parameters and indicators, conservation agriculture, safe disposal of agri-industrial waste for crop production, Agro-forestry systems, shifting cultivation, Alternate land use systems, Wastelands and their remediation for crop production.

## **Agricultural Economics**

Importance of agriculture in national economy: Theory of consumer behavior, theory of demand, elasticity of demand, indifference of curve analysis, theory of firm, cost curves, theory of supply, price determination, market classification, concept of macro economics, money and banking, national income. Agricultural marketing-role, practice, institutions, problem and reforms, role of capital and credit in agriculture, crop insurance, credit institutions, cooperatives, capital formation in agriculture, agrarian reforms, globalization, WTO & its impact on Indian agriculture.

Basic principles of farm management, concept of farming system and economics of farming systems, agricultural production economics-scope and analysis, factor-product relationship, marginal cost and marginal revenue, farm planning and budging, agricultural finance: nature and scope. Time value of money, compounding and discounting. Agricultural credit: meaning, definition, need, classification. Credit analysis: 4R's, 5C's and 7P's of credit, repayment plans. History of financing agriculture in India. Commercial banks, nationalization of commercial banks. Lead bank scheme, regional rural banks, scale of finance. Higher financing agencies, RBI, NABARD, AFC, Asian Development Bank, World Bank, role of capital and credit in agriculture; credit institutions, co-operatives and agrarian reforms in India.

## **Extension Education and Communication**

Extension Education-concept, meaning, principle, philosophy, scope and importance. Extension Programme Planning and evaluation-step and principle, models of organizing agricultural extension; historical development of extension, Rural development, meaning, importance and problems; Rural development programmes in India-Pre-independence era to recent ones; Extension Teaching Methods, definition and concept of sociology, differences between rural & urban communities, social stratification., social groups, social organization and social change. Rural leadership, educational psychology-learning and teaching, role of personality in agricultural extension Indian rural system-its characteristics; value system, caste and class; structure and customs, rural group organization and adult education.

Communication, principles, concept, process, elements and barriers in teaching methods. Different kinds of communication methods and media and AV aids/materials. Media mix, Campaign, Cyber extension- internet, cybercafé, Kisan Call Centers, teleconferencing, agriculture journalism, diffusion and adoption of innovations, adopter categories, capacity building of extension personnel and farmers- training to farmers, women and rural youth.

## **Entomology**

Crop Protection Principles in field and storage. Major insect pests and diseases of agricultural crops like rice, cotton, pulses, oilseed crops like groundnut, soybean and mustard, vegetables like tomato, Cole crops; fruit crops like mango and banana and their management principles.

Classification of animal kingdom up to class level and the distinguishing characters up to orders in class insecta and the general organization of an insect external morphology with special reference to lepidopteron larvae, coleopteran adults; and honeybee; metamorphosis and moulting; different physiological systems; insect plant relationship; insect pests of agricultural and horticultural crops, and their stored/processed products, insect vectors of plant diseases- identification, biology, nature of damage, and their management tactics; and pests of household, medical and veterinary importance and their control; useful and beneficial insects like honeybee, lac insect, silkworm and pollinators. Cultural, biological, insecticidal, quarantine, and regulatory aspects; insecticide classification and insecticide resistance management; and insect protective transgenic crops

### **Genetics & Plant Breeding**

Structure and function of cell organelles; mitosis and meiosis; Mendelian genetics; structure and functions of nucleic acids, Characteristics of prokaryotic and eukaryotic organisms, physical and chemical basis of heredity; chromosome structure; genes/operon concept; protein biosynthesis; transformation, recombination, Heterosis; elements of economic botany, Seed germination and dormancy; pollination/fertilization in flowering plant; methods of seed testing; breeders, foundation and certified seeds; seed production in self and cross pollinated crops, DUS testing & PPV & FR.

### **Plant Pathology**

Important plant pathogenic organisms. History of Plant Pathology. Survival and Dispersal of Plant Pathogens. Phenomenon of infection. Pathogenesis, Defense mechanism, Epidemiology, Forecasting. Principles of plant diseases management and integrated disease management (IDM). Etiological agents: rusts, smuts, powdery/downy mildews, wilts, yellows, mosaic, necrosis, enations, blights and witches- broom.

Major diseases of rice, wheat, sugarcane, red gram, cotton, potato, chilli, onion and cucurbits.

Sterilization, disinfection and pasteurization; Koch's postulates; History of Microbiology, Protection against infections. Characteristics of prokaryotic and eukaryotic organism, differences between fungi, bacteria, mycoplasma and viruses; Bacteriophages, viroids and prions.

### **Soil Science & Agricultural Chemistry**

Soil as a medium for plant growth, composition of earth's crust, weathering of rocks and minerals, components of soil-their importance, soil profile, soil partials-physical mineralogical and chemical nature. Mechanical analysis, Stokes law, assumptions, limitation and applications. Soil, physical properties-density, porosity, texture, soil structure and their brief descriptions. Rheological properties in soils, calculations of porosity and bulk density. Soil air-Aeration, causes of poor aeration, factors affecting aeration, importance for plant growth. Soil temperature-sources and losses of soil heat. Factors affecting soil temperature, its importance in plant growth. Soil water-structure of water, soil-water-energy relationship, classifications, surface tension and movement in soil. Soil colloids-properties, structure of silicate clay minerals, sources of negative charges, properties, kaolinite, illite, montmorillonite and vermiculite clay minerals, milli-equivalent concept, cation exchange capacity, anion exchange capacity, buffering of soils. Problem soils- acid, saline, sodic and acid sulphate soils-their characteristics, formation, problems and management. Irrigation, water quality and its evaluation. Waterlogged soils- basic features, distinction with upland soils. Pesticides.

Essential plant nutrients- criteria of essentiality, functions for plant growth, mechanisms for movement and uptake of ions in soils and plants, Forms of nutrients in soils, deficiency symptoms on plants, luxury consumption, nutrient interaction and chelated micronutrients. Soil fertility, evaluation and management for plant growth, soil testing and fertilizer recommendations. Soil classification- diagnostic surface and sub-surface horizons, soil survey-objectives, uses, land capability classification. Remote sensing and its application in agriculture, SIS, GIS and GPS- basic features and uses in agriculture, Soil micro-organisms, classification and their roles. Organic matter-decomposition, C:N ratio, mineralization and immobilization processes, humus, role of organic matter in soil quality. Soil erosion, types and control measures. Fertilizers and manures – classifications, NPK fertilizers, their reactions in

soil, green manuring, recycling of organic wastes, composting. Soil and water pollution-sources brief idea about different pollutants in soils and their managements.

### **Horticulture**

Importance & scope of horticulture. Climatic zones of horticulture crops. Orchard establishment including high density planting. Propagation methods & root stocks. Training & pruning methods, use of PGR. Production technology of fruit crops (Mango, Banana, Papaya, Ber, Apple, Guava, Citrus, Custard apple)

Importance & scope of vegetables. Classification of Vegetables. Package of practices of vegetables (Tomato, Brinjal, Chilli, Okra, Cucumber, Bottle gourd, Sponge gourd, Cabbage, Cauliflower, Onion, Garlic, Potato, Palak, Carrot, Radish, Drumstick, Peas & Cowpea) Establishment of Ornamental garden, uses of tree, shrubs, climbers & seasonal flowers in garden. Package of practices of Rose, Marigold and Chrysanthemum.

Importance & scope of spices, Aromatic, Medicinal and Plantation crops. Production Technology of Ginger, Turmeric Coriander, Fenugreek, Lemon grass, Coconut, Betel Vine, Dioscoria, Opium, Aloe and Stevia.

Importance & Scope of Post Harvest Technology of Horticulture crops. Maturity indices, grading, packing & storage of fruits & vegetables. Importance & Scope of Fruit & Vegetable Preservation. Principles of preservation by heat, low temperature, chemicals & fermentation. Preservation methods by canning, bottling, freezing, drying & dehydrated. Preparation of jams, jellies, candies, chutney, pickle, ketchup and squashes. Preservatives and colours permitted and prohibited in India.

### **Plant Biotechnology**

Importance of agriculture in national economy; principles of crop production: cultivation of rice, wheat chickpea pigeon-pea, sugarcane, groundnut, tomato and mango Major soils of India role of NPK and their deficiency symptoms. General structure and function of cell organelles; mitosis and meiosis; Mendelian genetics. Elementary knowledge of growth, development, photosynthesis, respiration and transpiration: Elements of economic botany. General structure and function of carbohydrates, proteins, nucleic acids, enzymes and vitamins Major pests and diseases of rice, wheat cotton, chickpea, sugarcane and their management. Organic farming; bio-fertilizer; bio-pesticides. Recombinant DNA technology; transgenic crops. Important rural development programmes in India; organizational set up of agricultural research, education and extension in India. Elements of statistics.

Importance of biochemistry in agriculture Acid-base concept and buffers; PH. Classification, structure and metabolic functions of carbohydrates, lipids and proteins. Structure and function of nucleic acids. Enzymes: structure nomenclature mechanism of action; vitamins and minerals as coenzymes and cofactors metabolic pathways: Metabolic pathways: glycolysis, TCA cycle, fatty acid oxidation triglyceride biosynthesis. Electron transport chain; ATP formation. Photosynthesis: C-3 C-4 and CAM pathways. Nitrate assimilation; biological nitrogen fixation. Colorimetric and chromatographic techniques.

Characteristics of prokaryotic and eukaryotic organisms differences between fungi, bacteria mycoplasmas and viruses. Physical and chemical basis of heredity; chromosome structure. DNA replication, transcription and translation; genetic code; operon concept. Genetic engineering; restriction enzymes; vectors gene cloning; gene transfer. Plant cell and tissue culture; micro-propagation; somaclonal variation. Transformation; recombination: heterosis General

application of biotechnology Molecular and immunological techniques. Concept of bioinformatics, genomics and proteomics.

**Plant Physiology** Importance in agriculture. Seed germination viability and vigour. Photosynthesis – significance of C-3 C-4 and CAM pathway; photorespiration and its implications. Translocation of assimilates; dry matter partitioning: Harvest index of crops. Growth and development; growth analysis; crop- water relationship. Plant nutrients and their functions. Phyto-hormones and their physiological role. Photo-periodism, vernalisation; pollination / fertilization in flowering plants. Post- harvest physiology and its significance.

### **Food Science & Technology**

General chemistry of food constituents, physical properties of foods, properties of colloidal systems. gels and emulsions. Minerals in foods physicochemical changes in foods during processing and storage, functions of food nutrients, dietary allowances and nutritional requirements. Metabolism of carbohydrates. lipids and protein. Biological value and PER. Food additives. Contaminants and anti-nutritional factors, Food flavors and puff-flavors National and international food standards modern analytical techniques in food analysis.

Engineering properties of food materials. System analysis. mass and energy balance. Principles operations and equipment for food materials flow handling, clearing dehusking sorting and grading; peeling size reduction, mixing and forming, bakery foods manufacture, extrusion, separation, filtration and membrane. Processes expression baking roasting, frying, extraction and leaching crystallization distillation blanching pasteurization, sterilization evaporation drying freezing packing heat exchange dairy specific operation. Process equipment design heat and mass transfer, equipment for steam generation compressed air, refrigeration and air conditioning, water and waste water treatment biochemical engineering and bacteriology. Automation, on-line data acquisition and process control. Food plant layout and design. Energy audit.

Preparation and manufacturing technology of cereals and bakery products, beef, pork, poultry, fish & sea foods and egg sausages and table ready meats, dairy products fresh fruits, fresh vegetables processed fruits processed vegetables. Post Harvest Handling and storage of Fruits and Vegetables, Sugars, sweets fats and oils, fermented foods. alcoholic and non-alcoholic beverages indigenous foods fast readymade and fashion foods. Dehydration and concentration methods, irradiation microwave and solar processing of foods, food by-products & downstream processing., flavoring and pigment technology Judging of food products, food plant management and legal aspects. Food plant safety, risk and hazards. Effluent treatment and environment pollution waste solids upgrading and treatment food storage function of packaging, packaging operations types of containers, FFS, heretics closures, conning packing materials and package testing, transportation and marketing food products.

Role intrinsic and extrinsic properties of food in relation to microbial growth. Microbiology of fruits, fruit products, vegetables, soft drinks, bakery products, milk and milk products, milk, fish, egg and marine produces. Spoilage of foods, food pathogens and their toxins in relations in relation to human health. Food preservation by sugar salt, chemicals, heat, cold, irradiation, dehydration and packaging. Microbiology of fermented foods and beverages and factors affecting their quality. Methods for microbiological examination of foods, food hygiene and safety regulations. water quality and waste disposal in food industry.

## **Agricultural Statistics**

Introduction: Definition of Statistics and its use and limitations; Frequency Distribution and Frequency Curves. Measures of Central Tendency : Characteristics of ideal Average, Arithmetic Mean, Median, Mode, Merits and Demerits of Arithmetic Mean. Measures of Dispersion: Variance, Standard deviation, and Coefficient of Variation. Probability: Concept of probability and definition; Normal Distribution and its Properties. Introduction to Sampling : Random Sampling; the concept of Standard Error. Tests of Significance – Types of Errors, Null 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 ; Students t-test for Single sample, Two Samples and paired t test, F test : Chi-Square Test in 2x2 Contingency Table, Yate's correction for continuity. Correlation: Types of Correlation and identification through 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 the Regression coefficients, fitting of regression equation. Experimental Designs: Basic Designs; 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.

Introduction to Computers, Input and output Devices, Units of Memory. Hardware, Software and Classification of computers. Types of Processors. Booting of Computers, warm and cold booting, computer viruses, worms and Vaccines Operating System – DOS and DOS commands. Operating system WINDOWS and its elements. MS- WORD, features of word processing. Creating, Editing document in word MS-EXCEL-Electronic spreadsheet, concept, packages. Creating, editing and saving a spread sheet. Editing cell contents. Commands for work sheet. Use of in-built Statistical and other functions and writing expressions. Use of Data Analysis tools, Correlation and Regression. Entering expressions, Creating graphs. t-test for two samples and ANOVA with one way classification. Introduction to MS Power Point, features of power point package. Creating new presentation, power point views. Introduction to MS Access, concept of data base, creating data base. Creating tables in data base. Principles of programming. Flow charts. Algorithms, illustration through examples. Introduction to Internet. World wide web, information retrieval. Introduction to electronic mail. Advantages of E-mail.

## **Plant Physiology**

Seed structures of important crops viz. gram, maize, castor, wheat, soybean etc., Process of seed formation, morphological, physiological and biochemical changes accompanying seed development. Seed viability and vigour, Physiology of seed germination with steps and phases involved. Factors affecting seed germination. Phases of growth. Factors affecting growth. Measurement of growth, growth analysis –definitions and mathematical formulae, application. Properties and physiological functions of water in plants. Water potential and its components. Measurement of water status in plants. Kinds of soil water

Anti transpirants, bleeding and guttation, water use efficiency (WEU) Stomatal structure and function. Raw material, pigment system, structure of chloroplast, photo-phosphorylation, light and dark reactions, C<sub>3</sub>, C<sub>4</sub> and CAM pathway, photorespiration, Phloem loading, translocation of assimilates, Source and sink relationship. Glycolysis, kreb's cycle, electron transport system. Pentose phosphate pathway. Glyoxylate cycle and fermentation. Factors affecting respiration. Measurement of respiration. Mengel's classification of nutrients, criteria of essentiality, physiological role, metabolic functions and deficiency symptoms of elements, foliar application,



hydroponics. Mechanism of mineral salt absorption and translocation. Classification of plants, thermo-periodism, phyto-chromes. Definition, nature of process and application, devernalization, mechanism and application. Occurrence, biosynthesis, physiological role and mode of action of auxins, gibberellins, cytokinins, ethylene, abscisic acid, growth retardants

Seed dormancy, Storage physiology, Fruit ripening –Climacteric and non climacteric fruits. Hormonal regulation of fruit ripening with ethrel, CCC, paleobuterozole and Polaris. Scope and importance of environmental studies. Multidisciplinary nature of environmental studies and need for public awareness. Natural resources and associated problems Forest resources, Water resources, Mineral resources, Food resources, Energy resources, Land resources Concept Structure and function of an ecosystem Producers, consumers and decomposers. Energy flow, Ecological succession. Food chain, food webs and ecological pyramids. Structure and function of the various ecosystem: Cropland ecosystem, Forest ecosystem, Grassland ecosystem, Desert ecosystem, Aquatic ecosystem

Bio-diversity and its Conservation. Biogeographical classification of India. Alue of biodiversity.

Biodiversity: at global, national and local level. India as a mega— diversity nation. Hot- spot and. Threats to biodiversity. Endangered and endemic species of India. In-situ and Ex-situ conservation of biodiversity. Environmental pollution Cause effects and control measures of Air pollution, Water pollution, Soil pollution, Marine pollution, Noise pollution, Thermal pollution and nuclear hazards. Solid waste management: Role of an individual in prevention of pollution. Disaster management: floods, earthquake, cyclone and landslides. Social issues and the Environment From Unsustainable to Sustainable development. Urban problems related to energy. Water conservation Resettlement and rehabilitation of people. Environmental ethics. Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Wasteland reclamation. Consumerism and waste products. The Environment protection Act. The Air (Prevention and Control of Pollution) Act. The Water (Prevention and Control of Pollution) Act. The Wildlife Protection Act. The Forest Conservation Act. Issues involved in enforcement of environmental legislation. Public awareness.

**Syllabus for M.Sc. (Agriculture/Horticulture/  
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for students having B.Sc. Horticulture/ B.Sc.  
(Honours) Horticulture Degree**

## **Horticulture**

Layout and establishment of orchards; pruning and training; propagation, climatic requirement and cultivation of fruits like mango, banana, citrus, guava, grape, pomegranate, ber, pineapple, papaya, sapota, pear, peach, jackfruit, avocado, Mangoesteen, litchi, Carambola, durian, passion fruit, almond, walnut, cherry, persimmon, strawberry, kivi, Queensland nut, Pecan nut, chestnut, apple, tamarind and plum; basic physiology of ripening in fruits and products, type of fruits and products, orchard management, role of growth regulators in fruit crops, nursery management, Post harvest Technology of major fruit Crops.

Cultivation of plantation crops like coconut and cashew nut, coffee, tea, oilpalm, cacao, arecanut, rubber etc. and spices; like black pepper, coriander, turmeric Cardamom, ginger, clove, nutmeg, cinnamon, all spice, curry leaf, coriander, fenugreek, fennel, cumin, dill, celery, bishops weed, saffron, vanilla, thyme and rosemary etc. Medicinal crops Safed Musli, Isabgoal, Opium, Chandrasoor, Ashwagandha, Kalmeg, Tulsi, Betelvine, periwinkle, Rauwolfia, Dioscorea, ammi majus, Belladonna, Cinchona, Pyrethrum etc., Aromatic Plants Citronella grass, khus grass, flag (baje), lavender, geranium, patchouli, bursera, musk, Ocimum etc.

Important physiological disorders; major vegetable crops of tropical, subtropical and temperate regions like cole crops (cauliflower, cabbage and knol khol, sprouting broccoli etc.), cucurbits (pumpkin, bottlegourd, bittergourd, luffa, muskmelon and watermelon, cucumber etc.), root crops (radish, tapioca, sweet potato and potato), leafy vegetables (fenugreek and spinach); solanaceous crops (tomato, chillies and brinjal); techniques for raising the nursery; nutritive value of fruits and vegetables and their role in human nutrition; basic physiology of ripening in vegetables and their products; type of vegetable products; protected cultivation of high value crops, Post harvest Technology of major vegetable Crops.

Major floricultural crops grown in India for commercial purposes like rose, carnation, chrysanthemum, marigold, tuberose, gladiolus, orchids; establishment and maintenance of lawns, trees, shrubs, creepers, hedges and annuals; type of gardens, Post harvest Technology of flower Crops. Gardens in India, type and style of gardens, principles and elements of landscape gardening, vase life for important cut flowers, dehydration of flowers,

Methods of crop improvement; male sterility and incompatibility; pure line and pedigree selection; backcross, mass selection and heterosis.

Plant health, plant nutrients, role and deficiency symptoms of nutrients, manures and fertilizers, systems of irrigation, important insect pests and diseases and their management in fruits, Plantation, Spices, vegetables, Medicinal, Aromatic and Ornamental crops.

Importance of horticulture in national and state economy; economics of horticultural crops, plant physiology; respiration, photosynthesis, transpiration, translocation, absorption of nutrients, methods of extension education, rural development programmes, methods of breeding and role of biotechnology in horticultural crops.

**Syllabus for M.Sc. (Forestry) Silviculture & Agro Forestry, M.Sc. (Agriculture/ Food Science & Technology) and MBA Entrance  
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## **Forestry**

### **UNIT- 1            Introductory Forest Economics**

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. Marginal Productivity theory, risk taking and uncertainty bearing theories of profit. Concept and types of inflation.

### **UNIT- 2            Principles of Cytology and Genetics**

Physical basis of heredity, cell reproduction – mitosis - meiosis and its significance. 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.

### **UNIT- 3            Principles of Plant Physiology**

Osmosis, imbibition, diffusion, absorption of water, mechanisms of absorption, ascent of sap. Stomata, structure, distribution, guttation, transpiration, 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. 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.

### **UNIT- 4            Fundamentals of Geology and Soil Science**

Composition of earth's crust, 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 apparent specific gravity/bulk density-factors influencing-field bulk density. Pore space-definition, Munsell colour chart moisture-organic matter, soil structure-definition-classification-clay. Soil air-air capacity-composition factors, chemical properties-soil colloids organic- humus. Soil organic matter decomposition-pH-nutrient availability-soil buffering capacity, soil water-forms-hygroscopic capillary. Soil survey – classification-aerial photography, soil orders-land capability-classification, water quality parameters and assessment.

### **UNIT- 5 Agro-meteorology**

Agro-meteorology-definition, aim and scope. Factors and elements of weather and climate. Air and soil temperature regimes, atmospheric humidity, Precipitation, hails and frost. Solar radiations-components and effect on plant growth. Effect of weather and climate on the growth and development of crops. Climatic normals for crops. Evaporation and transpiration. Use of remote sensing techniques in agrometeorology.

### **UNIT- 6 Introductory Botany**

Introduction to Botany and general classification of plants. Parts of a typical flowering plant. Morphology of root, stem, leaf and flower. Structure and types of plant tissues. Internal structure of Dicot and Monocot Stems, Roots and a typical Leaf. Significance of life cycle, Pinus and a flowering plant.

### **UNIT- 7 Plant Biochemistry and Biotechnology**

Classification-structures of glucose, fructose, ribose, maltose, lactose, starch and cellulose, physical and chemical properties of carbohydrates-isomerism, optical activity, reducing property, reaction with acids and alkalis-osazone formation. Lipids classification

### **UNI- 8 Tree Physiology**

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, sources ink 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.

### **UNIT- 9 Principle and Practices of Silvi-culture**

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.

### **UNIT- 10 Dendrology**

Systems of classification of plants. Bentham and Hooker's, Engler and Prantles, and Hutchinson's Systems. Principles and International Code of Botanical Nomenclature. Peculiarities of tree stems, twigs, Morphology and description of barks of common trees. Morphology of leaf. Reproductive morphology of plants with reference to description and identification of reproductive parts. Study of families, Sapotaceae, Caesalpiniaceae,

Santalaceae, Mimosaceae, Papilionaceae, Meliaceae, Compositae, Liliaceae, Euphorbiaceae, and Combretaceae. Important Indian trees, native trees, exotic trees, endemism, allelopathy with respect to forest trees.

#### **UNIT- 11 Forest Ecology and Biodiversity**

Forest environment- Major abiotic and biotic components and their interaction, trophic levels, food webs, ecological pyramids and energy flow. Ecological succession, Autecology of important tree species. Biodiversity and conservation. Principles of conservation biology, Ex situ and In situ methods of conservation.

#### **UNIT- 12 Chemistry and Fertility of Forest Soils**

Soil exchange phenomenon. Essential nutrient elements, soil fertility evaluation methods. nutrient cycling in forest soils. Transformation-carbon cycle with reference to organic matter decomposition and humus formation, Microbial degradation of cellulose & lignin. Bio-fertilizers. Nitrogen fixation. Microbial transformation of phosphorous, sulphur and micro nutrients. Mycorrhizae. Rhizosphere.

#### **UNIT- 13 Principles of Hydrology, Soil and Water Conservation**

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, runoff, factors affecting runoff, stream flow. Sedimentation, factors affecting sedimentation. 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. 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.

#### **UNIT- 14 Forest botany & Ethnobotany**

Terms employed in relation to ethnobotany. 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. Mythology mainly from the following families, Malvaceae, Fabaceae, Mimosaceae, Palmaceae, Santalaceae.

#### **UNIT- 15 Fundamentals of Horticulture**

Economic importance, area and production, principles, planning and layout, planting densities, nursery techniques and their management. Principles and methods of pruning and training of fruit crops, types and use of growth regulators in horticulture, fertility management, multi-tier cropping, factors influencing the fruitfulness and unfruitfulness., principles of organic farming.

#### **UNIT- 16 Wood Anatomy**

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).

#### **UNIT- 17 Logging and Ergonomics**

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 test 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.

#### **UNIT- 18 Soil Survey, Remote Sensing and Wasteland Development**

Soil survey, sampling methods, landuse classes and planning. Aerial photography and remote sensing-definition, meaning, scope, merits and brief history. Photogrammetry: Vertical and oblique photography. Agencies involved in remote sensing 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. Imagery and image analysis. Geographic Information systems. Salt affected soils, lateritic, marsh and swampy and rocky hills, rocky plains, murrummy and sandy soils, their characteristics and reclamation. Eroded ravines and gullies, various techniques of afforestation of adverse sites, trees suitable for adverse sites. Afforestation and reclamation of mine wastes.. Sewage water as source of tree nutrients.

#### **UNIT- 19 Forest Mensuration**

Introduction, definition, objectives. Units of measurement. Measurement of single tree - objectives, standard rules governing measurement at breast height. Measurement of tree diameter and girth, rulers, callipers and tapes. Bark measurements - objectives, thickness. Tree measurement instruments. Height measurements - direct and indirect methods. Height measurement employing geometric and trigonometric principles, height measuring instruments. Measurement of cross sectional area, basal 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. 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, advantages, kinds of sampling, random sampling: (simple, stratified, multistage and multiphase sampling).

#### **UNIT- 20 Principles of Tree Improvement**



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.

### **UNIT- 21 Tree Seed Technology**

Introduction – Seed and its importance – afforestation activity and seed requirements in India and HP. 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 roguing, 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.

### **UNIT- 22 Forest Tribology and Anthropology**

Anthropology – definitions, nature and scope of Anthropology. Branches of Anthropology & methods of anthropological study, Concepts of Culture, Society, Community, Groups and Institutions. Social Institutions: Family – forms and functions, Marriage – forms and functions, Kinship – decent, residence. Meaning, definitions and characteristics of Tribes. 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. Role of Tribals in Forest protection, development & conservation. The role of anthropology in tribal development.

### **UNIT- 23 Forest Engineering**

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 slopy grounds, chaining across obstacles; compass surveying, chain and compass traversing, magnetic and true bearings, prismatic compass, local attraction. 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. 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.

#### **UNIT- 24 Livestock Management**

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. Principles of rationing. Milk – definition, composition and nutritive value. Factors affecting quantity and quality of milk. Prevention and control of diseases.

#### **UNIT- 25 Wood Science and Technology**

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. 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, (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.

#### **UNIT- 26 Wood Products and Utilization**

Pulp and paper industry. Introduction and raw material; pulping-mechanical, chemical, semichemical 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. Impregnated wood, heat stabilized wood, compressed wood, and chemically modified wood). Destructive distillation of wood.. Production of wood molasses, alcohol and yeast.

#### **UNIT- 27 Silvi-culture of Indian Trees**

Origin, distribution, general description, phenology, silvicultural characters, regeneration methods, silvicultural systems and economic importance, *Cedrus deodara*, *Pinus roxburghii*, *Pinus wallichiana*, *Tectona grandis*, *Shorea robusta*, *Dalbergia sissoo*, *Eucalyptus spp.*, *Terminalia spp.*, *Santalum album*, *Pterocarpus santalinus*, *Diospyros melanoxylon*.

#### **UNIT- 28 Nursery Management**

Propagation concept. Site selection, planning and layout of nursery area. Methods of seed sowing. pricking. watering methods, weeding, hoeing, fertilization, shading, root culturing techniques, lifting windows, grading, packaging. Vegetative propagation techniques. Study of important nursery pests and diseases and their control measures. Nursery practices for some important tree species.

#### **UNIT- 29 Fundamentals of Wildlife**

Justification of wildlife conservation, 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. Indian Board for wildlife, CITES. Biological basis of wildlife management. Wildlife ecology.

### **UNIT- 30 Fundamentals of Extension Education**

Extension education: meaning, definition, nature, scope, objectives, principles, approaches and history. 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). Management and administration: meaning, definition, principles. Concepts of human resource development (HRD), rural leadership.

### **UNIT- 31 Forest Pathology**

History and importance of forest pathology in India and the world, Classification of tree diseases. 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. 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, jack, 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. Definition and scope of disease management in forestry. Principles of disease management such as exclusion, cultural, chemical, biological and immunization. Nursery diseases of important forest species.

### **UNIT- 32 Forest Business Management**

**Forest / agro forest business** Importance nature, scope (input and product sector Forest Policies)

### **UNIT- 33 Forest business Management**

Distinctive features, importance of good management Definition of management. Management functions - (1) Planning - Meaning, definition types of plan, characteristics of sound plan. Steps in planning. (2) Organization -definition, meaning importance (3) Staffing -means definition and importance (4) Directing, Motivation ordering Leading supervision, communication control.

### **UNIT- 34 Capital Management**

Financial Management of forest business / agro forestry, Business, Importance of financial statements Balance sheet, Profile and loss statement - Analysis of financial statements.

### **UNIT- 35 Agro forest based and forest based industries**

Definition, classification: importance and need types of agro forestry / forest business industries constraints in establishing forest / Agro forest product based industries

#### **UNIT- 36          Marketing Management**

Meaning: Definition, Marketing mix 4Ps of marketing mix, Market segmentation. Product life cycle marketing channels.

#### **UNIT- 37          Agro forestry / forest product price policies Definition, importance, need.**

Project Meaning, Definition project cycle and concepts Types, Phases in project cycle - conception or identification, (ii) formulation or preparation (iii) Appraisal (iv) Implementation (v) monitoring, and, Evaluation - Appraisal and evaluation techniques - NPW, BCR,IRR sensitivity analysis, criteria for selection of Agro forest projects. Characteristics of forest / agro forest based projects, and constraints

#### **UNIT- 38          Elementary Statistics and Computer Application**

Measures of location, mean, mode, median, geometric mean, harmonic mean, percentiles and quadrilles, 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, binominal, 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 Mendalian 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. Computer application: Introduction to computers and personal computers, basic concepts, operating system, DOS and Windows 95, introduction to programming languages, BASIC language, concepts, basic and programming techniques, MS Office, Win Word, Excel, Power Point, introduction to Multi-Media and its application. VISUAL BASIC-concepts, basic and programming techniques, introduction to Internet.

#### **UNIT- 39          Rangeland Management**

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. ultiple use.

#### **UNIT- 40 Silvicultural Systems**

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. Choice of silvicultural system. Dauerwald concept. Culm selection system in Bamboo. Tending operations - weeding, cleaning, thinnings, definitions, objectives and methods, increment felling and improvement felling. Pruning and lopping. Control of climbers and undesirable plants

#### **UNIT- 41          Plantation Forestry**

Definition, scope and impediments. Plantation forests - planting plan, plantation records, maps. 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, wet land, other adverse sites and taungya. Intercultural operations. Weed control, climber cutting, staking, singling and pruning. Thinning - definition, objectives. Effects of thinning. Energy and industrial plantation - definition, scope, species, establishment, management and impact on environment. Site selection and site preparation. Use of fertilizers, weedicides for plantation management.

#### **UNIT- 42          World Forestry Systems**

Geographical distribution of forests and their classification. 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. Recent trends in forestry development in the world. International forestry organizations.

#### **UNIT- 43          Wild Life Management**

Wildlife management and conservation in India. Habitat management. Wildlife census : Purpose, techniques. Direct and indirect methods of population estimation. Sample and total counts, indices, encounter rates and densities. Wildlife (Protection) Act, 1972. Sanctuary, National Park and Biosphere Reserves. Special projects for wildlife conservation. Project Tiger and Musk Deer Project. Wildlife corridors. MAB, Red Data Book, Category of threat, CITES. Conservation.

#### **UNIT- 44          Principles of Forest Economics, Project Planning and Evaluation**

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.

#### **UNIT- 45          Environmental Science**

Components of environment - interactions with organisms. Global and Indian environment - past and present status. Smog, acid rain, global warming, ozone hole, eutrophication,. Impact of different pollutions on humans, organisms and environment. India, international and voluntary agencies for environmental conservation - mandates and activities. International conferences, conventions and summits.

#### **UNIT- 46 Forest Management, Policy and Legislation**

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. Evenaged and unevenaged models. Yield regulation – general principles of even aged and unevenaged forest crop. Working Plan – definition, objects and necessity. Forest Policy: definition, necessity and scope. National Forest Policies. Forest Law: legal definition. Objects of special forest law. Indian Forest Act. Detailed study of IFA, 1927.

#### **UNIT- 47 Utilization of on-Timber Forest Products**

Introduction, methods of collection, management and importance of Non-Timber Forest Products (NTFP). Fodder (grasses and tree leaves), canes and bamboos. Essential Oils and non-essential oils. Gums and resins –definition, classification, sources, collection and uses. Resins and Oleoresins, their formation. Beedi leaves – sources, collection and processing.. Katha and Cutch – sources, extraction and uses. Spices, poisons.

#### **UNIT- 48 Agroforestry System and Management**

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.

#### **UNIT- 49 Medicinal and Aromatic Plants**

Opportunities and constraints in the cultivation and utilization of medicinal and aromatic plants in India. Importance, production, climatic and soil requirements, propagation and nursery techniques, nutritional and water requirements. Plant protection, harvesting, processing and economics of under mentioned important medicinal and aromatic plants. Medicinal Plants ginger, turmeric, *Rauvolfia*, isabgol. Aromatic Plants : *Citronella* grass, khus grass, *Mentha*, muskdana (musk mallow), *Ocimum*. Endangered medicinal and aromatic plants of India and their conservation.

#### **UNIT- 50 Forest Entomology**

Taxonomic classification of class Insecta, diagnostic characters of the orders and major families of economic importance. Methods and principles of pest control. Principles and techniques of Integrated Pest Management in forests. Classification of forest pests. Insect pests of forest seeds, forest nursery and standing trees of timber yielding species of natural forest.

#### **UNIT- 51 Entrepreneurship Development and Communication Skills**

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.

#### **UNIT- 52 Marketing and Trade of Forest Produce**

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.

# **Syllabus for M.Tech. (Agril Engg) /MBA Entrance for students having B.Tech. Degree**



## **UNIT 1**

Thermodynamics, laws of thermodynamics, Otto & diesel cycles. Equilibrium of forces. Frictional forces. Machine Elements. Determining velocity ratio., Drives, Bearings. Methods of projection. CAD. Design considerations of Agricultural Machines. Materials. Loads and stresses. Workshop tools and machines. Farm mechanization.. Field capacities. Tillage; Tillage equipments. Forces acting on tillage tools. Draft measurement: Earth moving machinery. Sowing, planting, transplanting, Fertilizer application, Weed control and Plant protection equipments. Harvesting machineries. Threshers, combines. Testing of farm machines. Cost analysis of machinery. Selection of machinery. Sources of farm power. Tractors and IC engines. Engine components. & systems. Fuels & combustion, detonation and knocking, lubricants. Tractor & machine maintenance. Systems of Tractor. Ergonomic

## **UNIT 2**

Surveying classification and basic principles, Linear measurements. Chain surveying. Compass survey, Plane table surveying. Leveling, Contouring, Computation of area and volume. Theodolite traversing. Introduction to setting of curves. Major and medium irrigation schemes of India, purpose of irrigation, sources of irrigation water, Measurement of irrigation water, water conveyance, design of irrigation field channels, underground pipe conveyance system, irrigation structures, soil water plant relationship, soil water movement, infiltration, evapo-transpiration, soil moisture constants, , irrigation efficiencies, methods of water application, border, check basin, furrow and contour irrigation; sprinkler and drip irrigation method, merits, demerits, selection and design; Participatory irrigation management. Economics of water resources utilization. Surface drainage, design of open channel, sub-surface drainage, investigations of design parameters, hydraulic conductivity, drainable porosity, water table, Design of surface drains, interceptor and relief drains. Design of subsurface drainage system. Vertical drainage. Bio-drainage. Salt balance, reclamation of saline and alkaline soils. Conjunctive use of fresh and saline waters. Economic aspects of drainage.

Properties of fluids: Ideal and real fluid. Pressure and its measurement, Pascal's law, pressure forces on plane, centre of pressure, buoyancy, metacentre and metacentric height, 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. Bernoulli's theorem, venturimeter, orifice-meter and nozzle. 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, hydraulic gradient and energy gradient. Dimensional analysis and similitude: Rayleigh's method and Buckingham's 'Pi' theorem.

Soil erosion - causes, types and agents of soil erosion; soil loss estimation - universal soil loss equation and modified soil loss equation, determination of their various parameters; erosion control measures – agronomical measures- mechanical measures. Gully control, factors affecting wind erosion, mechanics of wind erosion, soil loss estimation, wind erosion control measures , sedimentation - sedimentation in reservoirs and streams, estimation and measurement, land use capability classification; grassed water ways and their design; introduction to water harvesting techniques; introduction to stream water quality and pollution.

Functional requirements of soil erosion control structures; flow in open channels-types of flow, state of flow, regimes of flow, energy and momentum principles, specific energy and specific force, runoff measuring structures-parshall flume, H - flume and weirs; straight drop spillway,

hydrologic and hydraulic design, structural design, design of diversions; small earth embankments-their types and design principles, farm ponds and reservoirs, cost estimation of structures. Introduction of soil mechanics, Soil classification based on particles size, textural classification. Shear strength mohr stress circle, Numerical exercise based on various types of tests. Compaction composition of soils standard and modified protector test. Consolidation of soil: Earth pressure: Plastic equilibrium in soils, active and passive states.

Occurrence and movement of ground water, aquifer and its types, classification of wells, steady and transient flow into partially, fully and non-penetrating and open wells, design of open well, groundwater exploration techniques, methods of drilling of wells, groundwater hydraulics-determination of aquifer parameters 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, modeling, ground water project formulation. Pumping Systems: Water lifting devices; different types of pumping machinery, classification of pumps, design of centrifugal pumps, hydraulic ram, propeller pumps, mixed flow pumps, deep well turbine pump and submersible pump. Remote Sensing: Definition, stage in remote sensing, modern remote sensing technology versus conventional aerial photography.

### **UNIT 3**

Principal of size reduction, size reduction machines; – Rittinger's, Kick's and Bond's equation, fineness modulus. Theory of separation, sieve analysis, effectiveness of screens, pneumatic separation. Study of different types of material handling systems; belt, chain and screw conveyor, bucket elevator, gravity conveyor, capacity and power requirement. Modes of heat transfer, thermal conductivity of materials. Heat transfer coefficient in convection. Combined free and forced convection. Introduction. Kirchoff's law, solid angle, intensity of radiation. Radiation exchange. Types of heat exchangers, fouling factor, log mean temperature difference. Flick's law, mass transfer coefficients. Reynold's analogy.

### **UNIT 4**

Unit operation of various dairy and food processing systems, pasteurization sterilization, homogenization,. Physical, chemical and biological methods of food preservation, Moisture content and methods for determination, importance of EMC and methods of its determination, principle of drying, mechanism of drying- falling rate, constant rate, thin layer, deep bed and their analysis, critical moisture content, functional requirements of storage, control of temperature and relative humidity inside storage, calculation of refrigeration load; modified atmospheric storage and control of its environment, air movement inside the storage, storage of grains: destructive agents, respiration of grains, moisture and temperature changes in stored grains; artificial drying, grain storage structures such as Bukhari, Morai, Kothar, silo, CAP.

### **UNIT 5**

Principles of refrigeration, second law of thermodynamics applied to refrigeration, Carnot cycle, reversed Carnot cycle, coefficient of performance, unit of refrigeration, types of refrigeration system, mechanical vapour compression, vapour absorption system, components of mechanical refrigeration, refrigerant, desirable properties of ideal refrigerant, ultra low temperature refrigeration, cold storages, insulation material. Thermodynamic properties of moist air, adiabatic saturation process, wet bulb temperature and its measurement, psychometric chart and its use, elementary psychometric process. Factors affecting shelf life of food material during storage; spoilage mechanism during storage; definition, requirement,

importance and scope of packaging of foods. Different types of packaging materials used. Different forms of packaging, metal container, glass container, plastic container, flexible films, shrink packaging, vacuum & gas packaging. Packaging requirement & their selection for the raw & processed foods. Advantages & disadvantages of these packaging material. Printing, labeling and lamination. Economics of packaging, their merits and demerits.

#### **UNIT 6**

Classification of energy sources; Introduction to renewable energy sources; characterization of biomass; types, construction, working principle, uses and safety/ environmental aspects of different renewable energy devices like gasifiers, biogas plants, solar passive heating devices, photovoltaic cells and arrays; Brief introduction to wind energy, hydroelectric energy, briquetting and baling of biomass, biomass combustion, biodiesel preparation and energy conservation in agriculture.

#### **UNIT 7**

Characteristics of biological materials like shape, size, 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 frictional properties. Application of engineering properties in handling processing machines and storage structures. Methods of quality control, sampling; purpose, sampling techniques, requirements and sampling procedures for liquid, powdered and granular materials, sensory quality control, TQM and TQC, consumer preferences and acceptance, GMP, HACCP (Hazard analysis and critical control point) and ISO 9000 Series.

#### **UNIT 8**

Matrices, Eigen values. Fourier series. Gradient. Divergence and Curl. Stokes, Gauss and Green's theorems. Laplace transforms. Integration of trapezoidal and Simpson's rule.



## **Syllabus for Ph.D. Entrance Examination for students having M.Sc.(Ag) Agronomy Degree**

### **Agronomy**

#### **Unit-1**

Crop growth analysis in relation to environment; agro-ecological zones of India. Quantitative agro-biological principles and inverse yield nitrogen law; Mitscherlich yield equation, its interpretation and applicability; Baule unit. Effect of lodging in cereals; physiology of grain yield in cereals; optimization of plant population and planting geometry in relation to different resources, concept of ideal plant type and crop modeling for desired crop yield. Scientific principles of crop production; crop response production functions; concept of soil plant relations; yield and environmental stress.

#### **Unit-2**

Water and its role in plants; water resources of India, major irrigation projects, extent of area and crops irrigated in India and different states. Water movement in soil and plants; transpiration; soil-water-plant relationships; water absorption by plants; plant response to water stress, crop plant adaptation to moisture stress condition. Soil, plant and meteorological factors determining water needs of crops; scheduling, depth and methods of irrigation; micro-irrigation system; fertigation; management of water in controlled environments and poly-houses. Water management of the crops and cropping systems; quality of irrigation water and management of saline water for irrigation; water use efficiency. Excess of soil water and plant growth; water management in problem soils; drainage requirement of crops and methods of field drainage.

#### **Unit-3**

Cropping systems: definition, indices and its importance; physical resources, soil and water management in cropping systems; assessment of land use. Concept of sustainability in cropping systems and farming systems, scope and objectives; production potential under monoculture cropping, multiple cropping, alley cropping, sequential cropping and intercropping, mechanism of yield advantage in intercropping systems. Above and below ground interactions and allelopathic effects; competition relations; multi-storied cropping and yield stability in intercropping, role of non-monetary inputs and low cost technologies; research need on sustainable agriculture. Crop diversification for sustainability; role of organic matter in maintenance of soil fertility; fertilizer use efficiency and concept of fertilizer use in intensive cropping system. Plant ideotypes for dryland; plant growth regulators and their role in sustainability.

#### **Unit-5**

Organic farming - concept and definition, its relevance to India and global agriculture and future prospects; land and water management - land use, minimum tillage; shelter zones, hedges, pasture management, agro-forestry. Organic farming and water use efficiency; soil fertility, nutrient recycling, organic residues, organic manures, composting, soil biota and decomposition of organic residues, earthworms and vermicompost, green manures and biofertilizers. Control of weeds, diseases and insect pest management, biological agents and pheromones, biopesticides. Socio-economic impacts; marketing and export potential:

inspection, certification, labeling and accreditation procedures; organic farming and national economy.

#### **Unit-6**

Soil fertility and productivity - factors affecting; features of good soil management; problems of supply and availability of nutrients; relation between nutrient supply and crop growth Criteria of essentiality of nutrients; Essential plant nutrients – their functions, nutrient deficiency symptoms; transformation and dynamics of major plant nutrients. Commercial fertilizers; composition, relative fertilizer value and cost; crop response to different nutrients, residual effects and fertilizer use efficiency, fertilizer mixtures and grades; agronomic, chemical and physiological methods of increasing fertilizer use efficiency; nutrient interactions. Time and methods of manures and fertilizers application; foliar application and its concept; relative performance of organic and inorganic manures; economics of fertilizer use; integrated nutrient management; use of vermicompost and residue wastes in crops.

#### **Unit-7**

Weed biology and ecology, crop-weed competition including allelopathy; principles and methods of weed control and classification; weed indices. Herbicides introduction and history of their development; classification based on chemical, physiological application and selectivity; mode and mechanism of action of herbicides. Herbicide structure - activity relationship; factors affecting the efficiency of herbicides; herbicide formulations, herbicide mixtures; herbicide resistance and management; weed control through bio-herbicides, myco-herbicides and allelochemicals; Degradation of herbicides in soil and plants; herbicide resistance in weeds and crops; herbicide rotation. Weed management in major crops and cropping systems; parasitic weeds; weed shifts in cropping systems; aquatic and perennial weed control. Integrated weed management; cost : benefit analysis of weed management.

#### **Unit-8**

Definition, concept and characteristics of dry land farming; dry land versus rainfed farming; significance and dimensions of dry land farming in Indian agriculture. Soil and climatic parameters with special emphasis on rainfall characteristics; constraints limiting crop production in dry land areas; types of drought, characterization of environment for water availability; crop planning for erratic and aberrant weather conditions. Stress physiology and resistance to drought, adaptation of crop plants to drought, drought management strategies; preparation of appropriate crop plans for dry land areas; mid contingent plan for aberrant weather conditions. Tillage, tillth, frequency and depth of cultivation, compaction in soil tillage; concept of conservation tillage; tillage in relation to weed control and moisture conservation; techniques and practices of soil moisture conservation (use of mulches, kinds, effectiveness and economics); anti-transpirants; soil and crop management techniques, seeding and efficient fertilizer use. Concept of watershed resource management, problems, approach and components.

## **Syllabus for Ph.D. Entrance Examination for students having M.Sc.(Ag) Agricultural Economics & Farm Management Degree**

### **Agricultural Economics**

#### **Unit-1**

Theory of Consumer Behavior-Cardinal Utility Approach-Ordinal Utility Approach–Income effect and substitution effect–Applications of Indifference curve approach- Revealed Preference Hypothesis–Consumer surplus-Derivation of Demand curve–Elasticity of demand. Theory of Production- Production functions–Returns to scale and economies of scale–Technical progress–Theory of Costs–Cost curves–Profit maximization and cost minimization–Derivation of supply curve–Law of Supply–Producer’s surplus. Market Equilibrium-Behavior of Firms in Competitive Markets–Perfect Competition-Effect of Taxation and Subsidies on market equilibrium-Monopoly-Monopolistic-Oligopoly-Theory of Factor Markets. General Equilibrium Theory-Welfare Economics-Pareto Optimality–Social welfare criteria-Social Welfare functions.

#### **Unit-2**

Nature and Scope of Macro Economics-Methodology and Keynesian Concepts National Income-Concepts and measurement-Classical theory of Employment and Say’s Law-Modern theory of Employment and Effective Demand. Consumption function-Investment and savings-Concept of Multiplier and Accelerator-Output and Employment-Rate of interest-Classical, Neo classical and Keynesian version-Classical theory Vs Keynesian theory–Unemployment and Full employment. Money and classical theories of Money and Price. Inflation: Nature, Effects and control. IS & LM frame work-General Equilibrium of product and money markets-Monetary policy-Fiscal policy-Effectiveness of Monetary and Fiscal policy.

#### **Unit-3**

Evolution of Economic Thought vs. Economic History. Ancient economic thought–medieval economic thought. Development of Classical Thoughts (Adam Smith, Robert Malthus and David Ricardo).The birth of neoclassical economic thought–Marshall and Walras–General Equilibrium Theory-Welfare Theory–Keynesian economics. The Era of globalization–Experiences of developing world. Economic Thought in India–Naoroji and Gokhale–Gandhian Economics -Economic thought of independent India–Nehru’s economic philosophy-Experiences of the Structural adjustment programmes of the post liberalization era.

#### **Unit-4**

Nature, scope and significance of agricultural production economics-Agricultural. Factors of production, classification, interdependence, and factor substitution-Determination of optimal levels of production and factor application–Optimal factor combination and least cost combination of production-Theory of product choice; selection of optimal product combination. Cost functions and cost curves, components, and cost minimization Duality theory–cost and production functions and its applications-Derivation of firm’s input demand and output supply functions. Measuring efficiency in agricultural production; technical, a locative and economic efficiencies.

### **Unit-5**

Agricultural marketing issues, and enhance expertise in improving the performance of the marketing institutions and the players in marketing of agricultural commodities. Characteristic of Agricultural product and Production-Problems in Agricultural Marketing from Demand and Supply and Institutions sides. Market intermediaries and their role-Need for regulation in the present context-Marketable & Marketed surplus estimation. Marketing Efficiency-Structure Conduct and Performance analysis-Vertical and Horizontal integration-Integration over space, time and form-Vertical coordination. Marketing Co-operatives-APMC Regulated Markets-Direct marketing, Contract farming and Retailing- Supply Chain Management-State trading, Warehousing and other Government agencies-Performance and Strategies-Market infrastructure needs, performance and Government role-Value Chain Finance. Role of Information Technology and telecommunication in marketing of agricultural commodities-Market research-Market information service-electronic auctions (e-bay), e-Chaupals, Agmarket and Domestic and Export market Intelligence Cell (DEMIC) price forecasting-time series analysis-time series models. Price policy and economic development-non-price instruments. Theory of storage future trading Price discovery-Hedging and Basis-Fundamental analysis-Role of Government in promoting commodity trading and regulatory measures.

### **Unit-6**

Knowledge related to research process, data collection and data analysis etc. Importance and scope of research in agricultural economics. Types of research-Fundamental vs. Applied. Concept of researchable problem-research prioritization-selection of research problem. Hypothesis-meaning-characteristics-types of hypothesis-review of literature-setting of Course Objective and hypotheses-testing of hypothesis. Sampling theory and sampling design-sampling error-methods of sampling-probability and non-probability sampling methods. Project proposals- different types of projects to meet different needs. Research design and techniques-Types of research design. Data collection-assessment of data needs-sources of data collection. Mailed questionnaire and interview schedule. Scaling Techniques. Coding editing-tabulation- validation of data. Tools of analysis-data processing. Interpretation of results-Preparing research report / thesis-Universal procedures for preparation of bibliography-writing of research articles.

### **Unit-7**

Introduction-relationship between economic theory, mathematical economics, models and econometrics, methodology of econometrics-regression analysis. Basic two variable regression-assumptions estimation and interpretation approaches to estimation-OLS, MLE and their properties- extensions to multivariable models-multiple regression estimation and interpretation. Multicollinearity, heteroscedasticity, autocorrelation. Use of dummy variables-limited dependent variables-specification, estimation and interpretation. Simultaneous equation models-structural equations-reduced form equations-identification and approaches to estimation.

### **Unit-8**

Linear programming techniques. Decision Making-Concepts of decision making, introduction to quantitative tools, introduction to linear programming, uses of LP in different fields, graphic solution to problems, formulation of problems. Simple Method: Concept of simplex Method, solving profit maximization and cost minimizations problems. Formulation of farm and nonfarm problems as linear programming models and solutions. Extension of linear Programming



models: dynamic programming. Game Theory- Concepts of game theory, two person constant sums, zero sum game.

### **Unit-9**

Role and Importance of Agricultural Finance. Financial Institutions and credit flow to rural/priority sector. Agricultural lending–Direct and Indirect Financing–Financing through Co-operatives, NABARD and Commercial Banks and RRBs. District Credit Plan and lending to agriculture/priority sector. Micro-Financing and Role of MFI's-NGO, and SHG's. Lending to farmers–The concept of 5C's, 7P's and 3R's of credit. Estimation of Technical feasibility, Economic viability and repaying capacity of borrowers and appraisal of credit proposals. Understanding lenders and developing better working relationship and supervisory credit system. Credit inclusions–credit widening and credit deepening. Financial Decisions–Investment, Financing, Liquidity and Solvency. Preparation of financial statements-Balance Sheet, Cash Flow Statement and Profit and Loss Account. Ratio Analysis and assessing the performance of farm/firm. Project Approach in financing agriculture. Financial, economic and environmental appraisal of investment projects. Identification, preparation, appraisal, financing and implementation of projects. Project Appraisal techniques–Undiscounted measures. Time value of money–Use of discounted measures-B-C ratio, NPV and IRR. Agreements. Net work Techniques–PERT and CPM. Risks in financing agriculture. Risk management strategies and coping mechanism. Crop Insurance programmes–review of different crop insurance schemes–yield loss and weather based insurance and their applications.

## **Syllabus for Ph.D. Entrance Examination for students having M.Sc.(Ag) Entomology Degree**

### **Entomology**

#### **UNIT – 1**

External morphology of the insect's body i.e., head, thorax and abdomen, their appendages and functions. Principles, utility and relevance: insect body wall structure, cuticular outgrowths, colouration and special integumentary structures in insects, body tagmata, sclerites and segmentation. Head- Origin, structure and modification; types of mouthparts and antennae, tentorium and neck sclerites. Thorax- Areas and sutures of tergum, sternum and pleuron, pterothorax; Wings: structure and modifications, venation, wing coupling apparatus and mechanism of flight; Legs: structure and modifications. Abdomen- Segmentation and appendages; Genitalia and their modifications; Embryonic and post-embryonic development; Types of metamorphosis. Insect sense organs (mechano-, photo- and chemoreceptors). Structure, modification and physiology of different systems- digestive, circulatory, respiratory, excretory, nervous, sensory, reproductive, musculature, endocrine and exocrine glands. Thermodynamics; physiology of integument, moulting; growth, metamorphosis and diapause. Insect nutrition- role of vitamins, proteins, amino acids, carbohydrates, lipids, minerals and other food constituents; extra and intra-cellular microorganisms and their role in physiology; artificial diets.

#### **UNIT – 2**

Brief evolutionary history of Insects- introduction to phylogeny of insects and Major Classification of Superclass Hexapoda – Classes – Ellipura (Collembola, Protura), Diplura and Insecta- Orders contained. Distinguishing characters, general biology, habits and habitats of Insect orders and economically important families contained in them. Collembola, Protura, Diplura. Class Insecta: Subclass Apterygota – Archaeognatha, Thysanura. Subclass: Pterygota, Division Palaeoptera – Odonata and Ephemeroptera. Division: Neoptera: Subdivision: Orthopteroid and Blattoid Orders (=Oligoneoptera): Plecoptera, Blattodea, Isoptera, Mantodea, Grylloblattodea, Dermaptera, Orthoptera, Phasmatodea, Mantophasmatodea, Embioptera, Zoraptera, Subdivision: Hemipteroid Orders (=Paraneoptera): Psocoptera, Phthiraptera, Thysanoptera and Hemiptera. Distinguishing characters, general biology, habits and habitats of Insect orders and economically important families contained in them (Continued). Division Neoptera – Subdivision Endopterygota, Section Neuropteroid- Coleopteroid Orders: Strepsiptera, Megaloptera, Raphidioptera, Neuroptera and Coleoptera, Section Panorpid Orders Mecoptera, Siphonaptera, Diptera, Trichoptera, Lepidoptera, and Section Hymenopteroid Orders: Hymenoptera.

#### **UNIT – 3**

History and Definition. Basic Concepts. Organization of the Biological world. Abundance and diversity of insects, Estimates and Causal factors. Study of abundance and distribution and relation between the two. Basic principles of abiotic factors and their generalized action on insects. Implications for abundance and distribution of organisms including insects- Law of the Minimum, Law of Tolerance, and biocoenosis, Systems approach to ecology. Basic concepts of abundance- Model vs Real world. Population growth basic models Exponential vs Logistic models. Discrete vs Continuous growth models. Balance of life in nature- Concepts of Carrying capacity, Environmental Resistance. Vital Statistics- Life Tables and their application to insect biology. Survivorship curves. Case studies of insect life tables. Population dynamics- Factors

affecting abundance- Environmental factors, dispersal and migration, Seasonality in insects. Classification and mechanisms of achieving different seasonality- Diapause (Quiescence) - aestivation, hibernation. Biotic factors- Food as a limiting factor for distribution and abundance, Nutritional Ecology. Food chain- web and ecological succession. Interspecific interactions- Basic factors governing the interspecific interactions- Classification of interspecific interactions – The argument of cost-benefit ratios. Competition- Lotka-Volterra model, Concept of niche, ecological homologues, competitive exclusion. Prey-predator interactions- Defense mechanisms against predators/parasitoids- Evolution of mimicry, colouration, concept of predator satiation; evolution of life history strategies. Community ecology- Concept of guild, Organisation of communities. Relative distribution of organisms, Concept of diversity- the Wallacian view. Assessment of diversity. Diversity stability debate, relevance to pest management. Pest management as applied ecology.

#### **UNIT – 4**

History and origin, scope and need for IPM, definition and evolution of various related terminologies. Concept and philosophy, ecological principles, economic threshold concept, and economic consideration. Tools of pest management and their integration- legislative, cultural, physical and mechanical methods; pest survey and surveillance, forecasting, types of surveys including remote sensing methods, factors affecting surveys; political, social and legal implications of IPM; pest risk analysis; pesticide risk analysis; cost-benefit ratios and partial budgeting; case studies of successful IPM programmes. History, principles and scope of biological control; important groups of parasitoids, predators and pathogens; principles of classical biological control- importation, augmentation and conservation. Biology, adaptation, host seeking behaviour of predatory and parasitic groups of insects. Role of insect pathogenic nematodes, viruses, bacteria, fungi, protozoa etc., their mode of action. Biological control of weeds using insects. Mass production of quality biocontrol agents- techniques, formulations, economics, field release/application and evaluation. Successful biological control projects, analysis, trends and future possibilities of biological control. Importation of natural enemies- Quarantine regulations, biotechnology in biological control. Semiochemicals in biological control.

#### **UNIT – 5**

Definition and scope of insecticide toxicology; history of chemical control, Classification of insecticides and acaricides based on mode of entry, mode of action and chemical nature. Structure and mode of action of organochlorines, organophosphates, carbamates, pyrethroids, tertiary amines, neonicotinoids, oxadiazines, phenyl pyrozoles, insect growth regulators, microbials, botanicals, new promising compounds, etc. Principles of toxicology; evaluation of insecticide toxicity; joint action of insecticides synergism, potentiation and antagonism; factors affecting toxicity of insecticides; insecticide compatibility, selectivity and phytotoxicity. Insecticide metabolism; pest resistance to insecticides; mechanisms and types of resistance; insecticide resistance management and pest resurgence. Insecticide residues, their significance and environmental implications. Insecticide Act, registration and quality control of insecticides; safe use of insecticides; diagnosis and treatment of insecticide poisoning.

#### **UNIT – 6**

Systematic position, identification, distribution, host-range, bionomics, nature and extent of damage, seasonal abundance and management of insect and mite pests and vectors. Insect pests of cereals and millets and their management. Polyphagous pests: grasshoppers, locusts,

termites, white grubs, hairy caterpillars, and non-insect pests (mites, birds, rodents, snails, slugs etc.). Insect pests of pulses, tobacco, oilseeds and their management.

## **Syllabus for Ph.D. Entrance Examination for students having M.Sc.(Ag) Agricultural Extension and Communication/Extension Education & Communication Degree**

### **UNIT-1**

Extension Education, Adult Education and Distance Education. Poverty Alleviation Programmes – SGSY, SGRY, PMGSY, DPAP, DDP, CAPART – Employment Generation Programmes – NREGP, Women Development Programmes – ICDS, MSY, RMK, Problems in Rural Development. Current Approaches in Extension: Decentralized Decision Making, Bottom up Planning, Farming System Approach, Farming Situation Based Extension, Market – Led – Extension, Farm Field School, ATIC, Kisan Call Centers, and NAIP.

### **UNIT-2**

Communication and communication process, Communication skills, fidelity of communication, communication competence and empathy, communication effectiveness and credibility. Methods of communication: Meaning and functions, classification. Forms and types of communication, organizational communication. Key communicators– Meaning, characteristics and their role. Agricultural Journalism, Techniques of writing scripts for Radio and TV.

### **UNIT-3**

The adoption and Diffusion process, covert and overt processes at stages. Adopter categories and their rate of adoption, factors influencing rate of adoption. Diffusion effect and concept of over adoption, opinion leadership- measurement and Characteristics of opinion leaders, multi-step flow of innovation; concepts of homophile and heterophily.

### **UNIT-4**

Research, social research, Behavioural sciences research. Types and methods of Research. Review of literature, Research problem. Objectives, Concept & Construct, Variable, Hypothesis, Measurement. Validity and Reliability. Sampling – Universe, Sample and Sampling. Types of sampling and sampling procedures. Research Designs: types, advantages and limitations of each design. Data Collection devices – Interview, Enquiry forms, Schedules and Questionnaires Rating scales, Observation, Case studies and Social survey. Data processing and Report writing.

### **UNIT-5**

ICTs- Concept, definition, tools and application in extension education. Reorganizing the extension efforts using ICTs, advantages, limitations and opportunities. ICTs projects, case studies in India and developing world. Different approaches (Models) to ICTs, ICT use in field of extension- Expert systems, Agricultural web sites and portals related crop production and marketing etc. Community Radio, Web, Tele, and Video Conferencing, Computer Aided Extension, Knowledge management, Information kiosks, Multimedia, Online, Offline Extension, Tools-Mobile technologies, e-learning concepts.

### **UNIT-6**

Entrepreneur, Entrepreneurship and Agri – entrepreneurship, Theories of Entrepreneurship, Traits & Types of Entrepreneurs, Stages of establishing enterprise – Identification of sound

enterprise. Project Management and Appraisal – Market, Technical, Financial, Social Appraisal of Projects. Micro enterprises – Profitable Agri enterprises in India – Agro Processing, KVIC industries. Gender issues in entrepreneurship development – Understanding gender and subordination of women, Gender as a development tool, Policy approaches for women entrepreneurship development. Management, Extension Management, Planning and Decision making, Steps in DM Process, Meaning of Organization, Concept, Principles, Span of Management, Departmentalization, Authority and responsibility, Delegation and decentralization, line and staff relations. Coordination, Staffing, Training and Development and Direction. Supervision, Managerial Control, Budgeting, Observation, PERT and CPM, MIS.

#### **UNIT-7**

Human Resource Development, Conceptual frame work, inter disciplinary approach, function systems and case studies in HRD; HRD Interventions, Recruitment, Induction Staff Training and Development, Career planning; Social and Organizational Culture. Human Resource management: Collective bargaining, Negotiation skills; Human Resource Accounting (HRA). Intra personal processes: Collective behaviour, learning, and perception; Stress and coping mechanisms; Inter-Personal Process, Helping Process – communication and Feedback and interpersonal styles; Group & Inter group process: group information and group processes; Organizational communication, Team building Process and functioning, Conflict management, Collaboration and Competition; HRD & Supervisors: Task Analysis; Capacity Building – Counseling and Mentoring. Training and development strategies – Training types, models, methods and evaluation. Main issues in HRD: HRD culture and climate – organizing for HRD – emerging trends and Prospective.

## **Syllabus for Ph.D. Entrance Examination for students having M.Sc.(Ag) Genetics and Plant Breeding Degree**

### **UNIT –1**

Beginning of genetics; Cell structure and cell division; Mendel's laws; Multiple alleles, Sex determination, sex-linkage, Sex-influenced and sex-limited traits; in eukaryotes, Somatic cell genetics, Extra chromosomal inheritance. Population Genetics; Hardy-Weinberg equilibrium. Structural and numerical changes in chromosomes; Central Dogma; Genetic fine structure analysis, Jumping gene theory; Overlapping genes, pseudogenes, Oncogenes, Gene Regulation in Prokaryotes and eukaryotes; mutation; Bacterial plasmids, Molecular chaperones and gene expression. RNA editing. Gene isolation, synthesis and cloning, genomic and cDNA libraries, PCR based cloning; Nucleic acid hybridization and immunochemical detection; DNA sequencing; DNA restriction and modification, Anti-sense RNA and ribozymes; Micro-RNAs (miRNAs). Genomics and proteomics; Metagenomics. Transgenic bacteria and bioethics; Gene silencing; genetics of mitochondria and chloroplasts. Concepts of Eugenics, Epigenetics, Genetic disorders and Behavioural genetics.

### **UNIT-2**

Architecture of chromosome in prokaryotes and eukaryotes; Chromonemata, chromosome matrix, chromomeres, centromere, secondary constriction and telomere; artificial chromosome construction and its uses; Special types of chromosomes. Synapsis, structure and function of synaptonemal complex and spindle apparatus, anaphase movement of chromosomes and crossing over-mechanisms and theories of crossing over- recombination models, cytological basis, - Variation in chromosome structure: Evolutionary significance – Introduction to techniques for karyotyping; Chromosome banding and painting – in situ hybridization and various applications. Utilization of aneuploids in gene location somatic segregation and chimeras – Endomitosis and somatic reduction ; Evolutionary significance of chromosomal aberrations – balanced lethal and chromosome complexes. Inter- varietal chromosome substitutions; Polyploidy and role of polyploids in crop breeding allopolyploids utilization in gene mapping and gene blocks transfer – Alien addition and substitution lines – creation and utilization; Apomixis Reversion of autopolyploids to diploids; Genome mapping in polyploids – Interspecific hybridization and allopolyploids; Synthesis of new crops (wheat, triticale and brassica) Gene transfer using amphidiploids – Bridge species. Fertilization barriers in crop plants at pre- and post fertilization levels- In vitro techniques to overcome the fertilization barriers in crops; of haploids, dihaploids and doubled haploids in genetics and breeding.

### **UNIT –3**

History & objectives of plant breeding, patterns & characteristics of evolution of crop plants; centres of Origin-biodiversity; Genetic basis of breeding self- and cross - pollinated crops; components of variation; Heritability and genetic advance, genotype environment interaction; General and specific combining ability; gene actions and implications in plant breeding; Plant introduction and role of plant genetic resources in plant breeding. Self-incompatibility and male sterility; Pure line theory, pure line election and mass selection methods; Line breeding, pedigree, bulk, backcross, single seed descent and multiline method; Population breeding; Breeding methods in cross pollinated crops; Heterosis & Hybrid breeding ; seed production of

hybrid and their parent varieties/inbreds. Breeding methods in asexually/clonally propagated crops, clonal selection apomixes, clonal selection. Self-incompatibility and male sterility; Concept of plant ideotype and its role in crop improvement; Transgressive breeding. Mutation breeding; Breeding for abiotic and biotic stresses. Cultivar development- testing, release and notification, maintenance breeding, Participatory Plant Breeding, Plant breeders' rights and regulations for plant variety protection and farmers rights.

#### **UNIT-4**

Mendelian traits vs polygenic traits; Multiple factor hypothesis - analysis of continuous variation; Variations associated with polygenic traits - phenotypic, Models of G X E; non-allelic interactions; Nature of gene action - additive, dominance, epistatic and linkage effects. ANOVA; MANOVA, biplot analysis; Experimental Designs; Genetic diversity analysis; D2 analyses; correlations; Path analysis and Parent - progeny regression analysis; Discriminant function and principal component analyses; Selection indices; Simultaneous selection models heritability and genetic advance. Generation mean analysis; Mating designs; Concepts of combining ability and gene action; adaptability and stability; Models for GxE analysis and stability parameters; AMMI analysis – principles and interpretation. QTL mapping; Marker assisted selection (MAS).

#### **UNIT-5**

Ultrastructure of the cell; eukaryotic and prokaryotic cells, macromolecules; Structure and function of cell wall, nuclear membrane and plasma membrane; Cellular Organelles Bioenergetics; Ultrastructure and function of mitochondria and biological membranes; Chloroplast and other photosynthetic organelles; Interphase nucleus- Structure and chemical composition; Cell division and physiology of cell division. Historical background of molecular genetics; Genetic material in organisms; Structure and properties of nucleic acid, DNA transcription and its regulation – Transcription factors and their role; Genetic code, regulation of protein synthesis in prokaryotes and eukaryotes – ribosomes, t-RNAs and translational factors. Mechanisms of recombination in prokaryote; DNA organization in eukaryotic chromosomes – DNA content variation, types of DNA sequences; organelle genomes; Gene amplification and its significance; Proteomics and protein-protein interaction; Signal transduction; Genes in development; Cancer and cell aging.

#### **UNIT-6**

Biotechnology and its relevance in agriculture; Definitions, terminologies and scope in plant breeding. Tissue culture- History, callus, suspension cultures, cloning; Regeneration; Somatic embryogenesis; Anther culture; somatic hybridization techniques; Meristem, ovary and embryo culture; cryopreservation. Techniques of DNA isolation, quantification and analysis; Genotyping; Sequencing techniques; Vectors, vector preparation and cloning, Biochemical and Molecular markers: morphological, biochemical and DNA-based markers (RFLP, RAPD, AFLP, SSR, SNPs, ESTs etc.), mapping populations (F2s, back crosses, RILs, NILs and DH). Molecular mapping and tagging of agronomically important traits. Statistical tools in marker analysis, Robotics; Marker-assisted selection for qualitative and quantitative traits; QTLs analysis in crop plants, Gene pyramiding. Molecular breeding; Genomics and geno-informatics for crop improvement; Integrating functional genomics information on agronomically/economically important traits in plant breeding; Marker-assisted backcross breeding for rapid introgression, Generation of EDVs. Recombinant DNA technology, transgenes, method of transformation, selectable markers and clean transformation techniques, vector-mediated gene transfer, physical methods of gene transfer. Production of



transgenic plants in various field crops: cotton, wheat, maize, rice, soybean, oilseeds, sugarcane etc. Commercial releases. Biotechnology applications in male sterility/hybrid breeding, molecular farming. MOs and related issues (risk and regulations); GMO; International regulations, biosafety issues of GMOs; Regulatory procedures in major countries including India, ethical, legal and social issues; Intellectual property rights; Bioinformatics & Bioinformatics tools. Nanotechnology and its applications in crop improvement programmes.

#### **UNIT-7**

Variety Development and Maintenance; Definition- variety, cultivar, extant variety, essentially derived variety, independently derived variety, reference variety, farmers' variety, hybrid and population; Variety testing, release and notification systems in India and abroad. DUS testing- Genetic purity concept and maintenance breeding. genetic deterioration of varieties - safeguards during seed production; Maintenance of varieties; Principles & methods of seed production; Generation system of seed multiplication -nucleus, breeders, foundation, certified, - Quality seed production technology; of self and cross-pollinated crop varieties viz. cereals & millets (wheat, barley, paddy, pearl millet, sorghum, maize and ragi etc.); Pulses (greengram, blackgram, cowpea, pigeonpea, chickpea, fieldpea, lentil); Oilseeds (groundnut, soybean, sesame, castor, sunflower, safflower, linseed, rapeseed and mustard); fibres (cotton, jute) and forages (guar, forage sorghum, teosinte, oats, berseem, lucerne).; Seed certification procedures; Seed laws and plant variety protection regulations in India and international systems.

## **Syllabus for Ph.D. Entrance Examination for students having M.Sc.(Ag) Plant Pathology Degree**

### **UNIT 1**

Classification of fungi, economic mycology, edible fungi and entomogenous fungi mycorrhizal association, cell organelles, their morphology, functions and chemical composition.

### **UNIT 2**

Nature, composition and structure of viruses and viroids Symptomatology of important plant viral diseases, transmission, properties of viruses , host virus interaction, virus vector relationship. Virus nomenclature and classification, genome organization, replication and movement of viruses. Isolation and purification, electron microscopy, protein and nucleic acid based diagnostics. Myco-viruses, satellite viruses, satellite RNAs, phages, prions. Origin and evolution, mechanism of resistance, genetic engineering, ecology, and management of plant viruses.

### **UNIT 3**

Importance of phytopathogenic bacteria. Evolution, classification and nomenclature of phytopathogenic procaryota and important diseases caused by them. Growth, nutrition requirements, reproduction, preservation of bacterial cultures and variability among phytopathogenic procaryota. General biology of bacteriophages, L form bacteria, plasmids and bdellovibrios. Procaryotic inhibitors and their mode of action against phytopathogenic bacteria. Survival and dissemination of phytopathogenic bacteria.

### **UNIT 4**

Importance, definitions and concepts of plant diseases, history and growth of plant pathology, biotic and abiotic causes of plant diseases. Growth, reproduction, survival and dispersal of important plant pathogens, role of environment and host nutrition on disease development. Host parasite interaction, recognition concept and infection, symptomatology, disease development- role of enzymes, toxins, growth regulators; defense strategies- oxidative burst; Phenolics, Phytoalexins, PR proteins, Elicitors. Genetics of resistance; 'R' genes; mechanism of genetic variation in pathogens; molecular basis for resistance; marker-assisted selection; genetic engineering for disease resistance. Disease management strategies.

### **UNIT 5**

Pure culture techniques, use of selective media to isolate pathogens. Preservation of plant pathogens and disease specimens, use of haemo-cytometer, micrometer, centrifuge, pH meter, camera lucida. Microscopic techniques and staining methods, phase contrast system, chromatography, use of electron microscope, spectrophotometer, ultracentrifuge and electrophoretic apparatus, disease diagnostics, serological and molecular techniques for detection of plant pathogens. Evaluation of fungicides, bactericides etc.; field experiments, data collection and preparation of references.

### **UNIT 6**

Morphology and anatomy of typical monocotyledonous and dicotyledonous infected seeds. Recent advances in the establishment and subsequent cause of disease development in seed and seedling. Localization and mechanism of seed transmission in relation to seed infection, seed to plant transmission of pathogens. Seed certification and tolerance limits, types of losses caused by seed-borne diseases in true and vegetatively propagated seeds, evolutionary adaptations of crop plants to defend seed invasion by seed-borne pathogens. Epidemiological factors influencing the transmission of seed-borne diseases, forecasting of epidemics through seed-borne infection. Production of toxic metabolites affecting seed quality and its impact on human, animal and plant health, management of seed-borne pathogen/diseases and procedure for healthy seed production, seed health testing, methods for detecting microorganism.

#### **UNIT 7**

Molecular mechanisms of pathogenesis, process of infection, variability in plant pathogens. Mechanism of resistance. Host defense system. Antiviral protein. SAR, active oxygen radicals. Hypersensitivity and its mechanisms Tissue culture, elementary genetic engineering. Gene-for-gene concept, protein-for-protein and immunization basis, management of resistance genes. Strategies for gene deployment.

#### **UNIT 8**

Introduction, definition, concept and tools of disease management, components of integrated disease management- their limitations and implications. Development of IDM- basic principles, biological, chemical and cultural disease management. IDM in important crops- rice, wheat, cotton, sugarcane, chickpea, rapeseed, mustard, pearl millet, *kharif* pulses, vegetable crops and fruit crops.

## **Syllabus for Ph.D. Entrance Examination for students having M.Sc.(Ag) Soil Science & Agricultural Chemistry Degree**

### **UNIT-1**

Chemical (elemental) composition of the earth's crust and soils. Elements of equilibrium thermodynamics, chemical equilibria, electrochemistry and chemical kinetics. Soil colloids: inorganic and organic colloids – origin of charge, concept of point of zero-charge (PZC) surface charge characteristics of soils; diffuse double layer theories of soil colloids, zeta potential, stability, coagulation/flocculation and peptization of soil colloids; electrometric properties of soil colloids; sorption properties of soil colloids; soil organic matter – fractionation of soil organic matter and different fractions, clay- organic interactions. Ion exchange processes in soil; cation exchange – theories based on law of mass action adsorption isotherms, donnan-membrane equilibrium concept, clay-membrane electrodes and ionic activity measurement, thermodynamics, statistical mechanics; anion and ligand exchange – innersphere and outer-sphere surface complex formation, fixation of oxyanions, hysteresis in sorption-desorption of oxy-anions and anions, AEC, CEC; experimental methods to study ion exchange phenomena and practical implication in plant nutrition. Potassium, phosphate and ammonium fixation in soils covering specific and non-specific sorption; precipitation – dissolution equilibria; step and constant –rate K; management aspects. Chemistry of acid soils; active and potential acidity; lime potential, chemistry of acid soils; sub-soil acidity. Chemistry of salt- affected soils and amendments; soil pH, E<sub>ce</sub>, ESP, SAR and important relations; soil management and amendments. Chemistry and electrochemistry of submerged soils.

### **UNIT – 2**

Fundamentals of crystallography, space lattice, coordination theory, isomorphism and polymorphism. Classification, structure, chemical composition and properties of clay minerals; genesis and transformation of crystalline and non-crystalline clay minerals; identification techniques; amorphous soil constituents and other non-crystalline silicate mineral and their identification; clay minerals in Indian soils. Factors of soil formation, soil formation models; soil forming processes; weathering of rocks and mineral transformation; soil profile; weathering sequences of minerals with special reference to Indian soils. Concept of soil individual; soil classification system, soil mineralogy and soil maps – usefulness. Soil survey and its types; soil survey techniques – conventional and modern; soil series – characterization and procedure for establishing soil series; benchmark soils and soil correlations; soil survey interpretation; soil mapping, thematic soil maps, cartography, mapping units, techniques for generation of soil maps. Landform – soil relationship; major soil groups of India with special reference to respective states; land capability classification and land irrigability classification; land evaluation and land use type (LUT) – concepts and application; approaches for managing soils and landscapes in the framework of agro-ecosystem.

### **UNIT – 3**

Soil biota, soil microbial ecology, types of organisms in different soils; soil microbial biomass; microbial interaction; un-culturable soil biota. Microbiology and biochemistry of root-soil interface; phyllosphere; soil enzymes, origin activities and importance; soil characteristics influencing growth and activity of microflora. Microbial transformation of nitrogen, phosphorus, sulphur, iron and manganese in soil; biochemical composition and biodegradation of soil

organic matter and crop residues, humus formation; cycles of important organic nutrients. Biodegradation of pesticides, organic wastes and their use for production of biogas and manures; biotic factors in soil development; microbial toxins in the soil. Preparation and preservation of farmyard manure, animal manures, rural and urban composts and vermicompost. Biofertilizers – definition, classification, specifications, method of production and role in crop production.

#### **UNIT – 4**

Introduction and history of remote sensing; sources, propagation of radiations in atmosphere; interactions with matter. Sensor system – camera, microwave radiometers and scanners; fundamentals of aerial photographs and image processing and interpretations. Application of remote sensing techniques – land use soil surveys, crop stress and yield forecasting, prioritization in watershed and drought management, wasteland identification and management. Significance and sources of the spatial and temporal variability in soils; variability in relation to size of sampling; classical and geo- statistical techniques of evolution of soil variability. Introduction to GIS and its application for spatial and non – spatial soil and attributes.

#### **UNIT – 5**

Soil texture, textural classes, mechanical analysis, specific surface. Soil consistence; dispersion and workability of soils; soil compaction and consolidation; soil strength; swelling and shrinkage – basic concepts. Soil structure – genesis, types, characterization and management soil structure; soil aggregation, aggregate stability; soil tilth, characteristics of good soil tilth; soil crusting – mechanism, factors affecting and evaluation; soil conditioners; puddling, its effect on soil physical properties; clod formation. Soil water: content and potential, soil water retention, soil-water constants, measurement of soil water content, energy state of soil water, soil water potential, soil moisture characteristic curve; hysteresis, measurement of soil-moisture potential. Water flow in saturated and unsaturated soils, Poiseuille's law, Darcy's law; hydraulic conductivity, permeability and fluidity, hydraulic diffusivity; measurement of hydraulic conductivity in saturated and unsaturated soils. Infiltration; internal drainage and redistribution; evaporation; hydrologic cycle, field water balance; soil-plant-atmosphere continuum. Composition of soil air; renewal of soil air – convective flow and diffusion; measurement of soil aeration; aeration requirement for plant growth; soil air management. Modes of energy transfer in soils; energy balance; thermal properties of soil; measurement of soil temperature; soil temperature in relation to plant growth; soil temperature management.

#### **UNIT – 6**

Nature and sources of pollutants – agricultural, industrial, urban wastes, fertilizers and pesticides, acid rains, oil spills etc.; air, water and soil pollutants – their CPC standers and effect on plants, animals and human beings. Sewage and industrial effluents – their composition and effect on soil properties/health, and plant growth and human beings; soil as sink for waste disposal. Pesticides – their classification, behavior in soil and effect on soil microorganisms. Toxic elements – their sources, behavior in soils, effect on nutrients availability, effect on plant and human health. Pollution of water resources due to leaching of nutrients and pesticides from soil; emission of greenhouse gases – carbon dioxide, methane and nitrous oxide. Remediation/amelioration of contaminated soil and water; remote sensing applications in monitoring and management of soil and water pollution.

#### **UNIT – 7**

Soil fertility and soil productivity; nutrient sources; essential plant nutrients – functions and deficiency symptoms. Soil and fertilizer nitrogen – sources, forms, immobilization and mineralization, nitrification, denitrification; biological nitrogen fixation – types, mechanism, microorganism and factors affecting; nitrogenous fertilizers and their fate in soils; management of fertilizer nitrogen in lowland and upland conditions for high fertilizer use efficiency. Soil and fertilizer phosphorus – forms, immobilization, mineralization, reactions in acid and alkali soils; factors affecting phosphorus availability in soils; phosphatic fertilizers – behavior in soils and management under field conditions. Potassium – forms, equilibrium in soils and its agricultural significance; mechanism of potassium fixation; management of potassium fertilizers. Sulphur – source, forms, fertilizers and their behavior in soils; calcium and magnesium – factors affecting their availability in soils; management of sulphur, calcium and magnesium fertilizers. Micronutrients – critical limits in soils and plants; factors affecting their availability and correction of their deficiencies in plants; role of chelates in nutrient availability. Common soil test methods for fertilizer recommendation; quantity – intensity relationships; soil test crop response correlations and response functions. Fertilizer use efficiency; blanket fertilizer recommendations – usefulness and limitations; site-specific nutrient management; plant need based nutrient management; integrated nutrient management. Soil fertility evaluation; soil quality in relation to sustainable agriculture.

## **Syllabus for Ph.D. Entrance Examination for students having M.Sc.(Ag) (Horticulture) Fruit Science Degree**

### **(Horticulture) Fruit Science**

#### **UNIT-1**

Importance and management of tropical sub tropical temperate and dry land fruits grown in India. Commercial varieties of regional, national and international importance. Recent trends in propagation, rootstock influence, planting systems, cropping systems, root zone and canopy management, nutrient management, water management, fertigation, role of bio-regulators. Physiological disorders- causes and remedies, quality improvement by management practices; maturity indices, harvesting, grading, packing, storage and ripening techniques; industrial and export potential. Agri. Export Zones (AEZ) and industrial supports. Crops Mango, Banana, Citrus, Papaya, Guava, Sapota, Jackfruit, Aonla, Pomegranate, Ber, Apple, Pear, Grapes, Plums, Peach, Nuts- walnut, Almond Minor fruits- Bael, Fig and Jamun.

#### **UNIT-2**

Sexual propagation, apomixis, polyembryony, chimeras. Asexual propagation – rooting of soft and hard wood cutting under mist by growth regulators. Rooting of cuttings in hotbeds. Rejuvenation through top working–Progeny orchard and scion bank. Micro-propagation–principles and concepts, commercial exploitation in horticultural crops. Nursery–types, structures, components, planning and layout. Nursery management practices for healthy propagule production.

#### **UNIT-3**

Principles of biodiversity in germplasm conservation of fruit crops. Present status of gene centers; exploration and collection of germplasm *in situ* and *ex situ*; Intellectual property rights. Crops Mango, citrus, guava, banana, papaya, coconut.

#### **UNIT-4**

Principles and practices of breeding of fruit crops. Breeding systems, breeding objectives, approaches for crop improvement-introduction, selection, hybridization, mutation breeding, polyploidy breeding, rootstock breeding, improvement of quality traits, resistance breeding for biotic and abiotic stresses in the following selected fruit crops. Crops Mango, banana, citrus, grapes, guava, papaya.

#### **UNIT-5**

Principles and practices in canopy management of fruit crops. Canopy management-importance and advantages; factors affecting canopy development. Canopy types and structures with special emphasis on geometry of planting, canopy manipulation for optimum utilization of light. Canopy management through plant growth inhibitors, training and pruning and management practices in temperate fruits, grapes, mango, guava, citrus and ber. Role of hormones in different horticultural crops- fruit thinning, fruit drop, ripening, dormancy breaking and propagation.

# **Syllabus for Ph.D. Entrance Examination for students having M.Sc.(Ag) (Horticulture) Vegetable Science Degree**

## **(Horticulture) Vegetable Science**

### **UNIT-1**

Production technology of vegetable crops. Introduction, botany and taxonomy, climatic and soil requirements, commercial varieties / hybrids, sowing / planting times and methods, seed rate and seed treatment, nutritional and irrigation requirements, intercultural operations, weed control, mulching, physiological disorders, harvesting, post-harvest management, plant protection measures and seed production of vegetable crops like - solanaceous crops, root crops, bulb crops, cucurbitaceous crops, sweet potato, okra and leafy vegetables.

### **UNIT-2**

Breeding methods (introduction, selection, hybridization, mutation) of vegetable crops. Resistance breeding for biotic and abiotic stress, quality improvement, molecular marker, genomics like - Potato, tomato, okra, peas, cabbage, cauliflower, carrot, radish, melons and pumpkins.

### **UNIT-3**

Role of auxins, gibberellins, cytokinins and abscisic acid; Application of synthetic hormones, plant growth retardants and inhibitors for various purposes in vegetable crops; Role and mode of action of morphactins, antitranspirants, anti-auxin, ripening retardant and plant stimulants in vegetable crop production.

### **UNIT-4**

Genetical and agronomical principles of seed production; methods of seed production; use of growth regulators and chemicals in vegetable seed production, methods of hybrid seed production. Categories of seed; maintenance of nucleus, foundation and certified seed; seed certification, seed standards; seed act and law enforcement, plant quarantine and quality control. Agro-techniques for seed production in solanaceous vegetables, cucurbits, leguminous vegetables, cole crops, bulb crops, okra and leafy vegetables.

### **UNIT-5**

Production technology of underutilized vegetable crops. Introduction, botany and taxonomy, climatic and soil requirements, commercial varieties / hybrids, sowing / planting times and methods, seed rate and seed treatment, nutritional and irrigation requirements, intercultural operations, weed control, mulching, physiological disorders, harvesting, post harvest management, plant protection measures and production of: Asparagus, Elephant foot yam, lima bean, Sweet gourd, spine gourd and pointed gourd.

### **UNIT-6**

Organic farming in vegetable production. Importance, principles, perspective, concept and component of organic production of vegetable crops. Organic production of vegetables crops, viz., solanaceous crops, cucurbits, cole crops, root and tuber crops. Methods for enhancing soil



fertility, mulching, raising green manure crops. Indigenous methods of compost, Panchagavya, Bio-dynamics, preparation etc.

# **Syllabus for Ph.D. Entrance Examination for students having M.Sc. (Ag)**

## **Molecular Biology and Biotechnology/ Plant Biotechnology Degree**

### **Biotechnology**

#### **UNIT 1**

History, scope and importance; DNA structure, function and metabolism. DNA modifying enzymes and vectors; Methods of recombinant DNA technology; Nucleic acid hybridization; Gene libraries; PCR amplification; Plant and animal cell and tissue culture techniques and their applications. Molecular markers and their applications; DNA sequencing; Applications of gene cloning in basic and applied research; Genetic engineering and transgenics; Genomics, transcriptomics and proteomics. General application of biotechnology in Agriculture, Medicine, Animal husbandry, Environmental remediation, Energy production and Forensics; Public perception of biotechnology; Bio-safety and bioethics issues; Intellectual property rights in biotechnology.

#### **UNIT 2**

Historical developments of molecular biology; Nucleic acids as genetic material; Chemistry, structure and properties of DNA and RNA. Genome organization in prokaryotes and eukaryotes; Chromatin structure and function; DNA replication; DNA polymerases, topoisomerases, DNA ligase, etc; Molecular basis of mutations; DNA repair mechanisms. Transcription process; RNA processing; Reverse transcriptase; RNA editing; Ribosomes structure and function; Organization of ribosomal proteins and RNA genes; Genetic code; Aminoacyl tRNA synthases. Translation and post-translational modifications; Operon concept; Attenuation of trp operon; important features of gene regulation in eukaryotes.

#### **UNIT 3**

General structure and constituents of cell; Similarities and distinction between plant and animal cells; Cell wall, cell membrane, structure and composition of biomembranes, cell surface related functions. Structure and function of major organelles: Nucleus, Chloroplasts, Mitochondria, Ribosomes, Lysosomes, Peroxisomes. Endoplasmic reticulum, Microbodies, Golgi apparatus, Vacuoles, etc. Organellar genomes and their manipulation; Ribosomes in relation to cell growth and division; Cyto-skeletal elements. Cell division and regulation of cell cycle; Membrane transport; Transport of water, ion and biomolecules; Signal transduction mechanisms; Protein targeting.

#### **UNIT 4**

History of plant cell and tissue culture; Culture media; Various types of culture; callus, suspension, nurse, root, meristem, etc.; In vitro differentiation: organogenesis and somatic embryogenesis; Plant growth regulators: mode of action, effects on in vitro culture and regeneration; Molecular basis of plant organ differentiation. Micropropagation; Anther and microspore culture; Somaclonal variation; In vitro mutagenesis; In vitro fertilization; In vitro germplasm conservation; Production of secondary metabolites; Synthetic seeds. Embryo rescue and wide hybridization; Protoplast culture and regeneration; Somatic hybridization: protoplast fusion, cybrids, asymmetric hybrids, etc. Methods of plant

transformation; Vectors for plant transformation; Genetic and molecular analyses of transgenics; Target traits and transgenic crops; Biosafety issues, testing of transgenics, regulatory procedures for commercial approval.

#### **UNIT 5**

Introduction, scope and historical developments; Isolation, screening and genetic improvement (involving classical approaches) of industrially important organisms. Primary metabolism products, production of industrial ethanol as a case study; Secondary metabolites, bacterial antibiotics and non ribosomal peptide antibiotics; Recombinant DNA technologies for microbial processes; Strategies for development of industrial microbial strains with scale up production capacities; Metabolic pathway engineering of microbes for production of novel product for industry. Microbial enzymes, role in various industrial processes, production of fine chemicals for pharmaceutical industries ; Bio-transformations, Bio-augmentation with production of vitamin C as a case study; Bioreactors, their design and types; Immobilized enzymes based bioreactors; Microencapsulation technologies for immobilization of microbial enzymes. Industrial biotechnology for pollution control, treatment of industrial and other wastes, biomass production involving single cell protein; Bio-remediation of soil; Production of eco-friendly agricultural chemicals, bio-pesticides, bio-herbicides, bio-fertilizers, bio-fuels, etc.

#### **UNIT 6**

Principles of plant breeding; Breeding methods for self and cross pollinated crops; Heterosis breeding; Limitations of conventional breeding; Aspects of molecular breeding. Development of sequence based molecular markers - SSRs and SNPs; Advanced methods of genotyping; Mapping genes for qualitative and quantitative traits. QTL mapping using structured populations; AB-QTL analysis; Association mapping of QTL; Fine mapping of genes/QTL; Map based gene/QTL isolation and development of gene based markers; Allele mining by TILLING and Eco-TILLING; Use of markers in plant breeding. Marker assisted selection (MAS) in backcross and heterosis breeding; Transgenic breeding; Foreground and background selection; MAS for gene introgression and pyramiding: MAS for specific traits with examples.

# **Syllabus for Ph.D. Entrance Examination for students having M.Sc. (Ag) Plant Physiology Degree**

## **Plant Physiology**

### **UNIT 1**

Cell organelles and their physiological functions, Cell membrane structure and functions. Water and its role in plants, properties and functions of water in the cell. Water potential of plant cells. Mechanism of water uptake and transport in roots, aquaporins, Mycorrhizal association on water uptake. Energy balance-Solar energy input-energy dissipation at crop canopy level-evapotranspiration, transpiration Stomata structure and function. Influence of water stress at cell, organ, plant and canopy levels. Indices for assessment of drought resistance. The role of mineral nutrients in plant metabolism. Essential elements. Mechanisms of uptake-translocation of minerals in plants. Metabolic functions of mineral elements, deficiency symptoms, and toxicity. Foliar nutrition. Synthesis of sucrose, starch, oligo and polysaccharides (composition of cell wall). Translocation of photosynthates. Mitochondrial respiration, growth and maintenance respiration, cyanide resistant respiration. Lipid metabolism- Types of lipids. Biosynthesis of fattyacids, diacyl and triacyl glycerol, fatty acids of storage lipids. Secondary metabolites. Hormonal concept of growth and differentiation, plant growth hormones and their physiological role synthetic growth regulators. Growth retardants, Apical dominance, senescence, fruit growth, abscission. Photo morphogenesis- Photo receptors, physiology of flowering, Photoperiodism and Vernalisation.

### **UNIT 2**

Plant Biodiversity, evolution in plants. General Aspects – Plant growth and development; Analysis of plant growth. Mobilization of food reserves during seed germination; Hormonal control of seed germination and seedling growth. Shoot, Leaf and Root Development –Floral Induction and Development – Photoperiodism and Vernalization, Molecular genetics of floral development and floral organ differentiation; Sex determination. Seed Development and Dormancy – Molecular and genetic determinants; Seed maturation and dormancy. Senescence and Programmed Cell Death (PCD) – PCD in the life cycle of plants. Light Control of Plant Development. Phytochromes and cryptochromes, Molecular mechanisms of light perception, signal transduction and gene regulation; Biological clocks Embryonic Pattern Formation – Maternal , Zygotic and Homeotic gene effects in Drosophila; Embryogenesis and early pattern formation in plants. Regeneration and totipotency; Organ differentiation and development; Pollen germination and pollen tube guidance; Phloem differentiation; Sex determination in plants. Self-incompatibility and its genetic control; Heterosis and apomixis.

### **UNIT 3**

Definition of abiotic stresses. Abiotic stress factors. Water stress and Drought characteristic features. Physiological processes affected by drought. Drought resistance. mechanisms: Drought avoidance, Stress proteins. Water use efficiency as a drought resistant trait. Molecular responses to water deficit: Stress and hormones- ABA as a signaling molecule. Oxidative stress: Reactive Oxygen Species (ROS). High temperature stress: HSP's, Chilling stress: Salinity: Glycophytes and halophytes. Heavy metal stress: Phytochelatins

#### **UNIT 4**

Definition and classification of plant growth regulators- Hormones, endogenous growth substances and synthetic chemicals Site of synthesis, biosynthetic pathways and metabolism and the influence on plant growth development of individual group of hormones- Auxins, Gibberellins, cytokinins, Abscisic acid and Ethylene Brassinosteroids. Hormone mutants and transgenic plants in understanding role of hormones. Signal perception, transduction, and effect at functional gene level of different hormones- Auxins- cell elongation, Gibberellins -, germination of dormant seeds, cytokinins- cell division. Retardation of senescence of plant parts, Abscisic acid-Stomatal closure and induction of drought resistance, Ethylene- fruit ripening. Interaction of hormones in regulation of plant growth and development processes. Synthetic growth regulators- Classification, their effect on plant growth and development. Practical utility in agriculture and horticulture.

#### **UNIT 5**

Crop growth analysis, key growth parameters. Factors limiting crop growth and productivity- the concept of rate limitation. Phenology- Growth stages, Factors influencing flowering. Photoperiodic and thermo-periodic responses. Canopy architecture, light interception, energy use efficiency of different canopies. Source-sink relationships. Physiological and molecular control of sink activity. Plant growth analysis techniques, yield structure analysis, theoretical and actual yields. Plant ideotypes. Simple physiological yield models- Duncan's, Monteith's, and Passioura's. Crop growth models-empirical models testing and yield prediction.

#### **UNIT 6**

The cellular basis of growth and morphogenesis cyto-differentiation. The cell cycle- Cell division and cell organization. Cell structure, morphogenesis and cellular totipotency. Introduction to in vitro methods : Terms and definitions, Use of growth regulators. Beginning of in vitro cultures in our country. Embryo culture, embryo rescue Endosperm culture and production of triploids. Embryogenesis and organogenesis and their practical applications : Clonal Multiplication of elite species. (Micro-propagation) Haploids and their applications. Somaclonal variations. Protoplast isolation : Principles and applications. Testing of viability of isolated protoplast. Steps in the regeneration of protoplast. Somatic hybridization –Various methods for fusing protoplast. Use of markers for selection of hybrid cells. Practical applications of somatic hybridization (hybrids vs cybrids). Use of plant cells, protoplast and tissue culture for genetic manipulation of plant : Introduction to *A. tumefaciens*. Tumour formation on plants using *A. tumefaciens* (Monocots vs Dicots), Root – formation using *A. rhizogenes*.

#### **UNIT 7**

Photosynthesis- its significance in plant growth, development and bio-productivity. Physiological and biochemical aspects: chloroplast structure development and replication, photo systems, mechanism of light absorption, electron transport chain, Coupling factors and mechanisms of ATP synthesis, quantum yield. Photosynthetic carbon reduction cycle and its regulation. CO<sub>2</sub> Concentration Mechanism (CCM) as a complementary strategy for carbon fixation. CCM in photosynthetic bacteria, micro algae, Submerged Aquatic macrophages (SAM), C<sub>4</sub>, CAM and single celled C<sub>4</sub> organisms. Rubisco structure, assembly and kinetics, photorespiration and its significance. Carbon fluxes between chloroplast and cytoplasm, the concept of RA, RS and RM. Pi recycling, starch and sucrose synthesis and export. Concept of canopy photosynthesis, influence of environmental factors such as water stress, high light stress VPD etc. Molecular aspects: chloroplast genome organization, expression and

regulation of plastid genes Genes regulating potential traits of photosynthesis, biotechnological approaches for improving photosynthetic rate and productivity – transgenics. Conceptual approaches of expressing C4 photosynthesis genes in C3 species. Photosynthesis and crop productivity, energy utilization efficiency by crops. Photo inhibition, photo oxidation, excitation energy dissipation mechanisms, photochemical and no-photochemical quenching of chlorophyll fluorescence. Photosynthesis and transpiration interaction, significance of WUE, carbon isotope discrimination concept. Nitrogen assimilation in photosynthesizing cells –  $\text{NO}_3^-$  - $\text{NO}_2^-$  -reduction, GS-GOGAT pathway. Photorespiration loss of Ammonia and its re-assimilation and NUE.

## **Syllabus for Entrance Examination for Admission in Ph.D. Forestry (Silviculture & Agro Forestry) Degree Programme**

### **Silviculture**

Forest ecosystem concept, stand dynamics-forest succession, competition and tolerance, classification of world's forest vegetation. Productivity and vegetation forms of India, forest composition and structure. Ecophysiology of tree growth, effect of radiation & water relationship, mineral nutrients and temperature. Natural regeneration of species and types including unevenaged silviculture. Intermediate treatments

### **FOREST BIOMETRY**

Measurement of tree parameters. Estimation of volume, growth and yield of individual tree and forest stands. Preparation of volume & its application, yield and stand tables Forest inventory, Sampling methods adopted in forestry, Use of GPS in forest inventory. Measurement stand density. Simulation techniques. Growth and yield prediction models - their preparation and applications.

### **Forest management**

Principles of forest management; scope and object of forest management, ecosystem Management, development of forest management in India. Site quality evaluation and importance. Stand density, classical approaches to yield regulation in forest management, salient features and strategies. Forest valuation and appraisal in regulated forests.

### **Forests and people**

Forests and its importance, forest societies, interactions between forests and people, importance of forests in traditional farming systems, livestock economy and forests, social and cultural factors of forest management, man in ecosystem in relation to eco-philosophy. Afforestation programmes and forest conflicts, wildlife and human conflicts, important forest movements like Chipka Movement, Gender dimension of forest management, tribal economy and forests. Pastoralists and their dependence on forests. Forests and economic security of tribals. Management of Commons and Common Property Resources (CPRs) and open access resources, forest management and sustainable livelihood strategies, forests and food security, eco-tourism and local development, land use change and forestry. Forest rights, customary rights of people, community participation, biodiversity and ethnobotany, Joint Forest Management, global environmental change and land use; dams, forests and resettlement of tribals and non-tribals - case study, poverty alleviation and forests, tourism and forest management, role of NGOs and other CBOs community based organization in forest management.

### **General statistical methods & research methodology**

Introductory: Statistics scales of measurement, concept of graphical, exploratory and inferential data analysis, important variables of forestry sector. Probability and probability distributions: Review of probability theory, concept of random variable and expectation, probability distributions (Binomial, Poisson, Normal, Weibull). Correlation and regression: Simple, Rank, Partial, Multiple, Infraclass correlations, Furnivall Index and coefficient of determination. Linear and nonlinear regressions, parabolic, exponential, power and logarithmic functions Estimation and Testing of Hypotheses, Concept of point and interval estimation, estimators and estimates, properties of good estimators –un-biasedness and minimum variance, tests of significance - t, F, z, and  $\chi^2$ , testing significance of correlation and regression coefficients, analysis of variance (ANOVA) - one way and two way classification with single and more than one cell frequency.

Design of Experiments. Principles of experimental designs, Completely Randomized Design (CRD),

Randomized Block Design (RBD), Latin Square Design (LSD), Row- Column (alpha) designs, Split Plot and Strip Plot Designs. Sampling - Theory and applications Why sample? Simple Random Sampling (with and without replacement), Stratified Random Sampling, Double sampling, Multistage sampling, Cluster sampling Multivariate statistical techniques Multivariate Analysis of Variance, Principal Component Analysis, Factor Analysis, Cluster Analysis.

### **Agroforestry systems**

Agroforestry objectives, importance, potential and impediments in implementation. Land capability classification and land evaluation. Overview of global agro-forestry systems, shifting cultivation, taungya system, multiple and mixed cropping, alley cropping, shelter-belts and windbreaks, energy plantations and homestead gardens. Production potential of different silvi-pasture system. Concepts of community forestry and social forestry, linear strip plantations. Diagnosis and Design - Trends in Agroforestry systems research and development.

### **Soil and water management in agroforestry**

Soil and water management -objectives and scope in relation to agro-forestry systems. Soil and water conservation , land classification and carrying capacity. Irrigation potential and methods. Optimization of waters use in agroforestry systems and dry land farming . Soil water relations, moisture regimes and management techniques. Problem soils and their management, soil organisms and nitrogen fixation. Biogeochemical cycling of nutrients including organic matter decomposition. Nutrients budgeting and soil productivity under different agroforestry systems.

### **Seed collection, storage and testing**

Introduction, trends and development in tropical, sub-tropical and temperate forestry and their influence on seed demand. Seed problems limiting actors in tree propagation and afforestation. Flowering and seed production in gymnosperms and angiosperms. Development and maturation of seed/ fruit. Modes of seed dispersal. Determining optimal harvest maturity indices. Factors influencing choice of collection methods. Methods of seed collection and processing, stage methods and seed testing techniques. Seed certification. Eco-physiological role of seed storage. Classification of seed storage potential. Factors affecting seed longevity. Pre-storage treatment. Physiological change during ageing. Viability and vigor. Storage of orthodox, recalcitrant and pre-storage intermediate seeds, Fumigation and seed treatment.

### **Modern nursery technology**

Introduction and importance of nursery. Types of nurseries. Bare root, containerized and vegetatively produced nursery. Bare root nursery- nursery soil and water management, bed preparation, pre-sowing seed treatments, seed sowing and intermediate operations viz., pricking, watering, fertilization, weeding and hoeing. Physiology and nursery environment interaction affecting seedling growth. Root culturing techniques. Lifting windows, grading, packaging and storing and out-planting. Containerized nursery - Type and size of container including root trainers, selection of growing medium. Types of green house and mist chamber for propagation. vegetative propagation - importance, selection of superior phenotype, methods of propagation viz. cutting, budding, grafting and layering. Factors affecting rooting of cuttings. Structures, media fertilizers, sanitation and containers, source selection and management in vegetative propagation.

### **Forest products - chemistry and industries**

Importance of forest based industries in relation to Indian economy. Chemistry in relation to forest products. Description of different forest based industries - paper and pulp, furniture, bamboo, sports goods, pencil making, match box and splint making, use of wood of lesser known forest species for commercial purposes. Cell wall constituents. Chemistry of cellulose, starch, hemicelluloses and lignin. Extraneous components of wood - water and organic solvent soluble. Chemical composition of oleoresin from major pine species. Structural difference among different gums (arabic, ghatti, tragacanth). Chemical nature and uses of volatile oils, tannins, katha and cutch. Chemical nature



and uses of important forest based dyes and pigments.

### **Forest policy and laws and international conventions**

Forest policy - Relevance and scope; National Forest Policy - 1894, 1952 and 1988; General principles of criminal law; Indian Penal Code, criminal procedure code; Indian evidence act applied to forestry matters. Forest laws; Indian Forest Act -1927, general provision and detailed study; Forest Conservation Act 1980, Wildlife Protection Act 1972 Important Forest Rules and Guidelines. Important case studies and landmark judgments.

### **Tree improvement**

General concept of forest tree breeding, tree improvement and forest genetics. Reproduction in forest trees, dimorphism pollination mechanisms. Pollen dispersion distances, pollinators and their energetics. Attractants for pollinators. Pollen handling forced flowering for seed orchard manipulation. Pollination mechanisms. Variation in trees importance and its causes. Natural variation as a basis for tree improvement. Geographic variations - Ecotypes, clines, races and land races. Seed, seed formation, dispersal, storage, stratification and seed dormancy. Selective breeding methods- mass, family, within family, family plus within family. Plus tree selection for wood quality, disease resistance and agroforestry objectives. Selection strategies and choice of breeding methods and progress in selective breeding in forest trees. Indirect selection for biotic and abiotic stresses. Progeny and clone testing. Seed orchards - type, functions and importance. Estimating genetic parameters and genetic gain.

Heterosis breeding: inbreeding and hybrid vigour. Manifestation and fixation of heterosis. Species and racial hybridization. Indian examples -teak, sal, shisham, eucalypts, acacias, pines and poplars. Polyploidy, aneuploidy and haploidy in soft and hard wood species. Induction of polyploidy. Hardy-Weinberg law, null hypothesis, Wahlund's Principle. Biotechnology in tree improvement. Mutation breeding. Economics of tree breeding.

### **Forest protection**

Important diseases and insect pests of nurseries, farm forestry, plantations, avenue trees and their management. Assessment of losses due to diseases, insect pests, vertebrate pests, adverse weather, forest fires and weeds. Insect pests and mycoflora of seeds of forest trees and their management. Biodegradation of wood - microscopic and chemical effects of white rot, brown rot, soft rot and wood discoloration. Heart rots - factors affecting heart rots, damage caused, compartmentalization of decay in trees and management of heart rots. Role of mycorrhiza in tree health.

Theories of natural regulation of insect populations. Wildlife damage in nurseries, plantations and their management. Weed problems in nurseries, plantations and their control. Adverse climatic factors, acid rains and air pollutants in relation to forest tree health. Biological control of insect pests and diseases of forest trees. Molecular tools for developing disease resistance trees.

### **Remote sensing and geographic information system**

The use of aerial photography, satellite imagery and geographic information system for the collection, storage and spatial analysis for geo-referenced forest resources data and information. The integration of spatial data analysis systems with knowledge-based systems and/or simulation systems for the development of information/decision support systems for forest management; satellite systems; satellite imageries - techniques, uses and limitation; Future prospects of remote sensing in India; softwares used in remote sensing ; GIS versus remote sensing; GIS Software used in forestry and environments; Analysis of data; Application of GIS in forestry.

### **Economics of agroforestry systems**

Basic principles of economics applied to agro-forestry. Optimization techniques- Planting, budgeting and functional analysis. Role of time, risk and uncertainty in decision making Financial and socio-

economic analysis of agro-forestry projects. Principles of financial management and harvesting, post harvest handling marketing of agro-forestry products including benefit sharing.

#### **Range land and partial management**

Concept of watershed management. Ideo-types of watershed development plans and activities for the watershed. Criterion for watershed size determination. Principles and practices of range land management. Improvement of range productivity by vegetation manipulation through control of undesirable vegetation, burning, fertilization, soil and water conservation and protection. Range improvement and livestock management. Feeding habits and grazing behavior of range livestock. Optimal livestock and range utilization, fodder from trees/shrubs and their nutritive values, propagation techniques, Micro climatic studies, root behavior, crown architecture including methods for minimizing unfavorable interactions. Production potential of different silvi-pasture systems. Characteristics of a watershed and their role in watershed management. Quantification of the benefits and effectiveness of the package of practices adopted for management of watershed, Dynamics vis-à-vis plant growth and post harvest processing for evaluation of chemical constituents

Biological and engineering approach in the management of degraded and denuded habitats as an integrated and multiple approach. SPP Testing. Provenance trials. Seed certification and storage. Elite trees selection.

#### **Nutrient and weed management in nursery and plantation**

History of nutrient management in forest nurseries and plantation. Essential nutrient elements and their deficiency. Mechanism of nutrient uptake by plants, functions and translocation/ Interactions. Concept of nutrient availability. Climatic and soil conditions causing micronutrient deficiencies in plants. Occurrence and treatment of micronutrient disorders. Evaluation of soil for the supply of micronutrient. Rare and non-essential elements. Technology and use of complex liquid and suspension fertilizers. Fertilizer use efficiency factors. Biological nitrogen fixation and bio-fertilizers. Farm yard manure and other organic fertilizers. Mycorrhizal associations and their significance. Economic implications of nutrient management. Importance of renewable waste and their recycling. Principles of weed control. Methods of weed control-cultural, biological, mechanical and chemical. Herbicide/ weed side classification, properties and their application.

#### **Management of insect-pests and diseases**

Principles and methods of integrated pests management - physical, cultural, chemical and biological methods. Use of attractants and repellants. Male sterility techniques. Diseases of forest nurseries and plantations. Abiotic agents of tree diseases and their relationship with hosts. Methods of disease control - exclusion, cultural, biological and chemical. Rodents, Birds, squirrels, herbivores. Forest plant quarantine.

#### **Forest ecology and biodiversity conservation**

Advanced topics in forest ecology including forest population, forest community dynamics, forest community structure and analysis, forest productivity on a global scale, ecology of forest landscapes spatial heterogeneity; Hierarchy issues in ecology. Conservation of natural resources (hotspot areas, wildlife sanctuaries, national parks, biosphere reserve). Global warming and forests. Green House Effect and its consequences. Ozone depletion. Conservations laws and acts. Forest genetics resources of India: timber and non timber species. Survey exploration and sampling strategies. Documentation and evaluation of forests genetical resources (FGR), in situ and ex situ conservation of gene resources. Biological diversity and its significance to sustainable use. Handling and storage of FGR. Intellectual property rights. Quarantine laws and FGR exchange.

#### **Forest resource management and economics**

Application of microeconomics in solving forest resource problems. Emphasis on forest products demand and supply analysis, forest products marketing, forest capital theory. Inter-regional and

international trade in forest products. Impact of economics and physical variables upon forest appraisal and management decisions. Externalities and property rights. Natural and environmental resource accounting -methods and implications. Application of operations research tools in evaluating forest management alternatives in public and private forest planning.

#### **Fruit plants, trees and shrubs for agroforestry**

Introduction, importance of woody elements in agro-forestry systems, their role in biomass production. Suitability of species for different purposes. Multipurpose trees in agro-forestry systems. Fodder from trees/shrubs and their nutritive value propagation techniques. Fruits crop and their need and relevance in Agroforestry fruits tree suitable for various assemblage and then planting plan in different agro climatic situation and Agroforestry system. Modification in tending and pruning floor. Fertility management, yield and quality improvement. Role of nitrogen fixing trees/ shrubs. Choice of species for various agro climatic zones for the production of timber, fodder, fuel wood, fibre, fruits, medicinal and aromatic plants. Generic and specific characters of trees and shrubs for Agroforestry. Generic and specific characters of trees and shrubs for agro-forestry.

#### **Energy plantations and bio-fuels**

Introduction and advantages of energy plantations. Energy and biomass consumption patterns in India. Environmental impacts of biomass energy. Assessment of bio-energy programmes in India. Power generation from energy plantation, producer gas. High Density Energy Plantations (HDEP). Land and biomass availability for sustainable bio energy. Impact of energy efficiency in power sector. Need for research and development on environment friendly and socio economical relevant technologies. Energy from plants-problems and prospects. Petro-crops. Criteria for evaluation of different species for energy plantation. Recent energy technologies in the product of bio-fuels.

## **Syllabus for entrance examination for admission in Ph.D. Food Science & Technology, for students having M.Sc. in Food Tech/ Food Science & Technology**

### **FOOD CHEMISTRY AND NUTRITION**

#### **UNIT I**

Definition and importance; major food constituents and their physicochemical properties; role of water in food.

#### **UNIT II**

Carbohydrates, proteins and lipids: classification, physical, chemical, nutritional, and functional properties and their structural correlations; auto-oxidation of lipids and rancidity.

#### **UNIT III**

Properties of minerals, vitamins, pigments, anti-oxidants, flavor components, allergens, toxins and anti-nutritional factors in foods; Interaction of constituents in food systems; Changes during storage and processing; Browning reactions in foods.

#### **UNIT IV**

Food groups and their typical composition; essential nutrients- sources, functions, deficiency diseases; requirements and recommended dietary allowances; digestion, absorption, transport and metabolism of nutrients in human system; protein quality evaluation.

### **FOOD MICROBIOLOGY**

#### **UNIT I**

Growth and survival of microorganisms in foods; spoilage organisms of milk, fruits, vegetables, grains and oilseeds, meat and poultry; Physical and chemical methods to control microorganisms.

#### **UNIT II**

Biochemical changes caused by microorganisms; Microbes in food fermentation, putrefaction, lipolysis; Antagonism and synergism in microorganisms; Food poisoning and food borne infections; Microbial toxins.

#### **UNIT III**

Food hygiene and sanitation; Contamination during handling and processing and its control; indicator organisms: Rapid methods in detection of microorganisms.

#### **UNIT IV**

Food fermentation; Traditional fermented foods of India and other Asian countries; Probiotics and prebiotics; Fermented foods based on milk, meat and vegetables; Fermented beverages.

## **FOOD ENGINEERING**

### **UNIT I**

Introduction to Food Engineering & processes: principles of thermodynamics and heat transfer applied to Food Engineering; fundamentals of heat and analogy to mass transfer in food processing.

### **UNIT II**

Kinetics of biological reactions- kinetics of reactions occurring in processed foods, reaction velocity constant, order of reaction; quality changes during storage of foods; application of Arrhenius equation to biological reactions.

### **UNIT III**

Method for thermal process evaluation- Commercial sterility, pasteurization and sterilization methods based on slowest heating region; determination of the process time based on region of greatest temperature lag; the process equivalence in terms of minutes at 121°C; calculation of process time for fluids on stream line flow and turbulent flow heated in heat exchangers; general introduction to aseptic canning process, hydrostatic sterilizer and aseptic packaging practices and design problems.

### **UNIT IV**

Food chilling and freezing- Precooling and cold storage; CA and MA; Properties of frozen foods; freezing point depression; general introduction to enthalpy change during freezing; Plank's equation for preceding rates of product freezing; Cryogenic freezing and IQF; design of food freezing equipment such as air blast freezers, plate freezers and immersion freezers.

### **UNIT V**

Process Heat Transfer- Modes of heat transfer and overall heat transfer; thermal properties of foods such as specific heat and thermal conductivity; Fourier's law, steady state and unsteady state conduction; heat exchange equipment; energy balance; rate of heat transfer ; thermal boundary layer; heat transfer by forced convections; heat transfer to flat plate and in non Newtonian fluids; heat transfer in turbulent flow; heating and cooling of fluids in forced convection outside tubes; natural convection.

## **PRINCIPLES OF FOOD PROCESSING**

### **UNIT I**

Scope of food processing; historical development; principles of food processing and preservation.

### **UNIT II**

Processing and preservation by heat-blanching, pasteurization sterilization and UHT processing, canning, extrusion cooking, dielectric heating, microwave heating, baking, roasting and frying.

### **UNIT III**

Processing and preservation by low-temperature-refrigeration, freezing, CA, MA and dehydro-freezing.

#### **UNIT IV**

Processing and preservation by drying, concentration and evaporation- types of dryers and their suitability for different food products: ultra-filtration, reverse osmosis.

#### **UNIT V**

Processing and preservation by non-thermal methods, irradiation, high pressure, pulsed electric field, hurdle technology.

#### **UNIT VI**

Use and application of enzymes and microorganisms in processing and preservation of foods; food fermentations, pickling, smoking etc.; Food additives: definition, types and functions, permissible limits and safety aspects.

### **FOOD PACKAGING TECHNOLOGY**

#### **UNIT I**

Definitions, objectives and functions of packaging and packaging materials; Packaging requirements and selections of packaging materials; Types of packaging materials: Paper: pulping, fibrillation and beating, types of papers and their testing methods; Glass: composition, properties, types of closures. Methods of bottle making; Metals: Tinplate containers, tinning process, components of tinplate, tin free steel (TSL), types of cans, aluminum containers, lacquers; Plastics: types of plastic films, laminated plastic materials, co-extrusion, edible films, biodegradable plastics.

#### **UNIT II**

Properties of materials such as tensile strength, bursting strength, tearing resistance, puncture resistance, impact strength, tear strength, their methods of testing and evaluation; Barrier properties of packaging materials: Theory of permeability, factors affecting permeability, permeability coefficient, gas transmission rate (GTR) and its measurement, water vapour transmission rate (WVTR) and its measurement, prediction of shelf life of foods, selection and design of packaging material for different foods.

#### **UNIT III**

Food packaging systems: Different forms of packaging such as rigid, semi-rigid, flexible forms and different packaging system for (a) dehydrated foods (b) frozen foods (c) dairy products (d) fresh fruits and vegetables (e) meat, poultry and sea foods.

#### **UNIT IV**

Packaging equipment and machinery: Vacuum, CA and MA packaging machine; gas packaging machine; seal and shrink packaging machine; form and fill sealing machine; aseptic packaging systems; bottling machines; carton making machines.

### **FOOD QUALITY SYSTEMS & MANAGEMENT**

#### **UNIT I**

Concept of quality: Quality attributes- physical, chemical, nutritional, microbial, and sensory; their measurement and evaluation; Sensory *vis-avis* instrumental methods for testing quality.

#### **UNIT II**

Concept of quality management: Objectives, importance and functions of quality control; Quality management systems in India; Sampling procedures and plans; Food Safety and Standards Act, 2006; Domestic regulations; Global Food safety Initiative; Various organizations dealing with inspection, traceability and authentication, certification and quality assurance (PFA, FPO, MMPO, MPO, AGMARK, BIS); Labeling issues; International scenario, International food standards.

### **UNIT III**

Quality assurance, Total Quality Management: GMP/GHP; GLP, GAP; Sanitary and hygienic practices; HACCP; Quality manuals, documentation and audits; Indian & International quality systems and standards like ISO and Food Codex; Export import policy, export documentation; Laboratory quality procedures and assessment of laboratory performance; Applications in different food industries; Food adulteration and food safety. IPR and Patent.

## **TECHNIQUES IN FOOD ANALYSIS**

### **UNIT I**

Sampling techniques; Water activity, its measurements and significance in food quality; Calibration and standardization of different instruments.

### **UNIT II**

Spectroscopic techniques using UV/Vis, fluorescence, IR, FTIR, NIR, NMR, atomic absorption, ICP, polarimetry, refractometry, microscopic techniques in food analysis (light microscopy, SEM, TEM, XRD, particle size analysis, image analysis etc.).

### **UNIT III**

Chromatographic techniques: Adsorption, column, partition, affinity, ion-exchange, size exclusion, GC, GLC, HPLC, HPTLC, GCMS, LCMS.

### **UNIT IV**

Separation techniques: Gel filtration, dialysis, electrophoresis, sedimentation, ultrafiltration and ultracentrifugation, solid phase extraction, supercritical fluid extraction, isoelectric focusing, isotopic techniques, manometric techniques.

### **UNIT V**

Special techniques: Immunoassay techniques; Isotopic, non-isotopic and enzyme immunoassay; surface tension; enzymatic methods of food analysis; thermal methods in food analysis (Differential scanning calorimetry and others).

## **TECHNOLOGY OF FRUITS AND VEGETABLE PROCESSING**

### **UNIT I**

Indian and global scenario on production and processing of fruits and vegetable; Quality requirements of raw materials for processing; sourcing and receiving at processing plants; primary processing: grading, sorting, cleaning, washing, peeling, slicing and blanching; minimal processing.

### **UNIT II**

Processing for pulp, puree and concentrates, especially from mango, tomato, guava, papaya, apple, pineapple, pomegranate, grapes etc. using aseptic packaging, canning, RTS fruit beverages, IQF and frozen fruits and vegetables; for peas, mango pulps etc.

### **UNIT III**

Technology for processed products like pickles, chutneys, sauces particularly from raw mango, lime and other regional fruits and vegetables of importance.

### **UNIT IV**

Processing of fruits for candies, bars, toffees, jams and jellies, squashes and syrups using locally available fruits like papaya, mango, aonla and other under-utilized fruits.

### **UNIT V**

Dehydration of fruits and vegetables using various drying technologies like sun drying, solar drying (natural and forced convection), osmotic, tunnel drying, fluidized bed drying, convectional and adiabatic drying; application to raisins, dried figs, vegetables, intermediate moisture fruits and vegetables. Fruit powders using spray drying.

## **TECHNOLOGY OF CEREALS, PULSES AND OILSEEDS**

### **UNIT I**

General introduction and production and utilization trends; Structure and composition of common cereals, pulses and oilseeds.

### **UNIT II**

Wheat: Types and physicochemical characteristics; wheat milling-products and by products; factors affecting quality parameters; physical, chemical and theological tests on wheat flour; additives used in bakery products; flour improvers and bleaching agents; manufacture of bakery products, pasta products and various processed cereals-based foods; manufacture of whole wheat atta, blended flour and fortified flour.

### **UNIT III**

Rice: Classification, physicochemical characteristics; cooking quality; rice milling technology; byproducts of rice milling and their utilization; Parboiling of rice-technology and effect on quality characteristics; aging of rice quality changes; processed products based on rice.

### **UNIT IV**

Corn: Types of nutritive value; dry and wet milling, manufacture of value added products; processing of barley, oats, sorghum and millets.

### **UNIT V**

Legumes and oilseeds: composition, anti-nutritional factors, processing and storage; processing for production of edible oil, meal, flour, protein concentrates and isolates; extrusion cooking technology; snack foods; development of low cost protein foods.

## **FOOD ADDITIVES AND INGREDIENTS**

### **UNIT I**



Food additives- definitions, classification and functions, preservatives, antioxidants, colours and flavours (synthetic and natural), emulsifiers, sequesterants, hemectants, hydrocolloids, sweeteners, acidulants, buffering salts, anticaking agents, etc. chemistry, food uses and functions in formulations; indirect food additives; toxicological evaluation of food additives.

## **UNIT II**

Flavour technology: types of flavours, flavours generated during processing reaction flavours, flavor composites, stability of flavours during food processing, analysis of flavours, extraction techniques of flavours, flavor emulsions oils and oleoresins; authentication of flavours etc.

## **UNIT III**

Proteins, starches and lipids as functional ingredient; isolation, modification, specifications, functional properties and applications in foods and as nutraceuticals.

## **UNIT IV**

Manufacturing and applications of fibres from food sources,. fructooligosacchrides.

## **STATISTICAL METHODS FOR FOOD SCIENCE**

### **UNIT I**

Descriptive statistics, Mean, variance, probability, conditional probability, Probability distribution.

### **UNIT II**

Density functions, Mean variance.

### **UNIT III**

Data and its nature; data representation; diagrams and graphs using MSExcel, Measures of Central tendency; Dispersion, Swekness and Kurtosis;

Binomial and Normal Distributions.

### **UNIT IV**

Confidence Interval of mean; Test of significance; Non-parametric tests; Simple, Partial and Multiple correlations.

### **UNIT V**

Estimation, confidence intervals hypothesis testing, Basic principles of Experimental Designs; Analysis of Variance; Elements of Quality Control.

## **APPLIED NUTRITION**

### **UNIT I**

Importance of nutrition to health and growth; Relation of food and diseases; Nutritional requirement of human body & RDA.

### **UNIT II**

Preparation of balanced diets; Deficiencies of essential nutrients; Assessment of nutritional status of population; Effect of cooking and processing on nutrients; Nutritional value of processed foods; Therapeutic nutrition.

### **UNIT III**

Nutritional requirements of special group of people such as infants, pregnant and lactating mothers, patients, aged, etc.; Formulation of special dietary foods.

### **UNIT IV**

Functional foods and nutraceuticals with attributes to control cardiovascular diseases, cancer, obesity, ageing etc.; Food components and nutrients affecting immune systems, behaviour and performance.

### **UNIT V**

Functional aspects of dietary fiber, amino acids & peptides, lactic acid bacteria, antioxidants, vitamins, fatty acids etc. Assessment of nutritional quality of food.

## **Syllabus for entrance examination for admission in Ph.D Agricultural Engineering, for students having M.Tech. Farm Machinery and Power Engineering Degree**

### **Farm Machinery and Power Engineering**

**UNIT 1** Design and development of farm power and machinery systems. Procedure and their applications in agricultural tractors & machines. Design considerations of linkages/ components in farm machinery. Design of selected farm equipments:-tillage, seeding, planting, interculture, plant protection, harvesting and threshing. Design of rotary vibrating and oscillating machines.

**UNIT 2** Importance of ergonomics & its application in agriculture. Noise and vibration and their physiological effects. Thermal environment, effect on performance and behavior. General guideline for designing visual display, safety standards at work place. Man machine system concept.

**UNIT 3** Linear programming and integer programming models and applications, Network terminology, shortest route and minimal spanning tree problems, maximal flow problem, project planning and control with PERT and CPM. System approach in farm machinery management and application of programming techniques to the problems of farm power and machinery selection. Maintenance and scheduling of operations. Inventory control of spare parts, work study, productivity, method study. Time and motion study

**UNIT 4** Vibration motion and its terminology. Energy method, Rayleigh method. Forced vibrations with harmonic excitation and rotating unbalance, Energy dissipated by damping. Forced vibration with damping. Two degree of freedom systems. Principal modes of vibration. Vibration of lumped parameter systems and continuous systems. Lagrange equations. Vibration measuring instruments.

**UNIT 5** Modern trends in tractor design. Parameters affecting design of tractor engine. Design of fuel efficient engine components and tractor systems like transmission system, clutch, gearbox, differential, final drive, steering system, hydraulic system & hitching – fundamental of fluid power transmission, hydraulic system of tractor, design of hydraulic cylinder, hydraulic control in tractor, automatic hydraulic control, automatic position control, automatic draft control, design requirement of three point hitch system, three point linkage and hitching arrangements provided for different implements. Chassis, drivers seat, workplace area and control, tire selection. Mechanics of tractor chassis and stability static equilibrium of tractor, weight transfer, Centre of gravity of tractor. Computer aided design and its application in agriculture benefits of CAD, introduction to CAD.

**UNIT 6** Types of tests test procedure code. Test equipments. Prototype feasibility testing and field evaluation. Laboratory and field testing of selected of farm equipments- M.B. plough, Disc harrow, puddler, seed-cum-fertilizer drill, Manual paddy weeder, cereal harvesting machines, thresher, sprayer and duster, chaff cutter and potato planter. Tractor performance testing, evaluation and interpretation of results

**UNIT 7** Study of transmission system Clutch, Gear box, Differential. Final drive mechanism, brake mechanism

# **Syllabus for entrance examination for admission in Ph.D Agricultural Engineering, for students having M.Tech. Post Harvest Process and Food Engineering Degree**

## **Post Harvest Process and Food Engineering**

### **UNIT I**

Principles of fluid flow, Psychrometry, dehydration, EMC, Thermal processing operations; Evaporation, blanching, pasteurization, distillation, Refrigeration principles and Food freezing. Mechanical separation techniques, size separation equipments; Filtration, sieving, centrifugation, Material handling equipment, conveyors and elevators; Size reduction processes; Grinding and milling. Homogenization; Mixing- mixers, kneaders and blenders. Membrane technology. Food plant design; Food plant hygiene- cleaning, sterilizing, waste disposal methods. Food packaging: Function materials, technique, machinery and equipment.

Thermal processing: Death rate kinetics, thermal process calculations, methods of sterilization and equipments involved, latest Evaporation: Properties of liquids, heat and mass balance in single effect and multiple effect evaporator, aroma recovery, equipments and applications. Drying: Rates, equipments for solid, liquid and semi-solid material and their applications, theories of drying, types of dryer. Non-thermal processing: Microwave, irradiation, ohmic heating, Freezing: Freezing curves, thermodynamics, freezing time calculations, equipments, freeze drying, principle, equipments. Separation: Mechanical filtration, membrane separation, equipments and applications, latest developments in separation Extrusion: Theory, equipments, applications. Distillation and leaching

### **UNIT II**

Introduction to heat and mass transfer and their analogous behavior, steady and unsteady state heat conduction, analytical and numerical solution of unsteady state heat conduction equations. Applications in food processing including freezing and thawing of foods. Convective heat transfer in food processing heat transfer between fluids and solid foods. Functional design of heat exchangers: Shell and tube, plate and scraped surface heat exchangers, jacketed vessels. Radiation heat transfer and its governing laws, its applications in food processing. Physical characteristics of different food grains, fruits and vegetables; Shape and size, description of shape and size, volume and density, porosity, surface area. Rheology; terms, physical states of materials, classical ideal material, rheological models and equations, viscoelasticity, creep-stress relaxation, Non-Newtonian fluid and viscometry, rheological properties, force, deformation, stress, strain, elastic, plastic behaviour. Contact stresses between bodies, firmness and hardness, mechanical damage, , temperature, and surface roughness. Friction in agricultural materials, rolling resistance, angle of internal friction, , flow of bulk granular materials, aero dynamics of agricultural products, drag coefficients, terminal velocity. Thermal properties: Specific heat, thermal conductivity, thermal diffusivity, Electrical properties; Dielectric factor, A.C. conductivity and dielectric constant, method of determination. Application of engineering properties in design and operation of agricultural equipment and structures.

### **UNIT III**

Energy forms and units, energy perspective, norms and scenario; energy auditing, data collection and analysis for energy conservation in food processing industries. Sources of energy, sun drying and use of solar energy, biomass energy and other non-conventional energy sources in agro-processing industries. Reuse and calculation of used steam, hot water, chimney gases and cascading of energy sources. Economics of energy use. Production and utilization of cereals and pulses, grain structure of major cereals, pulses and oilseeds and their milling fractions; grain quality standards and BIS standard. Pre-milling treatments and their effects on milling quality; parboiling conventional, modern and integrated rice milling operations; wheat roller flour milling; processes for milling of corn, oats, barley, gram, pulses, paddy. Dal mills, handling and storage of by-products and their utilization.

Storage of milled products, Expeller and solvent extraction processing. Packaging of processed products. Storage of grains, biochemical changes during storage, storage factors affecting losses, storage requirements. Bag and bulk storage, godowns, bins and silos, rat proof godowns and rodent control, method of stacking. cold storage, controlled and modified atmosphere storage, effects of nitrogen, oxygen, and carbon dioxide on storage of durable and perishable commodities, irradiation, storage of dehydrated products, food spoilage and preservation. Physical factors influencing flow characteristics, mechanics of bulk solids, flow through hoppers, principles of fluidization;

### **UNIT IV**

Applications of engineering principles; mass and energy balance, fluid flow principles, unit operations of process engineering. Fundamentals of growth kinetics, maintenance energy and yield concepts, principles of media sterilization, media formulations of industrial fermentation. Aerobic and agitated Rheology of fermentative fluids, design and scale-up of bioreactors, enzyme reactors. Principles of recovery of fermented products in bio-processing, instrumentation, transport phenomenon. Power and Energy measuring techniques. Humidity measurement – Dry and Wet bulb, Hair hygrometer and Humister. Soil and Grain moisture transducers, pressure measurement–

### **UNIT V**

Nature and concepts of food analysis; Rules and regulations of food analysis, Safety in laboratory, sampling techniques. Principles and methodology involved in analytical techniques: PH Meter and use of ion selective electrodes–Spectroscopy, Ultra violet visible, florescence, Infrared spectro, Atomic absorption and emission, Chromatography –Adsorption, Column, Partition, Principles and methodology involved in analysis of foods ; Rheological analysis, Textural profile analysis of foods. Immunoassay techniques in food analysis; Isotopic and Non-isotopic immunoassay, Evaluation of analytical data ; Accuracy and precision, Sensory analysis of food; Objective method, Objective method. Introduction to neural network and its comparison with biological system. Perception and linear separable functions, multi-layers perceptions.



# **Syllabus for entrance examination for admission in Ph.D. Agricultural Engineering, for students having M.Tech. Soil and Water Engineering Degree**

## **Soil and Water Engineering**

### **UNIT I**

Properties affecting groundwater storage and movement, groundwater balance studies, Well hydraulics, two dimensional flow, steady and unsteady state flow in confined, unconfined and semi-confined aquifers, steady flow in sloping aquifers, partial penetrating wells. Analysis of multi-aquifers. Flow analysis in interfering wells. Pumping tests and determination of aquifer parameters. Groundwater modeling for water resources planning. Techniques for groundwater recharge. Basic hydraulic design of centrifugal pump, water hammering problem in centrifugal pump. Principle and performance characteristics of vertical turbine pump, submersible pump and axial flow pump and their design. Non-conventional energy sources for pumping, wind mills, micro turbines, solar pumps, hydraulic ram- their selection and design criteria. Design of pumping station, techno-economic evaluation. Energy conservation measures for pumping systems.

### **UNIT 2**

Hydrologic processes and systems; Hydrologic problems of small watersheds; Hydrologic characteristics of watersheds. Measurement and analysis of hydrologic parameters, rainfall-runoff models, stream flow measurement and analysis of data. Hydrograph analysis; Unit hydrograph theory; Synthetic and dimension less hydrograph, convolution of unit hydrograph. Concept of hydraulic flood routing, flood routing (reservoir and channel routing). Definition and concept of different types of hydrologic models for simulation of hydrologic problems. Problems of desertification and degradation. Models of sediment yield. Survey, monitoring, reclamation and conservation of agricultural and forest lands, hill slopes and ravines. Concept of operational watershed. National land use policy, legal and social aspects. Watershed management research; instrumentation and measurement, problem identification, simulation and synthesis Modeling of flood and drought phenomenon, drought management and dry farming.

### **UNIT 3**

Concepts of Irrigation; Irrigation principles, losses, conveyance, distribution; Application efficiencies. Scheduling parameters, water budgeting. Surface irrigation, hydraulics of water advance and recession, hydraulic resistance to flow, gravity irrigation. Design of Border irrigation, furrow irrigation, check basin irrigation; Sub Irrigation methods and concepts. Preliminary design criteria of sprinkler and micro irrigation systems, hydraulics of sprinkler and micro irrigation systems. Design of lateral, sub main and main line of sprinkler and micro irrigation. Fertigation aspects. Underground water conveyance system; Evaluation of irrigation systems and practices.

#### **UNIT 4**

Theories and applications of surface and sub-surface drainage, steady state, unsteady state drainage equations for layered and non-layered soils, horizontal sub-surface drainage. Principle and applications of Earnst, Glover Dumm, Kraijenhoff-van-deleur equations. Salt balance, leaching requirement and management practices under drained conditions. Design of different components of sub-surface drainage systems, theories of vertical drainage and multiple well point system. Disposal of drainage effluents, Management of drainage projects of waterlogged and saline soils, case studies.

#### **UNIT 5**

Concepts and significance of optimization in water resources, objective functions, deterministic and stochastic inputs. Mathematical programming techniques, linear programming and its extension: gradient method, simplex method, non-linear programming classical optimization. Geometric programming and dynamic programming, application of optimization techniques for water resources. Development and management including conjunctive use, crop production functions and irrigation optimization.

#### **UNIT 6**

Open channel and their properties. Energy and momentum principles. Critical flow computations and applications. Uniform flow. Its development. Formula and design computation. Boundary layer concept. Surface roughness. Velocity distribution and instability of uniform flow. Gradually varied flow theory and analysis. Method of computations. Hydraulic jump and its use as leveling energy dissipation Spatially varied flow. Unsteady flow. Rapidly varied flow.