

**Report of**  
**FOURTH DEANS COMMITTEE**  
**on**  
**Agricultural Education in India**

Supplement  
**(Syllabi)**



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# **Syllabus**

**For**

**B.Sc. (Hons.) Agriculture**

# AGRICULTURE

## 1. AGRONOMY

### 1. Principles of Agronomy and Agricultural Meteorology

3 (2+1)

Meaning and scope of Agronomy: National and International Agricultural Research Institutes in India, Agro-climatic zones of India and Rajasthan. Tillage, crops stand establishment, Planting geometry and its effect on growth and yield cropping systems, Harvesting. Agricultural meteorology: Weather and climate, micro-climate, weather elements, Earth's atmosphere, Composition and structure, solar radiation, Nature, properties, depletion, solar constant and energy balance, Atmospheric, temperature, factors affecting, horizontal and vertical distribution, variations and global warming, Air Pressure variations; Wind: factors affecting, cyclones and anticyclones and general circulation, Atmospheric humidity, vapour pressure and saturation, Process of condensation, formation of dew, fog, mist, snow, rain and hail; Formation and classification of clouds, Introduction to monsoon, Basics of weather forecasting.

**Practical:** Study of tillage implements; Practice of ploughing; Practice of puddling; Study of seeding equipments and introduction of remote sensing. Different methods of sowing; Study of manures, fertilizers and green manure crops / seeds (including calculations); Study of intercultivation implements and practice; Practice of methods of fertilizer applications; Participation in ongoing field operations; Site selection for Agromet observatory; Measurement of temperature; Measurement of rainfall; Measurement of evaporation (atmospheric/soil); Measurement of atmospheric pressure; Measurement of sunshine duration and solar radiation; Measurement of wind direction and speed and relative humidity; Study of weather forecasting and synoptic charts.

### 2. Field Crops-I (*Kharif*)

3(2+1)

Origin, geographic distribution, economic importance, soil and climatic requirement, varieties, cultural practices and yield of *kharif* crops, Cereals – rice, maize, sorghum, pearl millet and minor millets; Pulses : pigeonpea, mungbean and urdbean; Oilseeds: groundnut, sesame and soybean; Fibre crops: cotton, jute and sunhemp; and Forage crops: sorghum, maize, cowpea, cluster bean and napier.

**Practical:** Rice nursery preparation and transplanting/seed bed preparation and sowing of *Kharif* crops; Calculations on seed rate; Sowing of soybean, pigeonpea, mungbean, maize, groundnut, and cotton; Effect of seed size on germination and seedling vigour of soybean/groundnut; Effect of sowing depth on germination of soybean; Identification of weeds in rice, maize and soybean fields and study of weed control experiments in these crops; Top dressing of nitrogen in maize and rice and study of fertilizer experiments on rice, maize, sorghum and millets; Study of yield contributing characters, yield calculations, harvesting and yield estimation of above crops; Study of crop varieties and important agronomic experiments; Study of forage experiments.

### 3. Weed Management

2 (1+1)

Weeds: Introduction, harmful and beneficial effects, classification, propagation and dissemination; Weed biology and ecology, crop weed association, crop weed competition and allelopathy Concepts of weed prevention, control and eradication; Methods of weed control:

physical, cultural, chemical and biological methods. Integrated weed management; Herbicides: advantages and limitation of herbicide usage in India, Herbicide classification, formulations, methods of application; Introduction to Adjuvants and their use in herbicides; Introduction to selectivity of herbicides; Compatibility of herbicides with other agro chemicals; Weed management in major field and horticultural crops, shift of weed flora in cropping systems, aquatic and problematic weeds and their control.

**Practical:** Identification of weeds; Survey of weeds in crop fields and other habitats; Preparation of herbarium of weeds; Calculations on weed control efficiency and weed index; Herbicide label information; Computation of herbicide doses; Study of herbicide application equipment and calibration; Demonstration of methods of herbicide application; Preparation of list of commonly available herbicides; Study of phytotoxicity symptoms of herbicides in different crops; Biology of nut sedge, bermuda grass, parthenium and celosia; Economics of weed control practices; Tours and visits of problem areas.

#### **4. Water Management Including Micro Irrigation**

**3(2+1)**

Irrigation: definition and objectives, water resources and irrigation development in India and Rajasthan; Soil plant water relationships; Methods of soil moisture estimation, evapotranspiration and crop water requirement; effective rainfall, scheduling of irrigation; Methods of irrigation: surface, sprinkler and drip irrigation; Irrigation efficiency and water use efficiency, conjunctive use of water, irrigation water quality and its management. Water management of different crops (rice, wheat, maize, groundnut, sugarcane, mango, banana and tomato); Agricultural drainage.

**Practical:** Determination of bulk density by field method; Determination of soil moisture content by gravimetric method, tensiometer, electrical resistance block and neutron moisture meter; Determination of field capacity by field method; Determination of permanent wilting point; Measurement of irrigation water through flumes and weirs; Calculation of irrigation water requirement (Problems); Determination of infiltration rate; Demonstration of furrow method of irrigation; Demonstration of check basin and basin method of irrigation; Visit to farmers field and cost estimation of drip irrigation system; Demonstration of filter cleaning, fertigation, injection and flushing of laterals; Erection and operation of sprinkler irrigation system; Measurement of emitter discharge rate, wetted diameter and calculation of emitter discharge variability; Determination of EC, pH, carbonates, bicarbonates, Ca<sup>++</sup> and Mg<sup>++</sup> in irrigation water (quality parameters)

#### **5. Field Crops- II (*Rabi*)**

**3(2+1)**

Origin, geographical distribution, economic importance, soil and climatic requirements, varieties, cultural practices and yield of *rabi* crops; Cereals: wheat, barley; Pulses: chickpea, lentil, peas, french bean; Oilseeds: rapeseed and mustard, sunflower, safflower and linseed; Sugar crops: sugarcane and sugarbeet, Medicinal and aromatic crops such as mentha, lemon grass, citronella, palma rosa, isabgol and posta; Commercial crops: potato and tobacco, Forage crops: berseem, lucerne and oat.

**Practical:** Seed bed preparation and sowing of wheat, sugarcane and sunflower; Calculations on seed rate; Top dressing of nitrogen in wheat and study of fertilizer experiments on wheat and mustard; Identification of weeds in wheat and grain legumes, application of herbicide and study of weed control experiments; Morphological characteristics of wheat, sugarcane, chickpea and mustard; Yield contributing characters of wheat; Yield and quality analysis of

sugarcane; Crop distribution in the state and the region; Important agronomic experiments of *rabi* crops and visit to research stations related to *rabi* crops.

## **6. Farming Systems and Sustainable Agriculture** **2(1+1)**

Sustainable agriculture: Introduction, definition, goal and current concepts, factors affecting ecological balance and ameliorative measures; Land degradation and conservators of natural resources, LEIA & HEIA; Irrigation problems, waste lands and their development; Organic farming: definition, principles and components; Farming systems: definition, principles and components, IFS models for wetland, irrigated dryland and dryland situations.

**Practical:** Preparation of cropping scheme for irrigated situations; Preparation of cropping scheme for dryland situations; Study of existing farming systems in nearby villages; Preparation of integrated farming system model for wetlands; Preparation of integrated farming system model for drylands; Preparation of enriched Farm Yard Manure; Preparation of Vermicompost; Visit to urban waste recycling unit; Study of profitable utilization of agricultural wastes; Visit to poultry and dairy units to study resource allocation, utilization and economics; Visit to an organic farm to study various components and utilization; Study of degraded lands.

## **7. Practical Crop Production I (Kharif Crops)** **1(0+1)**

Crop planning, raising field crops in multiple cropping systems: Field preparation, seed treatment, nursery raising, sowing, nutrient management, water management, weed management and management of insect pests and diseases of crops harvesting, threshing, drying, winnowing, storage and marketing of produce. Preparation of balance sheet including cost of cultivation, net returns per student as well as per team of a group of students.

## **8. Practical Crop Production II (Rabi Crops)** **1(0+1)**

Crop planning, raising field crops in multiple cropping systems: Field preparation, seed treatment, nursery raising, sowing, nutrient management, water management, weed management and management of insect-pests and diseases of crops harvesting, threshing, drying, winnowing, storage and marketing of produce. Preparation of balance sheet including cost of cultivation, net returns per student as well as per team of a group of students.

## **9. Introductory Agriculture (Ancient Heritage, Agricultural Scenario and Gender Equity in Agriculture)** **1(1+0)**

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

## 10. Organic Farming

3(2+1)

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

**Practical:** Raising of vegetable crops organically through nutrient, diseases and pest management; vermicomposting; vegetable and ornamental nursery raising; macro quality analysis, grading, packaging, post harvest management.

## 2. GENETICS AND PLANT BREEDING

### 1. Principles of Genetics

3 (2+1)

Mendel's laws of inheritance and exceptions to the laws; Types of gene action, Multiple alleles, Pleiotropism, Penetrance and expressivity; Quantitative traits, Qualitative traits and differences between them; Multiple factor hypothesis; Cytoplasmic inheritance, its characteristic features and difference between chromosomal and cytoplasmic inheritance; Mutation and its characteristic features; Methods of inducing mutations and C / B technique. Gene expression and differential gene activation; Lac operon and Fine structure of Gene; Ultra structure of cell and cell organelles and their functions; Study of chromosome structure, morphology, number and types, Karyotype and Idiogram; Mitosis and meiosis, their significance and differences between them; DNA and its structure, function, types, modes of replication and repair. RNA and its structure, function and types; Transcription, Translation, Genetic code and outline of protein synthesis; Crossing over and factors affecting it; Mechanism of crossing over and Cytological proof of crossing over; Linkage, Types of linkage and estimation of linkage; Numerical chromosomal aberrations (Polyploidy) and evolution of different crop species like Cotton, Wheat, Tobacco, Triticale and Brassicas; Structural chromosomal aberrations.

**Practical:** Microscopy (Light microscopes and electron microscopes; Preparation and use of fixatives and stains for light microscopy; Preparation of micro slides and identification of various stages of mitosis; Preparation of micro slides and identification of various stages of mitosis; Preparation of micro slides and identification of various stages of meiosis; Preparation of micro slides and identification of various stages of meiosis; Monohybrid ratio and its modifications; Dihybrid ratio and its modifications; Trihybrid ratio; Chi-square analysis and Interaction of factors; Epistatic factors, Supplementary factors and Duplicate factors; Complementary factors, Additive factors and Inhibitory factors; Linkage – Two point test cross; Linkage – Three point test cross; Induction of polyploidy using colchicines; Induction of chromosomal aberrations using chemicals.

### 2. Principles of Seed Technology

3(2+1)

Introduction to Seed Production, Importance of Seed Production, Seed policy, Seed demand forecasting and planning for certified, foundation and breeder seed production, Deterioration of crop varieties, Factors affecting deterioration and their control; Maintenance of genetic purity during seed production, Seed quality; Definition, Characters of good quality seed, Different classes of seed, Production of nucleus & breeder's seed, Maintenance and multiplication of pre-release and newly released varieties in self and cross-pollinated crops;

Seed Production, Foundation and certified seed production in maize (varieties, hybrids, synthetics and composites); Foundation and certified seed production of rice (varieties & hybrids); Foundation and certified seed production of sorghum and bajra (varieties, hybrids, synthetics and composites); Foundation and certified seed production of cotton and sunflower (varieties and hybrids); Foundation and certified seed (varieties and hybrids) production of castor, tomato, brinjal, chillies, bhendi, onion, bottle gourd and ridge gourd; Seed certification, phases of certification, procedure for seed certification, field inspection and field counts etc.; Seed Act and Seed Act enforcement, Central Seed Committee, Central Seed Certification Board, State Seed Certification Agency, Central and State Seed Testing Laboratories; Duties and powers of seed inspectors, offences and penalties; Seed control order: Seed Control Order 1983, Seed Act 2000 and other issues related to seed quality regulation. Intellectual Property Rights, Patenting, WTO, Plant Breeders Rights, Varietal Identification through Grow-Out Test and Electrophoresis; Seed Drying: Forced air seed drying, principle, properties of air and their effect on seed drying, moisture equilibrium between seed and air, Heated air drying, building requirements, types of air distribution systems for seed drying, selection of crop dryers and systems of heated air drying, recommended temperature and depth of the seeds, management of seed drying, Planning and layout of seed processing plant; Establishment of seed processing plant. Seed processing: air screen machine and its working principle, different upgrading equipments and their use, Establishing a seed testing laboratory. Seed testing procedures for quality assessment, Seed treatment, Importance of seed treatment, types of seed treatment, equipment used for seed treatment (Slurry and Mist-O-matic treater), Seed packing and seed storage, stages of seed storage, factors affecting seed longevity during storage and conditions required for good storage, General principles of seed storage, constructional features for good seed warehouse, measures for pest and disease control, temperature control, Seed marketing, marketing structure, marketing organization, sales generation activities, promotional media, pricing policy; Factors affecting seed marketing.

**Practical:** Seed sampling principles and procedures; Physical Purity analysis of Field and Horticultural crops; Germination analysis of Field and Horticultural crops; Moisture tests of Field and Horticultural crops; Viability test of Field and Horticultural crops; Seed health test of Field and Horticultural crops; Vigour tests of Field and Horticultural crops; Seed dormancy and breaking methods; Grow out tests and electrophoresis for varietal identification; Visit to Seed production plots of Maize, Sunflower, Bajra, Rice, Sorghum, Cotton, Chillies and Vegetables. (Add or delete crops of the region); Visit to Seed processing plants; Visit to Seed testing laboratories; Visit to Grow out testing farms; Visit to Hybrid Seed Production farms; Varietal identification in seed production plots; Planting ratios, isolation distance, roguing etc

### **3. Principles of Plant Breeding**

**3(2+1)**

Classification of plants, Botanical description, Floral biology, Emasculation and Pollination techniques in cereals, millets, pulses, oil seeds, fibers, plantation crops etc. Aims and objectives of Plant Breeding; Modes of reproduction, Sexual, Asexual, Apomixis and their classification; Significance in plant breeding; Modes of pollination, genetic consequences, differences between self and cross pollinated crops; Methods of breeding – introduction and acclimatization. Selection, Mass selection Johannson's pure line theory, genetic basis, pure line selection; Hybridization, Aims and objectives, types of hybridization; Methods of handling of segregating generations, pedigree method, bulk method, back cross method and various modified methods; Incompatibility and male sterility and their utilization in crop improvement; Heterosis, inbreeding depression, various theories of Heterosis, exploitation of hybrid vigour development of inbred lines, single cross and double cross hybrids; Population

improvement programmes, recurrent selection, synthetics and composites; Methods of breeding for vegetatively propagated crops; Clonal selection; Mutation breeding; Ploidy breeding; Wide hybridization, significance in crop improvement.

**Practical:** Botanical description and floral biology; Study of megasporogenesis and microsporogenesis; Fertilization and life cycle of an angiospermic plant; Plant Breeder's kit; Hybridization techniques and precautions to be taken; Floral morphology, selfing, emasculation and crossing techniques; Study of male sterility and incompatibility in field plots; Rice and Sorghum; Maize and Wheat; Bajra and ragi; Sugarcane and coconut; Groundnut, Castor, Safflower and Sesamum; Redgram, Bengalgram and Greengram; Soybean and blackgram; Chillies, Brinjal and Tomato; Bhendi, Onion, Bottle gourd and Ridge gourd; Cotton and Mesta; Jute and Sunhemp

#### 4. Principles of Plant Biotechnology

3(2+1)

Concepts of Plant Biotechnology: History of Plant Tissue Culture and Plant Genetic Engineering; Scope and importance in Crop Improvement: Totipotency and Morphogenesis, Nutritional requirements of *in-vitro* cultures; Techniques of In-vitro cultures, Micro propagation, Anther culture, Pollen culture, Ovule culture, Embryo culture, Test tube fertilization, Endosperm culture, Factors affecting above *in-vitro* culture; Applications and Achievements; Somaclonal variation, Types, Reasons: Somatic embryogenesis and synthetic seed production technology; Protoplast isolation, Culture, Manipulation and Fusion; Products of somatic hybrids and cybrids, Applications in crop improvement. Genetic engineering; Restriction enzymes; Vectors for gene transfer – Gene cloning – Direct and indirect method of gene transfer – Transgenic plants and their applications. Blotting techniques – DNA finger printing – DNA based markers – RFLP, AFLP, RAPD, SSR and DNA Probes – Mapping QTL – Future prospects. MAS, and its application in crop improvement.

**Practical:** Requirements for Plant Tissue Culture Laboratory; Techniques in Plant Tissue Culture; Media components and preparations; Sterilization techniques and Inoculation of various explants; Aseptic manipulation of various explants; Callus induction and Plant Regeneration; Micro propagation of important crops; Anther, Embryo and Endosperm culture; Hardening / Acclimatization of regenerated plants; Somatic embryogenesis and synthetic seed production; Isolation of protoplast; Demonstration of Culturing of protoplast; Demonstration of Isolation of DNA; Demonstration of Gene transfer techniques, direct methods; Demonstration of Gene transfer techniques, indirect methods; Demonstration of Confirmation of Genetic transformation; Demonstration of gel-electrophoresis techniques.

#### 5. Breeding of Field / Horticulture Crops

3(2+1)

Breeding objectives and important concepts of breeding self pollinated, cross pollinated and vegetatively propagated crops; Hardy-Weinberg Law; Study in respect of origin, distribution of species, wild relatives and forms, Cereals, (rice, wheat, maize, millets, sorghum, bajra, ragi); Pulses (redgram, greengram, blackgram, soybean); Oilseeds (Groundnut, sesame, sunflower, safflower, castor, mustard) etc. Fibers (Cotton, kenaf, roselle, jute) etc. Vegetables (Tomato, bhindi, chilli, cucumbers); Flowers crops (Chrysanthemum, rose, galardia, gerbera & marigold); Fruit crops (aonla, guava, mango, custard apple, banana, papaya); Major breeding procedures for development of hybrids / varieties of various crops; Plant Genetic Resources their conservation and utilization in crop improvement; Ideotype concept in crop improvement; Breeding for resistance to biotic and abiotic stresses variability in pathogens and pests; Mechanisms of resistance in plant to pathogens and pest; Genetic basis of adaptability to unfavourable environments; Definition of biometrics, assessment of variability

i.e., additive, dominance and epistasis and their differentiation; Genotype x Environment interaction and influence on yield/performance. IPR and its related issues.

**Practical:** Emasculation and Hybridization techniques; Handling of segregating generations, pedigree methods; Handling of segregating generations, bulk methods; Handling of segregating generations, back cross methods; Field lay out of experiments; Field trials, maintenance of records and registers; Estimation of Heterosis and inbreeding depression; Estimation of Heritability, GCA and SCA; Estimation of variability parameters; Percentage of released varieties/hybrids; Problems on Hardy, Weinberg Law; Study of quality characters; Sources of donors for different characters; Visit to seed production and certification plots; Visit to AICRP trials and programmes; Visit to grow out test plots; Visit to various research stations; Visit to other institutions

### 3. SOIL SCIENCE AND AGRICULTURAL CHEMISTRY

#### 1. Introduction to Soil Science

3(2+1)

Soil: Pedological and edaphological concepts, Origin of the earth, Earth's crust; Composition: Rocks and minerals Weathering, Soil formation factors and processes Components of soils; Soil profile, Soil physical properties, Soil texture, Textural classes, Particle size analysis, Soil structure Classification, Soil aggregates, significance, Soil consistency, Soil crusting, Bulk density and particle density of soils & porosity, their significance and manipulation, Soil compaction, Soil Colour, Elementary knowledge of soil classification and soils of India; Soil water, Retention and potentials, Soil moisture constants, Movement of soil water, Infiltration, percolation, permeability, Drainage, Methods of determination of soil moisture Thermal properties of soils, Soil temperature, Soil air, Gaseous exchange, Influence of soil temperature and air on plant growth; Soil colloids, Properties, nature, types and significance; Layer silicate clays, their genesis and sources of charges, Adsorption of ions, Ion exchange, CEC & AEC Factors influencing ion exchange and its Significance. Soil organic matter, Composition, Decomposability, Humus, Fractionation of organic matter, Carbon cycle, C: N ratio. Soil biology, Biomass, Soil organisms and their beneficial and harmful roles.

**Practical:** Determination of bulk density and particle density, Aggregate analysis, Soil strength, Soil moisture determination, Soil moisture constants – Field capacity Infiltration rate, water holding capacity, soil texture and mechanical analysis – Soil temperature. Analytical chemistry – Basic concepts, techniques and calculations – Collection and processing of soil for analysis – Organic carbon, pH, EC, soluble cations and anions – Study of a soil profile – Identification of rocks and minerals.

#### 2. Manures, Fertilizers and Agro-Chemicals

3(2+1)

Introduction – Raw materials – Manures – Bulky and concentrated – FYM, Composts – Different methods, Mechanical compost plants, Vermicomposting, Green manures, Oil cakes, Sewage and sludge – Biogas plant slurry, Plant and animal refuges. Fertilizers – classifications, Manufacturing processes and properties of major nitrogenous (ammonium sulphate, urea, calcium ammonium nitrate, ammonium nitrate, ammonium sulphate nitrate) phosphatic (single super phosphate, enriched super phosphate, diammonium phosphate, ammonium poly phosphate), potassic and complex fertilizers their fate and reactions in the soil, Secondary and micronutrients fertilizers, Amendments. Fertilizer Control Order, Fertilizer storage; Biofertilizers and their advantage, Organic chemistry as prelude to agro chemicals, Diverse types of agrochemicals, Botanical insecticides (Neem), Pyrethrum,

Synthetic pyrethroids. Synthetic organic insecticides, Major classes, Properties and uses of some important insecticides under each class. Herbicides – Major classes – Properties and uses of 2, 4-D, atrazine, glyphosate, butachlor benthocarb; Fungicides – Major classes – Properties and uses of carbendazim, carboxin, captan, tridemorph and copper oxychloride – Insecticides Act, Plant growth regulators.

**Practical:** Total nitrogen and phosphorus in manures / composts – Ammoniacal and nitrate nitrogen – Water soluble  $P_2O_5$ , potassium, calcium, sulphur and zinc contents of fertilizers COD in organic wastes – Adulteration in fertilizer. Argentometric and iodometric titrations – their use in the analysis of lindane metasystox, endosulfan, malathion, copper and sulphur fungicides – Compatibility of fertilizers with pesticides.

### 3. Soil Chemistry, Soil Fertility and Nutrient Management

3 (2+1)

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

**Practical:** Principles of analytical Instruments and their calibration and applications, Colorimetry and flame photometry. Estimation of available N, P, K, S, and Zn in oils, pH, EC, soluble cations and anions in soil water extracts. Lime requirement and gypsum requirement of problem soils. Estimation of N, P and K in plants.

## 4. ENTOMOLOGY

### 1. Insect Morphology and Systematics

3(2+1)

History of Entomology in India. Factors for insects abundance. Classification of phylum Arthropoda upto classes. Relationship of class Insecta with other classes of Arthropoda. Morphology: Structure and functions of insect cuticle and moulting. Body segmentation. Structure of Head, thorax and abdomen. Structure and modifications of insect antennae, mouth parts and legs. Wing venation, modifications and wing coupling apparatus. Structure male and female genitalia. Sensory organs. Metamorphosis and diapause in insects. Types of larvae and pupae. Structure and functions of digestive, circulatory, excretory, respiratory, nervous, secretory (Endocrine) and reproductive system in insects. Types of reproduction in insects. Systematics: Taxonomy –importance, history and development and binomial nomenclature. Definitions of Biotype, Sub-species, Species, Genus, Family and Order. Classification of class Insecta upto Orders. Orthoptera, Acrididae. Dictyoptera, Mantidae, Odonata, Isoptera, Termitidae, Thysanoptera, Thripidae, Hemiptera, Pentatomidae, Coreidae, Pyrrhocoridae, Lygaeidae, Cicadellidae, Delphacidae, Aphididae, Coccidae, Aleurodidae, Pseudococcidae, Neuroptera, Chrysopidae Lepidoptera, Noctuidae, Sphingidae, Pyralidae,

Gelechiidae, Arctiidae, Coleoptera, Coccinellidae, Chrysomelidae, Cerambycidae, Curculionidae, Bruchidae, Scarabaeidae, Hymenoptera, Tenthredinidae, Apidae, Trichogrammatidae, Ichneumonidae, Braconidae, Diptera, Cecidomyiidae, Trypetidae, Tachinidae, Agromyziidae.

**Practical:** Methods of collection and preservation of insects including immature stages; External features of Grasshopper/Blister beetle; Types of insect antennae, mouthparts and legs; Wing venation, types of wings and wing coupling apparatus Types of insect larvae and pupae; Dissection of digestive system in insects (Grassopher); Dissection of male and female reproductive systems in insects (Grassopher); Study of characters of orders Orthoptera, Dictyoptera, Odonata, Isoptera, Thysanoptera, Hemiptera, Lepidoptera, Neuroptera, Coleoptera, Hymenoptera, Diptera and their families of agricultural importances

## **2. Insect Ecology and Integrated Pest Management Including Beneficial Insects**

**3 (2+1)**

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

**Practical:** Visit to meteorological observatory / automatic weather reporting station; Study of terrestrial and pond ecosystems of insects; Studies on behaviour of insects and orientation (repellency, stimulation, deterancy); Study of distribution patterns of insects, sampling techniques for the estimation of insect population and damage; Pest surveillance through light traps, pheromone traps and field incidence; Practicable IPM practices, Mechanical and physical methods; Practicable IPM practices, Cultural and biological methods; Chemical control, Insecticides and their formulations; Calculation of doses/concentrations of insecticides; Compatibility of pesticides and Phytotoxicity of insecticides; IPM case studies; Identification of common phytophagous mites and their morphological characters; Identification of common plant parasitic nematodes and their morphological characters; Identification of rodents and bird pests and their damage; Identification of earthworms in vermiculture – visit to vermiculture unit; Other beneficial insects – Pollinators, weed killers and scavengers

### 3. Crop Pests and Stored Grain Pests and Their Management

3(2+1)

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

**Practical:** Identification of pests, their damage symptoms and management of rice, sorghum, maize, wheat, sugarcane, cotton, pulses, Solanaceous and Malvaceous vegetables, cruciferous and cucurbitaceous vegetables, chilli, mango, carbon, citrus and sapota.

## 5. AGRICULTURAL ECONOMICS

### 1. Principles of Agricultural Economics

2 (2+0)

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

### 2. Agricultural Finance and Co-Operation

2(1+1)

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 7 P'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, Insurance and Credit Guarantee Corporation of India. Assessment of crop losses, determination of compensation. Crop insurance, advantages and limitations in application, estimation of crop yields. Agricultural cooperation: philosophy and principles. History of Indian cooperative Movement, pre-independence and post independence periods, cooperation in different plan periods, cooperative credit structure: PACS, FSCS. Reorganisation of cooperative credit structure in Andhra Pradesh and single window system. Successful cooperative systems in Gujarat, Maharashtra. Punjab etc.

**Practical:** Factors governing use of Capital and identification of credit needs; Time value of money, Compounding and discounting; Tools of financial management, Balance sheet, Income statement and cash flow analysis; Estimations of credit needs and determining unit

costs; Preparations and analysis of loan proposals; Types of repayment loans; Study of financial institutions: PACS, DCCB, Apex Banks, RRBs, CBs, NABARD.

### **3. Agricultural Marketing, Trade and Prices**

**2 (1+1)**

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

**Practical:** Identification of marketing channels; Study of Rythu Bazars, Regulated markets; Study of unregulated markets; Study of livestock markets; Price spread analysis; Visit to market institutions, NAFED; Study of SWC, CWC and STC; Analysis of information of daily prices; Marketed and marketable surplus of different commodities.

### **4. Production Economics and Farm Management**

**2 (1+1)**

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

**Practical:** Computation of cost concepts; Methods of computation of depreciation; Analysis of Net worth statement; Farm inventory analysis; Preparation of farm plans and budgets; Types of farm records and accounts; Preparation of profit and loss account; Break, Even analysis; Economics analysis of different crop and livestock enterprises; Application of Farm Management Principles.

### **5. Fundamentals of Farm Business Management**

**2 (1+1)**

**(Including Project Development, Appraisal and Monitoring)**

Agribusiness: Meaning, Definition, Structure of Agribusiness, (Input, Farm, Product Sectors). Importance of Agribusiness in the Indian Economy, Agricultural Policy. Agribusiness Management, Distinctive features, Importance of Good Management, Definitions of

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

**Practical:** Study of input markets: seed, fertilizers, pesticides. Study of output markets, grains, fruits, vegetables, flowers. Study of product markets, retail trade commodity trading, value added products. Study of financing institutions cooperatives commercial banks, RRBs, Agribusiness Finance Limited, NABARD; Preparations of projects, Feasibility reports; Project appraisal techniques; Case study of agro-based industries .

## 6. AGRICULTURAL ENGINEERING

### 1. Fundamentals of Soil, Water and Conservation Engineering

3(2+1)

Surveying: survey equipment, chain survey, cross staff survey, plotting procedure, calculations of area of regular and irregular fields. Levelling – levelling equipment, terminology, methods of calculation of reduced levels, types of levelling, contouring. Irrigation, classification of projects, flow irrigation and lift irrigation. Water source, Water lifting devices – pumps (shallow and deep well), capacity, power calculations. Irrigation water measurement – weirs, flumes and orifices and methods of water measurement and instruments. Water conveyance systems, open channel and underground pipeline. Irrigation methods – drip and sprinkle irrigation systems. Soil and water conservation – soil erosion, types and engineering control measures.

**Practical:** Acquaintance with chain survey equipment; Ranging and measurement of offsets; Chain triangulation; Cross staff survey; Plotting of chain triangulation; Plotting of cross staff survey; Levelling equipment – dumpy level, levelling staff, temporary adjustments and staff reading; Differential leveling; Profile leveling; Contour survey – grid method; Plotting of contours; Study of centrifugal pumping system and irrigation water measuring devices; Study of different components of sprinkler irrigation systems; Study of different components of drip and sprinkle irrigation systems; Uniformity of water application in drip and sprinkle systems; Study of soil and water conservation measures.

### 2. Farm Power and Machinery

2 (1+1)

Farm power in India: sources, I.C engines, working principles, two stroke and four stroke engines, I.C. engine terminology, different systems of I.C. engine. Tractors, Types, Selection of tractor and cost of tractor power. Tillage implements: Primary and Secondary tillage implements, Implements for intercultural operations, seed drills, paddy transplanters, plant

protection equipment and harvesting equipment; Equipment for land development and soil conservation.

**Practical:** Study of different components of I.C. Engine; Study of working of four stroke engine; Study of working of two stroke engine; Study of M.B. plough, measurement of plough size, different parts, horizontal and vertical suction, determination of line of pull etc.; Study of disc plough; Study of seed-cum-fertilizer drills-furrow opener, metering mechanism, and calibration; Study, maintenance and operation of tractor; Learning of tractor driving; Study, maintenance and operation of power tiller; Study of different parts, registration, alignment and operation of mower. Study of different inter cultivation equipment in terms of efficiency, field capacity; Repairs and adjustments and operation of sprayers; Repairs and adjustments and operation of dusters; Study of paddy transplanters.

### **3. Protected Cultivation and Post Harvest Technology**

**2 (1+1)**

Green house technology, Introduction, Types of Green Houses; Plant response to Green house environment, Planning and design of greenhouses, Design criteria of greenhouse for cooling and heating purposes. Green house equipment, materials of construction for traditional and low cost green houses. Irrigation systems used in greenhouses, Typical applications, passive solar green house, hot air green house heating systems, green house drying. Cost estimation and economic analysis. Choice of crops for cultivation under greenhouses, problems / constraints of greenhouse cultivation and future strategies. Growing media, soil culture, type of soil required, drainage, flooding and leaching, soil pasteurization in peat moss and mixtures, rock wool and other inert media, nutrient film technique (NFT) / hydroponics. Threshing, threshers for different crops, parts, terminology, care and maintenance. Winnowing, manual and power operated winnowers, care and maintenance. Groundnut decorticators, hand operated and power operated decorticators, principles of working, care and maintenance. Maize shellers & castor shellers. Drying, grain drying, types of drying, types of dryers. Storage, grain storage, types of storage structures. Fruits and vegetables cleaning, machinery for cleaning of fruits and vegetables, care and maintenance. Grading, methods of grading, equipment for grading of fruits and vegetables, care and maintenance. Size reduction. equipment for size reduction care and maintenance. Evaporation, Principle, types of evaporators, quality standards – FAQ, ASTA, FPO, FDA.

**Practical:** Study of different types of green houses based on shape, construction and cladding materials; Calculation of air rate exchange in an active summer winter cooling system; Calculation of rate of air exchange in an active winter cooling system; Estimation of drying rate of agricultural products inside green house; Testing of soil and water to study its suitability for growing crops in greenhouses; The study of fertigation requirements for greenhouses crops and estimation of E.C. in the fertigation solution; The study of various growing media used in raising of greenhouse crops and their preparation and pasteurization / sterilization; Visit to commercial green houses; Study of threshers, their components, operation and adjustments; Winnowers, their components, operation and adjustments; Study of different components of groundnut decorticator; Study of maize shellers; Study of castor shellers; Study of improved grain storage structure; Study of dryers; Study of cleaners & graders.

### **4. Renewable Energy**

**2 (1+1)**

Energy sources, Introduction, Classification, Energy from Biomass, Types of biogas plants, constructional details, Biogas production and its utilization, Agricultural wastes, Principles of combustion, pyrolysis and gasification, Types of gasifiers, Producer gas and its utilization.

Briquettes, Types of Briquetting machines, uses of Briquettes, Shredders. Solar energy, Solar flat plate and focussing plate collectors, Solar air heaters, Solar space heating and cooling, Solar energy applications / Solar energy gadgets, Solar cookers, Solar water heating systems, solar grain dryers, Solar Refrigeration system, Solar ponds, Solar photo voltaic systems, solar lantern, Solar street lights, solar fencing, Solar pumping systems. Wind energy, Types of wind mills, Constructional details & application of wind mills. Liquid Bio fuels, Bio diesel and Ethanol from agricultural produce, its production & uses.

**Practical:** Constructional details of KVIC & Janatha type biogas plants; Constructional details of Deen Bandu type biogas plants; Field visit to biogas plants; Constructional details of different types of gasifiers; Testing of gasifiers; Briquette preparation from biomass; To study and find the efficiency of solar cooker; To study and find the performance of a solar still; To study and find the performance of a solar dryers; Study and working of solar photovoltaic pumping system; Study and performance evaluation of domestic solar water heater; Study and performance evaluation of solar lantern; Study and performance evaluation of solar street light; To study the performance of different types of wind mills; Field visit to wind mills; To study the processing of Bio-diesel production from *Jatropha*.

## 7. PLANT PATHOLOGY

### 1. Plant Pathogens and Principles of Plant Pathology

4 (3+1)

Introduction, Important plant pathogenic organisms, different groups, fungi, bacteria, fastidious vesicular bacteria, phytoplasmas, spiroplasmas, viruses, virioids, algae, protozoa and phanerogamic parasites with examples of diseases caused by them. Prokaryotes: classification of prokaryotes according to Bergey's Manual of Systematic Bacteriology. General Characters of fungi, Definition of fungus, somatic structures, types of fungal thalli, fungal tissues, modifications of thallus, reproduction in fungi (asexual and sexual). Nomenclature, Binomial system of nomenclature, rules of nomenclature, classification of fungi. Key to divisions and sub-divisions. Introduction: Definition and objectives of Plant Pathology. History of Plant Pathology. Terms and concepts in Plant Pathology. Survival and Dispersal of Plant Pathogens. Phenomenon of infection – pre-penetration, penetration and post penetration. Pathogenesis – Role of enzymes, toxins, growth regulators and polysaccharides. Defense mechanism in plants – Structural and Bio-chemical (pre and post-infection). Plant disease epidemiology. Plant Disease Forecasting – Remote sensing – General principles of plant diseases management – Importance, general Principles – Avoidance, exclusion, protection – Plant Quarantine and Inspection – Quarantine Rules and Regulations. Cultural methods – Rouging, eradication of alternate and collateral hosts, crop rotation, manure and fertilizer management, mixed cropping, sanitation, hot weather ploughing, soil amendments, time of sowing, seed rate and plant density, irrigation and drainage. Role and mechanisms of biological control and PGPR. Physical Methods – Heat and Chemical methods – Methods of application of fungicides. Host plant resistance – Application of biotechnology in plant disease management –Development of disease resistant transgenic plants through gene cloning. Integrated plant disease management (IDM) – Concept, advantages and importance.

**Practical:** Acquaintance to plant pathology laboratory and equipments; Preparation of culture media for *fungi* and *bacteria*; Isolation techniques, preservation of disease samples; Study of *Pythium*, *Phytophthora* and *Albugo*; Study of *Sclerospora*, *Peronosclerospora*, *Pseudoperonospora*, *Peronospora*, *Plasmopara* and *Bremia*; Study of genera *Mucor* and *Rhizopus*. Study of *Oidium*, *Oidiopsis*, *Ovulariopsis*, *Erysiphe*, *Phyllactinia*, *Uncinula* and *Podospaera*; Study of *Puccinia* (different stages), *Uromyces*, *Hemileia*; Study of *Sphacelotheca*, *Ustilago* and *Tolyposporium*; Study of *Agaricus*, *Pleurotus* and *Ganoderma*;

Study of *Septoria*, *Colletotrichum*, *Pestalotiopsis* and *Pyricularia*; Study of *Aspergillus*, *Penicillium*, *Trichoderma*, and *Fusarium*; Study of *Helminthosporium*, *Drechslera*, *Alternaria*, *Stemphyllium*, *Cercospora*, *Phaeoisariopsis*, *Rhizoctonia* and *Sclerotium*; Demonstration of Koch's postulates; Study of different groups of fungicides and antibiotics; Preparation of fungicides – Bordeaux mixture, Bordeaux paste, Chestnut compound; Methods of application of fungicides – seed, soil and foliar; Bio-assay of fungicides – poisoned food technique, inhibition zone technique and slide germination technique; Bio-control of plant pathogens – dual culture technique, seed treatment. Visit to quarantine station and remote sensing laboratory.

## **2. Diseases of Field Crops and Their Management** **3 (2+1)**

Economic importance, symptoms, cause, epidemiology and disease cycle and integrated management of diseases of rice, sorghum, bajra, maize, wheat, sugarcane, turmeric, tobacco, groundnut, sesamum, sunflower, cotton, redgram, bengalgram, blackgram, greengram, tea, soybean.

**Practical:** Study of symptoms, etiology, host-parasite relationship and specific control measures of the following crop diseases. Presentation of disease samples survey and collection of Diseases of rice, sorghum; Diseases of wheat, bajra & maize; Diseases of sugarcane, turmeric & tobacco; Diseases of groundnut, castor & sunflower; Diseases of sesamum & cotton; Diseases of redgram, greengram, blackgram, bengalgram & beans; Field visits at appropriate time during the semester

Note: Students should submit 50 pressed, well mounted diseased specimens in three installments during the semester.

## **3. Diseases of Horticultural Crops and Their Management** **3(2+1)**

Economic Importance, symptoms, cause, disease cycle and integrated management of diseases of: citrus, mango, banana, grapevine, pomegranate, papaya, guava, sapota, apple, chilli, brinjal, bhendi, potato, crucifers, cucurbits, tomato, beans, onion, coconut, oil palm, betelvine, mulberry, coffee, tea, rose, chrysanthemum and jasmine.

**Practical:** Diseases of beans, citrus, guava, & sapota; Diseases of papaya, banana, pomegranate & ber; Diseases of mango, grapes & apple; Diseases of chilli, brinjal & bhendi; Diseases of potato, tomato & crucifers; Diseases of cucurbits, onion & betelvine; Diseases of oil palm, coconut, tea, coffee & mulberry; Diseases of rose, chrysanthemum and jasmine. Field visits at appropriate time during the semester.

Note: Students should submit 50 pressed, well mounted diseased specimens in three installments during the semester.

## **4. Introductory Nematology** **2 (1+1)**

Introduction: History of phytonematology. Economic importance. General characteristics of plant pathogenic nematodes. Nematode general morphology and biology. Classification of nematodes upto family level with emphasis on groups containing economically important genera. Classification of nematodes by habitat. Identification of economically important plant nematodes upto generic level with the help of keys and description. Symptoms caused by nematodes with examples. Interaction between plant parasitic nematodes and disease causing fungi, bacteria and viruses. Different methods of nematode management. Cultural methods (crop rotation, fallowing, soil amendments, other land management techniques), physical

methods (soil solarisation, hot water treatment) Biological methods, Chemical methods (fumigants, non fumigants). Resistant varieties. IDM.

**Practical:** Methods of survey – sampling methods, collection of soil and plant samples; Extraction of nematodes from soil and plant tissues following combined Cobb's decanting – sieving and Baermann funnel technique, counting and estimation of plant parasitic nematodes; Preparation of temporary and permanent mounts; Method of preparation of perineal patterns for identification of species of *Meloidogyne*; Study and identification of most important plant parasitic nematodes with special reference to their characteristics and symptomatology – *Meloidogyne*, *Pratylenchus*; *Heterodera*, *Ditylenchus*, *Globodera*, *Tylenchulus*, *Xiphinema*, *Radopholus*, *Rotylenchulus*, and *Helicotylenchus*. Experimental techniques used in pathogenicity studies with root knot nematode.

## 8. HORTICULTURE

### 1. Production Technology of Fruit Crops

3(2+1)

Definition and importance of horticulture. Divisions of horticulture. Climatic zones of horticulture crops. Area and production of different fruit crops. Selection of site, fencing, and wind break, planting systems, high density planting, planning and establishment. Propagation methods and use of rootstocks. Methods of training and pruning. Use of growth regulators in fruit production. Package of practices for the cultivation of major fruits – mango, banana, citrus, grape, guava, sapota, apple, litchi. Papaya, Minor fruits – pineapple, annonaceous fruits, pomegranate, ber, fig, phalsa, jack, pear, plum, peaches and cherry.

**Practical:** Study of horticultural tools and implements and their uses; Containers, potting mixture, potting, depotting and repotting; Plant propagation, seed propagation, scarification, and stratification; Propagation by cuttings (soft wood, hard wood and semi-hardwood) layering (simple layering, Air layering, stooping in guava); Layout and planting systems (Traditional system and high density planting methods); Methods of pruning and training; Training of ber, grape and pomegranate; Pruning of ber, grape, phalsa, fig, apple, pear, peach; Description and identification of varieties of mango, guava, grape, papaya, apple and sapota; Description and identification of varieties of banana, citrus, (lime lemon, sweet orange, mandarin, grape fruit) pomegranate, ber, pear and cherries; Irrigation methods in fruit crops including drip – Micro irrigation methods of establishment of orchard; Methods of Fertiliser application methods in fruit crops including fertigation technology; Visit to local commercial orchards; Preparation of growth regulators, powder, solution and lanolin paste for propagation; Application of growth regulators for improving fruit set, fruit size, quality, delaying ripening and hastening ripening.

### 2. Production Technology of Vegetables and Flowers

3(2+1)

Importance of Olericulture, vegetable gardens, vegetable classification. Origin, area, production, varieties, package of practices for fruit vegetables –, tomato, brinjal, chillies, and okera; Cucurbitaceous vegetables – cucumber, ridge gourd, ash gourd, snake gourd, bottle gourd, bitter gourd and melons, Cole crops – cabbage, cauliflower and knol-khol. Bulb crops – onion and garlic. Beans and peas – French beans, cluster beans, dolichos beans, peas and cowpea. Tuber crops – potato, sweet potato, tapioca, colocasia, yams; Root crops – carrot, radish, turnip and beet root; Leafy vegetables – amaranthus, palak, gogu; Perennial vegetables – drumstick, coccinia and curry leaf. Importance of ornamental gardens. Planning of ornamental gardens. Types and styles of ornamental gardens. Use of trees, shrubs,

climbers, palms, houseplants and seasonal flowers in the gardens. Package of practices for rose, jasmine, chrysanthemum, crossandra, marigold and tuberose.

**Practical:** 1 Planning and layout of kitchen garden; 2 Identification of important vegetable seeds and plants; Raising of vegetable nurseries; Identification of ornamental plants (trees, shrubs, climbers, house plants, palms etc.) and development of garden features; Transplanting of vegetable seedlings in main field; Layout of lawns and maintenance; Seed extraction in tomato and brinjal; Depotting, repotting and maintenance of house plants; Visit to commercial vegetable farms; Training and pruning of rose (standards, hybrid 'T' roses cented roses) and chrysanthemum (pinching and disbudding); Planning and layout of gardens and garden designs for public and private areas; Intercultural operations in vegetable plots; Seed production in vegetable crops; Harvesting indices of different vegetable crops; Grading and packing of vegetables; Prolonging the shelflife of cut flowers

### **3. Production Technology of Spices, Aromatic, Medicinal and Plantation Crops**

**3 (2+1)**

Importance and cultivation technology of Spices – ginger, turmeric, pepper, cardamom, coriander, cumin, fenugreek; Aromatic crops – lemon grass, citronella, palmarose, vetiver, geranium, dawana; Plantation crops – coconut, arecanut, betelvine, cashew, cocoa, coffee, oilpalm; Medicinal plants – diascoria, rauwolfia, opium, ocimum, perwinkle, aloe, guggul, belladonna, nuxvomica, *Solanum khasiamum*, aonla, senna, plantago, stevia, coleus and Acorus.

**Practical:** Botanical description and identification of aromatic plants; Identification of varieties in spices and plantation crops; Identification of medicinal plants; Propagation techniques in aromatic and spice crops; Selection of mother palm, and seed nuts in coconut and oil palm; Study of identification of aromatic plants; Distillation procedures for aromatic crops; Propagation methods in plantation crops; Propagation and planting methods in turmeric; Propagation and planting techniques in ginger; Harvesting procedures in aromatic plants; Processing and curing of spices (ginger, turmeric and black pepper); Training methods in betelvine; Rejuvenation practices in cashewnut; Products – byproducts of spices and plantation crops; Procedures for oleoresin extraction; Visit to local commercial plantations. Aromatic & medicinal plant nurseries and seed spices field.

### **4. Post Harvest Management and Value Addition of Fruits and Vegetables**

**2(1+1)**

Importance of post harvest technology in horticultural crops. Maturity indices, harvesting and post harvest handling of fruits and vegetables. Maturity and ripening process. Factors affecting ripening of fruits, and vegetables. Pre harvest factors affecting quality on post harvest shelf life of fruits and vegetables. Factors responsible for deterioration of harvested fruits and vegetables. Chemicals used for hastening and delaying ripening of fruits and vegetables. Methods of storage – precooling, prestorage treatments, low temperature storage, controlled atmospheric storage, hypobaric storage, irradiation and low cost storage structures. Various methods of packing, packaging materials and transport. Packing technology for export. Fabrication of types of containers, cushioning material, vacuum packing, poly shrink packing, specific packing for export of mango, banana, grapes kinnow, sweet orange, and mandarin etc. Importance and scope of fruit and vegetable preservation in India. Principles of preservation by heat, low temperature, chemicals and fermentation. Unit layout – selection of site and precautions for hygienic conditions of the unit. Preservation through canning, bottling, freezing, dehydration, drying, ultraviolet and ionizing radiations. Preparation of

jams, jellies, marmalades, candies, crystallized and glazed fruits, preserves, chutneys, pickles, ketchup, sauce, puree, syrups, juices, squashes and cordials Spoilage of canned products, biochemical, enzymatic and microbial spoilage. Preservatives, Colours permitted and prohibited in India.

**Practical:** Practice in judging the maturity of various fruits and vegetables. Conservation of zero energy cool chambers for on farm storage. 3& 4. Determination of physiological loss in weight (PLW), total soluble solids (TSS), total sugars, acidity and ascorbic and content in fruits and vegetables. Packing methods and types of packing and importance of ventilation. Pre cooling packing methods for export or international trade. Methods of prolonging storage life. Effect of ethylene on ripening of banana, sapota, mango, sapota. Identification of equipment and machinery used in preservation of fruits and vegetables. Preservation by drying and dehydration. Preparation of jam, jelly and marmalades. Preparation of squash, cordials and syrups. Preparation of chutneys, pickles sauces and ketchup. Visit to local processing units. Visit to local market yards and cold storage units. Visit to local market and packing industries.

## 9. AGRICULTURAL EXTENSION

### 1. Dimensions of Agricultural Extension

2(1+1)

Education – Meaning, Definition, Types – Formal, Informal and Non-formal education and their Characteristics. Extension Education and Agricultural Extension – Meaning, Definition, Concepts, Objectives and Principles. Rural development – Meaning, Definition, Concepts, Objectives, Importance and Problems in rural development. Developmental programmes of pre-independence era – Sriniketan, Marthandam, Gurgaon experiment and Gandhian constructive programme. Development programmes of Post independence era, Firka Development, Etawah – Pilot project and Nilokheri Experiment. Community Development Programme – Meaning, Definition, Concepts, Philosophy, Principles, Objectives, Differences between Community Development and Extension Education, National Extension service. Panchayat Raj system – Meaning of Democratic – Decentralization and Panchayat Raj, Three tiers of Panchayat Raj system, Powers, Functions and Organizational setup. Agricultural Development Programmes with reference to year of start, objectives & salient features – Intensive Agricultural District Programme (IADP), High Yielding Varieties Programme (HYVP), Institution Village Linkage Programme (IVLP), Watershed Development Programme (WDP), National Agricultural Technology Project (NATP), ATMA, ATIC. Social Justice and Poverty alleviation programmes – Integrated Tribal Development Agency (ITDA), Integrated Rural Development Programme (IRDP), Swarna Jayanthi Gram Swarojgar Yojana (SGSY), Prime Minister Employment Yojana (CMEY). New trends in extension, privatization. Women Development programmes – Development of Women and Children in Rural Areas (DWCRA), Rashtriya Mahila Kosh (RMK), Integrated Child Development Scheme (ICDS) and Mahila Samridhi Yojana (MSY). Reorganized extension system (T&V System) – Salient features, Fort night Meetings, Monthly workshops, Linkages, Merits and Demerits, Emergence of Broad Based Extension (BBE).

**Practical:** Visits to a village and kisan mandal to study the ongoing development programmes. Visits to Panchayat Raj Institutions to study the functioning of Gram Panchayat (GP) & Zilla Praja Parishad (ZPP). Visit and study the District Rural Development Agency (DRDA). Participation in monthly workshops of Training and Visit (T & V) System. Visit to Watershed Development Project area. Visit to a village to study the Self Help Groups (SHGs) of DWCRA. Visit to a voluntary organization to study the developmental activities.

Organizing PRA techniques in a village to identify the agricultural problems. Visit to villages.

## **2. Fundamentals of Rural Sociology and Educational Psychology**

**2 (2+0)**

Extension Education and Agricultural Extension – Meaning, Definition, Scope and Importance. Sociology and Rural Sociology, Meaning, Definition, Scope, Importance of Rural Sociology in Agricultural Extension and Interrelationship between Rural Sociology & Agricultural Extension. Indian Rural Society, Important characteristics, Differences and Relationship between Rural and Urban societies. Social Groups – Meaning, Definition, Classification, Factors considered in formation and organization of groups, Motivation in group formation and Role of Social groups in Agricultural Extension. Social Stratification – Meaning, Definition, Functions, Basis for stratification, Forms of Social stratification – Characteristics and – Differences between Class & Caste System. Cultural concepts – Culture, Customs, Folkways, Mores, Taboos, Rituals and Traditions – Meaning, Definition and their Role in Agricultural Extension. Social Values and Attitudes – Meaning, Definition, Types and Role of Social Values and Attitudes in Agricultural Extension. Social Institutions – Meaning, Definition, Major institutions in Rural society, Functions and their Role in Agricultural Extension. Social Organizations – Meaning, Definition, Types of organizations and Role of Social organizations in Agricultural Extension. Social Control – Meaning, Definition, Need of social control and Means of Social control. Social change – Meaning, Definition, Nature of Social change, Dimensions of social change and factors of social change. Leadership – Meaning, Definition, Classification, Roles of a leader, Different methods of Selection of Professional and Lay leaders. Training of Leaders – Meaning, Definition, Methods of training, Advantages and Limitations in use of local leaders in Agricultural Extension. Psychology and Educational Psychology – Meaning, Definition, Scope and Importance of Educational Psychology in Agricultural Extension. Intelligence – Meaning, Definition, Types, Factors affecting intelligence and Importance of intelligence in Agricultural Extension. Personality – Meaning, Definition, Types, Factors influencing the Personality and Role of personality in Agricultural Extension. Teaching – Learning process – Meaning and Definition of Teaching, Learning, Learning experience and Learning situation, Elements of learning situation and its characteristics. Principles of learning and their implication for teaching.

## **3. Extension Methodologies for Transfer of Agricultural Technology**

**2(1+1)**

Communication – Meaning, Definition, Models, Elements and their Characteristics, Types and Barriers in communication. Extension Programme Planning – Meaning, Definitions of Planning, Programme, Project, Importance, Principles and Steps in Programme Development Process, Monitoring and Evaluation of Extension Programmes. Extension Teaching methods – Meaning, Definition, Functions and Classification. Individual contact methods – Farm and Home visit, Result Demonstration, Field trials – Meaning, Objectives, Steps, Merits and Demerits. Group contact methods – Group discussion, Method demonstration, Field Trips – Meaning, Objectives, Steps, Merits and Demerits. Small group discussion techniques – Lecture, Symposium, Panel, Debate, Forum, Buzz group, Workshop, Brain Storming, Seminar and Conference. Mass contact Methods – Campaign, Exhibition, Kisan Mela, Radio & Television – Meaning, Importance, Steps, Merits & Demerits. Factors influencing in selection of Extension Teaching Methods and Combination (Media Mix) of Teaching methods. Innovative Information sources – Internet, Cyber Cafes, Video and Tele conferences, Kisan call centers, Consultancy clinics. Agricultural Journalism – Meaning, Scope and Importance, Sources of news, Types, Merits and Limitations. Diffusion and Adoption of Innovations – Meaning, Definition, Models of adoption Process, Innovation –

Decision Process – Elements, Adopter categories and their characteristics, Factors influencing adoption process. Capacity building of Extension Personnel and Farmers – Meaning, Definition, Types of training, Training to farmers, farm women and Rural youth – FTC and KVK.

**Practical:** Simulated exercises on communication. Identifying the Problems, Fixing the Priorities and selecting a most important problem for preparation of a project. Developing a project based on identified problems in a selected village. Organization of Group discussion and Method demonstration. Visit to KVK / FTC. Planning and Writing of scripts for Radio and Television. Audio Visual aids – Meaning, Importance and Classification. Selection, Planning, Preparation, Evaluation and Presentation of visual aids. Planning & Preparation of visual aids – Charts, Posters, Over Head Projector, (OHP) Transparencies, Power Point Slides. Planning and Preparation of Agricultural Information materials – Leaflet, Folder, Pamphlet, News Stories, Success Stories. Handling of Public Address Equipment (PAE) System, Still camera, Video Camera and Liquid Crystal Display (LCD) Projector.

#### **4. Entrepreneurship Development and Communication Skills 2 (1+1)**

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. Globalisation 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 agriculture sector. Venture capital. Contract farming and joint ventures, public-private partnerships. Overview of agri inputs industry. Characteristics of Indian agricultural 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.

**Practical:** 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.

### **10. BIOCHEMISTRY/PHYSIOLOGY MICROBIOLOGY/ ENVIRONMENTAL SCIENCES**

#### **1. Biochemistry 3(2+1)**

Biochemistry – Introduction and importance. Plant cell, cell wall and its role in live stock, food and paper industries. Bio-molecules – Structure, properties & applications: Amino acids, peptides and proteins –Plant proteins and their quality. Enzymes –Factors affecting the activity, classification, Immobilisation and other industrial applications. Lipids –Acyl lipids, Their industrial application in soaps, detergents, paints, Varnishes, lubricants, adhesives,

plastics, nylon, Bio-diesel, Biodegradable plastics etc. Carbohydrates; Nucleotides and Nucleic acids. Metabolic energy and its generation – Metabolism – Basic concepts, Glycolysis, Citric acid Cycle, Pentose phosphate pathway, oxidative phosphorylation, Fatty acid oxidation. General reactions of amino acid degradation. Biosynthesis – carbohydrates, Lipids, Proteins and Nucleic acids. Metabolic regulation. Secondary metabolites, Terpenoids, Alkaloids, Phenolics and their applications in food and pharmaceutical industries.

**Practical:** Amino acid models (atomic); Paper electrophoresis for the separation of plant pigments; Protein denaturation – heat, pH, precipitation of proteins with heavy metals, Protein estimation by Lowry method; Enzyme kinetics, competitive inhibition, enzyme immobilization; Extraction of nucleic acids, column chromatography of RNA hydrolysate; Characterization of lipids by T.L.C.; Extraction of oil from oil seeds; Estimation of fatty acids by G.L.C.; Models of sugars, sucrose & starch; Quantitative determination of sugars; Paper chromatography for the separation of sugars; Determination of phenols.

## 2. Crop Physiology

3(2 + 1)

Introduction, Importance in Agriculture. Seed Physiology, Seed structures, Morphological, physiological and biochemical changes during seed development, Physiological maturity – Morphological and physiological changes associated with physiological maturity in crop, Harvestable maturity, Seed viability and vigour, Factors affecting seed viability and vigour. Methods of testing seed viability and vigour, Germination, Utilization of seed reserves during seed germination, Morphological, physiological and biochemical changes during seed germination, Factors affecting seed germination. Growth and Development, Definition, Determinate and Indeterminate growth, Monocarpic and Polycarpic species with examples. Measurement of growth, Growth analysis Growth characteristics, Definitions and mathematical formulae. Crop Water Relations, Physiological importance of water to plants, Water potential and its components, measurement of water status in plants. Transpiration, significance, Transpiration in relation to crop productivity, Water Use Efficiency, WUE in C<sub>3</sub>, C<sub>4</sub> and CAM plants, Factors affecting WUE. Photosynthesis, Energy synthesis, Significance of C<sub>3</sub>, C<sub>4</sub> and CAM pathway, Relationship of Photosynthesis and crop productivity, Translocation of assimilates, Phloem loading, apoplastic and symplastic transport of assimilates, Source and sink concept, Photorespiration, Factors affecting Photosynthesis and productivity, Methods of measuring photosynthesis, Photosynthetic efficiency, Dry matter partitioning, Harvest index of crops. Respiration and its significance, Brief account of Growth respiration and maintenance respiration, Alternate respiration – Salt respiration – wound respiration – measurement of respiration. Nutriophysiology – Definition – Mengel's classification of plant nutrients – Physiology of nutrient uptake – Functions of plant nutrients – Deficiency and toxicity symptoms of plant nutrients – Foliar nutrition – Hydroponics. Introduction of Photoperiodism and Vernalisation in relation to crop productivity – Photoperiodism Plant Growth Regulators – Occurrence – Biosynthesis – Mode of action of Auxins, Gibberellins, Cytokinins, ABA, Ethylene. Novel plant growth regulators, Commercial application of plant growth regulators in agriculture. Senescence and abscission – Definition – Classification – Theories of mechanism and control of senescence – Physiological and biochemical changes and their significance. Post Harvest Physiology – Seed dormancy – Definition – types of seed dormancy – Advantages and disadvantages of seed dormancy – Causes and remedial measures for breaking seed dormancy, Optimum conditions of seed storage – Factors influencing seed storage (ISTA standards). Fruit ripening – Metamorphic changes – Climateric and non-climateric fruits – Hormonal regulation of fruit ripening (with ethrel, CCC, Polaris, paclobuterozole ).

**Practical:** Preparation of solutions; Growth analysis: Calculation of growth parameters; Methods of measuring water status in roots, stems and leaves; Measurement of water potential by Chardakov's method; Measurement of absorption spectrum of chloroplastic pigments and fluorescence; Measurement of leaf area by various methods; Stomatal frequency and index – Respirometer – Measurement of respirometer; Leaf anatomy of C<sub>3</sub> and C<sub>4</sub> plants; Transpiration of measurement; Imbibition of seed; Optimum conditions for seed germination; Breaking seed dormancy; (a) Chemical method (b) Mechanical method; Yield analysis; Seed viability and vigour tests; Effect of ethylene on regulation of stomata

### 3. Agricultural Microbiology

3(2+1)

History of Microbiology: Spontaneous generation theory, Role of microbes in fermentation, Germ theory of disease, Protection against infections, Applied areas of Microbiology Metabolism in bacteria: ATP generation, chemoautotrophy, photo autotrophy, respiration, fermentation. Bacteriophages: structure and properties of Bacterial viruses – Lytic and Lysogenic cycles: viroids, prions. Bacterial genetics; Gene expression; Genetic recombination: transformation, conjugation and transduction, genetic engineering, Plasmids, episomes, genetically modified Organisms. Soil Microbiology: Microbial groups in soil, microbial transformations of carbon, nitrogen, phosphorus and sulphur, Biological nitrogen fixation. Microflora of Rhizosphere and Phyllosphere microflora, microbes in composting. Microbiology of Water. Microbiology of food: microbial spoilage and principles of food preservation. Beneficial microorganisms in Agriculture: Biofertilizer (Bacterial Cyanobacterial and Fungal), microbial insecticides, Microbial agents for control of Plant diseases, Biodegradation, Biogas production, Biodegradable plastics, Plant – Microbe interactions.

**Practical:** General instructions, Familiarization with instruments, materials, glassware etc. in a microbiology laboratory : Practice of Aseptic methods: I - Evaluation of aseptic technique with Nutrient broth tubes. II- Evaluation of aseptic technique with a Nutrient agar plate. Methods of Sterilization and Preparation of media I- Preparation of nutrient broth, nutrient agar plates, nutrient agar slant and nutrient agar stab; II- Sterilization of glassware by Dry heating; III - Sterilization of nutrient broth by Filtration. Plating methods for Isolation and Purification of bacteria I - Isolation of bacteria by Streak plate method. II - Isolation of aerobic spore forming bacteria by Enrichment using Streak plate method. III - Checking of purity of a bacterial culture by Streak plating method. Identification of bacteria by staining methods and Biochemical tests: I– Morphological examination of bacteria by Simple and Differential staining. II – Different biochemical tests for identification of bacterial culture; Enumeration of bacteria: I - Enumeration of bacteria by Stain slide method. II- Enumeration of bacteria by Most probable number method. III - Enumeration of bacteria by Pour plate method and Spread plate method.

### 4. Environmental Science

2 (1+1)

Scope and importance of environmental studies. Natural resources: Renewable and non-renewable resources. Forest, Water, Food, energy and land resources. Ecosystems: Definition, concept, structure and functions. Producers, consumers and decomposers of an ecosystem. Energy flow in the ecosystem. Types of ecosystems. Bio-diversity: Definition, classification, threats to biodiversity and its conservation. Environmental pollution: Causes, effects and control of air, water, soil, thermal, noise and marine pollution. Causes, effects and management of soil nuclear hazards and industrial wastes. Disaster management, Floods, earthquakes, cyclones and land slides. Social issues and the environment, unsustainable to sustainable development.

The Environment Protection Act, The Air Act, The water Act, The Wildlife Protection. Act and Forest Conservation Act. Woman and child welfare, HIV/AIDS and Role of information technology on environment and human health.

**Practical:** Collection, processing and storage of effluent samples; Determination of Bio-Chemical oxygen demand (BOD) in effluent sample; Determination of chemical oxygen demand (COD) in effluent sample; Estimation of dissolved oxygen in effluent samples; Determination of sound level by using sound level meter; Estimation of respirable and non respirable dust in the air by using portable dust sampler; Determination of total dissolved solids (TDS) in effluent samples; Estimation of species abundance of plants; Estimation of nitrate contamination in ground water; Analysis of temporary and total hardness of water sample by titration; Estimation of pesticide contamination in Agro-Ecosystem; Visit to Social Service Organisation / Environmental Education Centre; Crop adaptation to environmental variables, soils conditions; Study of transpiration and water balance in plants; Visit to a local polluted site. Observations and remedial measures; Assessment of chlorophyll content of fresh water / sea water ecosystem.

## 11. STATISTICS AND COMPUTER APPLICATION

### 1. Statistics

2(1+1)

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: Standard Deviation, Variance and Coefficient of Variation; Probability: Definition and concept of probability; Normal Distribution and its properties; Introduction to Sampling: Random Sampling; the concept of Standard Error; Tests of Significance- Types of Errors, 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, Student's t-test for Single Sample, Two Samples and Paired t test. F test; Chi-Square Test in 2x2 Contingency Table, Yates' 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 equations. 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.

**Practical:** Construction of Frequency Distribution Tables and Frequency Curves; Computation of Arithmetic Mean for Un-Grouped and Grouped data; Computation of Median for Un-Grouped and Grouped data; Computation of Mode for Un-Grouped and Grouped data; Computation of Standard Deviation, Variance and Coefficient of Variation for Un-Grouped and Grouped data; SND test for Means, Single Sample; SND test for Means , Two Samples; Student's t-test for Single Sample; Student's t-test for Two Samples; Paired t test and F test; Chi-Square Test in 2x2 Contingency Table, Yates' Correction for continuity; Computation of Correlation Coefficient 'r' and its testing; Fitting of regression equations- Y on X and X on Y; Analysis of Completely Randomized Design (CRD); Analysis of Randomized Block Design (RBD); Analysis of Latin Square Design (LSD).

## 2. Introduction to Computer Applications

2(1+1)

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

**Practical:** Study of Computer Components; Booting of Computer and its Shut Down; Practice of some fundamental DOS Commands, TIME, DATE, DIR, COPY, FORMAT, VOL, LABEL, PATH; Practicing WINDOWS Operating System, Use of Mouse, Title Bar, Minimum, Maximum and Close Buttons, Scroll Bars, Menus and Tool Bars; WINDOWS Explorer, Creating Folders, COPY and PASTE functions; MSWORD: Creating a Document, Saving and Editing; MSWORD, Use of options from Tool Bars, Format, Insert and Tools (Spelling & Grammar) Alignment of text; MSWORD, Creating a Table, Merging of Cells, Column and Row width; MSEXCEL: Creating a Spreadsheet, Alignment of rows, columns and cells using Format tool bar; MSEXCEL: Entering Expressions through the formula tool bar and use of inbuilt functions, SUM, AVERAGE, STDEV; MSEXCEL: Data Analysis using inbuilt Tool Packs, Correlation & Regression; MSEXCEL: Creating Graphs and Saving with & without data; MSACCESS: Creating Database, Structuring with different types of fields; MS Power Point: Preparation of slides on Power Point; Transforming the data of WORD, EXCEL and ACCESS to other formats; Internet Browsing: Browsing a Web Page and Creating of E-Mail ID

## 12. ANIMAL PRODUCTION

### 1. Livestock Production and Management

3(2+1)

Place of livestock in the national economy, different livestock development programmes of Govt. of India. Important exotic and Indian breeds of cattle, buffalo, sheep, goat and swine. Measures and factors affecting fertility in livestock, reproductive behaviour like oestrus, parturition, farrowing etc. Milk secretion, milking of animals and factors affecting milk yield and composition. Selection and breeding of livestock for higher milk and meat production. Feeding and management of calves, growing heifers and milch animals and other classes and types of animals, housing principles, space requirements for different species of livestock. Disease control measures, sanitation and care, breeding, feeding and production records. Breed characteristics of poultry, their methods of rearing, breeding, feeding and management, incubation, hatching and brooding, vaccination and prevention of diseases, preservation and

marketing of eggs, its economics and keeping quality. Cost of production of milk, economical units of cattle, buffalo, sheep, goat and swine.

**Practical:** Identification, handling and restraining of animals; Judging and culling; Feeding and ration formulation; Hatching, housing and management of poultry; Visit to livestock farms and Economics of livestock production.

### 13. NON CREDIT COURSES

#### 1. Comprehension and Communication Skills in English

2(1+1)

**Comprehension:** Text for comprehension, Current English for Colleges, By N.Krishnaswamy & T.Sriraman, Macmillan India Limited, Madras, 1995; War Minus shooting – The sporting spirit George Orwell (a) Reading Comprehension (b) Vocabulary – Synonyms – Antonyms – Often confused words and (c) Two exercises to help the students in the enrichment of vocabulary based on TOEFL and GRE and other competitive examinations. A Dilemma – A layman looks at science Raymond B. Fosdick (a) Reading Comprehension (b) Vocabulary – Homonyms and Homophones (c) Exercises on Figurative Language & Idiomatic Language (E.g.: dust and ashes, doorstep of doom, boundaries of knowledge, Apple of one's eye, in a fix etc). 5&6 You and Your English – Spoken English and Broken English G.B.Shaw (a) Reading Comprehension (b) Language study, Functional Grammar, Agreement of verb with subject. **Written Skills:** Mechanics of good letter, Effective business correspondence, Personal Correspondence. Preparation of Curriculum vitae and Job applications. The Style, Importance of professional writing –Choice of words and Phrases, precision, conciseness clichés, redundancy, jargon, foreign words. **Precis writing and synopsis writing.** Interviews, Types of interviews, purpose, different settings, as interviewer, interviewee, physical makeup and manners, appearance, poise, speech, self reliance, Evaluation process. Review or feedback.

**Practical:** Listening Comprehension: Listening to short talks, lectures, speeches (scientific, commercial and general in nature) **Practical:** listening to at least two tape, recorded conversations aimed at testing the listening comprehension of students; **Communication:** Spoken English, oral communication, importance stress and intonation. **Practical:** Spoken English practice by using audiovisual aids, the essentials of good conversations, oral exercises in conversation practice (At the Doctor, at the Restaurant, at the Market Yard); **Oral Presentation of Reports:** Seminars and conferences, features of oral presentation, regulating speech, physical appearance, body language posture, eye contact, voice, audience, preparation of visual aids. **Practical:** One presentation by individual on the given topic related to agriculture like W.T.O, Developing new technologies in Agriculture, Bio fertilizers etc.; **Evaluation of a Presentation:** evaluation sheet, other strategies to be considered for evaluating a presentation, **Practical:** Mock evaluation of a presentation; **Dyadic communication,** face to face conversation, Telephonic conversation, rate of speech, clarity of voice, speaking and listening politeness, telephone etiquette, **Practical:** Practice of Telephonic conversation; **Reading skills,** using Dictionary, reading dialogues, rapid reading, intensive reading, improving reading skills; **Meetings:** purpose, procedure participation, chairmanship, physical arrangements, recording minutes of meeting; **Practice of Presentation by using power point and LCD projector;** **Conducting Mock interviews –** testing initiative, team spirit, leadership, intellectual ability – potential for development, memory, motivation, objectives, aptitude etc., **Group Discussions and Debates on current topics;** Review or Feed Back; **Practical examination.**

## 2. NSS/NCC / Physical Education

1(0+1)

NSS: Orientation of students in national problems, study of philosophy of NSS, fundamentals rights, directive principles of state policy, socio-economic structure of Indian society, population problems, brief of five year plan. Functional literacy, non-formal education of rural youth, eradication of social evils, awareness programmes, consumer awareness, highlights of consumer act. Environment enrichment and conservation, health, family welfare and nutrition. NCC: Introduction to NCC, defence services, system of NCC training, foot drill, sizing, forming up in three ranks, open and close order march, dressing, getting on parade, dismissing and falling out, saluting, marching, arms drill, shoulder arm, order arm, present arm, guard of honour, ceremonial drill, weapon training – rifle bayonet, light machine gun, sten machine carbine. Introduction and characteristic stripping, assembling and cleaning, loading, unloading and firing. Field craft, visual training, targets, judging distance, fire discipline and fire control orders, battle craft, field signals, description of ground, section formation, section battle drill, scouts and patrols, ambush, field engineering, map reading, conventional signs, grid systems, use of service protractor, prismatic compass and its use, self defence, general principles, precautions and training, attacks and counter attacks, marching and searching, first aid, hygiene and sanitation, civil defence, leadership and NCC song. Physical Education: Introduction to physical education. Posture, exercise for good posture, physical fitness exercises for agility, strength, coordination, endurance and speed. Rules regulations of important games, skill development in any one of the games, football, hockey, cricket, volleyball, badminton, throw ball, tennis. Participation in one of the indoor games, badminton, chess and table tennis. Rules and regulations of athletic events, participation in any one of the athletic events, long jump, high jump, triple jump, javelin throw, discuss throw, shot put, short and long distance running, Safety education, movement education, effective way of doing day-to-day activities. First-aid training, coaching for major games and indoor games. Asans and indigenous ways for physical fitness and curative exercises. Exercises and games for leisure time, use and experience.

Note: Warming up and conditioning exercises are compulsory before the commencement of each class.

**Syllabus**

**For**

**B.Sc. (Hons.) Horticulture**

# HORTICULTURE

## 1. FRUIT SCIENCE

### 1. Fundamentals of Horticulture

3(2+1)

Economic importance and classification of horticultural crops and their culture and nutritive value, area and production, exports and imports, fruit and vegetable zones of India and of different states, nursery management practices, soil and climate, vegetable gardens, nutrition and kitchen garden and other types of gardens – principles, planning and layout, management of orchards, planting systems and planting densities. Production and practices for fruit, vegetable and floriculture crops, nursery techniques and their management. Principles and methods of pruning and training of fruit crops, types and use of growth regulators in horticulture, water management, weed management, fertility management in horticultural crops, cropping systems, intercropping, multi-tier cropping, mulching, bearing habits, factors influencing the fruitfulness and unfruitfulness. Rejuvenation of old orchards, top working, frame working, principles of organic farming.

**Practical:** Features of orchard, planning and layout of orchard, tools and implements, layout of nutrition garden, preparation of nursery beds for sowing of vegetable seeds, digging of pits for fruit plants, planting systems, training and pruning of orchard trees, preparation of fertilizer mixtures and field application, preparation and application of growth regulators, layout of different irrigation systems, identification and management of nutritional disorder in fruits and vegetables, assessment of bearing habits, maturity standards, harvesting, grading, packaging and storage.

### 2. Plant Propagation and Nursery Management

2(1+1)

Propagation: Need and potentialities for plant multiplication, sexual and asexual methods of propagation, advantages and disadvantages. Seed dormancy (scarification & stratification) internal and external factors, nursery techniques, apomixes – mono-embryony, polyembryony, chimera & bud sport. Propagation Structures: Mist chamber, humidifiers, greenhouses, glasshouses, cold frames, hot beds, poly-houses, nursery (tools and implements), use of growth regulators in seed and vegetative propagation, methods and techniques of cutting, layering, grafting and budding physiological & bio chemical basis of rooting, factors influencing rooting of cuttings and layering, graft incompatibility. Anatomical studies of bud union, selection and maintenance of mother trees, collection of scion wood stick, scion-stock relationship, and their influences, bud wood certification, techniques of propagation through specialized organs, corm, runners, suckers. Micrografting, hardening of plants in nurseries. Nursery registration act. Insect/pest/disease control in nursery.

**Practical:** Media for propagation of plants in nursery beds, pot and mist chamber. Preparation of nursery beds and sowing of seeds. Raising of rootstock. Seed treatments for breaking dormancy and inducing vigorous seedling growth. Preparation of plant material for potting. Hardening plants in the nursery. Practicing different types of cuttings, layering, graftings and buddings including opacity and grafting, etc. Use of mist chamber in propagation and hardening of plants. Preparation of plant growth regulators for seed germination and vegetative propagation. Visit to a tissue culture laboratory. Digging, labeling and packing of fruit plants. Maintenance of nursery records. Use of different types of nursery tools and implements for general nursery and virus tested plant material in the nursery. Cost of establishment of a mist chamber, greenhouse, glasshouse, polyhouse and their

maintenance. Top grafting, bridge grafting and nursery management. Nutrient and plant protection applications during nursery.

### 3. Tropical and Sub-Tropical Fruits

3(2+1)

Horticultural classification of fruits including genome classification. Horticultural zones of India, detailed study of area, production and export potential, varieties, climate and soil requirements, propagation techniques, planting density and systems, after care, training and pruning. Management of water, nutrient and weeds, special horticultural techniques including plant growth regulators, their solution preparation and use in commercial orchards. Physiological disorders. Post-harvest technology, harvest indices, harvesting methods, grading, packaging and storage of the following crops. Mango, banana, bael, banana, grapes, citrus, papaya, sapota, guava, pineapple, jackfruit, avocado, mangosteen, litchi, carambola, durian and passion fruit. Bearing in mango and citrus, causes and control measures of special production problems, alternate and irregular bearing overcome, control measures. Seediness and kokkan disease in banana, citrus decline and casual factors and their management. Bud forecasting in grapes, sex expression and seed production in papaya, latex extraction and crude papain production, economic of production. Rainfed horticulture, importance and scope of arid and semi-arid zones of India. Characters and special adaptation of crops: ber, aonla, annona, jamun, wood apple, bael, pomegranate, carissa, date palm, phalsa, fig, west Indian cherry and tamarind.

**Practical:** Description and identification of varieties based on flower and fruit morphology in above crops. Training and pruning of grapes, mango, guava and citrus. Selection of site and planting system, pre-treatment of banana suckers, desuckering in banana, sex forms in papaya. Use of plastics in fruit production. Visit to commercial orchards and diagnosis of maladies. Manure and fertilizer application including bio-fertilizer in fruit crops, preparation and application of growth regulators in banana, grapes and mango. Seed production in papaya, latex extraction and preparation of crude papain. Ripening of fruits, grading and packaging, production economics for tropical and sub-tropical fruits. Mapping of arid and semi-arid zones of India. Botanical description and identification of ber, fig, jamun, pomegranate, carissa, phalsa, wood apple, West Indian cherry, tamarind, aonla, bael and annona.

### 4. Temperate Fruits

2(1+1)

Classification of temperate fruits, detailed study of areas, production, varieties, climate and soil requirements, propagation, planting density, cropping systems, after care training and pruning, self incompatibility and pollinisers, use of growth regulators, nutrient and weed management, harvesting, post-harvest handling and storage of apple, pear, peach, apricot, cherry, persimmon, strawberry, kiwi, Queens land nut (*Mecademia* nut), almond, walnut, pecan nut, hazel nut and chest nut. Re-plant problem, rejuvenation and special production problems like pre-mature leaf fall, physiological disorders, important insect – pests and diseases and their control measures.

**Practical:** Nursery management practices, description and identification of varieties of above crops, manuring and fertilization, planting systems, preparation and use of growth regulators, training and pruning in apple, pear, plum, peach and nut crops. Visit to private orchards to diagnose maladies. Working out economics for apple, pear, plum and peach.

## 5. Orchard Management

2(1+1)

Orchard management, importance, objectives, merits and demerits, clean cultivation, sod culture, Sod mulch, herbicides and inorganic and organic mulches. Tropical, sub-tropical and temperate horticultural systems, competitive and complimentary effect of root and shoot systems. Biological efficiency of cropping systems in horticulture, systems of irrigation. Soil management in relation to nutrient and water uptake and their effect on soil environment, moisture, organisms and soil properties. Integrated nutrient and pest management. Utilization of resources constraints in existing systems. Crop model and crop regulation in relation to cropping systems.

**Practical:** Layout of different systems of orchard soil management, clean, inter, cover and mixed cropping, fillers. Use of mulch materials, organic and inorganic, moisture conservation, weed control. Layout of various irrigation systems.

## 6. Plantation Crops

3(2+1)

History and development, scope and importance, area and production, export and import potential, role in national and state economy, uses, industrial importance, by products utilization, soil and climate, varieties, propagation: principles and practices of seed, vegetative and micro-propagation, planting systems and method, gap filling, systems of cultivation, mulching, shade regulation, weed and water management, training, pruning and handling, nutrition, foliar feeding, role of growth regulators, soil management, liming practices, tipping practices, top working, physiological disorders, harvesting, post-harvest handling and processing, packaging and marketing, yield and economics of coconut, arecanut, oil palm, palmyrah palm, cacao, cashew nut, coffee, tea and rubber.

**Practical:** Description and identification of coconut varieties, selection of coconut and arecanut mother palm and seed nut, planting of seed nuts in nursery, layout and planting of coconut, arecanut, oil palm, cashew nut, cacao gardens, manuring, irrigation; mulching, raising masonry nursery for palm, nursery management in cacao. Description and identification of species and varieties in coffee, harvesting, grading, pulping, fermenting, washing, drying and packing of coffee, seed berry collection, seed extraction, treatment and sowing of coffee, epicotyl, softwood, grafting and top working in cashew, working out the economics and project preparation for coconut, arecanut, oil palm, cashew nut, cacao, etc. Mother plant selection, preparation of cuttings and rooting of tea under specialized structure, training, centering, pruning, tipping and harvesting of tea.

## 7. Weed Management in Horticultural Crops

2 (1+1)

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

**Practical:** Identification of weeds; Survey of weeds in crop fields and other habitats; Preparation of herbarium of weeds; Calculations on weed control efficiency and weed index;

Herbicide label information; Computation of herbicide doses; Study of herbicide application equipment and calibration; Demonstration of methods of herbicide application; Preparation of list of commonly available herbicides; Study of phytotoxicity symptoms of herbicides in different crops; Biology of nut sedge, bermuda grass, parthenium and celosia; Economics of weed control practices; Tours and visits of problem areas.

### **8. Principles of Genetics and Cytogenetics**

**3 (2+1)**

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

**Practical:** Study of fixatives and stains. Squash and smear techniques. Demonstrations of permanent slides and cell division, illustration in plant cells, pollen fertility and viability, determination of gametes, Solving problems of monohybrid, dihybrid, and test cross ratios using chi-square test, gene interactions, estimation of linkages using three point test cross from F<sub>2</sub> data and construction of linkage maps. Genetics variation in man.

### **9. Principles of Plant Breeding**

**3 (2+1)**

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

**Practical:** Breeding objectives and techniques in major field crop plants. Floral biology – its measurement, emasculation, crossing and selfing techniques in major crops. Determination of mode of reproduction in crop plants, handling of breeding material and maintenance of experimental records in self and cross pollinated crops. Demonstration of hybrid variation and production techniques.

### **10. Breeding of Fruit and Plantation Crops**

**3 (2+1)**

Fruit breeding - History, importance in fruit production, distribution, domestication and adaptation of commercially important fruits, variability for economic traits, breeding strategies, clonal selection, bud mutations, mutagenesis and its application in crop improvement – policy manipulations – *in vitro* breeding tools (important fruit and plantation crops).

**Practical:** Exercises on floral biology, pollen viability; emasculation and pollination procedures; hybrid seed germination; raising and evaluation of segregating populations; use of mutagens to induce mutations and polyploidy.

## 2. VEGETABLE CROPS

### 1. Tropical and Sub-Tropical Vegetables

3(2+1)

Area, production, economic importance and export potential of tropical and sub-tropical vegetable crops. Description of varieties and hybrid, climate and soil requirements, seed rate, preparation of field, nursery practices; transplanting of vegetable crops and planting for directly sown/transplanted vegetable crops. Spacing, planting systems, water and weed management; nutrient management and deficiencies, use of chemicals and growth regulators. Cropping systems, harvest, yield and seed production. Economics of cultivation of tropical and sub-tropical vegetable crops; post-harvest handling and storage. Marketing of tomato, brinjal, chillies, okra, amaranthus, cluster beans, cowpea, lab-lab, snap bean, cucurbits, moringa, curry leaf, portulaca and basella.

**Practical:** Identification and description of tropical and sub-tropical vegetable crops; nursery practices and transplanting, preparation of field and sowing/planting for direct sown and planted vegetable crops. Herbicide use in vegetable culture; top dressing of fertilizers and intercultural; use of growth regulators; identification of nutrient deficiencies. Physiological disorder. Harvest indices and maturity standards, post-harvest handling and storage, marketing, seed extraction (cost of cultivation for tropical and sub-tropical vegetable crops), project preparation for commercial cultivation.

### 2. Spices and Condiments

2(1+1)

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

**Practical:** Identification of varieties: propagation, seed treatment – sowing; layout, planting; hoeing and earthing up; manuring and use of weedicides, training and pruning; fixing maturity standards, harvesting, curing, processing, grading and extraction of essential oils and oleoresins. Visit to commercial plantations.

### 3. Breeding of Vegetable, Tuber and Spice Crops

3(2+1)

Centres of origin, plant bio-diversity and its conservation. Models of reproduction, pollination systems and genetics of important vegetable, tuber and spice crops. Self-incompatibility and male sterility, its classification and application in crop improvement. Principles of breeding self-pollinated crops, pure line selection, mass selection, heterosis breeding, hybridization, pedigree method, mass pedigree method, bulk method, modified bulk method, single seed descent method and back cross method. Polyploidy breeding.

Mutation breeding. Principles of breeding cross pollinated crops, mass selection, recurrent selection, heterosis breeding, synthetics and composites. Application of biotechnology in crop improvement. Crops: Solanaceous vegetables, cole crops, cucurbits, bulb crops, root crops, leafy vegetables, okra, leguminous crops.

**Practical:** Floral biology and pollination mechanism in self and cross pollinated vegetables, tuber crops and spices. Working out phenotypic and genotypic heritability, genetic advance. Preparation and uses of chemical and physical mutagens. Polyploidy breeding and chromosomal studies. Techniques of F1 hybrid seed production. Maintenance of breeding records.

#### **4. Seed Production of Vegetable, Tuber and Spice Crops** **3(2+1)**

Introduction and history of seed industry in India. Definition of seed. Differences between grain and seed. Importance and scope of vegetable seed production in India. Principles of vegetable seed production. Role of temperature, humidity and light in vegetable seed production. Methods of seed production of cole crops, root vegetables, solanaceous vegetables, cucurbits, leafy vegetables, bulb crops, leguminous vegetables and exotic vegetables. Seed germination and purity analysis. Field and seed standards. Seed drying and extraction. Seed legislation.

**Practical:** Study of seed structure, colour size, shape and texture. Field inspection of seed crops. Practices in rouging. Harvesting and seed extraction. Germination and purity analysis. Methods of seed production in cole crops, root vegetables, bulb crops, solanaceous vegetables, cucurbits, leafy vegetables, leguminous vegetables and exotic vegetables. Seed processing machines. Visit to seed production units.

#### **5. Temperate Vegetables** **2(1+1)**

Importance of cool season vegetable crops in nutrition and national economy. Area, production, export potential, description of varieties and hybrids, origin, climate and soil, production technologies, seed production, post-harvest technology. Marketing of cabbage, cauliflower, knol-khol, sprouting broccoli, Brussels' sprout, lettuce, palak, Chinese cabbage, spinach, garlic, onion, leek, radish, carrot, turnip, beet root, peas, broad beans, rhubarb, asparagus, globe artichoke.

**Practical:** Identification and description of varieties/hybrids; propagation methods, nursery management; preparation of field, sowing/transplanting; identification of physiological and nutritional disorders and their corrections; post-harvest handling; cost of cultivation and field visits to commercial farms.

#### **6. Potato and Tuber Crops** **2(1+1)**

Origin, area, production, economic importance and export potential of potato and tropical, sub-tropical and temperate tuber crops; description of varieties and hybrids. Climate and soil requirement, season; seed rate; preparation of field; planting practices; spacing; water, nutrient and weed management; nutrient deficiencies. Use of chemicals and growth regulators; cropping systems. Harvesting practices, yield; seed production, economic of cultivation. Post-harvest handling and storage, field and seed standards, marketing. Crops to be covered – potato, tapioca, sweet potato, arrow root, cassava, colocasia, xanthosoma, amorphophallus, dioscorea, Jerusalem artichoke, horse radish and other under exploited tuber crops.

**Practical:** Identification and description of potato and tropical, sub-tropical and temperate tuber crops; planting systems and practices; field preparation and sowing/planting. Top dressing of fertilizers and interculture and use of herbicides and growth regulators; identification of nutrient deficiencies, physiological disorders; harvest indices and maturity standards, post-harvest handling and storage, marketing. Seed collection, working out cost of cultivation, project preparation of commercial cultivation.

### 3. POST-HARVEST TECHNOLOGY

#### 1. Post Harvest Management Of Horticultural Crops

3 (2+1)

Importance of post-harvest technology in horticultural crops. Maturity indices, harvesting, handling, grading of fruits, vegetables, cut flowers, plantation crops, medicinal and aromatic plants. Pre-harvest factors affecting quality, factors responsible for deterioration of horticultural produce, physiological and bio-chemical changes, hardening and delaying ripening process. Post-harvest treatments of horticultural crops. Quality parameters and specification. Structure of fruits, vegetables and cut flowers related to physiological changes after harvest. Methods of storage for local market and export. Pre-harvest treatment and pre-cooling, pre-storage treatments. Different systems of storage, packaging methods and types of packages, recent advances in packaging. Types of containers and cushioning materials, vacuum packaging, cold storage, poly shrink packaging, grape guard packing treatments. Modes of transport.

**Practical:** Practice in judging the maturity of various horticultural produce, determination of physiological loss in weight and quality. Grading of horticultural produce, post-harvest treatment of horticultural crops, physical and chemical methods. Packaging studies in fruits, vegetables, plantation crops and cut flowers by using different packaging materials, methods of storage, post-harvest disorders in horticultural produce. Identification of storage pests and diseases in spices. Visit to markets, packaging houses and cold storage units.

#### 2. Processing of Horticultural Crops

3 (1+2)

Importance and scope of fruit and vegetable preservation industry in India, food pipe line, losses in post-harvest operations, unit operations in food processing. Principles and guidelines for the location of processing units. Principles and methods of preservation by heat pasteurization, canning, bottling. Methods of preparation of juices, squashes, syrups, cordials and fermented beverages. Jam, jelly and marmalade. Preservation by sugar and chemicals, candies, crystallized fruits, preserves chemical preservatives, preservation with salt and vinegar, pickling, chutneys and sauces, tomato and mushrooms, freezing preservation. Processing of plantation crops, products, spoilage in processed foods, quality control of processed products, Govt. policy on import and export of processed fruits. Food laws.

**Practical:** Equipment used in food processing units. Physico-chemical analysis of fruits and vegetables. Canning of fruits and vegetables, preparation of squash, RTS, cordial, syrup, jam, jelly, marmalade, candies, preserves, chutneys, sauces, pickles (hot and sweet). Dehydration of fruits and vegetables – tomato product dehydration, refrigeration and freezing, cut out analysis of processed foods. Processing of plantation crops. Visit to processing units.

### 3. Fundamentals of Food Technology

2 (1+1)

Food and its function, physico-chemical properties of foods, food preparation techniques, nutrition, relation of nutrition of good health. Characteristics of well and malnourished population. Energy, definition, determination of energy requirements, food energy, total energy needs of the body. Carbohydrates: classification, properties, functions, source, requirements, digestion, absorption and utilization. Protein, classification, properties, functions, sources, requirements, digestion, absorption, essential and non-essential amino acids, quality of proteins, PER/NPR/NPU, supplementary value of proteins and deficiency. Lipids – classification, properties, functions, sources, requirements, digestion, absorption and utilization, saturated and unsaturated fatty acids, deficiency, rancidity, refining of fats. Mineral nutrition: macro and micro-minerals (Ca, Fe and P), function, utilization, requirements, sources, effects of deficiency. Vitamins: functions, sources, effects of deficiency, requirements of water soluble and fat-soluble vitamins. Balanced diet: recommended dietary allowances for various age groups, assessment of nutritional status of the population.

**Practical:** Methods of measuring food ingredients, effect of cooking on volume and weight, determination of percentage of edible portion. Browning reactions of fruits and vegetables. Microscopic examination of starches, estimation of energy, value proteins and fats of foods. Planning diet for various age groups.

## 4. FLORICULTURE & LANDSCAPING

### 1. Ornamental Horticulture

3 (2+1)

History, scope of gardening, aesthetic values. Gardens in India, types of gardens. Landscaping, historical background, definition. Floriculture industry: importance, area and production, industrial importance in India. Landscaping, basic principles and basic components. Principles of gardening, garden components, adornments, lawn making, methods of designing rockery, water garden, etc. Special types of gardens, their walk-paths, bridges, constructed features. Greenhouse. Special types of gardens, trees, their design, values in landscaping, propagation, planting shrubs and herbaceous perennials. Importance, design values, propagation, plating, climbers and creepers, palms, ferns, grasses and cacti succulents. Flower arrangement: importance, production details and cultural operations, constraints, post-harvest practices. Bio-aesthetic planning, definition, need, round country planning, urban planning and planting avenues, schools, villages, beautifying railway stations, dam sites, hydroelectric stations, colonies, river banks, planting material for play grounds. Vertical gardens, roof gardens. Culture of bonsai, art of making bonsai. Parks and public gardens.

**Practical:** Identification and description of annuals, herbaceous, perennials, climbers, creepers, foliage flowering shrubs, trees, palms, ferns, ornamental grasses; cacti succulents. Planning and designing gardens, layout of location of components of garden study, functional uses of plants in the landscape. Planning design of house garden, roadside planting, avenues for new colonies, traffic islands, preparation of land for lawn and planting. Description and design of garden structures, layout of rockery, water garden, terrace garden, and Japanese gardens, recreational and children's corner. Layout of terrarium, traffic islands, bottle garden, dish garden. Flower arrangement, bonsai practicing and training. Visit to nearby gardens. Identification and description of species/varieties of jasmine, chrysanthemum, marigold, dahlia, gladiolus, carnation, aster and their important inter-culture practices

## **2. Breeding and Seed Production of Ornamental Crops**

**3(2+1)**

History of improvements of ornamental plants, objectives and techniques in ornamental plant breeding. Introduction, selection, hybridization, mutation and biotechnological technique for improvement of ornamental plants. Breeding for disease resistance. Development of promising cultivars of important ornamentals. Role of heterosis and its exploitation, production of F1 hybrids and utilization of male sterility, production of open pollinated seed. Harvesting processing and storage of seeds, seed certification.

**Practical:** Study of floral biology and pollination in important species and cultivars. Techniques of inducing polyploidy and mutation. Production of pure and hybrid seeds. Harvesting, conditioning and testing of seeds. Practice in seed production methods

## **3. Principles of Landscape Gardening**

**1 (0+1)**

**Practical:** Principles and elements of landscape design, plant material for landscaping, symbols, tools and implements used in landscape design, layout of formal gardens, informal gardens, special type of gardens (bog garden, sunken garden, terrace garden, rock garden) and designing of conservatory and lathe house. Landscape design for specific areas.

## **4. Commercial Floriculture**

**3(2+1)**

Scope and importance of commercial floriculture in India, production techniques of ornamental plants like rose, marigold, chrysanthemum, orchid, carnation, gladiolus, jasmine, dahlia, tuberose, bird of paradise, china aster and gerbera for domestic and export market, growing of flowers under protected environments such as glass house, plastic house etc., post harvest technology of cut flowers in respect of commercial flower crops, dehydration technique for drying of flowers, production techniques for bulbous.

**Practical:** Identification of commercially important floricultural crops. Propagation practices in chrysanthemum, sowing of seeds and raising of seedlings of annuals. Propagation by cutting, layering, budding and grafting. Training and pruning of roses. Use of chemicals and other compounds for prolonging the vase life of cut flowers. Drying and preservation of flowers. Flower arrangement practices

## **5. PLANT PROTECTION (PLANT PATHOLOGY, ENTOMOLOGY AND NEMATOTOLOGY)**

### **1. Fundamentals of Plant Pathology**

**3 (2+1)**

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

**Practical:** Familiarity with general plant pathological laboratory and field equipments. Study of disease symptoms and signs and host parasite relationship. Identification and isolation of plant pathogens. Koch's postulates. Preparation of fungicidal solutions, slurries, pastes and their applications.

## 2. Mushroom Culture

1(0+1)

Introduction to mushrooms fungi – nutritional value, edible and poisonous types, edible mushrooms, *Pleurotus*, *Volvariella* and *Agaricus*, medicinal value of mushrooms, genetic improvement of mushroom, preparation of culture, mother spawn production, multiplication of spawn, cultivation techniques, harvesting, packing and storage; problems in cultivation – diseases, pest and nematodes – weed moulds and their management strategies. Economics of cultivation, post harvest technologies.

Equipment and sterilization techniques for culture media, isolation of mother culture, and spawn preparation and maintenance of mushroom beds of oyster mushroom, *Volvariella* and *Agaricus*. Processing and preservations of mushrooms, economics of spawn and mushroom production and mushroom recipes

## 3. Diseases of Fruits, Plantation and Medicinal and Aromatic Crops

3 (2+1)

Etiology, symptoms, mode of spread, epidemiology and integrated management of the diseases of fruits, plantation, medicinal and aromatic crops viz mango, banana, grape, citrus, guava, sapota, papaya, jack fruit, pineapple, pomegranate, ber, apple, pear, peach, plum, almond, walnut, strawberry, areca nut, coconut, oil palm, coffee, tea, cocoa, cashew, rubber, betel vine senna, neem, hemp, belladonna, pyrethrum, camphor, costus, crotalaria, datura, dioscorea, mint, opium, *Solanum khasianum* and Tephrosia. Important post-harvest diseases of fruit, plantation and medicinal and aromatic crops and their management.

**Practical:** Observations of disease symptoms, identification of casual organisms and host parasite relationship of important diseases. Examination of scrapings and cultures of important pathogens of fruits, plantation, medicinal and aromatic crops.

## 4. Diseases of Vegetable, Ornamental and Spice Crops

3 (2+1)

Etiology, symptoms, mode of spread, epidemiology and integrated management of diseases of the following vegetables, ornamental and spice crops: tomato, brinjal, chilli, bhindi, cabbage, cauliflower, radish, knol-khol, pea, beans, beet root, onion, garlic, fenugreek, ginger, potato, turmeric, pepper, cumin, cardamom, nutmeg, coriander, clove, cinnamon, jasmine, rose, crossandra, tuberose, geranium. Important post-harvest diseases of vegetables and ornamental crops and their management.

**Practical:** Observations of symptoms, causal organisms and host parasitic relationship of important diseases, examination of cultures of important pathogens of vegetables, ornamental and spice crops.

## 5. Fundamentals of Entomology

3 (2+1)

Introduction to phylum arthropoda. Importance of class Insecta. Insect dominance. Definition, division and scope of entomology. Comparative account of external morphonology-types of mouth parts, antennae, legs, wings and genetallia. Anatomy of digestive, excretory, nervous and reproductive systems. Postembryonic development-eclosion. Matamorphosis. Types of larvae and pupa. Classification of insects upto orders and families of economic importance and their distinguished characters.

**Practical:** Insect collection and preservation. Identification of important insects. General body organization of insects. Study on morphology of grasshopper. Preparation of permanent

mounts of mouth parts, antennae, legs and wings. Dissection of grasshopper and caterpillar for study of internal morphology. Observations on metamorphosis of larvae and pupae.

## **6. Nematode Pests of Horticultural Crops and their Management** **2 (1+1)**

History of development of nematology - definition, economic importance. General characters of plant parasitic nematodes, their morphology, taxonomy, classification, biology, symptomatology and control of important plant parasitic nematodes of fruits – (tropical, sub-tropical and temperate) vegetables, tuber, ornamental, spice and plantation crops. Role of nematodes in plant disease complex.

**Practical:** Methods of sampling and extraction of nematodes from soil and plant parts, killing, fixing and preparation of temporary and permanent nematode mounts. Nematicides and their use. Collection and preservation of 20 plant species/parts damaged by plant parasitic nematodes.

## **7. Insect Pests of Fruit, Plantation, Medicinal and Aromatic Crops** **3(2+1)**

General – economic classification of insects; ecology and insect-pest management with reference to fruit, plantation, medicinal and aromatic crops; pest surveillance. Distribution, host range, bio-ecology, injury, integrated management of important insect pests affecting tropical, sub-tropical and temperate fruits, plantation, medicinal and aromatic crops like coconut, areca nut, oil palm, cashew, cacao, tea, coffee, cinchona, rubber, betel vine senna, neem, hemp, belladonna, pyrethrum, camphor, costus, crotalaria, datura, dioscorea, mint, opium, *Solanum khasianum* and Tephrosia.. Storage insects – distribution, host range, bio-ecology, injury, integrated management of important insect pests attacking stored fruits, plantation, medicinal and aromatic crops and their processed products. Toxicology – insecticide residue problems in fruit, plantation, medicinal and aromatic crops and their tolerance limits.

**Practical:** Study of symptoms of damage, collection, identification, preservation, assessment of damage and population of important insect – pests affecting fruits, plantation, medicinal and aromatic crops in field and storage

## **8. Apiculture** **1(0+1)**

**Practical:** Importance and history of apiculture, different species of bees, morphology, anatomy, colony organization and life cycle, bee-keeping equipment, social behaviour, reproduction, queen rearing, bee pasturage, seasonal management, economics of bee-keeping. Bee enemies, diseases of bees, role of bees in increasing the productivity of horticultural crops in India economy, bee products and their uses. Recent trends in apiculture. Acquaintance with honey bee species, morphology, structural adaptation, biology-castes-bee-keeping equipment, bee forage plants. Collection and preservation of bee flora, enemies and diseases of bees. Handling of bee colonies and manipulation for honey production.

## **9. Insect Pests of Vegetable, Ornamental and Spice Crops** **3 (2+1)**

Economic importance of insects in vegetable, ornamental and spice crops -ecology and pest management with reference to these crops. Pest surveillance in important vegetable, ornamental and spice crops. Distribution, host range, bio-ecology, injury, integrated management of important insect-pests affecting vegetable, ornamental and spice crops.

Important storage insect-pests of vegetable, ornamental and spice crops, their host range, bio-ecology, injury and integrated management. Insect –pests of processed vegetables and ornamental crops, their host range, bio-ecology, injury and integrated management. Insecticidal residue problems in vegetables and ornamental crops, tolerance limits etc.

**Practical:** Study of symptoms, damage, collection, identification, preservation, assessment of damage/population of important insect-pests affecting vegetable, ornamental and spice crops in field and during storage.

## 6. NATURAL RESOURCE MANAGEMENT

### 1. Fundamentals of Soil Science

2(1+1)

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

**Practical:** Collection and preparation of soil samples, estimation of moisture, EC, pH and bulk density. Textural analysis of soil by Robinson's pipette method, chemical analysis of soil –  $\text{Fe}_2\text{O}_3$ , P, K, Ca, Mg and S, total N, organic carbon and cation exchange capacity.

### 2. Soil Fertility and Nutrient Management

2 (1+1)

Introduction to soil fertility and productivity- factors affecting. Essential plant nutrient elements- functions, deficiency systems, transformations and availability. Acid, calcareous and salt affected soils –characteristics and management. Role of microorganisms in organic matter- decomposition – humus formation. Importance of C:N ratio and pH in plant nutrition. Integrated plant nutrient management. Soil fertility evaluation methods, critical limits of plant nutrient elements and hunger signs. NPK fertilizers: composition and application methodology, luxury consumption, nutrient interactions, deficiency symptoms, visual diagnosis.

**Practical:** Analysis of soil for organic matter, available N,P,K and Micronutrients and interpretations. Gypsum requirement of saline and alkali soils. Lime requirement of acid soils.

### **3. Environmental Science**

**3 (2+1)**

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

**Practical:** Visit to local areas - river/forest/ grassland/catchment etc. to document components of ecosystem. Study of common plants, insects, birds and animals. Visit to industries to study pollution abatement techniques.

### **4. Soil and Plant Analysis**

**2 (1+1)**

Methods of soil and plant sampling and processing for analysis. Quantification of minerals and their abundance. Soil structure and aggregate analysis. Theories and concepts of soil moisture estimation – gravimetric, tensiometric, gypsum block, neutron probe and pressure methods. Characterization of hydraulic mobility – diffusion and mass flow. Renewal of gases in soil and their abundance. Methods of estimation of oxygen diffusion rate and redox potential. Soil fertility evaluation methods. Use of radio tracer techniques in soil fertility evaluation. Soil micro-organisms and their importance. Saline, alkali, acid, waterlogged and sandy soils, their appraisal and management. Chemical and mineral composition of horticultural crops. Leaf analysis standards, index tissue, interpretation of leaf analysis values. Principles of working of pH meter, electrical conductivity meter, spectrophotometer, flame photometer and atomic absorption spectrophotometer. Quality of irrigation water.

**Practical:** Collection and preparation of soil and plant samples for analysis. Determination of water holding capacity and hydraulic conductivity of soil. Estimation of moisture content in soils and plants. Determination of pH, electrical conductivity, sodium adsorption ratio and exchangeable sodium percentage of soils. Enumeration of soil microbes. Estimation of available macro and micronutrient elements in soils and their contents in plants. Irrigation water quality analysis.

### **5. Farm Power and Machinery**

**2 (1+1)**

Basic concepts of various forms of energy, unit and dimensions of force, energy and power, calculations with realistic examples. IC Engines: Basic principles of operation of compression, ignition and spark ignition engines, two stroke and four stroke engines, cooling and lubrication system, power transmission system, broad understanding of performance and efficiency, tractors, power tillers and their types and uses. Electric motors: types,

construction and performance comparison. Tillage: objectives, method of ploughing. Primary tillage implements: construction and function of indigenous ploughs, improved indigenous ploughs, mould board ploughs, disc and rotary ploughs. Secondary tillage implements: construction and function of tillers, harrows, levelers, ridgers and bund formers. Sowing and transplanting equipment: seed drills, potato planters, seedling transplanter. Grafting, pruning and training tools and equipment. Inter-culture equipment: sweep. Junior hoe, weeders, long handle weeders. Crop harvesting equipments: potato diggers, fruit pluckers, tapioca puller and hoists.

**Practical:** Calculation on force, power and energy. IC engines – showing the components of dismantled engines and motors. Primary and secondary tillage implements, hitching, adjustments and operations. Spraying equipment, calibration and operation. Plant protection equipment, calculation of dilution ratio and operation.

## **6. Water Management in Horticultural Crops**

**2(1+1)**

Importance of water, water resources in India. Area of different crops under irrigation, function of water for plant growth, effect of moisture stress on crop growth. Available and unavailable soil moisture – distribution of soil moisture – water budgeting – rooting characteristics – moisture extraction pattern. Water requirement of horticultural crops – lysimeter studies – Plant water potential climatological approach – use of pan evaporimeter – factor for crop growth stages – critical stages of crop growth for irrigation. Irrigation scheduling – different approaches – methods of irrigation – surface and sub-surface pressurized methods viz., sprinkler and drip irrigation, their suitability, merits and limitations, fertigation, economic use of irrigation water. Water management problem, soils quality of irrigation water, irrigation management practices for different soils and crops. Layout of different irrigation systems, drip, sprinkler. Layout of underground pipeline system.

**Practical:** Measurements of irrigation water by using water measuring devices, use of common formula in irrigation practices, practicing of land leveling and land shaping implements, layout for different methods of irrigation. Estimation of soil moisture constants and soil moisture by using different, methods and instruments, scheduling of irrigation, different approaches, practicing use of instruments, estimation of irrigation efficiency and water requirements of horticultural crops, irrigation planning and scheduling, soil moisture conservation practices.

## **7. Organic Farming**

**2(1+1)**

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

**Practical:** Raising of vegetable crops organically through nutrient, diseases and pest management; vermicomposting; vegetable and ornamental nursery raising; macro quality analysis, grading, packaging, post harvest management.

## 7. BASIC SCIENCES

### 1. Elementary Statistics and Computer Application

3(2+ 1)

Basic concepts: Variable statistics, types and sources of data, classification and tabulation of data, construction of frequency distribution, tables, graphic representation of data, simple, multiple component and percentage, bar diagram, pie diagram, histogram, frequency polygon and frequency curve average and measures of location, mean, mode, median, geometric mean, harmonic mean, percentiles and 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, poison 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 – split plot design, strip plot design, long term experiments, plot size, guard rows. 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.

**Practical:** Construction of frequency distribution table and its graphical representation, histogram, frequency polygon, frequency curve, bar chart, simple, multiple, component and percentage bar charts, pie chart, mean, mode for row and grouped data, percentiles, quadrille, and median for row and grouped data, coefficient of variation, ‘t’ test for independent, will equal and unequal variants, paired ‘t’ test, chi-square test for contingency tables and theoretical ratios, correlation and linear regression. Studies on computer components – BASIC language, VISUAL BASIC, programming techniques, MS Office, Excel, Power Point.

### 2. Elementary Plant Biochemistry and Biotechnology

3(2+1)

Carbohydrates: Occurrence classification and structure, physical and chemical properties of carbohydrates, isomerism, optical activity, reducing property, reaction with acids and alkalis, ozone formation. Lipids: Classification, important fatty acids and triglycerides, essential fatty acids. Physical and chemical control of oils, their rancidity, phospholipids, types and importance. Plant pigments – structure and function of chlorophyll and carotenoids, sterols, basic structure, role of brassinosterols in plants. Proteins: Classification, function and solubility, amino acids – classification and structure, essential amino acids, properties of amino acids, colour reactions, amphoteric nature and isomerism; structure of proteins – primary, secondary tertiary and quaternary properties and reaction of proteins. Enzymes: Classification and mechanism of action; factors affecting enzyme action, co-factors and co-enzymes. Vitamins and minerals as co-enzymes/co-factors. Carbohydrate metabolism – glycolysis and TCA-cycle; metabolism of lipids, fatty acid oxidation, biosynthesis of fatty acids, electron transport chain, bioenergetics of glucose and fatty acids, structure and function of nucleic acid replication, transcription and translation. History of biotechnology. Fundamental principles, micro-propagation and scope for commercialization. Application of

micro-grafting in horticultural crops, meristem culture, anther culture, pollen culture, embryo culture, callus culture, cell culture, somoclonal variation, protoplast isolation, culture, fusion and applications. Cryopreservation .Genetic engineering. Future scope and present trends. Importance of biotechnology in horticulture

**Practical:** Preparation of standard solutions and reagents. Carbohydrates – qualitative reaction, estimation of starch, reducing and non-reducing sugars; reaction of proteins, estimation of proteins by Lowery method. Estimation of free fatty acids; determination of iodine number of vegetable oils. Vitamins – estimation of ascorbic acid. Paper and thin layer chromatography. Sterilization techniques – composition and preparation of media – micro-propagation of tomato. Callus culture, sub-culturing, induction of rooting-techniques in hardening

### **3. Introductory Crop Physiology**

**2(1+1)**

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

**Practical:** Measurement of water potential, osmosis, root pressure, structure of the stomata, distribution, opening and closing of the stomata, measurement, transpiration and calculation of transpirational pull demonstration. Importance of light and chlorophyll in photosynthesis, pigment identification in horticultural crops and studying the enzyme activity of catalase, estimation of phenols, studying plant movements, root initiation in cuttings.

### **4. Introductory Economics**

**2(2+0)**

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

## 5. Horti- Business Management

2 (2+0)

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

## 6. Fundamentals of Extension Education

2(1+1)

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

**Practical:** Visits to study structure, functions, linkages and extension programmes of ICFRE institutes/voluntary organizations/Mahila Mandal, Village Panchayat, State Deptt. of Forests/All India Radio (AIR). Exercises on distortion of message, script writing for farm broadcasts and telecasts, planning, preparation & use of NPVA like poster, chart, flash cards, folders etc. and AVA like OHP & 35 mm slide projector transparencies. Identification of local leaders to study their role in extension work. Evaluation of some selected case studies of forestry extension programmes. Preparation of Village Agricultural productions plan.

## 7. Entrepreneurship Development and Communication Skills

2 (1+1)

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. Globalisation 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 horticulture sector. Venture capital. Contract farming and joint ventures, public-private partnerships. Overview of horti inputs industry. Characteristics of Indian horticultural 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.

**Practical:** 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.

## **8. Growth and Development of Horticultural Crops**

**2(1+1)**

Growth and development-definitions, components, photosynthetic productivity, leaf area index (LAI) - optimum LAI in horticultural crops, canopy development; different stages of growth, growth curves, growth analysis in horticultural crops. Plant bioregulators- auxin, gibberellin, cytokinin, ethylene inhibitors and retardants, basic functions, biosynthesis, role in crop growth and development, propagation, flowering, fruit setting, fruit thinning, fruit development, fruit drop, and fruit ripening. Flowering-factors affecting flowering, physiology of flowering, photoperiodism-long day, short day and day neutral plants, vernalisation and its application in horticulture, pruning and training physiological basis of training and pruning-source and sink relationship, translocation of assimilates. Physiology of seed development and maturation, seed dormancy and bud dormancy, causes and breaking methods in horticultural crops. Physiology of fruit growth and development, fruit setting, factors affecting fruit set and development, physiology of ripening of fruits-climatic and non-climacteric fruits.

**Practical:** Estimation of photosynthetic potential of horticultural crops, leaf area index, growth analysis parameters including harvest index, bioassay of plant hormones, identification of synthetic plant hormones and growth retardants, preparations of hormonal solution and induction of rooting in cuttings, ripening of fruits and control of flower and fruit drop. Important physiological disorders and their remedial measures in fruits and vegetables, rapid tissue test, seed dormancy, seed viability by tetrazolium test, seed germination and breaking seed dormancy with chemicals and growth regulators.

## **9. Structural Grammar and Spoken English (NC)**

**2 (1+1)**

Structural Grammar: Introduction of Word Classes; Structure of Verb in English; Uses of Tenses; Study of Voice; Study of Conjunctions and Prepositions; Sentence Patterns in English. Spoken English: Conversations of different situations in everyday life; the concept

of stress; stress shift in words and sentences; silent letters in words and pronunciation of words with silent letters, the basic intonation patterns.

**Practical:** Structural Grammar: Exercises in word classes, identification and study of verbs in sentences, application of tenses and voice, exercises in conjunctions and prepositions, other structural grammar exercises, report writing, letter writing (different types of letters). Spoken English: Conversations of everyday life, the concept of stress; stress shift. Silent letters in words, basic intonation patterns, preparing and address.

## 10. Introductory Microbiology

2(1+ 1)

History and Scope of Microbiology: The discovery of micro-organism, spontaneous generation conflict, germ theory of diseases, microbial effect on organic and inorganic matter. Development of microbiology in India and composition of microbial world. Microscopy and Specimen Preparation: The bright field microscope, fixation, dyes and simple staining, differential staining. Difference between prokaryotic and eucaryotic cells. Prokaryotic cell structure and functions. Types of culture media and pre-culture techniques. Microbial growth in models of bacterial, yeast and mycelial growth curve. Measurement of bacterial growth. General properties of viruses and brief description of bacteriophages. General principle of bacterial genetics, DNA as genetic material. Antibiosis, symbiosis, intra-microbial and extra-microbial association.

**Practical:** Examination of natural infusion and living bacteria; examination of stained cells by simple staining and Gram staining. Methods for sterilization and nutrient agar preparation. Broth culture, agar slopes, streak plates and pour plates, turbidometric estimation of microbial growth

## 8. OTHERS

### 1. Introductory Agroforestry

2 (1+1)

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

**Practical:** Identification and seeds and seedlings of multipurpose tree species. Nursery practices for poplar, *Grewia optiva*, *Morus alba*, *Acacia catechu*, *Dalbergia sissoo*, robinia, leucaena etc. Visit to agro-forestry fields to study the compatibility of MPTS with agricultural crops: silvipastoral, alley cropping, horti-silviculture, agro-silvipasture, fuel and fodder blocks. Visit to social forestry plantations – railway line plantations, canal plantations, roadside plantations, industrial plantations and shelterbelts. Rapid assessment of farmers needs for green manure, fodder, fuel wood in selected villages. Economics and marketing of products raised in agro-forestry systems.

## 2. Medicinal and Aromatic Crops

3 (2+1)

History, scope, opportunities and constraints in the cultivation and maintenance of medicinal and aromatic plants in India. Importance, origin, distribution, area, production, climatic and soil requirements, propagation and nursery techniques, planting and after care, cultural practices, training and pruning, nutritional and water requirements. Plant protection, harvesting and processing of under mentioned important medicinal and aromatic plants. Study of chemical composition of a few important medicinal and aromatic plants, extraction, use and economics of drugs and essential oils in medicinal and aromatic plants. Therapeutic and pharmaceutical uses of important species. Medicinal Plants: Betelvine, periwinkle, Rauvolfia, Dioscorea, Isabgol, *Ammi majus*, Belladonna, Cinchona, Pyrethrum and other species relevant to local conditions. Aromatic Plants: Citronella grass, khus grass, *flag* (baje), lavender, geranium, patchouli, bursera,  $\uparrow$  enthe, musk, *Ocimum* and other species relevant to the local conditions.

**Practical:** Collection of medicinal and aromatic plants from their natural habitat and study their morphological description, nursery techniques, harvesting, curing and processing techniques and extraction essential oils.

## 3. Introduction to Major Field Crops

2 (1+1)

Classification and distribution of field crops, definitions and concept of multiple cropping, mixed cropping, intercropping, relay and alley cropping, cultural practices for raising major cereals, pulses, oil seeds and fodder crops, green masuering, crop rotation.

**Practical:** Identification of crop plants, seeds and weeds. Preparation of cropping scheme. Application of herbicides in field crops

## 4. NSS/NCC / Physical Education (NC)

1(0+1)

NSS: Orientation of students in national problems, study of philosophy of NSS, fundamentals rights, directive principles of state policy, socio-economic structure of Indian society, population problems, brief of five year plan. Functional literacy, non-formal education of rural youth, eradication of social evils, awareness programmes, consumer awareness, highlights of consumer act. Environment enrichment and conservation, health, family welfare and nutrition. NCC: Introduction to NCC, defence services, system of NCC training, foot drill, sizing, forming up in three ranks, open and close order march, dressing, getting on parade, dismissing and falling out, saluting, marching, arms drill, shoulder arm, order arm, present arm, guard of honour, ceremonial drill, weapon training – rifle bayonet, light machine gun, sten machine carbine, introduction and characteristic stripping, assembling and cleaning, loading, unloading and firing. Field craft, visual training, targets, judging distance, fire discipline and fire control orders, battle craft, field signals, description of ground, section formation, section battle drill, scouts and patrols, ambush, field engineering, map reading, conventional signs, grid systems, use of service protractor, prismatic compass and its use, self defence, general principles, precautions and training, attacks and counter attacks, marching and searching, first aid, hygiene and sanitation, civil defence, leadership and NCC song. Physical Education: Introduction to physical education. Posture, exercise for good posture, physical fitness exercises for agility, strength, coordination, endurance and speed. Rules are regulations of important games, skill development in any one of the games – football, hockey, cricket, volleyball, ball badminton, throw ball, tennikoit. Participation in one of the indoor games – shuttle badminton, chess and table tennis. Rules and regulations of athletic events, participation in any one of the athletic

events – broad jump, high jump, triple jump, javelin throw, discus throw, shot put, short and long distance running, Safety education, movement education, effective way of doing day-to-day activities. First-aid training, coaching for major games and indoor games. Asanas and indigenous ways for physical fitness and curative exercises. Exercises and games for leisure time, use and experience.

Note: Warming up and conditioning exercises are compulsory before the commencement of each class.

### **5. Horticultural Work Experience**

**20 (0+20)**

The students will spend one full semester working with State Department of Horticulture; Horticulture based industries, commercial horticulture farms, plantation industries etc. to gain first hand information and hands-on-training in the chosen area of interest.

**Syllabus**

**For**

**B.Sc. (Hons.) Forestry**

# FORESTRY

## 1. SILVICULTURE & AGROFORESTRY

### 1. Principle and Practices of Silviculture

4(3+1)

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.

**Practical:** Acquaintance with various technical terms. Visits to different forest areas/types. Study of forest composition. Recording the observations on shoot development, growth rings, crown development, leafing, flowering and fruiting in a few selected tree species. Study of site factors like climatic, edaphic, physiographic and biotic. Study of forest succession. Study of the afforestation and reforestation success.

### 2. Silviculture of Indian Trees

3 (2+1)

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

**Practical:** Study of species composition in surrounding areas. Study of morphology and phenology of tree species growing in the area. Study of artificial regeneration of Pines, Bamboo, Oak, *Dalbergia sisoo* and *Acacia catechu*, etc. Practicing thinning in Bamboo clumps. Study on tree responses to the abiotic and biotic factors viz., light, fire, drought, frost, root suckering, coppicing and pollarding, etc. To study quality characters of nursery planting stock.

### 3. Agroforestry System and Management

3(2+1)

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.

**Practical:** Study characteristics of trees/shrubs/grasses for agroforestry. Volume and biomass estimation. Crown measurement, light interception and moisture measurement in agroforestry systems. Annual crops/grass growth measurements and yield estimation. Analysis of soil and plant samples for organic carbon N,P and K. Diagnosis and design - methodology. Survey agroforestry practices in local/ adjoining areas.

#### **4. Plantation Forestry**

**2(1+1)**

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

**Practical:** Study of tools, materials and operations for establishment of plantations. Site selection and site preparation. Exercises on planting and tending. Study of the special techniques for difficult sites. Exercises on protection of plantations. Exercise on plantation layout. Collection of data for survival and growth performance. Use of fertilizers, weedicides for plantation management.

#### **5. Silvicultural Systems**

**2(2+0)**

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

## 6. Nursery Management

2(1+1)

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

**Practical:** Preparation of production and planning schedule for bareroot and containerized nurseries. Nursery site and bed preparation. Pre-sowing treatments. Sowing methods of small, medium and large sized seeds. Pricking and transplanting of pricked out stock within nursery in transplant beds. Intermediate nursery management operations. Preparation of ingredient mixture. Filling of containers. Study of vegetative techniques – cutting, grafting etc. Visit to tissue culture laboratory and other nurseries.

## 7. World Forestry Systems

2(2+0)

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

## 8. Livestock Management

2(1+1)

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

**Practical:** Different tools/instruments used in livestock management; Routine management practices followed on livestock farms; Identification of feedstuffs and their nutritive value; Nutritive requirement animals; Computation of rations for livestock; Study of housing systems and requirements; Study of dairy farm records; Analysis of milk for fat, acidity, total solids and specific gravity; Preservation of fodder as hay, silage and leaf meal.

## 9. Forest Mensuration

3(2+1)

Introduction, definition, objectives and scope of forest mensuration. Scales of measurement (nominal, ordinal, interval and ratio scale). Units of measurement, standards of accuracy implied in their expression. Measurement of single tree - objectives, standard rules governing measurement at breast height. Measurement of tree diameter and girth using rulers, callipers and tapes. Comparison between tape and calliper measurements. Measurements of upper stem diameter and instruments such as Ruler, Finish Parabolic

Calliper, Relaskop, Pentaprism. Bark measurements - objectives, thickness, surface area and volume. Crown measurements - objectives, diameter, height, surface area and volume. Height measurements - direct and indirect methods. Height measurement employing geometric and trigonometric principles, height measuring instruments, errors in height measurement. Measurement of cross sectional area, basal area, bole surface area, leaf area. The tree stem form, taper and classification of form factors and form quotient. Volume estimation of felled and standing trees and formulae involved. Volume tables-definition and their classification, (general, regional and local volume tables), merchantable volume tables. Preparation of volume tables. Stand growth, site quality, site index, stand structure, yield tables and preparation of yield tables. Biomass measurement. Determination of age of trees. Tree growth measurements, objectives increment, determination of increment, stump analysis, stem analysis and increment boring. Measuring tree crops - objectives, diameter, diameter and girth classes, height measurement of crop, crop age and crop volume. Stand tables. Forest inventory- definition, objectives, kinds of enumeration. Sampling - definition, advantages, kinds of sampling, random sampling: (simple, stratified, multistage and multiphase sampling). Non random sampling (selective, systematic and sequential sampling) sampling design, size and shape of the sampling units. Point sampling - horizontal and vertical point sampling. Introduction to remote sensing and its application in forestry.

**Practical:** Units of measurement and their uses. Instruments used in forest mensuration and their working principles, pertaining to tree height, diameter, basal area, bark thickness and crown measurements. Measurement of bark thickness, bark volume, bark area and crown parameters. Volume estimation of logs, felled trees and standing trees. Preparation of volume tables, volume estimation of forest stands. Stump analysis and increment boring. Determination of age of standing trees. Calculation of CAI and MAI. Sampling exercises including Point sampling. Calculation of crop diameter, crop height and crop volume. Estimation of form factor. Estimation of canopy density. Use of aerial photographs in forest inventory. Study of different satellite images and their application in forestry.

## 10. Environmental Science

3 (2+1)

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

**Practical:** Visit to local areas - river/forest/Horticulture farm/ grassland/catchment etc. to document components of ecosystem. Study of common plants, insects, birds and animals. Visit to industries to study pollution abatement techniques.

## 11. Fundamentals of Horticulture

3(2+1)

Economic importance and classification of horticultural crops and their culture and nutritive value, area and production, exports and imports, fruit and vegetable zones of India and of

different states, nursery management practices, soil and climate, vegetable gardens, nutrition and kitchen garden and other types of gardens – principles, planning and layout, management of orchards, planting systems and planting densities. Production and practices for fruit, vegetable and floriculture crops, nursery techniques and their management. Principles and methods of pruning and training of fruit crops, types and use of growth regulators in horticulture, water management, weed management, fertility management in horticultural crops, cropping systems, intercropping, multi-tier cropping, mulching, bearing habits, factors influencing the fruitfulness and unfruitfulness. Rejuvenation of old orchards, top working, frame working, principles of organic farming.

**Practical:** Features of orchard, planning and layout of orchard, tools and implements, layout of nutrition garden, preparation of nursery beds for sowing of vegetable seeds, digging of pits for fruit plants, planting systems, training and pruning of orchard trees, preparation of fertilizer mixtures and field application, preparation and application of growth regulators, layout of different irrigation systems, identification and management of nutritional disorder in fruits and vegetables, assessment of bearing habits, maturity standards, harvesting, grading, packaging and storage.

## 2. FOREST BIOLOGY AND TREE IMPROVEMENT

### 1. Forest Ecology and Biodiversity

3(2+1)

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

**Practical:** Estimating productivity of a site; Study of microclimate and forest soils; Study of ecological modifications of leaves; Effects of fire on forest ecosystem; Study of population dynamics using model systems; Preparation of life tables; Study of spatial dispersion among plants; Study of Forest composition; Niche analysis; Computation of diversity indices; Measurement of diversity of plants and insects in a near by forest; Study of succession in field and water bodies; Visit to different ecosystems.

### 2. Dendrology

3 (2+1)

Introduction – importance and scope of dendrology, Morphology of woody plants and range of variation. Principles and systems of classification of plants. Bentham and Hooker's, Engler and Prantles, and Hutchinson's Systems. Plant Nomenclature – objectives, principles and International Code of Botanical Nomenclature. Role of vegetative morphology in identification of woody forest flora. Peculiarities of tree stems, twigs, general form of woody trunk and deviations like buttresses, flutes, crooks, etc. Morphology and description of barks of common trees. Characteristics of blaze on bark, colour, gums, latex, etc. Morphology of leaf, description of different types of leaves, colour of young and old leaves in some species

as (regular) features of identification. Reproductive morphology of plants with reference to description and identification of reproductive parts. Floristics and procedures; herbarium techniques, collection, processing and preservation of plant material. General study of herbarium, arboretum and xylarium. Description of the plant in scientific terms, study of sport characteristics of plants, naming and classifying based on adopted system. Study of families, as survey of forest resources: Magnoliaceae, Rhizophoraceae, Ebenaceae, Sapotaceae, Caesalpiniaceae, Santalaceae, Mimosaceae, Elaeagnaceae, Papilionaceae, Meliaceae, Salicaceae, Apocynaceae, Betulaceae, Verbenaceae, Fagaceae, Compositae, Moraceae, Poaceae, Tiliaceae, Liliaceae, Euphorbiaceae, Pinaceae, Dipterocarpaceae, Cupressaceae, Guttiferae, Taxaceae, Myrtaceae and Combretaceae. Geographical distribution of important Indian trees, native trees, exotic trees, endemism, allelopathy with respect to forest trees.

**Practical :** Morphological description of plant parts and method of collection of plants. Techniques of preparing herbarium specimens. Study of woody flora of: Magnoliaceae, Ebenaceae and Tiliaceae; Leguminosae, Betulaceae, Fagaceae; Dipterocarpaceae, Guttiferae and Liliaceae; Moraceae and Poaceae; Meliaceae, Elaeagnaceae and Salicaceae; Leguminosae and Apocynaceae; Combretaceae, Lythraceae, Myrtaceae and Santalaceae; Asteraceae, Ebenaceae, Sapotaceae and Verbenaceae; Euphorbiaceae, Pinaceae, Cupressaceae, Taxaceae.

### **3. Principles of Tree Improvement**

**3 (2+1)**

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.

**Practical:** Floral biology & phenological observations in some important species. Estimation of pollen sterility and viability. Emasculation & hybridization in self pollinated species. Emasculation & hybridization in cross pollinated species. Different breeding methods-flow chart. Species and provenance selection techniques. Recording observation in provenance trial of some important species-recording variation & working out coefficient of variation. Sampling in seed collection. Recording stand density in seed stands, seed output; season of seed collection. Vegetative propagation techniques and tree improvement. Estimation of phenotypic and genotypic coefficient of variation. Estimation of genetic advance, heritability and GCA. Exercise in plus-tree selection. Seed orchard designs. Recording the design and observations in teak, Eucalyptus seed orchards. Genetic engineering techniques in tree improvement.

### **4. Tree Seed Technology**

**2 (1+1)**

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.

**Practical:** Identification of seeds of tree species; Seed maturity tests; Physical purity analysis; Determination of seed moisture; Seed germination test; Hydrogen peroxide test; Tetrazolium test for viability; Seed vigour and its measurements; Methods of breaking dormancy in tree seeds; Testing membrane permeability; Study of seed collection and equipments; Planning of seed collection; Seed collection; Seed extraction; Visit to seed production area and seed orchard; Visit to seed processing unit/testing laboratory; Study of seed sampling equipments.

Note: Region specific aspects may be changed based on the locality

## **5. Fundamentals of Wildlife**

**2 (2+0)**

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

## **6. Forest Pathology**

**3 (2+1)**

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

and decay resistant woods. Principles of forest disease management. Definition and scope of disease management in forestry. Importance of disease cycle and economic threshold in disease management. Principles of disease management such as exclusion, cultural, chemical, biological and immunization. Nature of disease resistance. Fungicides and their use in nurseries and plantations. Integration of cultural, chemical, biological and host resistance in disease management, Meristem and tissue culture techniques in disease management. Nursery diseases of important forest species.

**Practical:** Study of microscope and micrometry; Collection, observation and preservation of diseased specimens and pathogenic structures; Morphological characters of fungi and bacteria; Morphological characters of viruses and phytoplasma; Preparation of culture media, isolation and subculturing of pathogens; Methods of inoculation and proving pathogenicity (Koch Postulates); Symptoms, signs and diagnosis of tree diseases; Measuring plant disease and methods of loss estimation; Symptoms, etiology and control of diseases/disorders of important tree species (sandal wood, teak and *Dalbergia*); Symptoms, etiology and control of disease/disorders of (eucalyptus, bamboo, cassia, semul and *Terminalia*); Symptoms, etiology and control of disease/disorders of important tree species (rubber, casuarina, neem and mango); Symptoms, etiology and control of disease/disorders of important tree species (*Albizia*, sal, sababul and *Acacia*); Symptoms, etiology and control of disease/disorders of important tree species (jack, *Lagerstroemia*, *Anogeissus* and *Emblica*); Fungicides, methods of their application and appliances used; Mushroom cultivation; Assessment of seed-microflora of tree species; Use of bio-control agents and mycorrhizae in disease management; Tissue culture techniques in forest pathology; Visit to nurseries and plantation.

## 7. Wild Life Management

3(2+1)

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

**Practical:** Field/laboratory studies of distinct and characteristics morphological and other features of fishes, reptiles, birds and mammals. Identification and study of wildlife in a nearby zoo. Bird watching : Preparation of inventory of an area. Direct and indirect methods of studying food habits of different wildlife. Studying habitat management and manipulation techniques. Wildlife damage and control : Questionnaire survey.

## 8. Forest Entomology and Nematology

3(2+1)

Definition, importance and scope of Entomology. Definition of insect and its position in the Animal Kingdom. Important characters of phylum arthropoda and class insecta. External

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

**Practical:** Study of distinguishing characters of phylum Arthropoda; Study of morphology, mouthparts and appendages of cockroach; Study of different types of insects; Study of immature stages of insects; Study of Anatomy of cockroach; Study of Insect collection, pinning, labelling and preservation; Study of representatives of insect orders and families; Study of predators and parasites; Study of insecticides and their formulations, plant protection appliances; Study of insect pests of forest seeds; Study of insect pests of forest nurseries; Study of insect pests of standing trees, freshly felled trees and finished products; Study of morphological characters of nematodes; Extraction of plant parasitic nematodes; Important symptoms of plant parasitic nematodes; Visit to forest nurseries and plantations.

### 3. FOREST PRODUCTS AND UTILIZATION

#### 1. Wood Anatomy

2 (1+1)

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).

**Practical:** Study of primary growth in typical dicot stem; Study of vascular bundles in monocots; Study of three dimensional features (cross, radial and tangential planes) of logs (woody trunks); Comparative anatomical features of softwoods and hardwoods; Study of gross features of different types of wood- straight, interlocked, spiral and wavy grain; texture; lusture; etc.; Study of anatomical features of different types of wood pores /vessels; Study of soft tissues in timbers and their distribution; Study of wood rays and their types; Study of non-porous woods, their physical and anatomical description; Study of cell inclusions in wood.

## 2. Logging and Ergonomics

2 (1+1)

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

**Practical:** Survey and demarcation of area intended for logging and listing of permanent boundary marks; Marking of trees for logging operation and preparation of marking list; Information procedure regarding handing and taking over before starting actual logging operation. Contract letters and other formalities to be completed; Equipments and tools used in logging operations and their uses; Planning and execution of different logging operation in a phase wise manner; Application of felling rules in the forests for felling of standing trees at different localities; Instructions regarding maintenance of various records and registers in logging operations; Conversion of felled trees into logs, poles, firewood, pulpwood etc.; Measurement of logs, poles and firewood in forests and maintenance of records in relevant registers; Minor and other types of transport practicable at felling sites; Final transport, information regarding transit permits for various types of forest produce; Visit to local dumping yard (timber depot) to trace the logs delivered from different forest sites; Sorting of logs, poles and firewood in the depots according to species, quality, length and girth classes; Stacking and stock checking of different logs, poles and firewood in the depots so as to confirm that all the converted materials in the forests have reached their destination; Lotting of the stacks for display and final disposal; Recording of the lots for auction sale. Final disposal of the material; Visit during the auction sale in the government timber depots; Preparation of ergonomic check lists.

## 3. Wood Products and Utilization

2(1+1)

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

**Practical:** Visit to paper industry to study pulp and papermaking. Study of different types of papers. Study of different types of paper boards. Visit to Rayon industry. Visit to plywood industry to study the manufacturing processes. Study of plywood, fiberboards, particleboards, and hard boards. Visit to other wood based industries. Visit to wood distillation unit. Visit to nearby industrial plantations. Study of types of improved wood.

#### 4. Wood Science and Technology

3 (2+1)

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

**Practical:** Different kinds and types of wood available as raw material. Parts of logs, other wooden raw materials and preliminary idea regarding procurement and temporary storage. Preliminary idea regarding conversion and milling. Estimation of moisture content and density of wood by oven dry method and by moisture meters. Seasoning of timber, air seasoning, kiln seasoning etc. Seasoning defects and their remedies. Testing of mechanical properties of wood. Woodworking, tools used and various stages and types of joints in wooden members, wooden fasteners, dowels, carving, sanding etc. Polishing and finishing of wood. Surface coating applications and wood primers. Wood preservatives. Chemicals used and methods of wood preservation and fire retardant treatments.

#### 5. Ethnobotany

3(2+1)

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

**Practical:** Visit to various places to collect information regarding traditional uses of plants. (This also includes nearby tribal areas).

#### 6. Utilization of Non-Timber Forest Products

3(2+1)

Introduction, methods of collection, management and importance of Non-Timber Forest Products (NTFP). Fodder (grasses and tree leaves), canes and bamboos. Essential Oils - methods of extraction, classification, storage and uses. Non-essential oils – nature, occurrence, methods of extraction, classification and uses. Important fixed oil yielding trees. Gums and resins –definition, classification, sources, collection and uses. Factors affecting

gum formation. Important gum yielding plants. Resins and Oleoresins, their formation in plants and classification of resins. Tans- nature, classification, uses and important tannin yielding plants. Dyes – classification and sources of dyes. Beedi leaves – sources, collection and processing. Fibers and flosses. Katha and Cutch – sources, extraction and uses. Drugs, wild fruits, spices, poisons and bio-pesticides.

**Practical:** Visit to nearby forests to study important NTFP yielding plants. Study of fodder: grasses and tree leaves. Study of canes and bamboos and their sources. Study of essential oils and their sources. Study of non-essential oils and their sources. Study of gums and resins and their collection. Study of tans and dyes and their sources. Study of fibers, flosses and their collection from nearby forests. Visit to Herbal Gardens and herbaria to study medicinal plants. Study of plants yielding drugs, spices, wild fruits, poisons and bio-pesticides and their collection from nearby forests. Visit to nearby extraction units.

## 7. Medicinal and Aromatic Plants

3 (2+1)

History, scope, opportunities and constraints in the cultivation and utilisation of medicinal and aromatic plants in India. Importance, origin, distribution, area, production, climatic and soil requirements, propagation and nursery techniques, planting and aftercare, training and pruning, nutritional and water requirements. Plant protection, harvesting, processing and economics of under mentioned important medicinal and aromatic plants. Medicinal Plants : pepper, cardamom, clove, ginger, turmeric, betelvine, periwinkle, *Rauvolfia*, *Dioscorea*, isabgol, *Ammi majus*, belladonna, *Cinchona*, pyrethrum and other species relevant to local conditions. Aromatic Plants : Citronella grass, khus grass, sweet flag (bach), lavender, geranium, patchouli, bursera, *Mentha*, muskdana (musk mallow), *Ocimum* and other species relevant to the local conditions. Endangered medicinal and aromatic plants of India and their conservation. Study of chemical composition of a few important medicinal and aromatic plants, their extraction and use. Therapeutic and pharmaceutical uses of important species.

**Practical:** Morphological description and identification of various medicinal plants. Collection of medicinal plants and plant parts from natural habitats. Survey and study of nursery techniques including training and pruning of medicinal plants. Harvesting, drying, grading, storage and processing techniques. Study of plant parts used in drug making. Visit to a nearby medicinal and aromatic plantation area /nursery /ayurvedic pharmacies /pharmaceutical industries.

## 4. NATURAL RESOURCE MANAGEMENT

### 1. Principles of Hydrology, Soil and Water Conservation

3(2+1)

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

methods; surface, subsurface, drip and sprinkler irrigation system. Drainage: types of drainage systems, their selection, design, installation and maintenance.

**Practical:** Study of hydrological equipment; Measurement and analysis of rainfall data; Estimation of runoff using rational formula; Preparation, use and analysis of hydrograph; Measurement of evaporation by different methods; Study of flood control reservoirs; Drainage and reclamation of water logged lands; Measurement of irrigation water by various method; Design of graded bunds; Design and layout of waterways; Survey design and layout of bench terraces; Design and layout of diversion channels; Study of different water harvesting structures; Land leveling and its cost estimation; Study of drip irrigation system; Study of sprinkler irrigation system; Study of pumping system; Economic analysis of wasteland development.

## **2. Soil Survey, Remote Sensing and Wasteland Development**

**3(2+1)**

Scope and objective; soil survey, sampling methods; planning, inventory, permanent sample plots; sample size allocation, landuse classes and planning. Aerial photography and remote sensing-definition, meaning, scope, merits and brief history. Electromagnetic spectrum; radiations, differential reflections by surfaces, active and passive remote sensing, earth observation satellites. Equipment and materials-aerial bases, cameras, filters, stereoscopes, computers, radars. Photogrammetry: Vertical and oblique photography. Photographs and images, scales, resolution, photo interpretation, photogrammetry, image analysis, mapping. Agencies involved in remote sensing and acquiring information from them. Remote sensing; principles, uses in forestry, status monitoring, fire, vegetation/cover classification and mapping, species identification, height and volume – estimation. Identification of tree species and their form stand delineation. Interpretation of land forms and soils; use of micro-level survey of farm forests, large scale photos in forest inventory, site selection. Imagery and image analysis – video satellite, computer and radars. Geographic Information systems-Computer softwares used. Characterization of wasteland, present status and extent of non-arable lands and their productivity. Salt affected soils, lateritic, marsh and swampy and rocky hills, rocky plains, murrummy and sandy soils, their characteristics and reclamation. Sites with superficial impervious hard pan. Eroded ravines and gullies, various techniques of afforestation of adverse sites, trees suitable for adverse sites. Afforestation and reclamation of mine wastes. Stabilization of tailing dumps and prevention of dust pollution. Sewage water as source of tree nutrients.

**Practical:** Exercise on sampling methods; Exercises on land use classes; Exercises on light-spectral characteristics; Study of equipment and materials used in aerial photography and remote sensing; Study of scales; Case studies-aerial photography and satellite imageries; Case studies – Geographic Information System – application in forestry; Computer software used in GIS; Analysis of soil for Gypsum and lime requirement; Exercises on study of eroded soils; Study on types of pits and trenches, tree species suitable for mined out areas; Visit to nearest mined areas.

## **3. Fundamentals of Geology and Soil Science**

**3(2+1)**

Composition of earth's crust, soil as a natural body-major components by volume-pedology-rocks-types- Igneous-sedimentary and metamorphic-classification-soil forming minerals-definition-classification-silicates-oxides carbonates – sulphides - phosphates-occurrence. Weathering of rocks and minerals-weathering factors-physical-chemical-biological agents involved, weathering indices-factors of soil formation, land forms-parent material-climate-organism-relief-time-soil forming processes-eluviations and illuviation-formation of various

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

**Practical:** Identification of rocks and minerals; Collection and preparation of soil samples; Soil analyses for moisture, colour, bulk density, organic matter, pH, EC; Textural analysis by hydrometer method; Study of soil profile I & II; Excursion tour for identification of rocks and minerals and profile studies; Practical introduction to Tensiometer, pressure plate and neutron probe etc.

#### 4. Rangeland Management

3 (2+1)

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

**Practical:** Identification of grasses, forbs and legumes and fodder trees; Rangeland inventory – ground cover, plant height, relative dominance, etc.; Assessing nutrient; Estimating range condition from plant composition; Determine range utilization, carrying capacity of rangelands; Indicators of heavy grazing; Studying plant preference by grazing animals; Grazing systems: simulations, indicators of heavy grazing.

## **5. Forest Management, Policy and Legislation**

**3 (2+1)**

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. Estimation of growing stock, density, quantity and increment. Yield regulation – general principles of even aged and unevenaged forest crop. Yield regulation based on area, volume, area and volume, increment and number of trees. Working Plan – definition, objects and necessity. Forest Policy: definition, necessity and scope. Legal and institutional approaches to forest resource management. National Forest Policies. Forest Law: legal definition. Objects of special forest law. Indian Forest Act. Detailed study of IFA, 1927. Himachal Pradesh State Forest Acts and Rules.

Practical: Visit to plantations of different age gradations, record the actual growing stock and workout increments. Visit to forests and enumerate the stock and test one of the method for yield regulation. Study the various units adopted in the forest management. Study of various records and forms maintained in the office of the RFO with regard to management of forests under their control. Study of procedure for seizure of property. Visit to forest department and courts to observe penalty procedures. Preparation of first information report and enactment report. Study of working plans of the forests and to prepare the working plan for one of the area in the range.

## **6. Agrometeorology**

**2(1+1)**

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

**Practical:** Study of temperature instruments, pressure instruments, humidity instruments, wind instruments, rain instruments and wind rose. Solar radiation instruments with pyranometer. Monthly variation of rainfall at Nauni. Lay out of an agromet observatory and types. Measurement of wind and evaporation. Measurement of sunshine hours. Measurement of soil temperature and dew.

## **7. Forest Business Management**

**2(1+1)**

(to be developed)

## **8. Marketing and Trade of Forest Produce**

**3(2+1)**

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.

**Practical:** Library review of studies on marketing, visits to local timber and non-timber markets; collection and analysis of price and quantity data for various forest products; study of marketing channels and price spread for important timber and non-timber forestry products.

## **9. Principles of Forest Economics, Project Planning and Evaluation** **2(1+1)**

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.

**Practical:** Exercises on demand and supply, production functions, price analysis, benefit-cost ratio and other measures of financial feasibility, CPM and PERT approaches.

## **10. Chemistry and Fertility of Forest Soils** **3(2+1)**

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

**Practical:** Study of forest soil profile; Determination of C.E.C. and exchangeable cations; Determination of soluble cations (Ca,Mg,Na, K); Determination of soluble anions (HCO<sub>3</sub>,CO<sub>3</sub>,Cl, SO<sub>4</sub>); Determination of available N, P & K content of soil; Basic sterilization techniques; culturing and maintenance of micro organism occurring in soil; Staining methods; Study of decomposition of forest litter by CO<sub>2</sub> – evolution method; Estimation of nitrification rate in soil; Isolation of legume bacteria and Azotobacter; Preparation and inoculation techniques for mycorrhizae and biofertilizers.

## **11. Forest Engineering** **2(1+1)**

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; cross staff surveying, compass surveying, chain and compass traversing, magnetic and true

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

**Practical:** Chain surveying, compass traversing; Plane table surveying, leveling, calculations of earth work for construction of forest; Roads & earth dams; Alignment of forest roads; Preparation of building plans; Design of waterways; Design of simple wooden beam bridge; Design of retaining walls; Design of check dams

## **12. Organic Farming**

**2(1+1)**

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

Practical: Raising of vegetable crops organically through nutrient, diseases and pest management; vermicomposting; vegetable and ornamental nursery raising; macro quality analysis, grading, packaging, post harvest management.

## **5. BASIC SCIENCES AND HUMANITIES**

### **1. Plant Biochemistry and Biotechnology**

**3(2+1)**

Carbohydrates-occurrence and 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-important fatty acids and triglycerides, essential fatty acids -rancidity of oils-acids value, saponification value & iodine value -phospholipids-types and importance-plant pigments-structure and function of chlorophyll and carotenoids-sterols-basic structure. Protein - classification - functional and solubility - amino acids-classification and structure-essential amino acids - properties of amino acids-colour reactions, amphoteric nature and isomerism-structure of proteins – primary, secondary, tertiary and quaternary properties and reactions of proteins. Enzymes-classification and mechanism of action-factors affecting enzyme action-cofactors and coenzymes - vitamins and mineral as coenzymes/cofactors-carbohydrate metabolism-glycolysis and TCA cycle-metabolism of lipids - lipases and phospholipases-fatty acid oxidation. Biosynthesis of fatty acids, protein metabolism-proteolytic enzyme, electron transport chain-ATP formation, bioenergetics of glucose and fatty acids. Photosynthesis and nitrogen fixation structure and component of nucleic acids, replication, transcription and translation. Historical developments in bio-technology. Application of plant tissue culture in plant improvement Micropropagation: Principales and application in forestry trees and medicinal plants; meristem culture; plant cell and suspension cultures; organogenesis and regeneration in vitro and somaclonal variations; genetic engineering techniques; transgenic plants with case studies of tree species to diseases, production of secondary metabolites; germplasm conservation; An introduction to

bioinformatics, genomics and proteomics, biodegradation of forestry wastes through genetically engineered microbes.

**Practical:** Preparation of standard solutions and reagents – carbohydrates – qualitative reactions, estimation of starch, reducing and non-reducing sugars-reactions of proteins and amino acids-estimation of proteins by Lowry method – determination of acid value, saponification value, iodine number of vegetable oils-vitamins-estimation of ascorbic acids-paper and thin layer chromatography. Sterilization techniques; preparation of culture medium for establishment of explants of forestry plants, multiplication of shoots, induction of roots; meristem culturing; callus cultures, induction of organogenesis;

## **2. Principles of Cytology and Genetics**

**3(2+1)**

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

**Practical:** Study of fixatives and stains; Preparation of slides showing various stages of mitosis; Preparation of slides showing various stages of meiosis; Testing the viability and germination of pollen grains; Solving the problems on monohybrid and dihybrid crosses; Estimation of linkages/chromosome mapping.

## **3. Entrepreneurship Development and Communication Skills**

**2 (1+1)**

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. Globalisation 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.

**Practical:** 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.

#### **4. Elementary Statistics and Computer Application**

**3(2+ 1)**

Basic concepts: Variable statistics, types and sources of data, classification and tabulation of data, construction of frequency distribution, tables, graphic representation of data, simple, multiple component and percentage, bar diagram, pie diagram, histogram, frequency polygon and frequency curve average and measures of location, mean, mode, median, geometric mean, harmonic mean, percentiles and 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, poison 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 – split plot design, strip plot design, long term experiments, plot size, guard rows. 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.

**Practical:** Construction of frequency distribution table and its graphical representation, histogram, frequency polygon, frequency curve, bar chart, simple, multiple, component and percentage bar charts, pie chart, mean, mode for row and grouped data, percentiles, quadrille, and median for row and grouped data, coefficient of variation, ‘t’ test for independent, will equal and unequal variants, paired ‘t’ test, chi-square test for contingency tables and theoretical ratios, correlation and linear regression. Studies on computer components – BASIC language, VISUAL BASIC, programming techniques, MS Office, Excel, Power Point.

#### **5. Principles of Plant Physiology**

**2(1+1)**

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

**Practical:** Measurement of water potential by different methods, Osmosis – demonstration, Plasmolysis – demonstration, Root pressure – demonstration, Transpiration rate, Studying the structure of stomata, studying the opening and closing of stomata, Demonstration of importance of light in photosynthesis, Separation of xanthophyll, Chlorophyll in plants, Studying the activity of catalase, Detection of phenols in plants, Studying the plant movements, Root initiation in cuttings.

## **6. Tree Physiology**

**3(2+1)**

Tree structure, growth, development, differentiation and reproduction. Plant growth functions and growth kinetics, Physiological functions and processes in trees. Environmental effects on growth and development. Productivity of tropical deciduous and evergreen forests. Light use efficiency in forest species, canopy structure, plant phyllotaxis and its importance in translocation. Plant light relationship environment. Branching in isolated plants. Monoculture and mixed tree communities. LAI, Photosynthetic efficiency and respiratory losses, source-sink relationship, Factors affecting photosynthesis. Radiation interception, absorption of water, ascent of sap and water balance. Transport processes with special reference to long distance transport in trees and its impact on plant water relations and photosynthesis. Development of seeds and seedlings. Biocides and growth regulators in forest ecosystems. Senescence and abscission. Role of trees in pollution control.

**Practical:** Measurement of growth and growth kinetics in seedlings; Measurement of linear growth in tree species; Biometric measurement of plant growth; Estimation of evapotranspiration; Measurement of WUE in trees; Pattern of light interception in different canopy architecture; Measurement of light use efficiency in tree species, using plant efficiency analysis; Growth as influenced by different spectral bands in visible light; Source sink relationship in plants; Translocation studies in plants; Effect of growth promoters on plants; Effect of growth retardants on plants; Use of biocides in tree species; Dormancy and germination studies in tree species; Methods of breaking dormancy in tree species; Studies on senescence in tree species; Regulation of senescence in tree species using agrochemicals; Chemical composition of tree species including shrubs, herbs and wood.

## **7. Introductory Forest Economics**

**2(2+0)**

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

## **8. Forest Tribology and Anthropology**

**2(2+0)**

Anthropology – definitions, nature and scope of Anthropology. Branches of Anthropology & methods of anthropological study, Concepts of Culture, Society, Community, Groups and Institutions. Race – concept criteria of racial classification, major races of India and the world. Social Institutions: Family – forms and functions, Marriage – forms and functions,

Kinship – decent, residence, Systems terminology and usages, Tribal Economy, Tribal religion. Meaning, definitions and characteristics of Tribes. History of Indian Tribes. Tribal Demography. Tribal - Social and Political organization. Tribal Law and Justice. Tribal taboo and Totem. Socio-cultural and socio-economic problems of tribes with special reference to indebtedness, land alienation, shifting cultivation, migration, depopulation, un-employment, impact of urbanization and industrialization, education and forest problems. Social and cultural change – its meaning and characteristics and difference between social & cultural change and recent changes among the tribals. Forest and Tribes – their relationship–forest ecosystem and cottage industries. Role of Tribals in Forest protection, development & conservation. Tribal welfare and social forestry, Tribals and Co-operative movements. History of tribal welfare and administration - the Constitutional safeguards for the scheduled tribes. Policies, plans and programmes of tribal development and their implementations. The role of anthropology in tribal development.

### **9. Fundamentals of Extension Education**

**2(1+1)**

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

**Practical:** Visits to study structure, functions, linkages and extension programmes of ICFRE institutes/voluntary organizations/Mahila Mandal, Village Panchayat, State Deptt. of Forests/All India Radio (AIR). Exercises on distortion of message, script writing for farm broadcasts and telecasts, planning, preparation & use of NPVA like poster, chart, flash cards, folders etc. and AVA like OHP & 35 mm slide projector transparencies. Identification of local leaders to study their role in extension work. Evaluation of some selected case studies of forestry extension programmes. Preparation of Village Agricultural productions plan.

### **10. Structural Grammar and Spoken English**

**2 (1+1)**

Applied Grammar: Introduction to Word Classes. Structure of the Verb in English. Uses of Tenses. Study of Voice. Use of Conjunctions and Prepositions. Sentence Patterns in English. Spoken English: Conversations of Different Situations in Everyday Life. The Concept of Stress, Stress Shift in Words and Sentences. Words with Silent Letters and their Pronunciations. The Basic Intonation Patterns.

**Practical:** Exercises in Word Classes. Study of Verb Patterns. Use of Tenses and Voice. Exercises in the Use of Conjunctions and Prepositions. Exercises in Sentence Patterns. Writing Reports on Topics relating to Horticulture/Forestry, using Active and Passive Sentences. (i) Conversations related to Everyday Situations, (ii) Selection and Practice of Conversations for the Study of the Concept of Stress, Stress Shift, Silent Letters in Words and Basic Intonation Patterns.

**11. Physical Education** **1(0+1)**

**12. NCC/NSS** **1(0+1)**

**13. Introductory Botany (NC)** **3(2+1)**

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 with special reference to alternation of generations in *Chlamydomonas*, *Rhizopus*, *Funaria*, *Adiantum*, *Pinus* and a flowering plant. Importance of plants in relation to environments.

**Practical:** Morphological studies of roots, stems, leaves and flowers. Studies of permanent slides of histology and anatomy. Morphological studies of gametophytes and sporophytes of the plants pertaining to the life cycle. General survey of the local vegetation. A field trip during the semester.

**14. Basic Mathematics (NC)** **3(3+0)**

Elementary idea of complex number. Arithmetic and Geometric progressions. Elementary idea of permutation and combinations. Binomial theorem for positive integral index, any index and their applications, addition and subtraction formulae. A, B and C, D formulae. Sine and Cosine formulae. Inverse Trigonometric functions. Introduction to matrices and determinants, special type of matrices, addition, subtraction and multiplication of matrices. Inverse of a matrix solution of system of linear equations using Cramer's rule and matrices method. Measures of central tendency and dispersion. Correlation and Regression. Elementary idea of probability theory.

## **6. FORESTRY WORK EXPERIENCE**

**1. Socio-economic Surveys (Village attachment - 11 days)** **2(0+2)**

**Practical:** Bench Mark Survey of Agroforestry related situations (cropping pattern, yield system etc.); Schedule development, tabulation, analysis and preparing plan of work. Data collection with respect to village profile-farmers/tribals socio-economic status gender issues and technology practices adopted. Understanding local forestry institutional and village level interventions (Panchayat, VFC's, Co-operatives, Corporations, Youth/Women Groups etc.). People's participation in developmental programmes with special reference to forestry. Preparation and use of extension methods and teaching aids for ToT.

**2. Field Training (Attachment with State Forest Department - 42 days)** **8(0+8)**

**Practical:** Visit to modern forest nurseries, herbal gardens and watersheds. To study the medicinal and aromatic plants diversity, their conservation and domestication. Study the felling and logging operations, timber lots and industrially important products. Introduction to Working Plan, data generation-enumeration and volume/yield calculation. Writing of compartment history files. Study the catchment area treatment plant and FDA. Study the Regeneration and Management of regionally important forestry tree species. Laying out sample plots, stump analysis, preparation of local volume table and use of forestry field equipments/ Instruments. Visit to National Parks, Sanctuaries and Bio-sphere reserves. Visit to ecologically degraded areas around cement plants, mined areas etc and study rehabilitation measures adopted.

**3. Hands on Training (Institutional– 28 days)**

**4 (0+4)**

**Practical:** Production of Quality Nursery Stock; Field Plantations; Processing & Packaging of non-wood forest products; Sericulture and Apiculture; Production of Biofertilizers and organic manure; Farming Systems – Agroforestry; Farm/Forest Management; Tractor driving and field Instrument's training; Carpentry and Bamboo craft.

**4. Hands on Training (Forest Based Industries - 40 days)**

**4 (0+4)**

**Practical:** Study the nature and structure of Industrial and Business Organization; Raw-material – Procurement and Processing; Production, Marketing and Economics at Wood workshop and saw mills/ Wood seasoning and preservation treatment units/ Pulp and Paper Industries/ Katha making industry/ Rosin and Turpentine Industry; Herbal Pharmacies/ Other wood Product Industries.

**5. Report Writing & Presentation (3 days)**

**2 (0+2)**

**Practical:** The students shall prepare a comprehensive report of all the training components and make an oral presentation.

**Syllabus**

**For**

**B.Sc. (Hons.) Home Science**

# HOME SCIENCE

## 1. BASIC COURSES

### 1. Human Physiology

3 (3+0)

The cell - structure, function and multiplication. The tissues – types, structure and their functions. The skeletal system - anatomy and functions. The circulatory system - anatomy and functions. The blood - composition and function, blood clotting, blood grouping, heart rate, blood pressure and factors affecting it. The respiratory system - anatomy, functions, mechanism, external and internal respiration. The digestive system - anatomy and functions of alimentary tract and accessory organs, digestion of food, absorption of digested food. The urinary system - anatomy and functions, formation and composition of urine. The reproductive system - male reproductive system – anatomy and functions, female reproductive system – anatomy and functions, menstrual cycle. The nervous system - elementary study of anatomy and functions. The endocrine system - important ductless glands of the body and their functions. Sensory organs - anatomy and functions.

### 2. Computer Applications

3 (1+2)

Introduction to programming, program definition, program life cycle, principles and techniques characteristics of a good program, data handling, introduction to flow charts. Spread Sheet Package - worksheet basic, data entry of numbers, text and formula, moving data in a worksheet, selecting data range, using the interface (Toolbars, Menus), editing basics, working with work books; saving and quitting, cell referencing. Formatting and Calculations. Calculations and worksheets using Auto Fill, working with formula, efficient data display with data formatting (number formatting, data formatting etc.), working with ranges, worksheet printing. Working with graphs and charts - Adding/Formatting text data with auto format; creating embedded chart using chart wizard, sizing and moving parts, updating charts, changing charts types, creating separate chart sheets, adding title, legends and gridlines, printing chart. Concepts of Data Base Management System - databases defined, relational databases defined, data structure; elements, fields, records, record layout; data codes – alphabetic, alphanumeric, numeric. Window Based DBMS Package – introduction, creating databases, adding records, viewing database, positioning database, saving database, editing; deleting records, files, ; modifying data base structure, opening and closing database file sorting and indexing, querying reports. DBMS programming of small application.

**Practical:** Flow Charts, Worksheet Basics, Formatting and Calculations, Working with Graphs and Charts, Concepts of Data Base Management, Creating Data Bases, Viewing Data Bases, Saving Data Bases, Modifying Data Base Structure, Sorting and Indexing, Querying reports, Small Applications.

### 3. Marketing Management

3 (2+1)

Meaning, significance and importance of markets and marketing. Marketing mix and marketing environment. Marketing Research. Buyer behavior - motives and factors influencing. Demand and sales forecasting. Pricing policies and pricing decisions. Product planning – meaning, product concept and dimension, produce policy. Sales management - Sales promotion mix, prerequisites of selling, after sales service, Features of salesmanship, types of salesmen, Entrepreneurship - Meaning and importance, Types and characteristics, Role of entrepreneurial development and relevant acts.

**Practical:** Study of different markets. Identification of channels of distribution. Study of sales/product promotion techniques. Comparative study on packaging material and packaging techniques. Market survey for learning product related strategies-branding, trade name, warranty and guarantee, Critical analysis of advertisement. Preparation of advertisement. Learning to plan advertisement budget.

#### **4. Women in Agriculture**

**3 (3+0)**

Status of rural women – demographic, sex ratio, nutrition, health, education, works, skill and entitlement of property, social political legal. Feminization of agriculture and its influence on status of farm women. Gender issues in agriculture, multiple role of farm women. Occupational health hazards, drudgery involved. Technological needs of farm women, technologies available, its transfer. Status of women in the rural families, family type, characteristic. Changing pattern of rural family. Empowerment of women – concept, need and ways of empowering women.

#### **5. Environmental Studies**

**3 (2+1)**

The Multidisciplinary nature of environment studies: Definition, Scope and importance, need for public awareness. Natural Resources: Renewable and non renewable resources: Natural resources and associated problems- Forest Resources: Use and over-exploitation, deforestation, case studies. Timber extraction, mining, dams and their effects on forest and tribal people. Water Resources: Use over utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems. Mineral Resources: Use and exploitation, environmental effects of existing and using mineral resources, case studies. Food Resources: World food problems, changes caused by agriculture and overgrazing effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies. Energy resources: Growing energy needs, renewable and non renewable energy sources, use of alternate energy sources, case studies. Land resources: Land as resources, land degradation, man induced landslides, soil erosion and desertification - Role of individual in conservation of natural resources, Equitable use of resources for sustainable lifestyle. Ecosystems: Concept of ecosystem, Structure and function of an ecosystem, Producers consumers and decomposers, Energy flow in the ecosystem, Ecological succession, Food chains, food webs and ecological pyramids, Introductions, types, characteristics features, structure and function of the following ecosystem- Forest ecosystem, Grassland ecosystem, Desert ecosystem, Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries). Biodiversity and its conservation: Introduction- Definition: genetic, species and ecosystem diversity, Biogeographical classification of India, Value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values, Biodiversity at global, national and local levels, India as mega diversity nation, Hot - spots of biodiversity; Threats of biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts, Endangered and endemic species of India, Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity. Environmental Pollution: Definition, Causes, effects and control measures of Air pollution, Water pollution, Soil pollution, Marine pollution, Noise pollution, Thermal pollution, Nuclear hazards. Solid waste Management- Causes, effects and control measures of urban and industrial wastes, Role of an individual in prevention of pollution, Pollution case studies, Disaster management: floods, earthquake, cyclone and landslides. Social Issue and the Environment: From Unsustainable to Sustainable development. Urban problems related to energy. Water conservation, rain water harvesting, watershed management. Resettlement and rehabilitation of people: its problems and concerns, Case studies. Environmental ethics: Issues and possible solutions. Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust, Case studies. Wasteland reclamation.

Consumerism and waste products. Environment Protection Act. Air (Prevention and Control of Pollution) Act. Water (Prevention and Control of Pollution) Act. Wildlife Protection Act Forest Conservation Act. Issues involved in enforcement of environmental legislation. Public awareness. Human Population and the Environment: Population growth, variation among nations. Population explosion- Family Welfare Programme. Environment and human health. Human Rights. Value Education. HIV/AIDS. Women and Child Welfare. Role of information Technology in Environment and human health. Case studies.

**Practical:** Visit to a local area to document environmental assets-river/forest/ grassland / hill / mountain. Visit to local polluted site – Urban / Rural / Industrial / Agricultural. Study of common plants, insects, birds. Study of simple ecosystems-pond, river, hills slopes, etc. (Field work equal to 5 Lecture hours). Case studies under different units.

## **6. Personality Development**

**2 (1+1)**

Meaning and definition of personality. Personality patterns, moulding the personality patterns, persistence and change. Personality determinants (physical, intellectual, emotional, social, educational and family). Aspirations and achievements. Personality adjustment.

**Practical:** Understanding the characteristics and types of personality (introvert and extrovert). Understanding the impact of physique, society, educational institutions, sex and family on personality characteristics.

## **7. Biochemistry**

**3 (2+1)**

Introduction- definition, historical development and relevance of biochemistry course for U.G. students of different faculties of agriculture. Water-pH, buffer and cell constituents. Classification, structure and functions of carbohydrates, lipids, protein and amino acids. Enzymes – nature, classification, functions, mechanism of enzyme action and factors affecting enzyme activity, coenzyme and cofactor. Metabolic Pathways – Glycolysis, TCA cycle, HMP shunt, degradation of starch, fatty acids and acyl glycerol. Biosynthesis Pathways – Photosynthesis, nitrogen fixation, fatty acid and glycogen formation. Nucleic acid – nitrogenous bases, nucleotides, DNA and RNA structure and protein synthesis. Role of vitamins and minerals in metabolism. Brief orientation to biochemical energetic and biological oxidation. Secondary metabolites – structure and functions.

**Practical:** Preparation of standards, buffers and colloidal solutions. Determination of pH. Qualitative tests of carbohydrates and amino acids. Quantitative estimation of soluble sugars. Demonstration of estimation of nitrogen by Kjeldhal method and fat by Soxhlet method. Determination of acid value, saponification value and iodine number. Demonstration on paper chromatography and thin layer chromatography. Demonstration of peroxidase and ascorbate peroxidase activity.

## **8. English and Technical Writing**

**2 (1+1)**

Tenses, Agreement of Subject and Verb, Passive Voice, Basic Sentence Patterns, Prepositions, Phrasal verbs, Common Grammatical Errors, Use of Articles, Punctuations, Modals, Gerund, Participle, Infinitive, Word Formation (Affixes, prefixes, suffixes, synonyms, and antonyms), Idioms, Synthesis & Transformation of sentences, Sentence Linkers.

**Practical:** Introduction to sounds – Vowels, Diphthong, Consonants, Phonetics Transcriptions. Word stress and exercises on pronunciation. Group discussion on current topics. Presentation of technical report.

## **9. Elementary Statistics**

**3 (2+1)**

Review of Central Tendency. Review of Dispersion. Karl Pearson's Correlation Coefficient. Simple Linear Regression. Test of Significance - Null Hypothesis and Alternative Hypothesis, Two types of Errors, Level of Significance, Critical Region, Degrees of Freedom. Standard Normal Deviate Test for Single Mean and difference between two Means. Students t-test for single mean and difference between two means. Paired t-test, Chi-square test for goodness of fit and independence of attributes in 2x2 contingency table, Yate's Correction (No mathematical derivatives).

**Practical:** Computation of A.M., Median and Mode for raw data and frequency distribution. Computation of S.D. and C.V. for raw data and frequency distribution. Computation of simple correlation coefficient. Estimation of Regression lines. S.N.D. test for single mean and difference between two means, t-test for single mean, t-test for difference of two means, Paired t-test. Test of significance of Correlation and Regression Coefficients. Chi-square test for goodness of fit and independence of attributes in 2x2 contingency table.

## **2. HUMAN DEVELOPMENT AND FAMILY STUDIES**

### **(a) CORE COURSES**

#### **1. Life Span Development**

**3 (2+1)**

Biological basis of development. Pregnancy and birth. Physical, cognitive and psycho-social development during infancy, early childhood, middle childhood and adolescence. Stages of personal development during adulthood and ageing. Marriage and family relationship during early, middle and late adulthood.

**Practical:** Study of physical, motor, social, emotional, intellectual, language, moral and personality development at different ages. Using available measurement tools, techniques and writing interpretative reports.

#### **2. Early Childhood Care and Development**

**3 (2+1)**

Meaning, characteristics and significance of early childhood years. Physical and motor development, cognitive development, language development, socio- emotional development, moral development, personality development during early childhood years. Early childhood education - significance of early childhood education. History of early childhood education and contribution of western and Indian educators in promoting early childhood education. Programme planning. Importance and types of play. Role and qualities of early childhood personnel. Parental involvement in early childhood education and care programmes.

**Practical:** Observation and recording of physical and motor development, cognitive development, language development, socio - emotional development and personality development. Developing and conducting activities to promote all the developments i.e. physical, motor, cognitive, language, socio-emotional and personality. Visit to early

childhood education centre and recording observation. Observation of a PTA meeting being conducted.

### **3. Children with Developmental Challenges** **3 (2+1)**

Definition and classification of children with developmental challenges. Current prevalence, its implications on the quality of life of the population. Multi-disciplinary view of children with developmental challenges. Types of developmental challenges – mental deficiency, sensory disabilities, neurological disorders, physical handicaps, definition, classifications, etiological factors, characteristics, educational and vocational intervention for different disabilities.

**Practical:** Study of etiology, characteristics, diagnosis of children with different disabilities and recording information. Conducting individual home based intervention. Collaborating with professionals in conducting center-based intervention - schools, clinics, pediatric wards, special school. Collaborating with professionals in development of intervention activities for children with developmental challenges. Writing reports.

### **4. Dynamics of Marriage and Family** **3 (3+0)**

Marriage - understanding the institution of marriage. Readiness for marriage. Meaning, definition, purpose, motives, functions and types of marriage. Marriage in different Indian societies. Marital harmony and personal compatibility in marriage. Different life styles. Family- orientation to family studies, origin, evolution, meaning, definition of family institution. Structure and forms of families across different countries. Laws related to marriage and family. Stages of family life cycle; family disorganization , its causes and consequences, marriage and family counseling.

## **(b) PROFESSIONAL COURSES**

### **I. Organization and Management of ECCD programmes**

#### **1. Family Counseling** **4 (2+2)**

Concept, nature, scope, principles and need of counseling. Types of counseling. Attributes of a counselor (personal and professional). Approaches to counseling. Thrust areas in family counseling – educational, vocational, social, personal, premarital and marital. Problems in family counseling. Approaches to evaluate family counseling. Counsellor's self awareness and growth.

**Practical:** Visits to the family guidance and counseling institutions. Observing the counseling sessions and reporting the observations. Identifying families with problems and conducting case studies. Acquiring familiarization with the tests and techniques used for the assessment of troubled families Developing intervention programmes for the identified families. Executing the intervention programmes. Making post-intervention evaluations and presenting reports. Visiting and developing resource files on local, state and national organizations working in the area of family guidance and counseling.

#### **2. Developmental Assessment of Young Children** **4 (1+3)**

Assessment – definition, functions, screening and measurement concepts. Trends and challenges in developmental assessment of young children. Tools and techniques of

assessment; Assessment of children from birth to 8 years; Interpretation of assessment information for parents, educators and policy makers. Identification of children with developmental challenges. Ethical issues in assessment of children.

**Practical:** Screening and diagnostic assessment of young children for various developments through different tools and techniques, physical and motor development; anthropometric measurements and reference standards. Motor and behavioral assessment using Bayley's scale. Intelligence test for children. Social and emotional maturity scale. Case studies. Home, environment scale. Early childhood environmental rating scale, Apgar early screening profile. Recording and interpretation of assessment and report writing. Development of action programme for parents, surrogates, field functionaries and other professionals.

### **3. Readiness Material for Children**

**4 (1+3)**

Concept of readiness – readiness as a process – registration, recognition and recall. Significance of readiness. Measures to foster readiness in children.

**Practical:** Identification and preparation of material to promote readiness process i.e. registration, recognition and recalling for different developmental domains – socio – emotional, cognitive, language and physical, motor. Planning, developing, executing and assessment of readiness outcomes.

### **4. Developing Play Material for Children**

**4 (1+3)**

Meaning, significance and value of play. Stages, types of play and play material. Implication of play on development.

**Practical:** Significance of educational play materials. Preparation of social and fantasy play materials. Mirrors, dolls, puppets, stuffed toys. Exploration and mastery of play materials. Wooden blocks, puzzles, pattern making materials, books, music, art and movement play materials. Art and craft materials, musical instruments, audio visual materials. Gross motor play materials. Push and pull toys. Preparation of flash cards, charts, posters and models, use of indigenous materials.

### **5. Creative Experiences for Children**

**4 (1+3)**

Concept of creativity – theoretical perspectives on creative expressions among children. Role of creativity in the overall development of the child. Identification of different types of creative expressions among children. Fostering creativity among children at home and in school. The early childhood creative expression. Use of creative activities in fostering learning in other areas of study – methods and strategies. Developing and using a creative environment for children- use of media.

**Practical:** Survey of indigenous and modern creative materials for school children. Creating activity – setting ECE programmes for different creative activities. Conducting creative art activities for school children. Developing creative art resource files for children. Training, personnel, working with child welfare institutions (preschool, play centres, day care centres, children's home etc.) in providing creative activities for children.

**6. Organization and Management of Dramatic and Rhythmic Activities for Children 4 (0+4)**

**Practical:** Understanding the significance of dramatic and rhythmic activities. Audio visual material used in ECE programmes for dramatization and rhymes. Criteria for preparation of different material for children. Collection of rhymes and stories, dramas and video material. Providing experiences in music. Development and use of material and field experiences for dramatization and rhymes. Role play and dramatization. Audio and visual presentation. Critical evaluation of existing material used for Dramatization and music in different ECCE centres.

**7. Intervention Programmes for Developmentally Challenged Children 4 (0+4)**

**Practical:** Identification of needs of developmentally challenged children. Orthopaedically handicapped, socially deviant and learning disabled. Survey of family and community opinion about developmentally challenged children. Programme development of different categories of developmentally challenged children to enhance different developmental aspects. Programme implementation and evaluation. Development of educational package for parents and teachers.

**8. Organization and Management of ECCD Programmes 5 (1+4)**

Application of theories (education and development) in early childhood education. Various types of ECE programmes - brief historical perspective of ECE programmes in India and abroad.

**Practical:** Observation and recording of Early Childhood Programmes. Theme-based developmentally appropriate programme. Planning on yearly, monthly weekly, daily basis. Individual and shared lesson plan, activity plan and flow chart. Preparation and collection of educational material. Implementation of prepared plan. Conducting pre and post sessions. Arranging and equipping the classroom – different corners. Carry out large and small groups activities. Supervision of transition throughout the day. Addressing emergencies. Feedback of plans and modification. Working with parents. Professional behaviour and ethics. Executive support role in the centers. Working on strategies to help children with mild behavioral problems.

**9. Entrepreneurship in Child Care Services 6 (2+4)**

Project planning – characteristics, functions, dimensions of planning. Types, ethics and scope. Format of submission of proposal. Funding agencies. Legal and regulatory processing,

**Practical:** The student will identify her own area for Entrepreneurship and develop one complete project for execution of the same on the following guidelines - identification of the project, selection of the locale and clientele, input sources – manpower, finance and infrastructure facilities. Scope for implementation (cost benefit analysis). Registration / licensing. Conducting a feasibility study. Presenting a report.

**10. Literature for Young Children 4 (1+3)**

Need, importance and types of children's literature. Criteria for the development of children's literature. Selection of theme, plot, illustration, characterization, format and language in

children's literature. Principles for developing literature for different developmental domains and age groups. Learning to correspond with publishers.

**Practical:** Appraisal of available children's literature in the market. Interviewing parents, children and school librarians to find out the reading habits of children. Reviewing the newspapers and magazines, children sections for developing and understanding regarding what is popular with children; Panel discussion on elements of writing for children. Learning to depict visuals on the basis of write ups. Developing a ready reckoner. Developing write up for different age group of children; Cover page designing. Computer aided technology book / literature writing; Learning to correspond with publishers. Visit to designing centers for observation. Visit to press for orientation. Visit to books fairs for updating knowledge.

### **11. Infant Stimulation Programmes**

**4 (0+4)**

Visit to different day care, infant and toddler centers. Observation and recording of development and behavior in different ecological settings. Study of existing stimulation practices and materials in home and institutional settings (infant, toddler centers, day care centres). Preparation of stimulation programme for physical, motor, cognitive, language, behavior, social and emotional domains. Development of stimulation kit from indigenous low cost materials and evaluation. Implementation of prepared programme in different ecological settings. Modification on the basis of evaluation.

### **12. Family and Child Welfare**

**3 (3+0)**

Concept and scope of family and child welfare in India and abroad. (Child, Adolescent, Women, Aged etc). Rights and responsibilities of children, parents and society. Historical orientation to family and child welfare services in India. Classification of family and child welfare agencies - organizational classification, government, private, national and international. Classification according to nature of services - supportive and substitutive. Welfare programmes at local, state, national and international level. Principles and policies. Organizational structure, function/ objectives of these programmes and beneficiaries.

## **3. FOODS AND NUTRITION**

### **(a) CORE COURSES**

#### **1. Food Science and Processing**

**3 (2+1)**

Functions of foods - energy giving, body building, protecting and regulating. Cooking methods - types, merits and demerits. Cereals and millets - structure, composition, processing techniques, effect of heat and acid, functions of starch in cookery. Legumes, nuts and oil seeds - composition, processing techniques, effect of heat, acid and alkali. Fruits and vegetables - types, composition, pigments, changes caused by heat, acid and alkali. Egg - structure, composition, grading of egg, function and changes during cooking. Meat, poultry and fish - kind, structure, composition, pigments, factors affecting tenderness, post-mortem changes and changes during cooking. Sugars - types, composition, manufacturing process, effect of heat and acid, functions in cookery. Fats and oils - kinds, composition, effect of heat, functions in cookery, processing techniques, rancidity of fats. Brief overview of beverages. Introduction to food additives. Condiments and spices; importance in daily life. Processed and convenience foods - precooked, ready to eat foods, frozen foods, dehydrated foods, instant food mixes.

**Practical:** Kitchen equipments and their uses. Weighing and measuring food items. Cooking methods. Cereal cookery - preparations showing dextrinization and gelatinization, functions of starch in cereals, gluten formation and factors affecting it, identification of the food grains. Legumes, nuts and oils seeds- ways of using, ways of making complete protein. Vegetable cookery- effect of heat and alkali on pigments, use of vegetables with other foods. Preparation of soups, salads and beverages. Milk and milk products- effect of heat, acid and alkali, uses of milk and milk products in various preparations. Egg cookery - preparations showing functions of egg, various ways of using egg. Meat cookery – preparations involving various methods of cooking. Sugars – preparations showing functions of sugar in cookery. Market survey of processed and convenience foods.

## **2. Human Nutrition**

**3 (2+1)**

Historical development and the relation of nutrition to health, growth and human welfare. Concept of recommended dietary allowances; recommended allowances for specific nutrients and energy. Concept of balanced diet, basic food groups – characteristics and their contribution to the diet. Energy- units, sources and requirements, fuel value of foods, methods of measuring energy value of food, energy requirement of the body, physical activity and thermogenic effect of food; BMR - methods of measurement, factors affecting. Digestion and absorption of carbohydrates, fats and proteins. Carbohydrates - types, functions, sources, requirement, health conditions affected by carbohydrates, significance of dietary fiber. Lipids - types, functions, sources, requirement, health problems associated with lipids. Proteins - types, functions, sources, requirement, quality evaluation, improvement and protein energy malnutrition. Vitamins - classification, functions, sources, requirement, deficiency and toxicity of the following: fat soluble- A, D, E, K; water soluble – C, B complex (thiamin, riboflavin, niacin, B<sub>6</sub>, B<sub>12</sub> and folic acid). Minerals - classification, functions, sources, requirements, deficiency and toxicity of calcium, phosphorus, iodine, fluorine, iron, sodium, potassium, chloride, copper and zinc; bio availability and factors affecting calcium and iron, electrolyte balance. Water: Functions, sources, distribution in body and water balance. Assessment of nutritional status.

**Practical:** Serving size and number of servings of common dishes. Planning and preparing nutrient rich dishes - protein, calcium, iron, vitamin A, thiamine, riboflavin, ascorbic acid. Calculate calorie and cost of dishes prepared for above nutrients. Evaluation of three days' energy balance. Simple processing to improve bioavailability of nutrients - germination, fermentation, mutual supplementation, malting etc. Planning and preparation of low cost nutritious recipes. Study of common deficiency diseases through audio-visual aids. Demonstration on bomb calorimeter.

## **3. Normal and Therapeutic Nutrition**

**3 (2+1)**

Importance of meal planning and factors to be considered while planning meals. Use of food groups and exchange list in planning meals for a normal adult, calorie consumption unit in planning meals for a family. Maternal nutrition- physiological changes and nutritional requirements during pregnancy and lactation. Infancy- growth, development and nutritional requirement, importance of breast feeding, weaning and supplementary foods. Pre-school, school age child and adolescent- growth and development, food habits and nutritional requirements. Old age - changes during old age and nutritional requirement. Importance and modification of normal diet to therapeutic diets. Methods of feeding (normal and artificial). Causes, symptoms and dietary management in following disorders - acute and chronic fevers, gastrointestinal disorders: diarrhoea, constipation, liver diseases: hepatitis, cardiovascular

diseases: atherosclerosis and hypertension, diabetes; problems of weight control: overweight and obesity.

**Practical:** Planning and preparation of balanced diet according to sex, preschool age, school age, adolescent, adult, old age. Planning and preparation of diets for different age groups - infancy, preschool age, school age, adolescent, adult, old age. Planning and preparation of diets for special conditions - pregnancy and lactation. Planning and preparation for special occasions: birthdays, festivals, packed lunches. Planning and preparation of diets during following disorders-typhoid, diarrhea, constipation, hepatitis, hypertension, diabetes, overweight/obesity.

#### **4. Food Preservation and Storage**

**3 (1+2)**

Importance and scope of food preservation and storage. Food spoilage- causes and effects. Selection and purchase of foods for preservation. Principles and methods of food preservation - drying and dehydration, use of high temperature, use of low temperature, foods as preservatives, use of chemicals, radiation, combination of above methods. Storage of common perishable, semi perishable and non perishable foods. Food standards and quality control. Packaging and packing material, labelling and costing of the product.

**Practical:** Market survey of raw and preserved foods. Drying of fruits and vegetables (blanched & un-blanched) – Solar drying, Sun drying, oven drying. Domestic preservation of foods by freezing. Preparation and storage of the following - squashes and syrups, cordials, jam, jellies, marmalades, preserves and murabbas, ketchup, sauces, chutneys, pickles with and without oil. Preparation of items utilizing cereals and legume flour and their storage. Preparation of sugar candies. Demonstration on canning and bottling of fruits and vegetables. Demonstration on storage of food grains. Visit to a dairy plant. Visit to a preservation centre.

### **(b) PROFESSIONAL COURSES**

## **II. Nutrition and Dietetics**

### **1. Nutrition for Special Groups**

**3 (3+0)**

An overview of groups with special nutritional needs. Relationship of nutrition with health of an individual with special needs. Current nutrition and health status of women and children in India. Nutritional management of vulnerable sections of the society – pregnant and lactating women, infants, preschoolers, adolescents and elderly. Dietary management of industrial workers, sports persons, astronauts and defense personnel.

### **2. Clinical Nutrition**

**3 (3+0)**

Pathogenesis of deficiency diseases. Etiology, prevalence, clinical signs and symptoms of common deficiency diseases. Etiology, metabolic changes, clinical manifestations, complications and dietary management of gastrointestinal disorders- vomiting, constipation, peptic ulcer, ulcerative colitis ; liver disorders – hepatitis, cirrhosis, hepatic coma; weight management- underweight, overweight; diabetes mellitus; cardiovascular diseases - hypertension, atherosclerosis; renal disorders- nephritis, urinary calculi, renal failure.

### 3. Hospital Dietetics

4 (2+2)

Importance of dietetics. Principles of hospital dietetics. Dietician as a part of medical team and outreach services. Dietetics department - structure, administration and function. Food service in hospital. Clinical information – medical history, assessment of patient profile. Methods of dietary assessment. Therapeutic adaptation to normal diet for- consistency, temperature, nutrients and amount. Modes of feeding – Enteral and Parenteral feeding, composition of tube feeding. Aesthetic attributes of diets.

**Practical:** Lay out of a dietetics department. Modification and preparation of diets for therapeutic purposes in terms of consistency, nutrients, temperature and quantity. Preparation of list of foods need to be avoided and /or included in different diseases. Planning, preparation and serving of diets low/ high in the following nutrients- energy, fibre, protein, lipids, carbohydrates, sodium, potassium, vitamin A and iron in reference to common diseases. Planning and preparation of diets for patients suffering from more than one diseases. Visit to dietary department of a hospital. Observation of clinical signs and diet served / consumed by patient.

### 4. Community Nutrition

3 (1+2)

Malnutrition – definition and causes. Assessment of nutritional status. Major nutritional problems prevalent in India and the state. National programmes and role of national and international agencies in improving nutritional status of the community. Food adulteration – definition, types, adulterants and their health hazards, prevention and control. Nutrition education.

**Practical:** Assessment of nutritional status of an individual / community using anthropometry and dietary survey. Visit to local health centers to identify clinical signs and symptoms of nutritional problems. Identification of adulterants in common foods. Visit to an ICDS block. Development of audio visual aids. Planning, implementation and evaluation of nutrition education for a target group.

### 5. Health, Hygiene and Sanitation

3 (3+0)

Concept, significance and interrelationship. Good health-characteristics. Cultivation of hygienic habits to promote health. Factors affecting personal health. Air and ventilation, water, food and soil- sources , impurities and effect on health. Municipal health services. Mobile units. Prevention and control of infectious diseases. Notification, quarantine, segregation, disinfection. Health service at fairs and festivals. Removal and disposal of refuse and excreta, sanitary drainage fittings.

### 6. Food Toxicology

2 (2+0)

Introduction and significance of food toxicology. Food poisoning –types, causative factors, signs and symptoms, preventive measures. Natural food toxins – anti-nutritional factors, other food toxins, their harmful effects and methods of removal. Microbial toxins and food intoxication – source of contamination, effect on health, preventive measures, methods of inactivation / destruction. Chemical toxins – pesticides, insecticides, metallic and others, residual effects, preventive measures, methods of removal. Food packaging material – potential contaminants from food packaging material.

## 7. Dietetic Foods

3(0+3)

**Practical:** Market survey for dietetic foods. Development of dietetic foods - energy dense, high/ low protein, low sodium, low cholesterol, high/low fibre, high complex carbohydrates, low calorie and low sodium, low protein and low fluid, high fibre and low fat, low fat and low sodium, low sodium and low protein and other combinations.

## 8. Food Standards and Quality Control

3 (2+1)

Importance of quality control and assurance; food laws and regulations; Sampling procedure. Application of food standards and their specifications for raw foods and food products for its constituents and additives. Various methods for the assessment of quality of different foods, selection of sensory panel and sensory evaluation of food products, grading and marking standards, specification of finished products, food toxins, food poisoning, identification of preventive measures, food adulteration - assessment and prevention.

**Practical:** Examination of agriculture, horticulture and animal foods and food products in relation to different standards - PFA, FPO, Agmark, BIS, Codex alimentarius, HACCP. Visit to quality control laboratory and food processing industries. Market survey of processed foods for quality assurance; development of score cards and evaluation of different foods.

## 9. Product Development

4 (1+3)

Importance and scope of product development. Selection and storage of raw material. Sensory evaluation and standardization. Packaging requirements of food products. Economics of products.

**Practical:** Market survey of available processed products in view of cost, label and quality assurance mark. Panel selection and training on sensory evaluation. Standardization of products- soups and beverages, chapaties, vegetables, snacks, continental dishes. Pricing, packaging, labeling and shelf life studies.

## 10. Bakery and Confectionary

4 (1+3)

Selection, properties and functions of ingredients used in bakery and confectionary. Flours and flour mixtures- role of gluten and starch, doughs and batters, their rheological properties. Emulsifiers used in bakery. Balancing the formula for bakery products. Tools and techniques used in bakery. Quality control of bakery products.

**Practical:** Use of different bakery equipments. Balancing the formula for bakery products. Standard methods of making different types of biscuits, cookies, cakes, pastries, cream rolls, swiss rolls, bread, buns, pizzas, puddings, tarts. Icings and cake decoration. Standard methods of making toffees and chocolates. Use of crystalline and non crystalline sugars in different preparations.

## 11. Dietary Counselling

4 (0+4)

**Practical:** Diet counselling - counselling process and its significance. Assessment of needs of patients. Establishing rapport. Communication process. Patient education. Case studies- selection of 2-3 patients, clinical, nutritional and biochemical profile, therapeutic modification of diets, report writing. Pre requisites and preparation for setting up a counselling center. Preparation of audio – visual aids for diet counselling. Organizing

counselling camps for specific diseases like GIT disorders, renal disorders, liver diseases, cardio-vascular diseases, hormonal- metabolic disorders, protein energy malnutrition, iodine deficiency disorders. Physical fitness in relation to chronic diseases.

## **12. Catering Management** **4 (1+3)**

Menu planning for various catering institutions. Micro-planning of a proposed project to be undertaken for running a food service institution.

**Practical:** Quantity food production and cost calculation. Preparation and service of Hi teas/ lunches for special occasions and a formal lunch. Organization, management and administration in institutions such as canteen, cafeteria, nursery school/ hostel mess. Project work.

## **13. Entrepreneurship Development** **4 (1+3)**

Concept, need and process of entrepreneurship development. Government policies and schemes for entrepreneurship development. Developing entrepreneurial competencies. Setting up an enterprise – enterprise selection, market analysis, SWOT analysis, resource mobilization, finance, technology, raw material, site and man power. Identification of marketing strategies, packaging, quality control, advertisement, costing and taxation.

**Practical:** Visit to small scale industries. Study of pertinent enterprises in detail. Interaction with successful entrepreneurs. Preparation of project proposal for funding by different agencies.

## **14. Traditional Indian Food Products** **3 (0+3)**

**Practical:** Exploring and enlisting traditional recipes of different states of the country. Standardization of common recipes of North, East, South, West and Central zone of country. Preparation of meals of different state. Value addition of traditional recipes and meals. Nutrient composition of traditional v/s value added meals.

## **15. Food Services in Institutions** **3 (2+1)**

Types of food service institutions. Styles of food services. Floor planning and layout. Principles, functions and tools of management. Personnel management – selection and training, desirable qualities, personnel appearance. Financial management – terms used, budgeting and account keeping. Selection, care and use of equipments. Food and personal hygiene. Types of menu and menu cards.

**Practical:** Development of recipe book. Preparation of various types of menu cards. Table setting, maintenance of accounts and record keeping, visit to different food service institutions.

## **16. Convenience and Health Foods** **3(1+2)**

Convenience foods-introduction, importance, types, cereal and pulse based convenience foods-ready to use mixes, extruded products-vermicelli, noodles, spaghetti and macaroni. Preparation of vadagam, appalam, kakra. Spices and pulse based convenience foods-ready to use curry mixes. Soup mixes-tomato, mushroom and corn soup mixes, ready to use sweet mixes.

**Practical:** Familiarisation of equipment used for convenience foods-standardization and preparation of ready to use mixes-idli, rava-dosa, idiappam, adai, vadai, bajji, pakoda and murukku mix-extruded products-cereal and pulse based-preparation of traditional foods-vadagam, appalam and kakra-curry mixes-sambar and rasam powder, masala powder-chicken, fish and mutton, parupu powder-soup mixes-vegetable, mushroom and corn-sweet mixes-halwa, kheer, gulabjamun, jangiri, cake and ice cream mix-effect of packaging material of convenience foods-Visit to vermicelli unit, appalam making unit, ready mix unit, masala powder unit. Market survey of convenience foods. Project preparation of convenience foods.

## 4. TEXTILES AND APPAREL DESIGNING

### (a) CORE COURSES

#### 1. Fundamentals of Clothing Construction

3 (1+2)

Equipment and accessories used in clothing construction : their care and use with special reference to sewing machine, common defects, general repair; clothing construction terminology; construction process: their suitability for different fabrics and clothing articles; preparation of fabrics for layout and cutting; importance and functions of clothes; clothing requirement of infants and toddlers, pre-schoolers and elementary school children.

**Practical:** Use of sewing equipment, working, care and repair of sewing machine, preparation of samples of basic hand stitches, seams, edge finishing, disposal of fullness, finishing of necklines, placket openings, fasteners and mending, preparation and layout of different fabrics; Drafting, cutting and stitching of laundry bag, apron, panties/bloomer and frock.

#### 2. Textile Science and Care

3 (2+1)

Introduction of textiles; textile fibres- classification; terminology used in textiles; processing and manufacturing method, properties and use of different textile fibres – cotton, silk, wool, rayon, polyester, acrylic, other minor fibres; labels and tags used in textiles; spinning methods –mechanical & chemical; yarn classification, characteristics and their use; method of fabric construction – weaving, knitting, lace making, felting, non-woven; consumer application, use and care of textiles; laundry equipment, their use and care; principles and methods of washing and finishing; stain removal – principles, classification and techniques; cleansing agents – water, detergent, soaps and others; laundry reagents – acidic, alkaline reagents and bleaching agent; additives used in laundry- stiffening agents and blueing; principles of dry cleaning- use of absorbents and solvents; introduction to textile finishes; common finishes used in textiles; disinfecting and storage and clothes.

**Practical:** Identification of textile fibres- visual test, microscopic test, burning test, chemical test; Study of yarns- types, yarn size; thread count, bow, skewness; Study of common fabrics available in the market; Removal of common stains from different fabrics; Demonstration of laundry equipment; Washing, finishing and storage of following textile articles – cotton, silk, wool, synthetics and other special articles- zari, embroidered fabric, lace etc.; visit to a textile mill and reporting.

### **3. Apparel Designing and Construction**

**3 (1+2)**

Study on different types of fabrics available in the market for apparel purposes; design elements and principles as applied to clothing and apparel designing; factors affecting clothing selection; clothing requirements of adolescents, adults and senior citizens; clothing awareness; symbolism; socialization and self concept; clothing budget; wardrobe planning; consumer behaviour and motivation.

**Practical:** Survey on different types of materials available; taking body measurements – children and adults; drafting child's bodice and sleeve blocks; frock- designing, pattern alteration, estimation of fabric, drafting, cutting of frock; petticoat, blouses, lady's shirt, churidar payjama / salwar, night suit, creation of new dress designs, stitching and finishing of articles; display of articles.

### **4. Fundamentals of Textile Designing**

**3 (2+1)**

Introduction – techniques of textile designing – weaving, knitting, braiding, crocheting and lace making; weaving-history of weaving, weaving principles, weaving accessories, loom and its parts; Weave calculations- estimation of warp and weft yarn for weaving, preparation of warp and weft yarns for weaving; basic weaves- plain-rib & basket, twill, satin and sateen weaves - lifting and drafting plans, mode of interlacement, characteristics, applications; knitting-terminology, principles of knitting and classification; knitting machines and their nomenclature; types of knits – warp knits and weft knits and their applications; performance of knits; introduction to basic hand embroidery stitches; dyeing and printing- brief study of the types of dyes; dyeing methods – fibre, yarn and piece dyeing, advantages and disadvantages, Printing – introduction and brief study of different methods of printing.

**Practical:** Preparation of fabric for dyeing, textile designing through tie and dye, batik and block printing; yarn calculation, preparation of yarn for weaving-preparing the warp and setting the warp and on the loom, plain weave-preparing lifting and drafting plans, weaving samples of plain weave, colour and weave effects in weaving; knitting machine - parts and accessories, setting of the machine, making patterns, preparing samples with different stitches and multi coloured knitting samples; hand knitting – basic skills, basic stitches, shaping stitches, casting off and selvages, textured patterns, preparing samples using various techniques; hand embroidery – various types and method of stitching; preparing sample with embroidery stitches.

## **(b) PROFESSIONAL COURSES**

### **III. Apparel Production Management\*/ Textile Designing\*\***

#### **1. Traditional Indian Textiles**

**3 (2+1)**

Traditional textiles-study of woven textiles – Patola, Kullu shawls, Maheswari, Chanderi, Kosa silks, Baluchari Buttidar, Brocades of Banaras – Madhanpura, Aliapura, Mulmuls of Bihar, Bandhas from Orissa, Sambalpuri sarees, Dacca muslin, Paithani, Himroos, Amroos, Sholapur durries, karalakudi sarees, Irkal sarees, Mysore silks, Sutada durries, Kanchipuram sarees, Tribhuvanam sarees, Arni sarees, Salem, Coimbatore sarees, Madurai sarees, Pochampally, Arani, Venkatagiri, Guntur sarees, Chirala & Jandrapet, Gadwal, Uppada, Mangalgiri, Dharmavaram, Madhanapalli, Narayanapet sarees etc traditionally dyed and printed textiles – Bhandinis; Madhubani; Ajark; Khadi, Kalamkari and embroideries – Kashida,; Mochibarat, Kantha, Kasuthi, Kutch, Banjara work present in different states of

India. Their importance and present scenario in textiles and apparel. Factors affecting diversity of textiles.

**Practical:** Sample preparation of traditional Indian embroideries and textiles; documentation of Indian Textiles and embroideries; preparation of two articles using combination of few of the following traditional textile crafts- Kalamkari; Madhubani; Sangneri; Indian miniatures; Patola; Ikat; Bandhani; visit to Museum & Art Galleries.

## **2. Principles of Design Application**

**3 (1+2)**

Basic designing, classification of textile design (woven & printed), traditional motifs in relation to textiles, design development and adjustment, effect of yarn, weave, colour and finishing process of textiles on fashion, general role of the design. Other methods of producing designs on textiles and comparison; selection of textile designs for apparel, home furnishings and other household articles.

**Practical:** Creative projects in sketching and preparing geometrical, abstract, stylized, natural, ethnic & traditional motifs with different colour schemes suitable for dyeing, printing, embroidery techniques; suitable for clothing as well as furnishing fabrics; field visit to printing and textile design centre.

## **3. Computer Aided Designing**

**4 (0+4)**

**Practical:** Importance of computer in the field of textiles and apparel; status of CAD technology; basics of graphic software; basic commands- lines, circle, square and triangle etc., familiarization, application; drawing basic silhouettes and proportions of fashion figures styles and designs; colour application and creation of new textures; analysis of line, shape and form; drawing garment patterns, alteration and modification of the patterns, different tools for photo-realistic draping of garments; designing a garment, making patterns, preparation of spec sheets and costing.

## **4. Traditional Costumes of India**

**3(2+1)**

Traditional costumes prevalent in different states of India- women, men, children, dance and tribal –Northern & west regions - Jammu & Kashmir, Himachal Pradesh, Punjab, Haryana, Rajasthan, Gujarat, Uttar Pradesh, Bihar, Madhya Pradesh; Eastern region – West Bengal Orissa, Sikkim, Assam, Meghalaya, Tripura, Mizoram, Manipur, Nagaland, Arunachal Pradesh; Southern region– Andhra Pradesh, Karnataka, Tamilnadu and Kerala, Maharashtra, Goa, Pondichery, Andaman & Nicobar , Lakshadweep; their importance in present scenario for textiles and apparel industry; factors affecting diversity of costumes in India.

**Practical:** Visit to museum and art gallery and reporting; developing designs for women based on the traditional costumes of different states – planning for casual wear, party wear, executive wear; developing designs for men-planning casual wear, party wear, executive wear; documentation of women's and men's wear.

## **5. Fashion Merchandising**

**3 (2+1)**

Fashion retailing and merchandising terminology; fashion cycle, theories of fashion adoption, factors affecting fashion, fashion analysis, retailing- types of retailing; store retailing - departmental stores, chain stores, discount stores, niche stores, boutiques - organizational structure of the stores, non-store retailing - mail order, electronic and other forms of retailing;

merchandising- role and responsibilities of a merchandiser; trends in retailing and merchandising, fashion forecasting and its significance in product plan and retailing merchandising for buying houses, export houses, sale promotion techniques - advertisement, types of advertisement, advantages, limitations, planning and executing advertisement; visual merchandising- importance, types of displays, planning for exterior and interior displays – window displays; export and import procedure, role of organization for export promotion.

**Practical:** Market analysis through visit to retail and wholesale textile market, show rooms, chain stores, factory outlets, niche stores, boutiques and reporting; developing display techniques for visual merchandising of apparel and textiles and presentation. Sourcing for fashion.

## **6. Computer Aided Designing – Textile Designing**

**3 (0+3)**

**Practical:** Introduction to software, learning Corel Draw software commands and practicing exercises create a drawing, render with different colours, patterns, textures; drawing basic motives – Natural/floral, stylized, abstract, and geometric; rendering with colours and textures; creating a designer’s logo, representation of geometrical actions, developing lattice and designs for border patterns, developing lattice for all over pattern – brick, diamond, diaper, ogee, spot; creation of pattern for upholstery, apparels, sarees, bed sheets, curtains; creating suitable backgrounds for border and all over patterns

## **7. Designing through Dyeing and Printing**

**3 (1+2)**

Dyes classification, natural and synthetic – direct, acid, basic, vat, naphthol, fibre reactive, pigment; selection of suitable dyes, dyeing methods – fibre, yarn, fabric – advantages, disadvantages; printing-methods, types-stencil, block, flock, transfer, screen, resist dyeing-tie and dye and batik, combination techniques, pollution through dyeing and printing, ISO 14000.

**Practical:** Preparation of yarn and fabric for dyeing; techniques of tie and dye – sample preparation; designing garments with tie and dye techniques - tying and dyeing and finishing; Batik – tools and techniques of batik – designing garments with batik designs, washing dyeing dewaxing and finishing; stencil printing - preparation of stencil, printing and finishing; screen printing - preparation of screen, printing samples; visit to dyeing and printing units and reporting; visit to a ISO 14000 unit, observation of ecological factors, report writing.

## **8. Fabric Embellishment-I**

**3 (0+3)**

**Practical:** Introduction to fabric embellishment, survey of embellishments available in the market, Introduction about the embroidery tools and supplies – Yarns, threads, fabrics, frames, hoops, needles, design transfer material; designing and selection for hand embroidery – sources and interpretation, choosing, colors, enlarging and reducing designs ;transferring the design-hot iron, dress makers carbon, pricking, using embroidery frame; open work-drawn thread work – preparation of the fabric – stem, simple, knotted., grouping, laced stitches; metal thread embroidery; demonstration – Ari, Zardosi; Macramé – materials required, basic macramé knots, square, double, half hitch; Bead work - one needle method, couching, tambour beading; mirror work- round, square, oval mirrors, sample preparation; quilting: Wadded or English, Italian, Trapunto/stuffed, shadow, flat/queen Anne, herring bone/cord quilting, quilting - assembling the material, sample preparation; tatting - basic stitches, abbreviations, making motifs and lace; appliqué –types and sample preparation;

patch work- mosaic-one shaped, block/unit, overlapping, crazy; crochet – materials required, method of crocheting – chain, single crochet, hay double crochet, treble crochet, slipstitch, gauge, shaping-increasing, decreasing and abbreviations; preparation of motifs and edges; preparation of any commercially viable article; Mood board preparation for article with above embroidery stitches; cost estimation of prepared article; evaluation and display.

### **9. Computer Aided Designing - Customization**

**3 (0+3)**

**Practical:** Introduction to CAD & portfolio Development; Photoshop- Introduction to software-scalar & vector images; setting up image resolutions, creating new images-scanning, saving copy, file saving etc; overview of tool box; familiarization of tools; working with layers-creating new layers, layer lock options link/unlink layers, layer mask, layer set, trash etc.; practicing layers; use of colour gradient, enhancing colour, colour harmony, working with filters, making suitable background for portfolio presentation; creation of background for portfolio presentation, creation of back ground by collage work; rendering fashion figures-change of colours, textures and patterns; creation of different frock, kameez, tops and skirts designs, for women party wear, nighties and customization; creation of Apparel Library, developing portfolio.

### **10. Design Studio Practices and Project Work**

**4 (0+4)**

**Practical:** Creation of designs for commercialization; designing and construction of 5 garments on a given theme; projection of work through fashion shows and exhibition, making a portfolio with 5 lines.

### **11. Apparel Industry Management\***

**3 (3+0)**

Apparel Industry Management: definition and importance; planning of garment business; capital management; support system-banks, govt. agencies and institutions; working capital; costing and pricing of products - costing of garments in the industry, methods of costing, advantages of each method; industrial organizations and management practices, management aids, modernization of apparel industry; Computer Integrated Management; quality aspects of management – ISO 9001-2000, ISO- 14,000; personnel management – roles and responsibility of various cadres, basic amenities supplied; factory and labour laws; trade globalization and its effect on Indian apparel industry, status of apparel industry in India, recent trends in apparel industry.

### **12. Apparel Manufacture – I\***

**3 (1+2)**

Anthropometric measurements– techniques & importance; garment designing, basic paper pattern making , development, grading & adaptation; introduction to draping, principles of draping; types of silhouettes; dart location & manipulation; Fitting – standards for good fit, factors affecting good fit. Common fitting problems & their remedies (Upper & lower garment).

**Practical:** Flat pattern techniques: developing paper pattern of bodice block, skirt block & their variation. development of patterns for various collars, sleeves, yokes, necklines, etc.; designing 5 garments for different age groups – making patterns and analysis of design features, pattern grading; visit to different garments & apparel manufacturing units and project report .

### 13. Apparel Manufacture -II\*

3 (3+0)

Apparel Manufacturing Industry-Infrastructure - Fundamentals of apparel production; departments of apparel industry - design department – main functions and scope; main functions and scope of finance and purchase departments; production and marketing departments; ware house and packing department; machinery; equipments for planning and spreading; marker making; cutting and finishing equipment; stitches; seam types; types of feed mechanisms – pressure foot, throat plate, feed dogs; needles – Functions, parts of needles, sizes of needles; sewing threads- functions and characteristics of threads and their types; fundamentals and classification - basic sewing machines and special sewing machines; work aids - machine beds; tables; work chairs; bundle clamps; stackers; methods of fusing, welding and adhesives; apparel standards and quality control- importance, measuring standards and specifications of raw material and product; accepted quality level; introduction, importance, different stages of quality control; visit to apparel industry

### 14. Fashion Illustrations\*

3 (1+2)

Terminology used in fashion industry and fashion illustrations, selection of material – types of papers, pencils, pens, colouring media, brushes and other media. Fashion figure preparation, forms of sketching, principles of fleshing out, steps in creating movement in figures, figure type and achieving proportions – structure, contour, proportion symmetry and posture; history of style, development of fashion from ancient to the present, principles and rules in sketching and proportioning face, profiles, hands, arms, legs, feet and hair; components and characteristics of fashion – silhouettes, details, texture and colour. Importance and types of rendering techniques – outlines, shading, highlights, representing textures and patterns, role of fashion illustrator and career opportunities.

**Practical:** Body proportions in relation to age, sex and style, body form in totality; figure types and achieving perfect proportions; material used for sketching- getting acquainted with types of materials used and their characteristics; getting used to drawing type of lines; preparation of fashion figure – learning to draw-planning page, proportions, road map grids; drawing masses of body using simplified geometric shapes, fleshing out the figure; moving figures- proportioning, choosing the pose curving the spine, marking feet, drawing angles of shoulders, hip & knees; sketching different types of silhouettes; shaping and fleshing out the posed figure; drawing front facial, profile, three quarter facial view and facial features; learning to draw various hairstyles; drawing legs, sandals, boots, flats and heels; drawing hands and arms form and shape and various styles; textures and patterns- obtaining various textures of fabrics using pencil; drawing specific details-necklines and collars; sketching sleeve types, skirts, drapes, cowls, ruffles, frills, ruching; sketching garments – different types, creation of style according to age, season, special needs; analysis of design created; visit to fashion designing institutes and report writing.

### 15. Draping Techniques\*

3 (0+3)

**Practical:** Introduction to draping; equipment needed, features of dress form, padding and marking of dress form, modeling basic bodice front and back – preparation of muslin and draping steps, trueing; marking and tracing of bodice front, basic skirt pattern – preparation of muslin and draping steps, marking and tracing the skirt-joining the skirt to the bodice, basic sleeve-draping the sleeve, shaping the cap, setting the sleeve and adjustments; dart manipulation – waistline, centre front and French dart; double dart, neckline dart, bust line dart at centre front and armhole, yokes-fitted midriff – bodice yoke and hip yoke preparation and draping; bodice yoke; necklines-Halter neck-preparation of muslin and draping steps;

draping princess bodice-front and back, cowls-basic cowls; variation of basic skirts-one piece basic skirt, the pleated skirt, gored skirt and flared skirt; collars –Peter pan, convertible and mandarin; sleeves-kimono, raglan; visit to fashion institutes; designing and draping any three garments, construction and display.

### **16. Fabric Embellishment-II\***

**3 (0+3)**

**Practical:** Introduction to ari embroidery-acquainting with the tools, setting of the ari frame-Karchobe and fixing of the fabric and transferring the design, handling of needle and thread, practicing with the needle and thread; techniques of handling various types of needle and threads; learning basic stitches of ari-line, chain, filling, net, knot etc.; designing a sample using basic stitches; making samples using basic stitches; various types of threads, finishing samples; survey of accessories available in the market suitable for ari work; handling techniques of various accessories used in ari; stitching of accessories using ari techniques, finishing techniques, observation, making sample and finishing of the types of Zari work on ari frame; designing a garment/household article based on ari techniques, making and finishing of the article.

### **17. Structural Fabric Design\*\***

**3 (1+2)**

Introduction to fabric structures: Woven structures, knitted structures and non woven structures. Introduction and history of weaving, study of various types of handlooms, financial assistance for development of handlooms and khadi industry and organisations related to handlooms and khadi industries. Basic weaves and variations: Study of basic weaves - plain, twill, satin and its variations. Loom and its part; weaving accessories; preparation of yarn for weaving, drafting and lifting plan; characteristics of woven fabrics; warp and filling, fabric count, grain balance, selvedge, fabric width and fabric weight; environmental impact of weaving.

**Practical:** Demonstration on loom and its part, weaving accessories; preparation of yarn for weaving; preparation of warp, setting the warp on the loom; threading, preparing the weft; drafting and lifting plan; weaving samples on loom- Plain weave, basket weave, rib weave ,twill and satin weave. Project work on frame loom- preparing a small rug; Visit to weaving centres, mills, etc.

### **18. Printed Fabric Designing\*\***

**3 (0+3)**

**Practical:** Creation of art work to actualize the imagination on any fabric surface with following suggested exercises. Children's wear: Theme- All over pattern with colour, for-evening wear, fabric- cots wool, method- Batik effect through screen printing, colour scheme- own choice. Theme: Toys and alphabets (all over); for- night wear; fabric- rubia voile method- block printing; colour scheme- maximum four colour. Theme: Flower heads; For- Day wear (winter); Fabric silk, method- hand painting, colour scheme- Maximum three colours. Teen age wear (girls): Theme- Flower with leaves, For- dresses, fabric- cambric, colour scheme- Three colours. Theme- shells, For- beach wear, fabric- knitted method-screen printing, colour scheme of your own choice. Boys wear: Theme- decorative motifs, for boys shirts fabric cambric, method- block printing, colour scheme of your own choice. Theme- Animal skin texture, for- T-shirts, fabric- knitted, method- screen printing, colour scheme of your own choice. Ladies wear: Theme- jewelry design, for- evening wear in winter, fabric, silk, method, screen printing, colour scheme, precious stone colours. Theme: Japanese art, for- night wear fabric- of your own choice, method – batik, colour scheme according to the theme. Gents wear: Theme- Graph weave effect with tie and dye, for –

shirts, fabric- poplin, method- screen printing, colour scheme minimum three colour. Theme: Geometrical and floral, for- bush shirts, fabric- khadi- screen printing, colour scheme of your own choice.

### **19. Knitting Technology- I\*\***

**3 (1+2)**

Knitting yarn, their classifications, description, properties and use; Counts and size of yarn; conditioning of yarn their strength, twist and elasticity; Principal sources of supply- testing of yarn for count, uniformity and colour fastness; knitting machines, their nomenclature and uses, mechanisms and adaptability for various purposes, components, their names and descriptions, functions and adjustments, care and maintenance; Hand- knitting needles, their types and uses; sketching of chief functional parts of knitting machine; Machine gauge and its estimation, methods of selection of yarn of right count for different gauges of knitting machines.

**Practical:** Method of knitting of basic stitches (with two and more yarns) i.e. plain, rib and pearl and combinations; selection of yarns for various knitted garments; adjustment of knitting machines; feeding and functioning of various parts of different kinds of knitting machines; Designing and knitting of different samples and patterns on flat and circular machines; calculation of machine gauge and count; Methods of repair of various types of defects in knitted fabrics.

### **20. Textile Design and Colourways\*\***

**3 (0+3)**

**Practical:** Design analysis- Structural and applied design variation in fibre, yarn and fabric construction, embroidery, dyeing, printing and finishes. Sources of inspiration for basic sketching and painting- Nature, religion, mythology and achieving textural effects. Process of designing- motif development, geometrical, simplified, naturalized, stylized, abstract and ornamental, big and small motifs, colour consideration and colour harmonies. Creation of patterns and designs combining motifs and placement and repeats for all over patterns. Introduction to related computer software- creating design (6-8) of different fabrics through variation in fibre and yarn construction techniques by employing traditional and contemporary motifs for decorating fabrics. Colour- meaning terminology, classification of colour, theories of colour, colour schemes, effects of colors.

### **21. Knitting Technology – II\*\***

**3 (0+3)**

**Practical:** System of fabric manufacture - fashioned, circular and seamless; Methods of yarn feed and wind-up tackle; stitches employed in knitting, their description and application- cutting, sewing, drawing and clocking- Trimming and make up-Choice of materials- knitted fabrics, their trade name and description, styles and standards specifications- tucks, lace and embroidered fabrics imperfections and their remedies; Calculation, measurements and their systems - yarn numbering system, determination of counts of folded yarns average counts in knitted fabrics, weight percentage of mixture articles speed of frames and production. Cost of raw materials and yarn; cost of hosiery products for the trade marketing of finished products.

### **22. Textile Industry Management\*\***

**3 (3+0)**

**Textile Industry Management:** definition and importance; terminology used; planning of textile business; capital management; support system-banks, govt. agencies and institutions; working capital; costing and pricing of products - costing, methods of costing, advantages of

each method; industrial organizations and management practices, management aids, modernization of textile industry; Computer Integrated Management; quality aspects of management – ISO 9001-2000, ISO- 14,000; personnel management – roles and responsibility of various cadres, basic amenities provided; factory and labour laws; trade globalization and its effect on Indian textile industry, status of textile industry in India, recent trends in textile industry.

**Note:** Courses without asterisk are common for both professional courses in TAD

## 5. FAMILY RESOURCE MANAGEMENT

### (a) CORE COURSES

#### 1. Management of Family Resources

3 (3+0)

Definition, scope and significance of management. Managerial functions of families. Systems approach to FRM. Values - definition, importance, classification and characteristics. Goals – definition, characteristics and types. Standards-definition, classification and criteria of selecting standards. Resources-definition, classification, characteristics, increasing satisfaction, objectives and principles of use of resources. Communication- definition, process, classification and barriers. Decision making process- types of decisions, steps in decision making and factors affecting decision-making. Management process- definition, Planning- importance, types, characteristics and techniques, Organizing; Controlling- definition, phases and factors, Evaluation. Management process applied to time - philosophy of time, tools of time management, process of time management. Management process applied to energy - concept, fatigue, measures to relieve fatigue, process of energy management and effective use of body. Management process applied to money - types and sources of income, methods of handling budget, management of money (Budgeting), steps in making budget, controlling budget and evaluation of budget. Work simplification - concept, techniques and classes of change.

#### 2. Housing and Space Management

3 (2+1)

Housing and its importance, housing needs at different stages of family life cycle. Selection of site, orientation and zoning. Factors considered while planning a house. Building bye-laws. Economy in constructing a house - Buying/ building a house, government / semi government housing. Housing problems in India. Housing finance.

**Practical:** Learning architectural symbols. Drawing of house plans for different income levels and activity groups. Drawing elevations of different house plans. House plan for renovation according to needs of residents.

#### 3. Fundamentals of Art and Design

3 (1+2)

Elements of art and principles of design - their application in rural and urban houses. Colour and its importance in interior decoration. Selection, care and maintenance of furniture and furnishings. Home lighting. Accessories. Table setting and table etiquettes.

**Practical:** Developments of motif and designs through art principles. Colour - obtaining standard colours, tints and shades, drawing of colour wheel and developing colour schemes. Care and arrangements of furniture for different purposes. Care of furnishings. Mounting of picture and hangings. Preparation and placements of accessories for interior enrichment. Table setting. Drawing of lighting plan.

#### **4. Family Economics and Consumer Education**

**3 (2+1)**

Meaning and scope of family finance management. Family - definitions, characteristics, its types and factors affecting family income and expenditure. Budgeting - steps and types of family budget, Engel's law of consumption. Account keeping and record keeping. Credit - need, types, use and credit institutions. Planning for family's financial security - savings, investments, insurance, taxation and will. Consumer - definition and role. Consumer problems in rural and urban areas. Consumerism - its growth, consumers right and responsibilities. Unfair trade practices - adulteration, faulty weights and measures etc., Sources of consumer information - advertisements, labels, packages etc. Consumer protection and welfare. Consumer protection laws.

**Practical:** Making personal and family budget, Family financial record keeping, Bank withdrawals, deposits, drafts etc. Visit to saving and insurance institutions. Calculation of credit costs and taxes. Adulteration detection. Critical analysis of labels and brands of consumer products, standardized marks, weights and measures etc.

#### **(b) PROFESSIONAL COURSES**

#### **IV. Interior and Exterior Space Designing\*/ Institutional House Keeping\*\***

##### **1. Furniture Design and Arrangement**

**3 (1+2)**

Furniture style in different periods. Types of furniture and their selection. Arrangements and care of different types of furniture. Cost estimation of furniture for different income groups and areas.

**Practical:** Designing comfortable furniture for various activities and space saving multipurpose furniture. Arrangement of furniture for various occasions and different income group on scale drawing with contents. Market survey for latest trends. Designing comfortable furniture used for work, rest, relaxation, sleep, physically handicapped and elderly persons.

##### **2. Floor and Floor Treatments**

**3 (1+2)**

Floor - definition, importance and types. Floor and floor treatment - types, care and maintenance. Carpet and rugs - its type and selection. Indoor and outdoor carpeting. Storage of floor covering, pretreatment and storage techniques.

**Practical:** Market survey for various types of floors and floor covering. Traditional and contemporary floor treatments. Care of floor coverings.

##### **3. Walls and Window Treatments**

**3(1+2)**

Exterior and interior wall materials. Finishes and surfacing - wall paper, paints, wood paneling, laminator, ceramic tiles, linoleum and fabrics, their care and maintenance. Wall elements - windows, doors and fire places - their types and styles. Windows treatments - suspension methods, factors influencing choice of window treatment.

**Practical:** Study of latest wall finishes and method of use; Market survey for various types of drapery and curtain materials and costs. Planning window dressings for different types of windows, problem windows and their treatment, element and principles of design in window treatments.

#### **4. Flower Arrangement**

**3 (1+2)**

Seasonal flowers – identification, characteristics, storage of seeds and bulbs, maintenance of lawns, identification and maintenance of potted plants.

**Practical:** Bonsai – important species and maintenance. Flower making from different materials. Flower collection, storage and arrangement. Care of flowers and foliage. Selection and preparation of plant materials. Drying and preservation of flowers and foliage. Application of flower arrangements for different areas and occasions. Preparation of permanent arrangement. Preparation of bouquets, garlands etc.

#### **5. Drawings in Interior\***

**4 (1+3)**

The theory of projections – Introduction. Types of axonometric drawings. Perspective drawings (one point, two point). Oblique drawings. Orthographic projection (Parallel projection). Isometric drawing. Different rendering techniques and rendering symbols used in architectural drawings.

**Practical:** To know about different projections and views - Orthographic projections and views. Isometric projection and view. Axonometric views. Oblique projection. Perspective drawings. Learning to draw isometric views from orthographic projections.

#### **6. Traditional and Contemporary Interiors\***

**3 (3+0)**

Concept of interior decoration in India. History of interior decoration. Architecture and decorative art. Period art in interior decoration. Changing ideas of homes in India – style, period, characteristics and adaptation of design in interiors. Traditional and modern handicrafts of India. Adventure in colour.

#### **7. Computer Aided Designing\***

**4 (0+4)**

**Practical:** Preparation of house plans, room layouts and home lighting arrangements with the help of software packages. Making of colour schemes for various rooms including placement of wall hangings and other accessories. Designing and cost estimation of material for furniture, upholstery and draperies.

#### **8. Basics in Building Construction\***

**4 (2+2)**

Foundations – definition, purpose of foundation, causes of failure of foundation. Damp proofing and water proofing. Walls and types. Masonry – stone masonry, brick masonry. Stairs, lintels and arches. Roof and roof coverings. Structural steel work. Specification for low cost buildings. Causes and prevention of cracks in buildings. Plastering and pointing, preliminary estimates for building / projects. Project management through PERT / CPM.

**Practical:** Types of foundations, Site inspection and preliminary investigation, Materials used for damp proofing. Treatment for damp proofing and water proofing. A visit to stone masonry and brick masonry sites. Drawing of different types of stairs. A visit to site for roof coverings. Preliminary estimates for a residential building. Drawing of any one network building. Analysis and scheduling of network.

## 9. Accessories for Interior Enrichment\*

3 (0+3)

**Practical:** Importance of accessories in home interiors. Types of accessories - functional and decorative, selection and placement in different areas of the house. Market survey on latest trends in accessories. Preparation of any ten accessories. Organizing an exhibition on accessories.

## 10. Fitting, Fixtures and Services\*

3 (1+2)

Interior and exterior fitting designs and styles. Wall, floor, window and cupboard fittings, kitchen and bathroom fittings and built in units. Wood paneling. Interior and exterior fixtures. Safety fittings - Locking system and remote control. Lighting fixtures and fittings for different rooms / areas and light control. Water supply system, drainage system, drainage bye-laws. Electrical layout and wiring system, bye - laws related to electricity. Special services, acoustics, garbage disposal, intercommunication system and anti termite treatment.

**Practical:** Market survey of latest fitting designs and fixtures. Bathroom fittings and fixture plan. Sanitary ware and fixtures plan. Kitchen fittings and fixtures plan. Walls, floors, work surface units, cabinets and storage plan. Exterior fittings and fixtures. Market study of lighting equipment - traditional and modern. Planning architectural luminaries. Schemes for exterior and interior environment. Visits to residential and commercial areas to study lighting fixtures and fittings. Study of water supply system drainage system and electrical layouts. Preparation and maintenance of compost pit for garbage disposal – vermiculture. Layout for inter – communication system.

## 11. Space Designing – I (Residential Buildings)\*

3 (0+3)

**Practical:** Plans of various residential buildings – single story, multi story, bungalow, flats, apartments, duplex, detached and semi detached. Planning various spaces – drawing room, dining room, bedroom, storage, kitchens, toilets, dressing and pooja room. Ergonomic designing of storage and cabinets. Elevations of residential building. Sections of residential building and different spaces. Perspective drawing of residential buildings and different spaces. Visits of residential building sites.

## 12. Landscape Designing\*

3 (1+2)

Introduction of landscaping from interior space design point of view. Historical references of landscape. Location and orientation. Climatic condition. Land profile. Soil types. Availability of water sources. Understanding of various materials for paving, walk ways etc (Stone masonry and brick masonry).

**Practical:** Fencing to entrance gate and other gates. Plan tree guards, sit-outs, open ground sheds for semi-shady plants, green house, gazebo, pedestals, monuments, statues, abstract etc. Study of indoor and outdoor plant species (natural/Artificial). Variety of shrubs, creepers, grass etc. (natural/artificial). Drainage - water drains through potted plants, rain water from terrace. Waterproofing and checking the strength of terrace slab for terrace garden. Water bodies - natural and artificial. Garden furniture. Designing of terrace garden. Designing of party outdoor and indoor landscaping.

### **13. Space Designing – II (Public Buildings)\***

**3 (1+2)**

Introduction to public building and its types. Building-by-laws. Lighting arrangement for public buildings. Ergonomic designing of spaces in public buildings. Functional designing for person regarding special need; Indoor climate of public buildings.

**Practical:** Plans of various public buildings - educational buildings, school, college and library, commercial buildings, banks, offices, recreational buildings: hotels, restaurant and clubs. Planning different spaces in public buildings. Elevations of different types of public buildings. Sections of different types of public buildings. Perspective of different types of public buildings. Visits to various public building sites.

### **14. Functional Interiors for Special Needs\***

**4 (2+2)**

Housing environments - Interior types based on functional needs, environment for specific purposes – interiors for youth, elderly and other special needs. Planning, programming, designing and evaluating interiors for elderly and special needs; Functional interior options for specific purposes and special needs including independent living, congregate living, shared living, continuing care environment and nursing care environments.

**Practical:** Simulating interior environments for specific purposes. Making master plan concepts through drawings of interior representations for special needs. Arranging simulated interiors for special needs specific purposes. Oral presentations and written reports of any functional master plan.

### **15. Entrepreneurship Development\***

**4 (1+3)**

Concept, need and process of entrepreneurship development. Government policies and schemes for entrepreneurship development. Developing entrepreneurial competencies. Setting up an enterprise – enterprise selection, market analysis, SWOT analysis, resource mobilization, finance, technology, raw material, site and man power. Identification of marketing strategies, packaging, quality control, advertisement, costing and taxation.

**Practical:** Visit to small scale industries. Study of pertinent enterprises in detail. Interaction with successful entrepreneurs. Preparation of project proposal for funding by different agencies.

### **16. Institutional House Keeping Concepts\*\***

**4 (2+2)**

Different types of institutions – meaning of organization, organizational structure, authority and delegation. Theories of organization – appraisal on the organizational set up of different institutions. Design and facilities in institutions. Communication techniques and skills – types of communication. Handling complaints and emergencies. Hostess training – image projection, grooming, hygiene, appearance, etiquette, poise, manner, duties and job descriptions of hostess. Hostess desk and management. Handling of room service – receiving guests and art of conversation.

**Practical:** Study of different institutions such as hospitals, hotels, guest houses, etc. on the organizational set up, functioning and facilities available. Review and evaluation reports on the institutions and submissions of reports. Practicing different techniques of communications and developing appropriate skill in hospitality. Mock sessions in handling complaints and emergencies. Practical exercises on etiquette, manners and art of conversation. Visits to

institutions to observe the characteristics, duties and responsibilities of hostess. Submission of report.

### **17. Institutional Maintenance\*\***

**4(2+2)**

Importance of periodical and regular maintenance of hardware and software used in institutions. Materials used in the maintenance of hardware and software- polishes, cleaning agents, stain removals etc. Room services. Treatment of water and waste. Public health regulations related to food handlings. Insect and pest control measures.

**Practical:** Visits to small, medium and large scale institutions to observe maintenance practices of hard and soft wares. Use of audio-visual aids to enrich students on institutional maintenance. Use of different cleaning agents for routine maintenance of institutional facilities.

### **18. Services: Residences and Establishments\*\***

**4 (2+2)**

Water supply system - water supply system to commercial and residential building, water tanks, water pipes, traps used in water supply system, taps, stop cocks (dimensions, sizes, material etc). Laying and fixing of water supply pipes,-water supply to bathroom, toilet, WC and kitchen. Bye- laws related to water supply. Drainage system - types of drainage system. Drainage system with municipal drain lines, drainage system using septic tank and soak pit. Types of drain pipes – dimensions, material etc., types of traps used in drainage system, drainage bye- laws. Electrical layout and wiring system, types of wire and conduits. Wiring system – wiring for fans, tube lights, television, telephone and domestic appliances. Types of lamps and light fixture, Bye laws related to electricity. Special service - types of air conditioning, air conditioning ducting layout. Fire fighting - fixtures and fittings, fire fighting layouts, fire fighting bye-laws. Acoustics - acoustic materials, techniques of implementing acoustic treatment. Garbage disposal - Vermi composting, garbage disposal for multi storied building. Inter communication system - technique of inter - communication system. Anti-termite treatment.

**Practical:** Study of water supply system, drainage system and electrical layouts. Preparation and maintenance of compost pit for garbage disposal – vermiculture. Layout for inter – communication system.

### **19. Table Service Management\*\***

**4 (2+2)**

Menu planning for different occasions. Delivery and service of food. Cost control factors. Table etiquette. Trends in table setting, Table appointment. Table ware and maintenance.

**Practical:** Table appointment.-cover flatware, hollow ware, dinnerware and beverage ware. Materials used for table appointments- china, porcelain, earthenware, pottery, stainless steel, stoneware, plastic, glassware and silverware. Setting the table-linens, table decoration, laying flatware, placing beverage ware, placing dinnerware, placing service dishes of food, setting the auxiliary service table, waiting on table, cleaning the table, serving at table, left hand and right hand service, serving the dessert course, serving of hot beverages. Setting the table for different occasions.

### **20. Hospitality and Hostess Training\*\***

**4 (2+2)**

Communication techniques and skills – types of communications, handling complaints and emergencies. Hostess training – image projection, grooming, hygiene, appearance, etiquette,

poise, manners. Duties and job description of hostess, hostess desk and management, handling of room service. Receiving guests, art of conversation.

**Practical:** Practicing different techniques of communication and developing appropriate skills in hospitality. Mock sessions in handling complaints and emergencies. Practical exercises on etiquette, manners, art of conversation. Visits to institutions to observe the characteristics, duties and responsibilities of a hostess. Submission of reports.

### **21. Storage Designing\*\***

**4 (1+3)**

Plan and layout of storage structure for various rooms/ areas/ different establishments as per the requirement. Factors influencing the need of storage space- climate, composition of family activities and interest.

**Practical:** Ergonomically designing of built in storage space, other storage structure for various rooms; Market survey.

### **22. Interior Designing and Decoration\*\***

**4 (2+2)**

Objective of interior decoration. Elements of Art and principles design in interior decoration. Colour – theories, characteristics and application of colour in interiors. Lighting- types and effect of architectural and decorative lighting, lighting requirements for various activities and areas, optical illusion, outdoor lighting. Texture- types and effects in interior designing and decoration.

**Practical:** Application of elements of art and principles of design in interior decoration. Planning of various areas and rooms of residential and institutional buildings. Planning colour schemes and lighting for various areas. Creating optical illusion. Estimating furnishing cost for different rooms/ areas.

### **23. Front Office Management\*\***

**4 (2+2)**

Importance of front office management and basic terminology used. Front Office coordination with other departments. Planning furniture and equipment for front reception – handling front office/ reception. Accommodation, reservation, activities, systems and documents, checking in and out. Maintenance of cash and account – maintenance of front office records. Guest relations, services and problems. Lobby arrangement.

**Practical:** Planning furniture and equipment for front office of different institutions. Observing and assisting the staff of front office in institutions. Preparing reports and reviews on the experiences and visits. Hands on experience in using front office systems.

### **24. Use and Care of Institutional Equipment\*\***

**4 (2+2)**

Types, use and care of institutional equipment – food related equipment, laundry equipment, cleaning equipment, recreational equipment, communication equipment, heating and cooling equipment, waste disposal equipment, safety equipment.

**Practical:** Handling and maintenance of different materials used in institutional equipment, appliances and tools.

## 25. Communication Skills\*\*

2 (0+2)

**Practical:** Impression management using verbal communication, using presentation skills that get results, using negotiation skills, motivating teams and raising accountability, using verbal communication to communicate vision strategy and goals clearly. Learning electronic and non electronic presentations.

Note: Courses without asterisk are common for both professional courses in FRM

## 6. HOME SCIENCE EXTENSION AND COMMUNICATION MANAGEMENT

### (a) CORE COURSES

#### 1. Home Science Extension and Rural Development

3 (3+0)

Extension education – concept, need and importance with special reference to Home Science, philosophy, principles and objectives. Concept and need of rural development, meaning aim and functions of extension education for rural development. Constraints in rural development. Changing scenario of rural India. Historical development of extension education – glimpses of evolution of extension during pre-independence era. Community development programme – concept, objectives organization, activities, achievement and failures. Panchayati Raj Institutions - concept, structure and function. Recent developmental programmes for rural families - WDP, SJSY, KVKs. Role of ICAR, SAUs and NGOs in rural development.

#### 2. Instructional Technology

3 (2+1)

Concept meaning and principles of teaching and learning in Home Science Extension. Classification of extension teaching methods. Communication approaches – individual, group and mass. Concept, use, importance and limitations of following extension teaching methods: Home visits; Discussion and meetings; Field trips; Campaign; Exhibition; Printed material; Demonstration and Dramatization. Selection of extension teaching methods. Audiovisual aids-meaning, importance, classification and functions. Graphic communication media - charts, posters, flash cards, bulletin board display, leaflet, folder and pamphlet. Projected aids-transparencies and slides. Electronic media – Radio, T.V., Internet, E-mail. Three dimensional communication aids – specimen, objects and models. Folk media-importance and types.

**Practical:** Familiarization with accessories for preparing instructional materials. Preparation and use of following audio visual aids – charts /posters /flash cards, bulletin board display, transparencies, Puppets. Handling of slide projector and overhead projector. Planning and use of selected extension teaching methods.

#### 3. Communication and Adoption

3 (3+0)

Communication – concept, importance, elements. Communication barriers and ways to overcome them. Diffusion – concept and elements. Meaning of related terms – innovation, adoption, innovation-decision process, rate of adoption, discontinuance, over adoption, social change, change agent and opinion leaders, change proneness. Characteristics of innovation with special reference to homestead technologies. Communication channels for technology transfer. Stages of adoption process (Innovation Decision Process). Adopter categories. Rate

of adoption and factors affecting adoption. Consequences of adoption. Constraints in adoption of technologies.

#### **4. Programme Planning, Implementation and Evaluation** **3 (2+1)**

Programme planning – Concept and importance; objectives and principles. Steps in programme planning. Involvement of local people in planning programme, Leader and Leadership – meaning, qualities and roles. Types of leaders – identification and training of leaders, Execution of programme – Environment building; Involvement of local leaders, local bodies, organizations and extension agencies; Constraints in implementation of programme at grass root level and ways to overcome them. Monitoring and evaluation of Extension programme – concept, importance types and techniques. Concept of five year plans and rural development . Participatory Rural Appraisal - Concept and techniques.

**Practical:** Establishing rapport with rural families. Conducting village and household survey. Development of small need based programme, its implementation and evaluation. Writing report and its presentation.

#### **(b) PROFESSIONAL COURSES**

### **V. Information Technology and Communication Management**

#### **1. Print Journalism** **4 (1+3)**

Journalism Concepts. Concepts related with print journalism. Role of press in development. Trends in print media. Principles of print media. Press laws, ethics and issues. Rural press and its importance in development. News gathering and interviewing techniques. News agencies and their working. Writing, editing, proof reading and reporting news, news stories, press release.

**Practical:** Developing, designing and layout of various types of print materials-handout, leaflet, newspaper, newsletter and announcement. Working on a lab journal by application of writing, editing, and proof reading skills and final production. Testing the readability of prepared material. Visit to press.

#### **2. Electronic Journalism** **4 (1+3)**

Introduction to electronic media - Expansion of radio and TV network. Role of TV and radio network in development. Writing and editing script for TV and radio programme. Media policies, laws and ethics for electronic journalism.

**Practical:** Learning about basics of radio and TV production techniques. Gathering Radio and TV news, visualizing news, field reporting of specialized news-cultural, political, sports, developmental etc. compiling, editing, news reading, anchoring, and presenting radio and TV news. Planning and production of radio and TV programmes.

#### **3. Photojournalism** **4 (1+3)**

Concept of photo journalism, Principles of photojournalism. Qualities of photojournalists. Understanding different types of camera and their handling. Techniques and processing of photography.

**Practical:** Handling and use of photographic equipment. Techniques of photography using different types of camera and computer. Exposing, developing, printing, caption writing, photo editing, writing and reporting for photo features, exhibitions and displays etc.

**4. Mass Communication** **4 (1+3)**

Meaning, nature, importance and characteristics of mass communication. Different mass media - their characteristics and use in communication. Trends in media and technology. Application of computer based instruction in extension.

**Practical:** Preparation of instructional modules for different mass media.

**5. Designing Information Material** **4 (1+3)**

Principles of designing, Different software for print media and presentation material. Field testing – concept and importance.

**Practical :** Operation and use of applied software like M.S. Office, Power Point, Corel Draw/Illustrator, PhotoShop, Page Maker, Graphics, Animation, DTP, etc., Preparing Computer aided aids - Leaflet/Handout/Poster, Booklet/flipbook, Slides. Field testing of any one developed aid. Web page for computer advertisement.

**6. Instructional Video Production** **4 (1+3)**

Use of video in mass communication. Understanding video camera and it's parts. Different video formats and its accessories. Steps in video production - planning for scripting, recording and editing.

**Practical:** Familiarization and handling of video camera - changing and loading battery pack, inserting video cassette, focusing, zooming and shooting. Script writing, recording, editing and evaluating the prepared programme.

**7. Audio Video Recording and Editing** **4 (1+3)**

Understanding the utility of sound recording. Different equipments and its parts, their functions, advantages and limitations. Software required in sound recording and sound effects. Understanding the role of preparing Audio Video programmes for video production. Video capturing, titling, designing graphics and editing, video talking, video story telling and targeted documentation.

**Practical:** Familiarization with sound recording equipment and their handling. Acquiring competencies in learning sound recording software. Video capturing - learning to handle video capturing software. Sound video editing.

**8. Digital Advertising** **4 (1+3)**

Advertising-concept, importance, role, types, elements, principles and techniques. Principles and types of designing. Planning of advertisements for different media-print, radio, television, (folders, banners, posters, wall writings, cartoons etc.)

**Practical:** Familiarization and handling of the digital camera, capturing on computer, editing and presentation.

**9. Multimedia Production** **4 (1+3)**

Multimedia – Concept, importance and application. Process of developing multimedia. Software for producing multimedia and interface elements. Hardware for multimedia – video capture card and CD-writer. Understanding the use of LCD panel and projector for multimedia presentation.

**Practical:** Multimedia applications. Operational handling of CD-Writer and multimedia kit. Multimedia development process. Designing the interface elements, Production and preparation of output of developed one multimedia package in the form of C.D. Use of LCD panel and projector.

## **10. Training and HRD**

**3 (1+2)**

Training–concept, need and importance of training for HRD in Home Science. Concept, dimension, need and strategic intervention in HRD. Facilitation skills in training and different training methods. Designing , conducting and evaluation of training programmes.

**Practical:** Planning and practicing different training methods. Conducting case studies of selected ongoing training programme. Designing and conducting training programmes for HRD of 3-5 days duration. Developing and use of evaluation tools for measuring learning outcomes.

## **11. Project Management**

**3 (1+2)**

An overview of project management. Project initiation and resource allocation. Market and demand analysis. Environmental appraisal of projects. Cost benefit analysis. Project planning formulation, budgeting, scheduling, monitoring and control.

**Practical:** Identification of clientele. Planning and development of a viable project. Visit to different banks and other financing institutions. Studying new schemes for financing home related projects.

## **12. Entrepreneurship Development for Rural Families**

**4 (1+3)**

Concept, need and importance of entrepreneurship development for farm families. Process of initiating enterprise. Type of enterprises - their merits and demerits. Government policies and schemes for entrepreneurship development among farm women. Entrepreneurial motivation. Competencies required in women entrepreneurs - management of financial resources, launching and organizing enterprise, marketing management.

**Practical:** Visit to a small scale and cottage industry. Study of one enterprise in detail. Preparing a project proposal for submitting to a funding agency. Interaction with successful women entrepreneurs.

## **13. Public Relations and Social Marketing**

**4 (1+3)**

Relevance of public relations in changing scenario including public, private and governmental sector. Public relation – laws and ethics. Concept and philosophy of social marketing. Marketing V/S sale. Principles of social marketing. Importance of social marketing in development. Social marketing requirements and changing Indian marketing situations. Marketing oriented strategic planning, scanning the marketing environment, analyzing the consumer market and buyer behaviour, managing marketing channels etc.

**Practical:** Practical exercise on designing and pricing social products. Role of social marketing in change in public behaviour. Scanning Social market situations – strategies and constraints. Controlling and evaluating social marketing strategy.

**Syllabus**

**For**

**B. Tech. (Agricultural Engineering)**

# AGRICULTURAL ENGINEERING

## 1. BASIC SCIENCES AND HUMANITIES

### 1. Engineering Mathematics-I

3 (3+0)

Differential calculus: Taylor's and Maclaurin's expansions; indeterminate form; curvature, asymptotes, tracing of curves, function of two or more independent variables, partial differentiation, homogeneous functions and Euler's theorem, composite functions, total derivatives, derivative of an implicit function, change of variables, Jacobians, error evaluation, maxima and minima. Integral calculus: Reduction formulae; rectification of standard curves, volumes and surfaces of revolution of curves; double and triple integrals, change of order of integration, Gamma and Beta functions, application of double and triple integrals to find area and volume. Ordinary differential equations: Exact and Bernoulli's differential equations, equations reducible to exact form by integrating factors, equations of first order and higher degree, Clairaut's equation, Differential equations of higher orders, methods of finding complementary functions and particular integrals, method of variation of parameters, Cauchy's and Legendre's linear equations, simultaneous linear differential equations with constant coefficients, series solution techniques, Bessel's and Legendre's differential equations. Vector calculus: Differentiation of vectors, scalar and vector point functions, vector differential operator Del, Gradient of a scalar point function, Divergence and Curl of a vector point function and their physical interpretations, identities involving Del, second order differential operator; line, surface and volume integrals, Stoke's, divergence and Green's theorems (without proofs).

### 2. Engineering Physics

3 (2+1)

Dia, Para and ferromagnetism-classification. Langevin theory of dia and paramagnetism. Adiabatic demagnetization, Weiss molecular field theory and ferromagnetism. Curie-Weiss law. Wave particle quality, de-Broglie concept, uncertainty principle. Wave function, Time dependent and time independent Schrodinger wave equation, Qualitative explanation of Zeeman effect, Stark effect and Paschan Back effect, Raman spectroscopy. Statement of Bloch's function, Bands in solids, velocity of Bloch's electron and effective mass. Distinction between metals, insulators and semiconductors, Intrinsic and extrinsic semiconductors, law of mass action, Determination of energy gap in semiconductors, Donors and acceptor levels. Superconductivity, critical magnetic field, Meissner effect, Isotope effect, Type-I and II superconductors, Josephson's effect DC and AC, Squids, Introduction to high  $T_c$  superconductors. Spontaneous and stimulated emission, Einstein A and B coefficients, Population inversion, He-Ne and Ruby lasers, Ammonia and Ruby masers, Holography-Note. Optical fiber, Physical structure, basic theory. Mode type, input output characteristics of optical fiber and applications. Illumination: laws of illumination, luminous flux, luminous intensity, candle power, brightness

**Practical:** To find the frequency of A.C. supply using an electrical vibrator; To find the low resistance using Carey Foster bridge without calibrating the bridge wire; To determine dielectric constant of material using De Sauty's bridge; To determine the value of specific charge (e/m) for electrons by helical method; To study the induced e.m.f. as a function of velocity of the magnet; To obtain hysteresis curve (B-H curve) on a C.R.O. and to determine related magnetic quantities; To study the variation of magnetic field with distance along the axis of a current carrying circular coil and to determine the radius of the coil; To determine the energy band gap in a semiconductor using a p-n Junction diode; To determine the slit

width from Fraunhofer diffraction pattern using laser beam; Determination of ultrasonic wave velocity in a liquid medium; To find the numerical aperture of optical fiber; To set up the fiber optic analog and digital link; To study the phase relationships in L.R. circuit; To study LCR circuit; To study the variations of thermo e.m.f. of a copper-constantan thermocouple with temperature; To find the wave length of light by prism.

### 3. Engineering Chemistry

3 (2+1)

Phase rule and its application to one and two component systems. Fuels: classification, calorific value. Colloids: classification, properties. Corrosion: causes, types and method of prevention. Water: temporary and permanent hardness, disadvantages of hard water, scale and sludge formation in boilers, boiler corrosion. Analytical methods like thermogravimetric, polarographic analysis, nuclear radiation, detectors and analytical applications of radio active materials. Enzymes and their use in the manufacturing of ethanol and acetic acid by fermentation methods. Principles of food chemistry, introduction to lipids, proteins, carbohydrates, vitamins, food preservatives, colouring and flavouring reagents of food. Lubricants: properties, mechanism, classification and tests. Polymers. types of polymerization, properties, uses and methods for the determination of molecular weight of polymers. Introduction to IR spectroscopy.

**Practical:** Determination of temporary and permanent hardness of water by EDTA method; Estimation of chloride in water; Estimation of dissolved oxygen in water; Determination of BOD in water sample; Determination of COD in water sample; Estimation of available chlorine in bleaching powder; Determination of viscosity of oil; Estimation of activity of water sample; Estimation of alkalinity of water sample; Determination of carbonate and non-carbonate hardness by soda reagent; Determination of coagulation of water and chloride ion content; Determination of specific rotation of an optically active compound; Determination of  $\lambda_{\max}$  and verification of Beer Lambert Law; Determination of calorific value of fuel; Identification of functional groups (alcohol aldehyde, ketone, carboxylic acid and amide) by IR; Chromatographic analysis; Determination of molar refraction of organic compounds.

### 4. Environmental Science

3 (3+0)

Definition, Scope and Importance. Ecosystem: Types, structure and functions : Bio-diversity: value, threats and conservation. Natural Resources: forest, mineral, soil and water –their uses and abuses. Environmental pollution –Causes, effects and control measures of air, water, soil, marine, thermal and noise pollution. Nuclear hazards. Bio-safety and risk assessment. Rural and urban waste management. Global warming. Environmental act and related issues. Human population, health and social welfare.

### 5. Engineering Mathematics-II

3 (3+0)

Matrices: Elementary transformations, rank of a matrix, reduction to normal form, Gauss-Jordan method to find inverse of a matrix, consistency and solution of linear equations, Eigen values and Eigen vectors, Cayley-Hamilton theorem, linear transformation, orthogonal transformations, diagonalisation of matrices, Bilinear and quadratic forms. Functions of a Complex variable: Limit, continuity and derivative of complex functions, analytic function, Cauchy-Reimann equations, conjugate functions, Harmonic functions. Fourier series: Infinite series and its convergence, periodic functions, Fourier series, Euler's formulae, Dirichlet's conditions, functions having arbitrary period, even and odd functions, half range series, Harmonic analysis. Partial differential equations: Formation of partial differential equations, Lagrange's linear equation, Higher order linear partial differential equations with constant

coefficients, solution of non-linear partial differential equations, Charpit's method, application of partial differential equations (one dimensional wave and heat flow equations, two dimensional steady state heat flow equation (Laplace equation).

## **6. Engineering Mathematics-III**

**3 (3+0)**

Numerical analysis: Finite differences, various difference operators and their relationships, factorial notation, interpolation with equal intervals, Newton's forward and backward interpolation formulae, Bessel's and Stirling's central difference interpolation formulae, interpolation with unequal intervals, Newton's divided difference formula, Lagrange's interpolation formula; numerical differentiation, differentiation based on equal interval interpolation, first and second order derivatives by using Newton's forward and backward, Stirling's and Bessel's formulae; maxima and minima of a tabulated function, numerical integration, numerical integration by Trapezoidal, Simpson's and Weddle's rules; Difference equations, order of a difference equation, solution of linear difference equation, rules for finding complimentary function and particular integral; numerical solution of ordinary differential equations by Picard's method, Taylor's series method, Euler's method, modified Euler's method, Runge-Kutta method. Laplace transforms: Definition of Laplace transform, Laplace transforms of elementary functions, properties of Laplace transforms, inverse Laplace transforms, transforms of derivatives, integrals, transform of function multiplied by  $t^n$ , transform of function divided by  $t$ , convolution theorem; application of Laplace transforms to solve ordinary differential equations and simultaneous differential equations, Laplace transforms of unit step function, unit impulse function, periodic function.

## **2. AGRICULTURAL SCIENCES**

### **1. Agriculture for Engineers**

**4 (3+1)**

Soils: Nature and origin of soil; soil forming rocks and minerals, their classification and composition, soil forming processes, classification of soils – soil taxonomy orders; important soil physical properties; and their importance; soil particle distribution; soil inorganic colloids – their composition, properties and origin of charge; ion exchange in soil and nutrient availability; soil organic matter – its composition and decomposition, effect on soil fertility; soil reaction – acid, saline and sodic soils; quality or irrigation water; essential plants nutrients – their functions and deficiency symptoms in plants; important inorganic fertilizers and their reactions in soils. Agronomy: Definition and scope of agronomy. Classification of crops, Effect of different weather parameters on crop growth and development. Principles of tillage, tith and its characteristics. Soil water plant relationship and water requirement of crops, weeds and their control, crop rotation, cropping systems, Relay cropping and mixed cropping. Horticulture: Scope of horticultural and vegetable crops. Soil and climatic requirements for fruits, vegetables and floriculture crops, improved varieties, Criteria for site selection, layout and planting methods, nursery raising, macro and micro propagation methods, plant growing structures, pruning and training, fertilizer application, fertigation, irrigation methods, harvesting, grading and packaging, post harvest practices, Garden tools, management of orchard, Extraction and storage of vegetables seeds.

**Practical:** Identification of rocks and minerals; Examination of soil profile in the field; Determination of bulk density; particle density and porosity of soil; Determination of organic carbon of soil; Identification of crops and their varieties seeds and weeds; Fertilizer application methods; Different weed control methods; Judging maturity time for harvesting of crop; Study of seed viability and germination test; Identification and description of

important fruit; flowers and vegetables crops; Study of different garden tools; Preparation of nursery bed; Practices of pruning and training in some important fruit crops.

### **3. CIVIL ENGINEERING**

#### **1. Surveying and Leveling**

**3 (1+2)**

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

**Practical:** Chain survey of an area and preparation of map; Compass survey of an area and plotting of compass survey; Plane table surveying; Leveling. L-section and X-sections and its plotting; Contour survey of an area and preparation of contour map; Introduction of software in drawing contour; Theodolite surveying; Ranging by theodolite, Height of object by using theodolite; Setting out curves by theodolite; Minor instruments.

#### **2. Engineering Drawing**

**2 (0+2)**

**Practical:** Introduction of drawing scales; Principles of orthographic projections; Reference planes; Points and lines in space and traces of lines and planes; Auxiliary planes and true shapes of oblique plain surface; True length and inclination of lines; Projections of solids (Change of position method, alteration of ground lines); Section of solids and Interpenetration of solid-surfaces; Development of surfaces of geometrical solids; Isometric projection of geometrical solids.

#### **3. Engineering Mechanics**

**3 (2+1)**

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

**Practical:** Problems on; Composition and resolution of forces, moments of a force, couples, transmission of a couple, resolution of a force into a force & a couple; Problems relating to resultant of; a concurrent - coplaner force system, nonconcurrent - coplaner force system, nonconcurrent - noncoplaner force system, parallel - noncoplaner force system, system of couples in space; Problems relating to centroids of composite areas; Problems on moment of inertia, polar moment of inertia, radius of gyration, polar radius of gyration of composite areas; Equilibrium of concurrent – coplaner and nonconcurrent – coplaner force systems; Problems involving frictional forces; Analysis of simple trusses by method of joints and method of sections; Analysis of simple trusses by graphical method; Problems relating to simple stresses and strains; Problems on shear force and bending moment diagrams; Problems relating to stresses in beams; Problems on torsion of shafts; Analysis of plane and complex stresses.

#### **4. Soil Mechanics**

**3 (2+1)**

Introduction of soil mechanics, field of soil mechanics, phase diagram physical and index properties of soil classification of soils, general classification based on particles size, textural classification and I.S. soil classification system stress condition in soils, effective and neutral

stress, elementary concept of Bousinesque and Westergaard's analysis, Newmark influence chart. Shear strength Mohr stress circle, theoretical relationship between principal stress Mohr-Coulomb failure theory, effective stress principle. Determination of shear parameters by direct shear test, Mohr circle, theoretical test. Numerical exercise based on various types of tests. Compaction: Standard and modified Proctor test, AASHTO compaction and Jodhpur mini compaction test. Field compaction method and control. Consolidation of soil: Consolidation of soils, one dimensional consolidation spring analogy, Terzaghi's theory. Laboratory consolidation test, calculation of void ratio and coefficient of volume change, Taylor's and Casagrande's method, determination of coefficient of consolidation. Earth pressure: Plastic equilibrium in soils, active and passive states, Rankine's theory of earth pressure active and passive earth pressure for cohesive soils, simple numerical exercise. Stability of slopes: Introduction to stability analysis of infinite and finite slopes friction circles method Taylor's stability number.

**Practical:** Determination of water content of soil; Determination of specific gravity of soil; Determination of field density of soil by core cutter method; Determination of field density by sand replacement method; Grain size analysis by sieving (Dry sieve analysis); Grain size analysis by hydrometer method; Determination of liquid limit by Casagrande's method; Determination of liquid limit by cone penetrometer and plastic limit; Determination of shrinkage limit; Determination of permeability by constant head method; Determination of permeability by variable head method; Determination of compaction properties by standard Proctor test; Determination of shear parameters by Direct shear test; Determination of unconfined compressive strength of soil; Determination of shear parameters by Triaxial test; Determination of consolidation properties of soils.

## 5. Fluid Mechanics

3 (2+1)

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

**Practical:** Study of manometers and pressure gauges; Verification of Bernoulli's theorem; Determination of coefficient of discharge of venturimeter and orifice meter; Determination of coefficient of friction in pipeline; Determination of coefficient of discharge for rectangular and triangular notch; Determination of coefficient of discharge, coefficient of velocity and coefficient of contraction for flow through orifice; Determination of coefficient of discharge for mouth piece; Measurement of force exerted by water-jets on flat and hemispherical vanes; Determination of metacentric height; Determination of efficiency of hydraulic ram; Performance evaluation of Pelton and Francis turbine; Study of current meter; Velocity distribution in open channels and determination of Manning's coefficient of rugosity.

## 6. Strength of Materials

3 (2+1)

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

**Practical:** To perform the tension test on metal specimen (M.S., C.I.), to observe the behaviour of materials under load, to calculate the value of E, ultimate stress, permissible stress, percentage elongation etc. and to study its fracture; To perform the compression test on; Concrete cylinders & cubes, C.I., M.S. & Wood specimens and to determine various physical and mechanical properties; To perform the bending test on the specimens; M.S. Girder, Wooden beam, Plain concrete beams & R.C.C. beam, and to determine the various physical and mechanical properties; To determine Young's modulus of elasticity of beam with the help of deflection produced at centre due to loads placed at centre & quarter points; To study the behaviour of materials (G.I. pipes, M.S., C.I.) under torsion and to evaluate various elastic constants; To study load deflection and other physical properties of closely coiled helical spring in tension and compression; To perform the Rockwell, Vicker's and Brinell's Hardness tests on the given specimens; To perform the Drop Hammer Test, Izod Test and Charpay's impact tests on the given specimens; To determine compressive & tensile strength of cement after making cubes and briquettes; To measure workability of concrete (slump test, compaction factor test); To determine voids ratio & bulk density of cement, fine aggregates and coarse aggregates; To determine fatigue strength of a given specimen; To write detail report emphasizing engineering importance of performing tension, compression, bending, torsion, impact and hardness tests on the materials

## 7. Design of Structures

3 (2+1)

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

**Practical:** Design and drawing of steel roof truss; Design and drawing of RCC building; Design and drawing of Retaining wall.

## 4. COMPUTER SCIENCE AND ELECTRICAL ENGINEERING

### 1. Computer Programming and Data Structures

3 (1+ 2)

Introduction to high level languages, Primary data types and user defined data types, Variables, typecasting, Operators, Building and evaluating expressions, Standard library functions, Managing input and output, Decision making, Branching, Looping, Arrays, User defined functions, passing arguments and returning values, recursion, scope and visibility of a variable, String functions, Structures and union, Pointers, Stacks, Push/Pop operations, Queues, Insertion and deletion operations, Linked lists.

**Practical:** Familiarizing with Turbo C IDE; Building an executable version of C program; Debugging a C program; Developing and executing simple programs; Creating programs using decision making statements such as if, go to & switch; Developing program using loop statements while, do & for; Using nested control structures; Familiarizing with one and two

dimensional arrays; Using string functions; Developing structures and union; Creating user defined functions; Using local, global & external variables; Using pointers; Implementing Stacks; Implementing push/pop functions; Creating queues; Developing linked lists in C language; Insertion/Deletion in data structures.

## 2. Applied Electronics and Instrumentation

3(2+1)

Semiconductors, p-n junction, V-I characteristics of p-n junction, diode as a circuit element, rectifier, clipper, clamper, voltage multiplier, capacitive filter, diode circuits for OR & AND (both positive and negative logic), bipolar junction transistor: operating point, classification(A,B & C) of amplifier, various biasing methods (fixed, self, potential divider), h-parameter model of a transistor, analysis of small signal, CE amplifier, phase shift oscillator, analysis of differential amplifier using transistor, ideal OP-AMP characteristics, linear and non-linear applications of OP-AMP (adder, subtractor, integrator, active rectifier, comparator, differentiator, differential, instrumentation amplifier and oscillator), zener diode voltage regulator, transistor series regulator, current limiting, OP-AMP voltage regulators, Basic theorem of Boolean algebra, Combinational logic circuits(basic gates, SOP rule and K-map), binary ladder D/A converter, successive approximation A/D converter, generalized instrumentation, measurement of displacement, temperature, velocity, force and pressure using potentiometer, resistance thermometer, thermocouples, bourden tube, LVDT, strain gauge and tacho-generator.

**Practical:** To study V-I characteristics of p-n junction diode; To study half wave, full wave and bridge rectifier; To study transistor characteristics in CE configurations; To design and study fixed and self bias transistor; To design and study potential divider bias transistor; To study a diode as clipper and clamper; To study a OP-AMP IC 741 as inverting and non-inverting amplifier; To study a OP-AMP IC 741 as differentiator amplifier; To study a differential amplifier using two transistor; To study a OP-AMP IC 741 as differential amplifier; To study a zener regulator circuit; To study a OP-AMP IC 741 as a active rectifier; To study a OP-AMP IC 741 as a comparator; To familiarize with various types of transducers.

## 3. Electrical Machines and Power Utilization

3 (2+1)

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

**Practical:** To get familiar with AC, DC machines and measuring instruments; To perform open circuit and short circuit tests on a single phase transformer and hence find equivalent circuit, voltage regulation and efficiency; To study the constructional details of D.C. machine and to draw sketches of different components; To obtain load characteristics of d.c.

shunt/series /compound generator; To study characteristics of DC shunt/ series motors; To study d.c. motor starters; To Perform load-test on 3 ph. induction motor & to plot torque V/S speed characteristics; To perform no-load & blocked –rotor tests on 3 ph. Induction motor to obtain equivalent ckt. parameters & to draw circle diagram; To study the speed control of 3 ph. induction motor by cascading of two induction motors, i.e. by feeding the slip power of one motor into the other motor; To study star- delta starters physically and (a) to draw electrical connection diagram (b) to start the 3 ph. induction motor using it. (c) to reverse the direction of 3 ph. I.M.; To start a 3-phase slip –ring induction motor by inserting different levels of resistance in the rotor ckt. and to plot torque –speed characteristics; To perform no-load & blocked –rotor test on 1 ph. induction motor & to determine the parameters of equivalent ckt. drawn on the basis of double revolving field theory; To perform load –test on 1 ph. induction motor & plot torque –speed characteristics.

#### **4. Database Management and Internet Applications**

**2 (0+2)**

**Practical:** Basic database concepts, introduction to RDBMS, SQL Commands, Data constraints, Joins, set operations, working with forms, Basics of HTML, developing web pages using meta tags, dynamic pages using Java scripts, connectivity with RDBMS, Project. Basic database concepts; Introduction to RDBMS; SQL Commands DDL, DML; Select command, Joins and functions; Group functions, Set functions; Working with Forms; Basic of HTML; Development of Web pages using meta tags; Dynamic pages using Java Scripts; Connectivity of Web pages with databases; Project.

#### **5. Electrical Circuits**

**3 (2+1)**

Average and effective value of sinusoidal and linear periodic wave forms. Independent and dependent sources, loop current and loop equations (Mesh current method), node voltage and node equations (Nodal voltage method), Network theorems: Thevenin's, Norton's, Superposition, Reciprocity and Maximum power transfer, Star- Delta conversion solution of DC circuit by Network theorems, Sinusoidal steady state response of circuits, Instantaneous and average power, power factor, reactive and apparent power, Concept and analysis of balanced polyphase circuits, Laplace transform method of finding step response of DC circuits, Series and parallel resonance, Classification of filters, constant-k, m-derived, terminating half network and composite filters.

**Practical:** To familiarize with the components and equipments used in Laboratory; To verify Kirchhoff's current laws; To verify Kirchhoff's voltage laws; To verify Thevenin theorems; To verify Norton's theorems; To verify Superposition theorem; To verify reciprocity theorem; To study the sinusoidal response of RL series circuit; To study the sinusoidal response of RC series circuit; To study the step response of RL series circuit; To study the step response of RC series circuit; To study the response of constant K-filters; To study the response of m-derived filters; To study power consumed in a three-phase circuit.

### **5. MECHANICAL ENGINEERING**

#### **1. Workshop Practice**

**1 (0+1)**

**Practical:** Introduction to various carpentry tools, materials, types of wood and their characteristics and Processes OR operations in wood working; Preparation of simple joints: Cross half Lap joint and T-Halving joint; Preparation of Dovetail joint, Mortise and tenon joint; Introduction to Smithy tools and operations; Jobs on Bending, shaping etc.; Jobs on Drawing, Punching, Rivetting; Introduction to tools and measuring instruments for fitting; Jobs on sawing, filing and right angle fitting of MS Flat; Practical in more complex fitting

job; Operations of drilling, reaming, and threading with tap and dies; Practical test; Introduction to tools and operations in sheet metal work; Making different types of sheet metal joints using G.I. sheets.

## **2. Thermodynamics and Heat Engines**

**4 (3+1)**

Thermodynamics properties, closed and open system, flow and non-flow processes, gas laws, laws of thermodynamics, internal energy. Application of first law in heating and expansion of gases in non-flow processes. First law applied to steady flow processes. Kelvin-Planck and Clausius statements. Reversible processes, Carnot cycle, Carnot theorem. Entropy, physical concept of entropy, change of entropy of gases in thermodynamics processes. Difference between gas and vapour, change of phase during constant pressure process. Generation of steam, triple point and critical point. Internal energy and entropy of steam. Use of steam tables and Mollier chart, heating and expansion of vapour in non-flow processes, measurement of dryness fraction. Classification of steam boilers, Cochran, Lancashire, locomotive and Babcock-Wilcox boilers. Boiler mountings and accessories. Desirable properties of working fluid used for power plants. Rankine cycle. Expansive and non expansive working. Saturation curve and missing quantity, governing. Calculations of cylinder dimensions, Introduction to compound steam engines. Air Standard efficiency, other engine efficiencies and terms. Otto, diesel and dual cycles. Calculation of efficiency, mean effective pressure and their comparison. Measurement of IP, BP and heat balance calculations (not involving combustion). Engine efficiencies and performance.

**Practical:** Study of boilers; Study of various mountings and accessories of boilers; Study of steam engine; To measure dryness fraction of steam; Performance test of steam engine; Study of I.C. engines; Study of valve timing diagram of 2-stroke engines; Study of valve timing diagram of 4-stroke engines; Performance test on 2- cylinder diesel engines; Performance test and heat balance test on a four cylinder horizontal diesel engine; Practical test; To conduct Morse test on multi-cylinder petrol engine; Comparison of different temperature measuring methods; To verify inverse square law of radiation; To verify Stefan-Boltzman relationship; To determine the emissivity of a given material.

## **3. Heat and Mass Transfer**

**2 (2+0)**

Introductory concepts, modes of heat transfer, thermal conductivity of materials, measurement. General differential equation of conduction. One dimensional steady state conduction through plane and composite walls, tubes and spheres with and without heat generation. Electrical analogy. Insulation materials, critical thickness of insulation. Fins, Free and forced convection. Newton's law of cooling, heat transfer coefficient in convection. Dimensional analysis of free and forced convection. Useful non dimensional numbers and empirical relationships for free and forced convection. Equation of laminar boundary layer on flat plate and in a tube. Laminar forced convection on a flat plate and in a tube. Combined free and forced convection. Introduction. Absorptivity, reflectivity and transmissivity of radiation. Black body and monochromatic radiation, Planck's law, Stefan-Boltzman law, Kirchoff's law, grey bodies and emissive power, solid angle, intensity of radiation. Radiation exchange between black surfaces, geometric configuration factor. Heat transfer analysis involving conduction, convection and radiation by networks. Types of heat exchangers, fouling factor, log mean temperature difference, heat exchanger performance, transfer units. Heat exchanger analysis restricted to parallel and counter flow heat exchangers. Steady state molecular diffusion in fluids at rest and in laminar flow, Flick's law, mass transfer coefficients. Reynold's analogy.

#### 4. Workshop Technology

3 (2+1)

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

**Practical:** Introduction to welding equipment, processes tools, their use and precautions; Jobs on ARC welding – Lap joint, butt joint; T-Joint and corner joint in Arc welding; Gas welding Practice – Lab, butt and T-Joints; Introduction to metal casting equipment, tools and their use; Mould making using one-piece pattern and two pieces pattern; Demonstration of mould making using sweep pattern, and match plate patterns; Practical test; Introduction to machine shop machines and tools; Demonstration on Processes in machining and use of measuring instruments; Practical jobs on simple turning, step turning; Practical job on taper turning, drilling and threading; Operations on shaper and planer, changing a round MS rod into square section on a shaper; Demonstration of important operations on a milling machine, making a plot, gear tooth forming and indexing; Any additional job.

#### 5. Theory of Machines

3 (2+1)

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

**Practical:** Demonstration in mechanisms study using models; Analysis of 4-bar mechanism, slider crank mechanism and their inversions; Complete velocity and acceleration analysis (Graphical or Analytical) of few practical linkage mechanisms; Study of gears and gear trains and motion analysis of some practical complex compound gear train; Motion analysis Epicyclic gear trains using tabular and formula methods; To design a compound gear train and epicyclic gear train for a desired speed ratio; Practical test; To study the flywheel and governor action in laboratory; To graphically synthesize the cam profile for a desired standard follower motion; Study on the cam follower demonstration machine for follower

displacement as a function of cam rotation angle and phenomenon of follower jump; Demonstration of static and dynamic balancing in the laboratory. Calculations on balancing a multi rotor unbalanced system by putting masses in two different planes.

## **6. CAD/CAM Computer Graphics and Machine Drawing**

**3 (1+2)**

First and third angle methods of projection. Preparation of working drawing from models and isometric views. Drawing of missing views. Different methods of dimensioning. Concept of sectioning. Revolved and oblique section. Sectional drawing of simple machine parts. Types of rivet heads and riveted joints. Processes for producing leak proof joints. Symbols for different types of welded joints. Nomenclature, thread profiles, multi-start threads, left and right hand thread. Square headed and hexagonal nuts and bolts. Conventional representation of threads. Different types of lock nuts, studs, machine screws, cap screws and wood screws. Foundation bolts. Design process, application of computers for design, definition of CAD, benefits of CAD, CAD system components. Computer hardware for CAD. Display, input and output devices. Graphic primitives, display file, frame buffer, display control, display processors, Line generation, graphics software. Points and lines, Polygons, filling of polygons. Text primitive. Other primitives. Windowing and clipping, view port. Homogeneous coordinates. Transformations. Planar and space curves design. Analytical and synthetic approaches. Parametric and implicit equations. B-spline and Bezier curves. Geometric modeling techniques. Wire frames. Introduction to solid modeling. Introduction to numerical control, basic components of NC system, NC coordinates and motion control systems. Computer numerical control, direct numerical control, combined CNC/DNC. NC machine tools and control units. Tooling for NC machines, part programming, punched tape, tape coding and format, manual and computer assisted part programming.

**Practical:** Preparation of manual drawings with dimensions from Models and Isometric drawings of objects and machine components; Preparation of sectional drawings of simple machine parts; Drawing of riveted joints and thread fasteners; Demonstration on computer graphics and computer aided drafting use of standard software; Practice in the use of basic and drawing commands on auto cad; Generating simple 2-D drawings with dimensioning using autocad; Practice in the use of modify and rebelling commands; Practice in graphics mathematics, curve fitting and transformations; Demonstration on CNC machine

## **7. Machine Design**

**3 (2+1)**

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

**Practical:** Problems based on load and stress analysis of machine components; Problems based on practical application of theories of failure and fatigue and determination of factor of safety; Design and drawing of pin connections, Knuckle joint; Design of bolted joints cases of electric loading; Exercises on design of levers rockers arm for diesel engines; Assignment

test; Problems on design of shafts, keys and coupling; Problems in selection/ design of belts; Selection of roller bearings use of catalogue; Problems on design of helical and leaf spring; Problems on gear design of spur gears.

## 6. SOCIAL SCIENCES

### 1. Agribusiness Management and Trade

3 (3+0)

Management concepts and principles, process of management, functions of management, concept of agribusiness and application of management principles to agribusiness, production, consumption, and marketing of agricultural products, agricultural processing, meaning and theories of international trade, WTO provisions for trade in agricultural and food commodities, India's contribution to international trade in food and agri - commodities

### 2. Entrepreneurship Development and Communication Skills

2 (1+1)

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. Globalisation 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 horticulture sector. Venture capital. Contract farming and joint ventures, public-private partnerships. Characteristics of Indian farm machinery 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.

**Practical:** 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.

## 7. FARM POWER & MACHINERY

### 1. Farm Machinery & Equipment-I

3 (2+1)

Objectives of farm mechanization. Classification of farm machines. Materials of construction & heat treatment. Principles of operation and selection of machines used for production of crops. Field capacities & economics. Tillage; primary and secondary tillage equipment. Forces acting on tillage tools. Hitching systems and controls. Draft measurement of tillage equipment ; Earth moving equipment - their construction & working principles viz Bulldozer, Trencher, Elevators etc.; sowing, planting & transplanting equipment - their calibration and adjustments. Fertilizer application equipment. Weed control and Plant

protection equipment - sprayers and dusters, their calibration, selection, constructional features of different components and adjustments.

**Practical:** Introduction to various farm machines, visit to implements shed and research hall; Field capacity and field efficiency measurement for at least two machines/implements; Draft & fuel consumption measurement for different implements under different soil conditions; Construction details, adjustments and working of M.B. plow, disc plow and discharrow and secondary tillage tools; Introduction, construction and working of earth moving equipment; Construction and working of rotavators and other rotary tillers, measurement of speed & working width; Working of seed-cum-fertilizer drills, planters and their calibration in field; Working of transplanters and operation; Weeding equipments and their use; Study of sprayers, dusters, measurement of nozzle discharge, field capacity etc.

## **2. Farm Machinery & Equipment-II**

**3 (2+1)**

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

**Practical:** Familiarization with various Farm machines related to harvesting, threshing, root harvesting, combine etc; Study of various types of mowers, constructional details, materials and working; Study of various types of reaper, constructional details, materials and working & performance; Study of various types of reaper binder, constructional details, materials and working; Study of various types of potato harvesters, constructional details, materials and working; Study of various types of groundnut harvesters, constructional details, materials and working & performance; Study of various types of forage harvester, constructional details, materials and working; Study of various types of sugarcane harvester, constructional details, materials and working; Study of various types of maize sheller, constructional details, materials and working & performance; Study of various types of threshers, constructional details, materials and working & performance; Study of various types of cotton pickers and strippers, constructional details, materials and working; Study of various types of harvester tools, constructional details, materials and working; Study of various types of combine harvester, constructional details, materials and working; Study of various types of straw combines, constructional details, materials and working; Study of various types of fruit harvester equipment, constructional details, materials and working.

## **3. Farm Power**

**3 (2+1)**

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

freeze and anti-corrosion materials, lubricant types & study of their properties. Engine governing systems.

**Practical:** Introduction to different systems of an CI engine; Engine parts and functions, working principles etc; Valve system – study, construction and adjustments; Oil & Fuel - determination of physical properties; Air cleaning system; Fuel supply system of SI engine; Diesel injection system & timing; Cooling system, and fan performance, thermostat and radiator performance evaluation; Part load efficiencies & governing; Lubricating system & adjustments; Starting and electrical system; Ignition system; Tractor engine heat balance and engine performance curves; Visit to engine manufacturer/ assembler/ spare parts agency.

#### **4. Tractor Systems and Controls**

**3 (2+1)**

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

**Practical:** Introduction to transmission systems and components; Study of clutch functioning, parts and design problem on clutch system; Study of different types of gear box, calculation of speed ratios, design problems on gear box; Study on differential and final drive and planetary gears; Study of brake systems and some design problems; Steering geometry and adjustments; Study of hydraulic systems in a tractor, hydraulic trailer and some design problems; Traction performance of a tractor wheel; Finding C.G. of a tractor by weighing technique; Finding CG of a tractor using suspension/balancing techniques; Finding moment of Inertia of a tractor; Appraisal of various controls in different makes tractors in relation to anthropometric measurements.

#### **5. Renewable Energy Sources**

**3 (2+1)**

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, ocean energy, briquetting and baling of biomass, biomass combustion, biodiesel preparation and energy conservation in agriculture.

**Practical:** Preparation of biomass sample; Determination of calorific value; Estimation of ash content of biomass; Estimation of moisture content of biomass; Estimation of fixed carbon and volatile matter of biomass; Demonstration of down draft throatless rice husk gasifier; Demonstration of down draft gasifier with throat; Demonstration of rice husk gasifier for thermal use; Demonstration of working of a fixed dome type biogas plants; Demonstration of working of a floating drum type biogas plants; Demonstration of biodiesel preparation; Measurement of basic solar parameters; Demonstration of solar water heater; Demonstration of PVC; Demonstration of solar cooker; Determination of fuel properties.

#### **6. Field Operation & Maintenance of Tractor & Farm Machinery–I**

**1(0+1)**

**Practical:** Introduction to various systems of a tractor viz. fuel, lubrication, cooling, electrical, transmission, hydraulic & final drive system. Familiarisation with tractor controls & learning procedure of tractor starting and stopping. Driving in forward and reverse gears. Driving safety rules. Hitching, adjustments, settings and field operation of farm machinery.

Familiarisation with different makes & models of 4- wheeled tractors. Starting & stopping practice of the tractor. Familiarisation with instrumentation panel & controls; Road signs, traffic rules, road safety, driving & parking of tractor; Tractor driving practice forward & reverse driving practice; Tractor driving practice with two wheeled tractor trailer forward & reverse; Study and practising the hitching and dehitching of implements; Study operation and field adjustments of m.b. plough & disk plough; Field operation of trailing & mounted disk harrow; Field operation and adjustments of seed drill/planter/sprayer.

## **7. Field Operation & Maintenance of Tractors and Farm Machinery –II 2(1+1)**

Introduction to tractor maintenance procedure and trouble shooting. Scheduled maintenance after 10,50,100,250,500 and 1000 hrs. of operation. Safety hints. Top end overhauling. Fuel saving tips. Preparing the tractor for storage. Care and maintenance procedure of agricultural machinery during operation and off-season. Repair and maintenance and workshop requirements.

**Practical:** Familiarisation with tools and equipment used for maintaining & servicing of tractors & farm machines; Doing the 10-hours service jobs & Maintenance after 50- hours of operation; Maintenance after 100 hours of operation; Maintenance after 250 hours of operation; Maintenance after 500 hours and 1000 hours of operation, adjustment of tractor track; Dismantling and assembling of major engine parts; Visit to tractor/ engine repair workshop, injection pump injector repair shop; Doing minor repair of electric, mechanical and hydraulic system; Adjustment and maintenance of primary and secondary tillage equipment viz. m.b. plough, disc-plough and disc harrow etc.; Adjustment and maintenance of seeding & planting and transplanting machines; Adjustment and maintenance of plant protection equipment; Adjustment and maintenance of reapers & threshers; Adjustment & maintenance of combine harvesters, straw combines, balers etc; Visit to small scale farm machinery manufacturers and their repair shops, seasonal repair of farm machinery.

## **8. PROCESSING AND FOOD ENGINEERING**

### **1. Engineering Properties of Biological Materials & Food Quality 3 (2+1)**

Importance of engineering properties of biological materials, Study of different physical and thermal characteristics of important 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. Concept, objectives and need of quality, quality control, methods of quality control, sampling; purpose, sampling techniques, requirements and sampling procedures for liquid, powdered and granular materials, sensory quality control, panel selection methods, interpretation of sensory results in statistical quality control, TQM and TQC, consumer preferences and acceptance, Food Laws and Regulations in India. Food grades and standards BIS, AGMARK, PFA, FPO, CAC (Codex Alimentarius Commission), sanitation in food industry, GMP, HACCP (Hazard analysis and critical control point) and ISO 9000 Series.

**Practical:** To find the shape and size of grains and fruits and vegetables. To determine bulk density and angle of repose of grains. To determine the particle density/true density and porosity of solid grains. To find out the co-efficient of external and internal friction of

different crops; To study the separating behaviour of a grain sample in a vertical wind tunnel (Aspirator column). To find the thermal conductivity of different grains. To determine specific heat of some food grains. To determine cooking quality of rice. To determine impurities and invisible stress cracks in grains. Preparation of a ready reckoner of change in unit weight of food grains as affected by change in its moisture content (w.b.) (5% - 25%). Milling quality of paddy; Determination of hardness of food material; Detection of adulteration in food products viz. milk, ghee, honey etc.

## **2. Agricultural Structures and Environmental Control**

**3 (2+1)**

Planning and layout of farmstead. Physiological reactions of livestock to solar radiation and other environmental factors, livestock production facilities, BIS. Standards for dairy, piggery, poultry and other farm structures. Design, construction and cost estimation of farm structures; animal shelters, compost pit, fodder silo, fencing and implement sheds, barn for cows, buffalo, poultry, etc. Design and construction of rural grain storage system Engineering for rural living and development, rural roads, their construction cost and repair and maintenance. Sources of water supply, norms of water supply for human being and animals, drinking water standards and water treatment suitable to rural community. Site and orientation of building in regard to sanitation, community sanitation system; sewage system- its design, cost and maintenance, design of septic tank for small family. Estimation of power requirement for domestic and irrigation, source of power supply, use of alternate source of energy, electrification of rural housing. Scope, importance and need for environmental control, renewable and non-renewable resources and their equitable use, concept of eco system, biodiversity of its conservation, environmental pollution and their control, solid waste management system, BOD and COD of food plant waste, primary and secondary treatment of food plant waste.

**Practical:** Instruments for measurements of environmental parameters. Environmental indices for your city. Harmonic analysis for sole-air temperature. Reflective and non-reflective air space in buildings. Cooling load of a farm building e.g. poultry house. Moisture condensation in agricultural buildings. Design and layout of a dairy farm. Design and layout of a poultry house. Design and layout of a sheep/goat house. Design of a biogas plant. Design of a farm fencing system. Design of ventilation system for dairy and poultry house. Design of a feed/fodder storage structures. Familiarization with local grain storage structures. Design of grain storage structures. Cost estimation of a farm buildings.

## **3. Crop Process Engineering**

**3 (2+1)**

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

**Practical:** Preparation of flow and layout charts of a food processing plant; Determination of fineness modulus and uniformity index; Performance evaluation of hammer mill; Performance evaluation of attrition mill; Study of cleaning equipment; Separation behaviour in pneumatic separation; Study of grading equipment; Evaluation of performance of indented cylinder and screen pre-cleaner; Mixing index and study of mixers; Study of conveying equipments; Performance evaluation of bucket elevator.

#### **4. Dairy and Food Engineering**

**3 (2+1)**

Dairy development in India. Engineering, thermal and chemical properties of milk and milk products, unit operation of various dairy and food processing systems, process flow charts for product manufacture, working principles of equipment for receiving, pasteurisation sterilization, homogenisation, filling & packaging, butter manufacture, dairy plant design and layout, composition and proximate analysis of food products. Deterioration in products and their controls. Physical, chemical and biological methods of food preservation, changes undergone by the food components during processing, evaporation, drying, freezing juice extraction, filtration, membrane separation, thermal processing, plant utilities requirement.

**Practical:** Study of a composite pilot milk processing plant & equipments; Study of pasteurisers; Study of sterilizers; Study of homogenisers; Study of separators; Study of butter churners; Study of evaporators; Study of milk dryers; Study of freezers; Design of food processing plants & preparation of layout; Visit to multiproduct dairy product; Determination of physical properties of food products; Estimation of steam requirements; Estimation of refrigeration requirements in dairy & food plant; Visit to Food industry.

#### **5. Drying and Storage Engineering**

**4(3+1)**

Moisture content and methods for determination, importance of EMC and methods of its determination, EMC curve and EMC model, principle of drying, theory of diffusion, mechanism of drying- falling rate, constant rate, thin layer, deep bed and their analysis, critical moisture content, drying models, calculation of drying air temperature and air flow rate, air pressure within the grain bed, Shred's and Hukill's curve, different methods of drying including puff drying, foam mat drying, freeze drying, etc. Study of different types of dryers- performance, energy utilization pattern and efficiency, study of drying and dehydration of agricultural products. Types and causes of spoilage in storage, conditions for storage of perishable products, functional requirements of storage, control of temperature and relative humidities 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; conditioning of environment inside storage through natural ventilation, mechanical ventilation, artificial drying, grain storage structures such as Bukhari, Morai, Kothar, silo, CAP, warehouse - design and control of environment. Storage of cereal grains and their products, storage of seeds, hermetically sealed and air-cooled storages-refrigerated, controlled atmosphere, modified atmospheric and frozen storages. Storage condition for various fruits and vegetables under cold and CA storage system. Economic, aspects of storage.

**Practical:** Study of mechanics of bulk solids affecting cleaning, drying and storage of grains; Measurement of moisture content during drying and aeration; Measurement of relative humidity during drying and aeration using different techniques; Measurement of air velocity during drying and aeration; Drying characteristic and determination of drying constant; Determination of EMC and ERH; Study of various types of dryers; To study the effect of

relative humidity and temperature on grains stored in gunny bags; Design and layout of commercial bag storage facilities; Design and layout of commercial bulk storage facilities; Study of different domestic storage structures; Visits to commercial handling and storage facilities for grains.

## **6. Refrigeration and Air Conditioning**

**3(2+1)**

Principles of refrigeration, second law of thermodynamics applied to refrigeration, Carnot cycle, reversed Carnot cycle, coefficient of performance, unit of refrigeration. Refrigeration in food industry, types of refrigeration system, mechanical vapour compression, vapour absorption system, components of mechanical refrigeration, refrigerant, desirable properties of ideal refrigerant, Centrifugal and steam jet refrigeration systems, thermoelectric refrigeration systems, vortex tube and other refrigeration systems, ultra low temperature refrigeration, cold storages, insulation material, design of cold storages, defrosting. Thermodynamic properties of moist air, perfect gas relationship for approximate calculation, adiabatic saturation process, wet bulb temperature and its measurement, psychrometric chart and its use, elementary psychrometric process. Air conditioning – principles- Type and functions of air conditioning, physiological principles in air conditioning, air distribution and duct design methods, fundamentals of design of complete air conditioning systems – humidifiers and dehumidifiers – cooling and calculations, types of air conditioners – applications.

**Practical:** Study of vapour compression and vapour absorption systems; Study of electrolux refrigerator; Solving problems on refrigeration on vapour absorption system; Experiments with the refrigeration tutor to study various components of refrigeration; Determination of the coefficient of performance of the refrigeration tutor; Experiment on humidifier for the determination of humidifying efficiency; Experiment on dehumidifier for the determination of dehumidifying efficiency; Experiment on the cooling efficiency of a domestic refrigerator; Experiments on working details of a cold storage plant and air conditioning unit; Experiments with air conditioning tutor to study various components; Determination of the coefficient of performance of air conditioning tutor; Estimation of refrigeration load; Estimation of cooling load for air conditioner; Estimation of humidification and dehumidification load; Design of complete cold storage system.

## **9. SOIL AND WATER ENGINEERING**

### **1. Soil and Water Conservation Structures**

**3 (2+1)**

Introduction; classification of structures, functional requirements of soil erosion control structures; flow in open channels-types of flow, state of flow, regimes of flow, energy and momentum principles, specific energy and specific force; hydraulic jump and its application, type of hydraulic jump, energy dissipation due to jump, jump efficiency, relative loss of energy; runoff measuring structures-parshall flume, H - flume and weirs; straight drop spillway - general description, functional use, advantages and disadvantages, structural parts and functions; components of spillway, hydrologic and hydraulic design, free board and wave free board, aeration of weirs, concept of free and submerged flow, structural design of a drop spillway-loads on headwall, variables affecting equivalent fluid pressure, determination of saturation line for different flow conditions, seepage under the structure, equivalent fluid pressure of triangular load diagram for various flow conditions, creep line theory, uplift pressure estimation, safety against sliding, overturning, crushing and tension; chute spillway-general description and its components, hydraulic design, energy dissipaters, design criteria of a SAF stilling basin and its limitations, drop inlet spillway- general description, functional

use, design criteria; design of diversions; small earth embankments-their types and design principles, farm ponds and reservoirs, cost estimation of structures.

**Practical:** Design of H-flume; Design of Parshall flume; Construction of specific energy and specific force diagram; Measurement of hydraulic jump parameters and amount of energy dissipation; Hydraulic design of a straight drop spillway; Determination of uplift force and construction of uplift pressure diagram; Determination of loads on headwall and construction of triangular load diagram; Stability analysis of a straight drop spillway; Hydraulic design of a chute spillway; Design of a SAF energy dissipater; Design of small earth embankments and water harvesting structures; Cost estimation of structures.

## **2. Irrigation Engineering**

**4(3+1)**

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

**Practical:** Measurement of soil moisture by different soil moisture measuring instruments; measurement of irrigation water; measurement of infiltration rate; computation of evaporation and transpiration; land grading exercises; design of under ground pipe line system; infiltration-advance in border irrigation; measurement of advance and recession in border irrigation and estimation of irrigation efficiency; measurement of advance and recession in furrow irrigation and estimation of irrigation efficiency; measurement of uniformity coefficient of sprinkler irrigation method; measurement of uniformity coefficient of drip irrigation method; field problems and remedial measures for sprinkler and drip irrigation method.

## **3. Groundwater, Wells and Pumps**

**3 (2+1)**

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

priming devices, rotodynamic pumps for special purposes such as deep well turbine pump and submersible pump.

**Practical:** Verification of Darcy's Law; Study of different drilling equipments; Sieve analysis for gravel and well screens design; Estimation of specific yield and specific retention; Testing of well screen; Drilling of a tubewell; Measurement of water level and drawdown in pumped wells; Estimation of aquifer parameters by Thies method, Coopers-Jacob method, Chow method, Theis Recovery method; Well design under confined and unconfined conditions, well losses and well efficiency; Estimating ground water balance; Study of artificial ground water recharge structures; Study of radial flow and mixed flow centrifugal pumps, multistage centrifugal pumps, turbine, propeller and other pumps; Installation of centrifugal pump; Testing of centrifugal pump and study of cavitations; Study of performance characteristics of hydraulic ram; Study and testing of submersible pump.

#### **4. Drainage Engineering**

**2 (1+1)**

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

**Practical:** In-situ measurement of hydraulic conductivity; determination of drainage coefficients; installation of piezometer and observation well; preparation of iso-bath and iso-bar maps; measurement of hydraulic conductivity and drainable porosity; design of surface drainage systems; design of subsurface drainage systems; determination of chemical properties of soil and water; fabrication of drainage tiles; testing of drainage tiles; determination of gypsum requirement for land reclamation; installation of sub-surface drainage system; cost analysis of surface and sub-surface drainage system.

#### **5. Soil and Water Conservation Engineering**

**3(2+1)**

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

**Practical:** Study of soil loss measurement techniques; Study of details of Coshocton wheel and multi-slot runoff samplers; Determination of sediment concentration through oven dry method; Problems on Universal Soil Loss Equation; Preparation of contour map of an area and its analysis; Design of vegetative waterways; Design of contour bunding system; Design of graded bunding system; Design of various types of bench terracing systems; Determination of rate of sedimentation and storage loss in reservoir; Design of Shelter belts and wind breaks.

## **6. Watershed Hydrology**

**3 (2+1)**

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

**Practical:** Visit to meteorological observatory; Study of different types of rain gauges; Exercise on analysis of rainfall data; Double mass curve technique; Determination of average depth of rainfall and frequency analysis; Study of stage recorders and current meters; Exercise on estimation of peak runoff rate and runoff volume; Exercises on hydrograph and unit hydrograph; Exercises on design and location of retards for channel improvement; Exercises on flood routing problems.

## **10. CAFETERIA COURSES**

### **1. Food Packaging Technology**

**3 (2+1)**

Factors affecting shelf life of food material during storage; spoilage mechanism during storage; definition, requirement, importance and scope of packaging of foods; types and classification of packaging system; advantage of modern packaging system. 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 materials; effect of these materials on packed commodities, Package testing, Printing, labeling and lamination. Economics of packaging; performance evaluation of different methods of packaging food products; their merits and demerits; scope for improvements; disposal and recycle of packaging waste.

**Practical:** Identification of different types of packaging materials; determination of tensile strength of given material; Determination of compressive strength of given package; To perform different destructive tests for glass containers; To perform non-destructive tests for glass containers; Vacuum packaging of agricultural produces; Determination of tearing strength of paper board; measurement of thickness of packaging materials; To perform grease-resistance test in plastic pouches; Determination of bursting strength of packaging

material; Determination of water-vapour transmission rate; Shrink wrapping of various horticultural produce; Testing of chemical resistance of packaging materials; Determination of drop test of food package; Visit to relevant industries.

## **2. Design and Maintenance of Greenhouse**

**3 (2+1)**

History and types of greenhouse; importance, function and features of green house; scope and development of green house technology. Location, Planning and various component of greenhouse; design criteria and calculation; constructional material and methods of construction; covering materials and its characteristics, solar heat transfer, solar fraction for green house, steady state analysis of green house, Greenhouse heating, cooling, shedding and ventilation systems; Carbon Dioxide generation and monitoring and lighting systems, instrumentation & computerized environmental Control Systems. Watering, fertilization, root substrate and its pasteurization, containers and benches, plant nutrition. Alternative cropping systems; plant tissue culture, chemical growth regulation; disease control; integrated pest management; postproduction quality and handling Cost analysis of greenhouse production; Applications of green house & its repair & maintenance.

**Practical:** Study/visit to a functional green house; planning and layout of green house & associated utilities; Material selection for the construction of green house; Measurement of temp. using thermomseter, thermistor & thermocouples inside the green house; Measurement of humidity & air velocity using various methods; Measurement of solar radiations inside the green house; Application of psychometric charts; estimation of cooling requirements in a green house; estimation of ventilation requirements; Thermal performance of green house; Application of data loggers for simultaneous estimation & control of different parameters like temp., RH, solar radiations etc.; Calculations of environment indices inside a green house; Structural analysis of green house; Economic analysis of green house; Visit to a commercial green house.

## **3. Waste and By-Product Utilization**

**2(1+1)**

Types and formation of byproducts and waste; magnitude of waste generation in different food processing industries; concept scope and maintenance of waste management and effluent treatment, Temperature, pH, Oxygen demands (BOD, COD), fat, oil and grease content, metal content, forms of phosphorous and sulphur in waste waters, microbiology of waste, other ingredients like insecticide, pesticides and fungicides residues, Waste utilization in various industries, furnaces and boilers run on agricultural wastes and byproducts, briquetting of biomass as fuel, production of charcoal briquette, generation of electricity using surplus biomass, producer gas generation and utilization, waste treatment and disposal, design, construction, operation and management of institutional community and family size biogas plants, concept of vermi-composting, Pre-treatment of waste: sedimentation, coagulation, flocculation and floatation, Secondary treatments: Biological and chemical oxygen demand for different food plant waste– trickling filters, oxidation ditches, activated sludge process, rotating biological contractors, lagoons, Tertiary treatments: Advanced waste water treatment process-sand, coal and activated carbon filters, phosphorous, sulphur, nitrogen and heavy metals removal, Assessment, treatment and disposal of solid waste; and biogas generation.

**Practical:** Waste characterization: (a) temperature (b) pH (c) solids content (d) turbidity (e) BOD (f) COD; Determination of ash content of agril. wastes; Determination of unburnt carbon in ash of paddy straw; To study about briquetting of agricultural residues; Estimation of excess air for better combustion of briquettes; To study about extraction of oil from rice

bran; To study about waste treatment plant in food industry; To study about utilization of whey; To study about recovery of peel oil; To study about recovery of germ and germ oil from by-product of cereals; Practical on bioconversion of agro-wastes; Practical on recycling of agro-wastes and by-products; Visits to various industries using waste and food by-products.

#### **4. Development of Processed Products & Equipments**

**3(2+1)**

Applications of unit operations to the food industry, analytical processing concepts with regards to mass and energy balances, equipment involved in the commercially important food processing methods and unit operations; value addition to cereals like rice, wheat etc. Parboiling of rice, quality of processed products of rice & wheat. Processing of pulses, spices and condiments; extruded food product, fermented food product, frozen and dried product, technology of meat, fish and poultry products, technology of milk and milk products. Technology of oilseeds and fat products, snack foods, Fruits and vegetables product: candy, nutraceuticals, food product development trends, food additives and labeling. Process equipment for thermal processing-evaporation, dehydration, drying, blanching, pasteurization, distillation; mechanical separation-filtration, sieving, centrifugation, sedimentation; mechanical handling-conveying and elevation; size reduction and classification-mixing; kneading, blending.

**Practical:** Working principle and operation of Engleberg huller; study of different cleaners and graders used in agro processing industries; working principle, operation and maintenance of paddy destoner-cum-cleaner, rubber roll sheller, paddy separator and vertical cone whitener; familiarization with operation and performance of machinery and equipments of Satake rice milling unit of 500 kg/hr; planning and layout of roller wheat flour milling & rice milling; visit to milk plant; visit to roller flour mill; visit to markfed canneries; visit to fruit/vegetable processing plants; flow process diagram and study of various models of the machines used in a sugar mill.

#### **5. Food Processing Plant Design & Layout**

**2 (1+1)**

Meaning and definition of plant layout. Objectives and principles of layout. Types of layout. Salient features of processing plants for cereals, pulses oilseeds, horticultural and vegetable crops, poultry, fish and meat products, milk and milk products. Location selection criteria, selection of processes, plant capacity, project design, flow diagrams, selection of equipments, process and controls, handling equipments, plant layout, Plant elevation, requirement of plant building and its components, labour requirement, plant installation, power and power transmission, sanitation. Cost analysis, preparation of feasibility report.

**Practical:** Planning, visit and layout of flour milling plant; Planning, visit and layout of rice milling plant; Planning, visit and layout of milk plant; Planning, visit and layout of bakery plant; Planning, visit and layout of fruits and vegetable dehydration plant; Planning, visit and layout of beverages industry; Planning, visit and layout of edible oil extraction plant; Planning, visit and layout of ice-cream plant; Planning, visit and layout of sugar mill plant; Planning, visit and layout of honey/turmeric/chillies processing plant.

#### **6. Micro Irrigation Systems Design**

**3 (2+1)**

Past, present and future need of micro-irrigation systems, Role of Govt. for the promotion of micro-irrigation in India, Merits and demerits of micro-irrigation system, Types and components of micro-irrigation system, Micro-irrigation system- design, design synthesis,

installation, and maintenance. Sprinkler irrigation - types, planning factors, uniformity and efficiency, laying pipeline, hydraulic lateral, sub-mains and main line design, pump and power unit selection. Drip irrigation – potential, automation, crops suitability. Fertigation – Fertilizer application criteria, suitability of fertilizer compounds, fertilizer mixing, injection duration, rate and frequency, capacity of fertilizer tank. Quality control in micro-irrigation components, design and maintenance of polyhouse; prospects, waste land development – hills, semi-arid, coastal areas, water scarce areas, Benefit and Cost analysis.

**Practical:** Study of different types of micro-irrigation systems and components; Field visit of micro-irrigation system; Study of water filtration unit; Discharge measurement study of different micro-irrigation systems; Study of water distribution and uniformity coefficient; Study of wetted front and moisture distribution under various sources of micro-irrigation system; Design of micro-irrigation system for an orchard; Design of micro-irrigation system for row crops design of spray type micro-irrigation system; Design of micro-irrigation system for hilly terraced land; Study of automation in micro-irrigation system; Study of micro climate inside a Polyhouse; Study of maintenance and cleaning of different components of various systems; Design of sprinkler irrigation system; Design of landscape irrigation system

## **7. Watershed Planning and Management**

**3 (2+1)**

Watershed management - problems and prospects; watershed based land use planning, watershed characteristics – physical and geomorphologic, factors affecting watershed management, hydrologic data for watershed planning, watershed delineation, delineation of priority watershed, water yield assessment and measurement from a watershed; hydrologic and hydraulic design of earthen embankments and diversion structures; sediment yield estimation and measurement from a watershed and sediment yield models; rainwater conservation technologies - in-situ and storage, design of water harvesting tanks and ponds; water budgeting in a watershed; effect of cropping system, land management and cultural practices on watershed hydrology; evaluation and monitoring of watershed programmes; people's participation in watershed management programmes; planning and formulation of project proposal; cost benefits analysis of watershed programmes; optimal land use models; case studies.

**Practical:** Study of watershed characteristic; analysis of hydrologic data for watershed management; Delineation of watershed and measurement of area under different vegetative and topographic conditions; Measurement of water and sediment yield from watershed; Study of different watershed management structures; Study of various water budget parameters; Study of watershed management technologies; Preparation of a techno-economically effective project proposal.

## **8. Minor Irrigation and Command Area Development**

**3 (2+1)**

Major, medium and minor irrigation projects – their comparative performance; development and utilization of water resources through different minor irrigation schemes. Basic concepts of command area – definition, need, scope, and development approaches: historical perspective, command area development authorities; Interaction/collaboration of irrigation water use efficiency and agricultural production. Planning and execution of on farm development activities with in the scope of command area development; Use of remote sensing techniques for command area development; case studies of some selected commands; Farmers participation in command area development.

**Practical:** Topographic survey and preparation of contour map; preparation of command area development layout plan; land leveling design for a field; earthwork and cost estimation; irrigation water requirement of crops; preparation of irrigation schedules; planning and layout of water conveyance system; design of Irrigation systems; conjunctive water use planning; application of remote sensing for command area development; technical Feasibility and economic viability of a command area project. Study tour to minor irrigation and command area development projects.

## **9. Environmental Engineering**

**3 (2+1)**

Importance of safe water supply system. Domestic water requirements for urban and rural areas. Sources of Water supply. Intakes and transportation of water. Drinking water quality. Indian Standards of drinking water. Introduction to water treatment. Importance of sanitation. Domestic waste water: quantity, characteristics, disposal in urban and rural areas. Sewer: types, design discharge and hydraulic design. Introduction to domestic wastewater treatment. Design of septic tank. Solid waste: quantity, characteristics and disposal for urban and rural areas. Introduction to air pollution. Types of pollutants properties and their effects on living beings. ISI standards for pollutants in air and their abetments.

**Practical:** Determination of turbidity; pH of solution; Suspended solids; Dissolved solids; Total solids; Temporary hardness; Permanent hardness; Fluorides; Chlorides, dissolved oxygen; BOD; Collection of air samples and their analysis; Numerical problems related to theory; Visit to treatment plant.

## **10. Gulley and Ravine Control Structures**

**3(2+1)**

Introduction; floods - causes of occurrence, flood classification - probable maximum flood, standard project flood, design flood, flood estimation - methods of estimation; estimation of flood peak - Rational method, empirical methods, Unit hydrograph method; Statistics in hydrology, flood frequency methods - Log normal, Gumbel's extreme value, Log-Pearson type-III distribution; depth-area-duration analysis; flood forecasting, flood routing - channel routing, Muskingum method, reservoir routing, modified Pul's method; flood control - history of flood control, structural and non-structural methods of flood control measures, storage and detention reservoirs, levees, channel improvement; Gulley erosion and its control; soil erosion and sediment control measures; river training works, planning of flood control projects and their economics.

**Practical:** Determination of flood stage-discharge relationship in a watershed; determination of flood peak-area relationships. Determination of frequency distribution functions for extreme flood values using Gumbel's method; Determination of frequency distribution functions for extreme flood values using log-Pearson Type-III distribution; Determination of confidence limits of the flood peak estimates for Gumbel's extreme value distribution; Determination of probable maximum flood; Standard project flood and spillway design flood; Design of levees for flood control; Design of jetties; Study of vegetative and structural measures for Gulley stabilization; Designing and planning of a flood control project; Cost and benefit analysis of a flood control project.

## **11. Remote Sensing and GIS Application**

**3 (2+1)**

Remote Sensing: Definition, stage in remote sensing, modern remote sensing technology versus conventional aerial photography; visual image interpretation, image interpretation, basic principles of image interpretation, factors governing the quality of an image; factors

governing interpretability, visibility of objects, elements of image interpretation, techniques of image interpretation, digital image processing, digital image; remote sensing in agriculture progress and prospects, microwave radiometry for monitoring agriculture crops and hydrologic forecasting; aerial photo interpretation for water resources development and soil conservation survey.

GIS: History of development of GIS definition, basic components, and standard GIS packages; data-entry, storage and maintenance; data types-spatial-non-spatial (attribute data), data structure, data format- point line vector-raster – polygon-object structural model, files, files organization-data base management systems (DBMS), entering data in computer-digitizer-scanner-data compression.

**Practical:** Familiarization with remote sensing and GIS hardware; use of instruments for aerial photo interpretation; interpretation of aerial photographs and satellite imagery; basic GIS operations such as image display; study the various features of GIS software package; scanning and digitization of maps; data base query and map algebra; GIS supported case studies in water resources management.

## **12. Reservoir and Farm Pond Design**

**3 (2+1)**

Earthen embankments - functions, advantages and disadvantages, classification - hydraulic fill and rolled fill dams - homogeneous, zoned and diaphragm type; foundation requirements, grouting, seepage through dams - estimation of seepage discharge, location of seepage/phreatic line by graphical and analytical methods, flow-net and its properties, seepage pressure, seepage line in composite earth embankments, drainage filters, piping and its causes; design and construction of earthen dam, stability of earthen embankments against failure by tension, overturning, sliding etc; stability of slopes - analysis of failure by slice method; types of reservoirs and farm ponds, design and estimation of earth work; cost analysis.

**Practical:** Study of different types and materials of earthen dams; Determination of the position of phreatic line in earth dams for various conditions; Stability analysis of earthen dams against head water pressure; Stability analysis of earthen dams against foundation shear; Stability analysis of earth dams against sudden draw down condition; Stability of slopes of earth dams by friction circle method / different methods; construction of flow net for isotropic and anisotropic medium; Computation of seepage by different methods; determination of settlement of earth dam; Input-output-storage relationships by reservoir routing; design of farm ponds; cost estimation of farm ponds and other structures.

## **13. Tractor Design and Testing**

**3 (2+1)**

Procedure for design and development of agricultural tractor, Study of parameters for balanced design of tractor for stability & weight distribution, hydraulic lift and hitch system design. Design of mechanical power transmission in agricultural tractors. Design of Ackerman Steering and tractor hydraulic systems. Study of special design features of tractor engines and their selection. Design of seat and controls of an agricultural tractor. Tractor Testing.

**Practical:** Design problem of tractor clutch – (Single/ Multiple disc clutch); Design problem on spur gears; Design problem of bevel gears; Design problem of helical gears; Design of gear box(synchromesh/constant mesh); Design of variable speed constant mesh drive; Selection of tractor tires – Problem solving; Problem on design of governer; Problem related

to selection of hydraulic pump; Engine testing as per BIS code – various test; Drawbar performance in the lab; PTO test and measure the tractor power in the lab/field; Determining the turning space, turning radius and brake test, hydraulic pump performance test and air cleaner and noise measurement test; Visit to tractor testing centre/industry.

#### **14. Hydraulic Drives and Controls**

**3(2+1)**

Hydraulic Basics: Pascal's Law, Flow, Energy, Work, and Power. Hydraulic Systems, Color Coding, Reservoirs, Strainers and Filters, Filtering Material and Elements. Accumulators, Pressure Gauges and Volume Meters, Hydraulic Circuit, Fittings and Connectors. Pumps, Pump Classifications, Performance, Displacement, Designs, Gear Pumps, Vane Pumps, Piston Pumps, Pump Operation. Hydraulic Actuators, Cylinders, Construction and Applications, Maintenance, Hydraulic Motors. Valves, Pressure-Control Valves, Directional-Control Valves, Flow-Control Valves, Valve. Installation, Valve Failures and Remedies, Valve Assembly, Troubleshooting Valves Hydraulic Circuit Diagrams and Troubleshooting, United States of American Standards Institute USASI Graphical Symbols Tractor hydraulics, nudging system, ADDC. Pneumatics: Air services, logic units, Fail safe and safety systems Robotics: Use of Hydraulics and Pneumatics drives in agricultural systems, PLCs (Programmable Logic Controls).

**Practical:** Introduction to Hydraulic Systems; Study of Hydraulic Pumps; Study of Hydraulic Actuators; Study of Hydraulic Motors; Study of Hydraulic Valves; Hydraulic codes and circuits; Building simple Hydraulic Circuits; Hydraulics in Tractors; Introduction to Pneumatics; Pneumatics Devices; Pneumatics in Agriculture; Use of Hydraulics and Pneumatics for Robotics.

#### **15. Farm Power & Machinery Management**

**3(2+1)**

The role of mechanization and its relationship to productivity, employment, social and technological change; performance and power analysis; cost analysis of machinery: fixed cost and variable costs, effect of inflation on cost; selection of optimum machinery and replacement criteria; Break-even analysis, reliability and cash flow problems; mechanization planning; case studies of agricultural mechanization in India.

**Practical:** Solving problems related to Various capacities, pattern efficiency, system limitation, power requirement and other operational parameters; Solving of Problems related to cost analysis and inflation; Solving problem related to selection of equipment, replacement, break-even analysis, time value of money etc.; Presentation of seminar on topic assigned related to farm machinery management; Design of farm mechanization plan for different farm size and cropping pattern.

#### **16. Renewable Energy Technologies**

**3 (2+1)**

Design and operational parameters, performance evaluation and maintenance aspects of different renewable technologies like gasifiers, biogas plants, solar passive heating devices, photovoltaic cells and arrays, briquetting machines and balers; bio-diesel utilization in CI engines.

**Practical:** Performance evaluation of solar water heater; performance evaluation of solar cooker; Characteristics of solar photovoltaic panel; evaluation of solar air heater/dryer; Performance evaluation of a rice husk throatless gasifier engine system; Performance evaluation of down draft gasifier with throat for thermal application; Performance evaluation

of a fixed dome type biogas plant; Performance evaluation of floating drum type biogas plant; Estimation of calorific value of producer gas; Testing of diesel engine operation using biodiesel; Evaluation of briquetting machine using biomass material; evaluation of rice straw briquette.

### **17. Human Engineering and Safety**

**3(2+1)**

Human factors in system development – concept of systems; basic processes in system development, performance reliability, human performance. Information input process, visual displays, major types and use of displays, auditory and factual displays. Speech communications. Biomechanics of motion, types of movements, Range of movements, strength and endurance, speed and accuracy, human control of systems. Human motor activities, controls, tools and related devices. Anthropometry: arrangement and utilization of work space, atmospheric conditions, heat exchange process and performance, air pollution. Dangerous machine (Regulation) act, Rehabilitation and compensation to accident victims, Safety gadgets for spraying, threshing, Chaff cutting and tractor & trailer operation etc.

**Practical:** Calibration of the subject in the laboratory using bi-cycle Ergometer as loading device, versus different physiological parameters; Calibration of the subject in the laboratory using mechanical treadmill as loading device versus different physiological parameters; Study of Respiration gas meter and its use in selected farm operation and their comparison from energy point of view; Calibration of the subject using Heart Rate Monitor and farm operation as a loading device; Study of general fatigue of the subject using Blink ratio method; Study on the use of electromyograph equipment; Anthropometric measurements of a selected group of farm workers and its statistical analysis; Study of optimum work space layout and locations of controls of different factors; Familiarization of the noise and vibration equipment.

### **18. Biomass Management for Fodder and Energy**

**3(1+1)**

Introduction to biomass management, biomass resource assessment management techniques/supply chains, Processing of paddy straw, densification- Extrusion process, pellets, mills and cubers, Baling-classification, uses; residue management for surface mulch and soil incorporation, Paddy Straw choppers and spreaders as an attachment to combine Harvester, Mulch seeder, Paddy Straw Chopper-cum-Loader, Balar for collection of straw; Processing of straw/ fodder for animal use; Agricultural and horticultural use, Cushioning material for fruits and vegetables, Mulching and Composting, Paper and cardboard manufacturing, Straw as a fuel.

**Practical:** Familiarization with different straw management techniques; on-farm and off-farm uses of straw; collection, loading and transport equipments for unbruised loose straw; briquetting machine and preparation of briquettes; straw baler and making of bales in the field; straw/ fodder chopping machines; straw/ mulching & incorporating machinery; machinery requirement for baling forage crops for silage.

### **19. Production Technology of Agricultural Machinery**

**3 (2+1)**

Critical appraisal in production of Agricultural Machinery; Modelling and stress analysis of Machinery parts by using standard software; Advances in material used for tractor & Agril. Machinery. Cutting tools including CNC tools and finishing tools. Advanced manufacturing techniques like powder metallurgy, EDM (Electro-Discharge Machining), Heat Treatment of steels including pack carburizing, shot pining process, chemical vapor deposition (CVD) etc.

Limits, Fits & Tolerances, Jigs & Fixtures, Microstructure Analysis. Industrial lay-out planning, Quality management,. Economics of process selection. Techno-economic feasibility of Project Report. Selection of Standard/ critical components. Case studies of manufacturing of agril. machinery. Servo motors, drives & controllers, CNC controllers for machine tools. CNC programming. Assembly and plant automation. Storage and transportation.

**Practical:** To draw an exhaustive design plan for a machine & describe its kinematics; Part modelling of agril. machinery by using standard software; Problem on design of cultivator and drill parts; Problem on design of sprayer parts and fluid flow; Problem on design of harvesting and threshing machinery parts; Visit to Central Tool Room/ Industry with Advanced manufacturing techniques; Jigs and Fixtures – study in relation to Agril Machinery; Design problems on fits, tolerances and limits; Layout planning of a small scale industry; Problem on Economics of process selection; Preparation of a project report; Case study for manufacturing of weeder/ thresher through industry visit; Study of different CNC controllers/ servo motors; CNC programming; Case studies for manufacturing of tractor through industry visit

## **20. Mechanics of Tillage and Traction**

**3(2+1)**

Introduction to mechanics of tillage tools, engineering properties of soil, principles and concepts, stress strain relationship, design of tillage tools principles of soil cutting, design equation, force analysis, application of dimensional analysis in soil dynamics performance of tillage tools. Introduction to traction and mechanics, off road traction and mobility, traction model, traction improvement, traction prediction, tyre size, tyre lug geometry and their effects, tyre testing, soil compaction and plant growth, variability and geo statistic, application of GIS in soil dynamics.

**Practical:** Measurement of static and dynamic soil parameters related to tillage; Measurement of soil parameters related to puddling and floatation; Measurement of draft for passive rotary and oscillating tools; Measurement of slip and sinkage under dry and wet soil conditions; Measurement of load and fuel consumption for different farm operations; Economics of weight transfer and tractor loading including placement and traction aids; Studies on tyres, tracks and treads under different conditions; Studies on compaction and number of operations.

## **21. Systems Engineering**

**3 (3+0)**

System concepts. Requirements for a Linear programming problems. Mathematical formulation of Linear Programming problems and its Graphical solution. Response of systems. Computer as a tool in system analysis. Simplex method. Degeneracy and Duality in linear programming. Artificial variable techniques, Big M method and two phase methods. Mathematical models of physical systems. Modelling of Agricultural Systems and operations. Cost analysis. Transportation problems. Assignment problems. Waiting line problems. Project management by PERT/CPM. Resource scheduling.

**Syllabus**

**For**

**B. Tech. (Dairy Technology)**

# DAIRY TECHNOLOGY

## 1. DAIRY ENGINEERING

### 1. Dairy Engineering

3(2+1)

Sanitization : Materials and sanitary features of the dairy equipment. Sanitary pipes and fittings, standard glass piping, plastic tubing, fittings and gaskets, installation, care and maintenance of pipes & fittings. Description, working and maintenance of can washers, bottle washers. Factors affecting washing operations, power requirements of can the bottle washers, CIP cleaning and designing of system. Mechanical Separation: Fundamentals involved in separation. Sedimentation, Principles involved in filtration, Types, rates of filtration, pressure drop calculations. Gravity setting, principles of centrifugal separation, different types of centrifuges. Application in Dairy Industry, clarifiers, tri processors, cream separator, self-disludging centrifuge, Bacto-fuge, care and maintenance of separators and clarifiers. Homogenization : Classification, single stage and two stage homogenizer pumps, power requirement, care and maintenance of homogenizers, aseptic homogenizers. Pasteurization: Batch, flash and continuous (HTST) pasteurizers, Flow diversion valve, Pasteurizer control, Care and maintenance of pasteurizers. Different type of sterilizers, in bottle sterilizers, autoclaves, continuous sterilization plant, UHT sterilization, Aseptic packaging and equipment. Care and maintenance of Sterilizers. Filling Operation: Principles and working of different types of bottle filters and capping machine, pouch filling machine (Pre-pack and aseptic filling bulk handling system, care and maintenance. Mixing and agitation : Theory and purpose of mixing. Equipments used for mixing solids, liquids and gases. Different types of stirrers, paddles and agitators. Power consumption of mixer-impeller, selection of mixing equipment in dairy industry, mixing pumps.

**Practical :** To study : S.S.Pipes and fitting, gasket materials and S.S.milk pumps: Milk tanker and milk storage tanks: Can washer and bottles washer: C.I.P. Cleaning equipment: Homogenizers: Batch and Continuous pasteurizers: Different controls on pasteurizer: Different sterilizers: Pouch filling machine: Different types of agitators: Bottle filling and Capping machine: Determination of the rate of filtration and settling: Visit to a dairy plant.

### 2. Dairy Process Engineering:

3 (2+1)

Evaporation : Basic principles of evaporators, construction and operation, Different types of evaporators used in dairy industry, Calculation of heat transfer area and water requirement of condensers, Basic concepts of multiple effect evaporators, Operations and various feeding systems, Economy of operation, Thermo processor and MVR system, Care and maintenance of evaporators. Drying : Introduction to principle of drying, Equilibrium moisture constant, bound and unbound moisture, Rate of drying- constant and falling rate, Effect of Shrinkage, Classification of dryers-spray and drum dryers, spray drying, etc., air heating systems, Atomization and feeding systems. Factors affecting bulk density of power, spray dryer controls, Theory of solid gas separation, cyclone separators, Bag Filters, Care and Maintenance of drum and spray dryers. Fluidization: Mechanisms of fluidization characteristics of gas-fluidization systems, Minimum Porosity, Bed Weight, Pressure drop in fluidized bed, Application of fluidization in drying, Batch fluidization, Fluidized bed dryers. Mechanization and equipment used in manufacture of indigenous dairy products, Butter and Ghee making machine, Ice-cream and Cheese making equipments. Packaging machines for milk & milk products. Membrane Processing : Ultra filtration, Reverse Osmosis and electro

dialysis, Materials for membrane construction, Ultra filtration of milk, Effect of milk constituents on operation, membranes for electro-dialysis.

**Practical:** Study of construction and operation of : Vacuum pan: Double effect evaporator: Spray dryer: Vacuum and atmospheric drum dryers. Study and operation of Butter, Ghee, Ice-cream and cheese making equipments, Study the Reverse Osmosis and Ultra filtration system: Design problems on Double effect evaporator and Vacuum pan. Visit to a milk product plant.

### **3. Dairy Plant Design and Layout**

**3(2+1)**

Introduction of Dairy Plant design and layout. Type of dairies, perishable nature of milk, reception flexibility. Classification of dairy plants, Location of plant, location problems, selection of site. Dairy building planning, Process schedule, basis of dairy layout, importance of planning, principles of dairy layout. Space requirements for dairy plants, estimation of service requirements including peak load consideration. General points of considerations for designing dairy plant, floor plant types of layouts, service accommodation, single or multilevel design. Arrangement of different sections in dairy, siting the process sections, utility/service sections, offices and workshop. Arrangement of equipment, milk piping, material handling in dairies, Common problems, office layouts-flexibility. Development and presentation of layout, model planning, use of planning table in developing plot plan and detailed layout. Choice of building construction materials, floors, general requirement of dairy floor finishes, floors for different section of dairy. Foundations, walls doors and windows, Drains and drain layout for small and large dairies. Ventilation, fly control, mold prevention, illumination in dairy plants.

**Practical :** Building symbols and convention layouts for small, medium and large size dairies. Isometric presentation of piping. Design and layout of: Milk collection/chilling centre; Fluid milk plant (small, medium and large); Single product dairy (i) Cheese, (ii) ice-cream, (iii) butter and (iv) ghee. Composite dairy plant.

### **4. Instrumentation and Process Control:**

**3(2+1)**

Absolute and secondary instruments, Types of secondary instruments, Essentials of indicating instruments, Constructional details of indicating instruments. Principle of induction type instruments- shaded pole method and two pole methods, compensation for frequency and temperature errors. Induction type voltmeter, Ammeter, advantage and disadvantages, induction type single phase watt hour meter , their errors and remedies, Numerical, wattmeter, power fractometer, etc. Characteristics of Instruments and Measuring Systems: Elements of generalized measuring system, static calibration, accuracy, sensitivity, reproducibility, static errors, dead zone, drift in measuring instruments. Analog and digital representation of signals, Factors influencing the choice of transducers. Mechanical Input Transducers: Level, Pressure, Flow, Velocity and Humidity- Resistive, Capacitive and Inductive, Dielectric system for humidity measurements. Temperature Transducers : Resistive, inductive, capacitive and thermoelectric transducer. Magnetic Transducers : Systems based on induction and magnetic effects on moving charges, Transducers based on permeability variation.

**Practical :** Preparation and calibration of thermocouple; study the construction and working of Bourden pressure gauge. Study the mechanism of pH meter and its electrodes. Study a pressure transducer. Study a Proximity sensor. Study of the different parts and working of Rotameter. Study the different parts and working of pressure switch. Study the different parts

of an indicating instrument. Study the different parts and their working of single phase induction type watt-hour meter. Visit to a microprocessor controlled dairy plant.

### **5. Engineering Drawing:**

**2(0+2)**

Drawing of lines, lettering and dimensioning types of lines, types, types of lettering, types of dimensioning. Drawing of scales. Plain scale, diagonal scale, comparative scale and Vernier scale. Drawing of projections; Orthographic projections, methods of projections. Drawing of screw threads; Types of threads and terminologies used in lit. Screw fastening: Types of nuts, types of bolts, stud, locking arrangements for nuts and Foundation bolt. Drawing of rivets and riveted joints forms of rivet heads, types of riveted joints, failure of riveted joints. Drawing of welded joints: Forms of welds, location and dimensions of welds. Drawing of keys, cotter joint, pin joints types of keys, types of cotter joints, pin joints. Drawing of shaft couplings: Rigid couplings, loose couplings, flexible couplings universal coupling. Drawing of shaft bearings. Journal bearings, pivot bearings, collar bearings.

### **6. Principles of Dairy Machine Design**

**3(2+1)**

Basic concepts in Statics and Dynamics. Force Systems. Equilibrium condition, friction, Law of friction, Second moments of inertia, Parallel axis theorem. Dynamics : Equation of motion. Translation and rotation of a Rigid body, work and mechanics of materials : Stress-Axial Load classification Strain-Hooke's law, stress-strain diagram, Poisson's Ratio : Shearing Stresses. Torsion, Torsion formula, Angle to Twist of circular members. Power transmission shear force and bending moments, Shear in Beams, Bending Moment in beams. Pure bending of beams, Flexural stress shearing stresses in beams relations between centre, Torsional and flexural loads. Machine Design : Procedures, Specification, strength, design factor, factor of safety selection of factor of safety. Materials and properties. Static strength, ductility, hardness, fatigue, designing for fatigue conditions. Theories of failure, Stresses in elementary machine parts, Design of a drive system. Design of length and thickness of belt. Bearing : Journal and Anti-friction bearings. Selection of ball, tapered roller and thrust bearing. Springs, helical and leaf springs. Energy stored in springs. Design and selection of springs.

**Practical:** Engineering Statics & Dynamics. Work and Energy. Linear and Angular Momentum. Stress-strain diagram evaluation of elastic constants. Power transmission. Shear force and bending moment diagrams. Flexural stresses. Shearing stresses in Beams. Fits and tolerances. Design stresses in elementary machine parts. Design of shafts, axles keys Springs, Couplings, Bearing

### **7. Workshop Practice**

**2(1+1)**

Introduction to workshop practice, safety, care and precautions in workshop. Wood working tools and their use, Carpentry and pattern making. Mould material and their applications. Heat treatment processes: hardening, tempering, annealing, normalizing etc. Metal cutting. Soldering & Brazing, Electric arc welding, Gas welding. Smithy and forging operations, tools and equipment. The bench : Flat surface filing, Chipping, Scraping Marking out, Drilling and Screwing. Use of jigs and fixtures in production. Introduction to following machine tools : (a) Lathe (b) Milling machine (c) Shaper and planer (d) Drilling and boring machines (e) Grinder (f) CNC machines.

**Practical:** Simple exercises in Filing and Fitting, Chipping and Hack sawing, Chiseling, Tapping and Smithy practice, Simple exercises in Arc, Gas, & Argon welding. Simple exercises in Soldering, Brazing, Basic joints in carpentry.

## 8. Fluid Mechanics

3(2+1)

Units and dimensions, Properties of fluids. Static pressure of liquids: Hydraulic pressure, absolute and gauge pressure, pressure head of a liquid. Pressure on vertical rectangular surfaces. Compressible and non compressible fluids. Surface tension, capillarity. Pressure measuring devices, simple, differential, micro, inclined manometer, mechanical gages, Piezometer. Floating bodies: Archimedes principle, stability of floating bodies. Equilibrium of floating bodies. Metacentric height. Fluid flow: Classification, steady uniform and non uniform flow, Laminar and turbulent, continuity equation, Bernolli's theorem and its applications. Flow through pipes: Loss of head, determination of pipe diameter. Determination of discharge, friction factor, critical velocity. Flow through orifices, mouthpieces, notches and weirs, Vena contracta, hydraulic coefficients, discharge losses, Time for emptying a tank. Loss of head due to contraction, enlargement at entrance and exit of pipe. External and internal mouthpieces, types of notches, rectangular and triangular notches, rectangular weirs. Venturimeters, pitot tube, Rota meter. Water level point gauge, hook gauge. Dimensional analysis: Buckingham's theorem application to fluid flow phenomena. Froude Number, Reynolds number. Weber number and hydraulic similitude. Pumps : Classification, reciprocating, centrifugal pump. Pressure variation, work efficiency. Types of chambers, selection and sizing.

**Practical :** Study of different tools and fittings. Plotting flow rate versus pressure drop with U-tube manometer. Verification of Bernoulli's theorem. Determination of discharge coefficient for venturi, Orifice, V-Notch. Verification of emptying time formula for a tank. Determination of critical Reynold's number by Reynold' apparatus. Study of reciprocating, centrifugal and gear pump. Calibration of Rota meter. Study of different types of valves. Problems on following topics: Pressure, capillarity and surface tension. Floating bodies, Liquid flow, venturimeter, orifice, weir, flow through pipes, pumps.

## 9. Heat & Mass Transfer

3(2+1)

Basic heat transfer process, thermal conductivity, convective film co-efficient, Stefan Boltzman's constant and equivalent radiation co-efficient, Overall heat transfer co-efficient, physical properties related to heat transfer. Working principles and application of various instruments for measuring temperature. One-dimensional steady state conduction: Theory of heat conduction, Fourier's law, Derivation of Fourier's equation in Cartesian co-ordinates, Linear heat flow through slab, cylinder and sphere. Heat flow through slab, cylinder and sphere with non-uniform thermal conductivity. Concept of electrical analogy and its application for thermal circuits, Heat transfer through composite walls and insulated pipelines. One dimensional steady state heat conduction with heat generation : Heat flow through slab, hollow sphere and cylinder with uniform heat generation, Development of equations of temperature distribution with different boundary conditions. Steady-state heat conduction with heat dissipation to environment :Introduction to extended surfaces (FINS) of uniform area of cross-section. Equation of temperature distribution with different boundary conditions. Effectiveness and efficiency of the FINS. Introduction to unsteady state heat conduction. Convection: Forced and free convection, use of dimensional analysis for correlating variables affecting convection heat transfer, Concept of Nusselt number. Prandtl number, Reynolds number, Grashoff number, Some important empirical relations used for determination of heat transfer coefficient. Heat Exchangers: General discussion, fouling factors, jacketed kettles, LMTD, parallel and counter flow heat exchangers, Shell and tube and plate heat exchangers, Heat exchanger design. Application of different types of heat exchangers in dairy and food industry. Fick's Law of diffusion, steady state diffusion of gases

and liquids through solids. Equimolar diffusion. Mass transfer co-efficient and problems on mass transfer.

**Practical :** Determination of thermal conductivity: milk, solid dairy & food products. Determination of overall heat transfer co-efficient of : Shell and tube, plate heat exchangers and Jacketted kettle used in Dairy & Food Industry. Studies on heat transfer through extended surfaces. Studies on temperature distribution and heat transfer in HTST pasteuriser. Design problems on heat exchangers. Study of various types of heat exchangers. Design problems on Mass Transfer.

## 10. Thermodynamics

3(2+1)

Basic concepts: systems, processes, cycles, energy, The Zeroth Law of Thermodynamics. Ideal gases: Equation of state, Compression and expansion of gases. The first Law of Thermodynamics: Internal energy, enthalpy. The second Law of Thermodynamics: Thermodynamic temperature scale, Carnot cycle, entropy, reversibility, availability. Air Cycles: Otto, Diesel, dual efficiencies, Plotting the cycles on various thermodynamic planes viz., p-V, T-S, p-h diagram; etc. IC. Engines: Two stroke and four stroke cycles, construction, injection and ignition of fuel, Performance of IC engines. Fuels: Chemical properties, air for combustion, Calorific value and its determination, Burners, firing of fuels. Renewable energy sources. Properties of steam: Wet, dry saturated, superheated steam, Use of steam tables and Molier charts. Steam generators : Fire tube boilers, Water tube boilers. Boiler mountings and Boiler accessories. Draught : Natural, forced, fan, jet, Measurement of Height of chimney. Condensers. Layout of pipe-line and expansion joints. Boiler trial: Codes, Indian Boiler Regulation acts. Air Compressors: Reciprocating, Single and two stage air compressors.

**Practical:** Application of thermodynamics in engineering problems. Study of 2-stroke engine and 4-strokes engines. Performance tests on I.C. engines. Determination of dryness fraction of steam. To study the boiler installed in Model Plant, Water softening plant, Lancashire boiler, Locomotive boiler, Babcock & Wilcox boiler, Electrode boiler, Boiler mounting and steam-line layout and steam traps. Visit to sugar mill/rice mill or plant with steam utilization. Study of Solar water heater and biogas plants and appliances.

## 11. Refrigeration & Air Conditioning

3(2+1)

Basic refrigeration cycles and concepts : Standard rating refrigerating machines, Elementary vapour compression refrigeration cycle with reciprocating, rotary and centrifugal compressors. Theoretical vapour compression cycle, Departure from theoretical vapour compression cycle, representation on T- and p-h diagrams, Mathematical analysis of vapour compression refrigeration system. Refrigerants: Primary and secondary refrigerants, common refrigerants (Ammonia, Freon), Brine, their properties and comparison. Multiple evaporator and compressor systems: Applications, One compressor systems: dual compression, comparison of system, Control of multiple evaporator system, Working and mathematical analysis of above systems. Refrigeration equipments: Compressor, Condenser, evaporator, Cooling tower, spray pond, Basic elements of design, Construction, operation and maintenance, balancing of different components of the system. Refrigeration Controls: Low side and high side float valves, capillary tube, thermostatic expansion valve, automatic expansion valve, solenoid valve, High pressure and low pressure cutouts, thermostat, overload protector, common defects and remedies. Refrigeration Piping: Purpose, materials, joint and fittings, water and brine pipe size selection. Absorption Refrigeration Systems: Simple vapour absorption refrigeration systems, Practical absorption system, Refrigerant absorbent combinations Absorption cycle analysis. Psychrometry: definition, properties of air-vapour mixtures, Psychrometric charts, Processes involving air vapor mixtures, Dehumidification,

humidifiers, Humidity measurements, humidity control. Wet bulb, dry bulb temperature dew point temperature. Cooling load calculations: Types of loads, design conditions for air cooling, air conditioning loads. Cold storage: Types of cold storage, Types of loads in cold storage, Construction of cold storage. Insulating materials and vapour barriers.

**Practical :** Study of tools used in installation of a refrigeration plant including charging and detection of leaks. To study different parts and learn operation of bulk milk cooler. Study of different parts and learn the operation of a refrigeration plant/ice plant using ammonia refrigerant. Study of different parts and learn the operation of a vapour absorption refrigeration plant. Dismantling and assemble an open compressor and a sealed unit. Study different parts and refrigeration controls of the following (a) Refrigerator (b) Water cooler (c) Deep Freezer (d) Compare their cooling coils and other systems. To find out the rating (cooling rate) at different suction temperatures (temperature differences) and air handling capacity of the air cooling unit. Plotting the practical refrigeration cycle on a pressure enthalpy diagram and to compare it with a theoretical refrigeration cycle. Study different parts and operation of a (a) Air washer, (b) Room cooler, (a) Air conditioner, (d) Chemical dehumidifiers, (e) Cooling. Plotting of psychrometric process: Sensible heating & cooling. Dehumidification & cooling and heating & humidification. Study of different humidity indicating, recording and controlling devices. Problems on cold storage. Visit to cold storage.

## 12. Electrical Engineering

3(2+1)

Alternating current fundamentals: Electromagnetic induction magnitude of induced E.M.F. Alternating current, R.M.S. value and average value of an alternating current. Phase relations and vector representation. A.C. series and parallel circuits, Concept of resonance, polyphase alternating current circuits, three-phase concept, Star and delta connections, star delta transformation, Energy measurement. Transformers: Fundamental of transformer, Theory, vector diagram without load and with load, Losses, voltage regulation and efficiency of transformer, auto-transformer. Alternators: Elementary Principles, Construction and different types of alternators, E.M.F. in alternators, circuit breakers. Induction motors : Fundamental principles, production of rotating fields, construction, Rotor winding-squirrel cage and phase wound rotors, Analysis of current and torque, starting of induction motors, Motor housing, selection of motor and its controls. D.C. Machines: Construction and operation of D.C. generator, Types of generators, various characteristics of generator, D.C. motors, torque-speed characteristics of D.C. motors, Starting and speed control of D.C. motors. Electric Power Economics: Maximum demand charge, Load factor and power factor correction. Measuring Instruments: Classification of instruments, Elements of a generalized measurement system, static and dynamic characteristics.

**Practical:** Study of voltage resonance in L.C.R. circuits at constant frequency; (a) Star connection-study of voltage and current relation (b) Delta connection-study of voltage and current relation. Measurement of power in 3-phase circuit; (a) For balanced loads (b) For unbalanced loads, by wattmeter and energy meters. Polarity test, no-load test, efficiency and regulation test of single phase. Voltage and current relation in a 3-phase transformer of various kinds of primary and secondary connection systems. Starting of induction motor by the following starters : (i) D.O.L. (ii) Manual star- delta (iii) Automatic star-delta (iv) Manual auto-transformer. Starting of slip-ring induction motor by normal and automatic rotor starters. Test on 3-phase induction motor, determination of efficiency, line current, speed, slip, power factor at various outputs. Determination relation between the induced armature voltage and speed of separately excited D.C. generator. Magnetization characteristic of D.C. generator. Study the starter connection and starting reversing and adjusting speed of a D.C. motor. Study of various measuring instruments.

### **13. Food Engineering**

**4(3+1)**

Rheology of processed food, properties of fluid foods, Rheological method, Measurement of rheological parameters, properties of granular food and powders, Properties of solids foods, Visco-elastic models. Measurement of food texture. Food Freezing : Thermal properties of frozen foods. Prediction of freezing rates. Plank's equation, Neumann problem and Tao solution. Design of food freezing equipment, Air blast freezers, Plate freezers and immersion freezers, storage of frozen foods. Food dehydration : Estimation of drying time for food products, constant rate period and falling rate period dehydration. Diffusion controlled falling rate period. Use of heat and mass balanced in analysis of continuous dryers, fixed tray dehydration, cabinet drying, tunnel drying. Freeze Dehydration : Heat and mass transfer, Calculation of drying times, Industrial freeze drying. Equipment for pulping, Fruit juice extraction, Blanching, Dehulling, Size reduction and distillation.

**Practical:** Study of rheological properties of foods. Study of freezers and freeze dryers. Design problems on batch freezers. Design problems for continuous freezers. Design problems on dryer. Visit to cold storage. Visit to food processing plant.

## **2. DAIRY MICROBIOLOGY**

### **1. Fundamentals of Microbiology**

**3(2+1)**

Microbiology: history and scope; contributions of Leeuwenhock, Pasteur and Koch. Principle of microbiology: Light Microscopy (Bright field, dark field, phase contrast, fluorescence); preparation and staining of specimens; electron microscopy. Microbial taxonomy: principles; numerical taxonomy; major characteristics used in taxonomy; classification according to Bergey's manual of systematic bacteriology. Structure and functions of prokaryotic cells; difference between prokaryotes and eukaryotes. Microbial growth and nutrition: the growth curve; factors affecting growth of microorganisms, estimation of bacterial growth; bacteriostatic and bactericidal agents; the common nutrient requirements and nutritional types of microorganisms. Bacterial genetics; DNA as the genetic material; structure of DNA; bacterial mutations (spontaneous and induced); genetic recombination- (transformation, transduction, conjugation). Micro flora of air, soil and water: methods for controlling microorganisms in air; water as carrier of pathogens.

**Practical:** General instruction for microbiological laboratory. Microscope- simple and compound; Microbiological equipments; autoclave, hot air oven, incubator, centrifuge, colorimeter, laminar airflow, membrane filter. Simple staining- methylene blue; crystal violet; negative staining. Differential staining (Gram, spore, acid fast). Mortality of microorganisms; hanging drop technique. Measurement of microorganisms by micrometry. Preparation of commonly used growth media liquid and solid: simple and differential media. Isolation technique for microorganisms- Streak & pour plate Enumeration of microorganisms in air and soil. Enumeration of microorganisms in water: total viable count, coliform (MPN).

### **2. Introductory Dairy Microbiology**

**3(2+1)**

Hygienic milk production system; microbial quality of milk produced under organized v/s unorganized milk sector in India and comparison with developed countries; microbial and non microbial contaminants, their sources and entry points in milk during various stages of production; Good Hygiene Practices (GHP) during milk production operations Microorganisms associated with raw milk; morphological and biochemical characteristics of important groups and their classification; significance of different groups of bacteria i.e.

psychrotrophs, mesophiles, thermodurics, and thermophiles in milk. Microbiological changes in bulk refrigerated raw milk; Impact of various stages like milking, chilling, storage and transportation on microbial quality of milk with special reference to psychrotrophic organisms; Direct and indirect rapid technique for assessment of microbial quality of milk. Role of microorganisms in spoilage of milk; souring, curdling, bitty cream, proteolysis, lipolysis; abnormal flavors and discoloration. Mastitis milk: Processing and public health significance, organisms causing mastitis, somatic cells secreted in milk; detection of somatic cell count (SCC) and organisms causing mastitis in milk. Milk as a vehicle of pathogens; Food infection, intoxication and toxic infection caused by milk borne pathogens like *E. coli*, *Salmonella typhi*, *Staph aureus*, *Bacillus cereus* etc. Antimicrobial substances in milk: immunoglobulin, lactoferin, lysozymes, LP systems etc.

**Practical:** Morphological examination of common dairy organism (size and shape, arrangement and sporulation). Enumeration of psychrotrophic, thermophilic, thermoduric and spore forming bacteria in milk. Detection of sources of contamination: air, water, utensils, equipment and personnel line testing. Spoilage of milk caused by microorganisms souring, sweet curdling, gassiness, lipolysis, ropiness, proteolysis and discoloration. Detection of mastitis milks, pH, SLST, somatic cell count, chloride content, Hotis test, CAMP test. Detection and estimation of coliforms; presumptive test, rapid coliform count, IMVIC test. Detection of important pathogens using selective media; *E.coli*, *Staphylococcus aureus* *Salmonella* and *Bacillus cereus*. Estimation of microbial load in milk by SPC and Dye reduction tests-(MBRT, RRT). Detection of antibiotic residues using qualitative test

### 3. Food and Industrial Microbiology

3(2+1)

Food Microbiology: Basic aspects and scope of food microbiology. Intrinsic and extrinsic factors that affect microbial growth in foods. Microbial spoilage of fruits, fruit juices, vegetables, cereals, meat, poultry, sea foods, carbonated soft drinks, canned foods; control of spoilage. Food preservation : physical methods; chemical preservatives and natural antimicrobial compounds, biology based preservation system. Industrial Microbiology: Fermentation processes: the range, components and types (submerged, surface and solid state fermentation): criteria for selection of industrially important microorganisms; media for industrial and inoculums development; down stream processing of fermented products. Fermenters: types, functions, design and control; chemostat and turbidostat. Microorganism and processes involved in the production of industrial alcohol, organic acids (citric lactic), enzymes (protease, lipase and rennet), vitamin (B-12), antibiotic (nisin) and microbiology of effluent treatment in food industry.

**Practical:** Microbiological examination of: fresh and canned fruits/ vegetables/ juices; flour and bread, eggs and meat. Design and control of a tabletop and 10 liter lab fermenter (Demonstration). Isolation of psychrophile, salt and sugar tolerant microorganisms from foods. Isolation of industrially important microorganisms from environment. Production and assaying of microbial enzymes (protease/ lipase). Production of lactic acid from whey. Production of nisin and assaying the antimicrobial activity of the culture. Production of ethyl alcohol from molasses and whey by yeasts. Production of fermented whey beverages. Educational tour to food processing/ fermentation industries.

### 4. Starter Cultures and Fermented Milk Products

3(2+1)

Introduction of starter cultures & their importance in dairy industry, classification of Lactic Acid Bacteria; Metabolism of Lactic Acid Bacteria and diacetyl production, production of antibacterial substances by lactic starter cultures. Mixed and define strain starter culture;

propagation of starter cultures; factors affecting their propagation; starter concentrates- direct bulk and direct vat starter cultures; starter distillates. Quality and activity of starter cultures; defects in starters and their control; starter failures; antibiotic residues, sanitizers and bacteriophages. Preservation of starter cultures: freezing and freeze-drying; factors affecting the survival of cultures during preservation. Role of starter cultures in the preparation of various fermented milks; classification of fermented milks Microbiology of dahi and yoghurt; different types of dahi and yoghurt; preparation; defects and their control. Microbiology of milk products; their nutritional and therapeutic significance. Kefir and Kumiss: origin and characteristics: microbiology of Kefir grains. Microbiology of other fermented milks such as Bugarian milk, cultured buttermilk, Leben and Yakult; their significance. Concept of probiotic starters and their application in probiotic dairy food.

**Practical:** Testing for purity of starter cultures; gram's staining, catalase test; creatine test. Starter activity tests: die reduction tests, Horrall-Elliker test, Whitehead and Cox test. Preparation of single and mixed starter cultures: homofermentation and hetrofermentation separately and also in combinations. Maintenance and preservation of starter cultures- Freeze drying techniques demonstration. Preparation of concentrated starter – freeze dried and frozen types. Effect of physical factors on dairy starter: temperature, pH, salt, sugar. Testing milk for the presence of inhibitory substance using *B. stearothermophilus* and *S. thermophilus* as indicator organisms. Effect of antibiotic residues in milk on starter activity. Associative growth of microorganisms in milk and cream. Detection of bacteriophages in cheese whey by plaque assay. Preparation and evaluation of quality and grading of Dahi, Yoghurt, cultured butter milks, acidophilus milk and Kumiss. Microbiological analysis of processed cheese- Total spore count & Anaerobic spore count. Microbiological analysis at different stages of manufacture of (storage and ripening) hard varieties of cheese- such as Cheddar cheese.

## 5. Dairy Biotechnology

3(2+1)

Definition, scope and historical development of biotechnology, achievement and future application: structure of DNA and RNA; DNA replication, protein synthesis, genetic code, mutations: Vectors, cloning strategies in bacteria and animals, DNA technology. Protoplast fusion & Tissue culture in dairy cultures. Application of biotechnology in food and dairy industry, dairy effluents. Genetic manipulation of dairy starters for improved attributes of commercial value. Dairy enzymes and whole cell immobilization. Ethical issues related to use of genetically modified foods.

**Practical :** Isolation of plasmid and genomic DNA from bacteria (*E. coil*, lactic acid bacteria Agarose gel electroporesis of DNA fragments). Restriction analysis of DNA. Curing of plasmids. Preparation of competent cell. Conjugal transfer in *E. coli* cells. Transformation of *E. coli* by calcium chloride treatment/ electro oration. Preparation of protoplasts and protoplast fusion. PCR technique demonstration. Visit to a biotechnology lab.

## 6. Quality and Safety Monitoring in Dairy Industry

3(2+1)

Current awareness on quality and safety of dairy foods; consumer awareness and their demands for safe foods; role of codex alimentarius commission (CAC) in harmonization of international standards; quality (ISO 9001:2000) and food safety (HACCP) system and their application during milk production and processing. National and international food regulatory standards; BIS, PFA, ICMSF, IDF etc., their role in the formulation of standards for controlling the quality and safety of dairy foods. Rapid assessment of dairy food for microbial and non-microbial contaminants; Enumeration Principles in detection of

predominant spoilage organisms and pathogens like indicator organisms, *E.coli*, *salmonella*, *shigella*, *staph aureus*, *Bacillus cereus* and non microbial contaminants like antibiotic residues, aflatoxin, pesticides other inhibitors etc from. dairy foods and their control measures. Microbial quality of water and environmental hygiene in dairy plant; chlorination of dairy water supply, quality of air. Personnel hygiene, treatment and disposal of waste water and effluents; setting up of a microbiological/ pathogen lab in a dairy plant and its safety concern.

**Practical :** Evaluation of common sanitizing agents used in dairy plants by a) suspension b) capacity test. Microbiological tests for assessing equipment and personnel hygiene by swap and rinse methods. Detection of faecal and non- faecal coliforms and faecal streptococci in dairy plant. Detection and enumeration of different pathogenic bacteria in dairy products: *Staphylococcus aureus*, *Bacillus cereus*, *Salmonella* and *Shigella*. Bacteriological analysis of dairy water for : a) total viable counts b) coliform counts (MPN). Detection of antibiotic residues, pesticides, aflatoxins and staphylococcal enterotoxins in milk using rapid techniques. Determination of BOD in dairy waste water. Quality evaluation by HACCP in the preparation of dairy products.

### 3. DAIRY TECHNOLOGY

#### 1. Market Milk

4(3+1)

Market milk industry in India and abroad: Distinctive features of tropical dairying as compared to those of the tropical climate of developed countries. Collection and transportation of milk; a) Organization of milk collection routes b) Practices for collection of milk, preservation at farm, refrigeration, natural microbial inhibitors, lactoperoxidase system. c) Microbial quality of milk produced on farm. Effect of pooling and storing on microbial quality of refrigerated milk. Role of psychrotrophs, Role of tropical climate on spoilage of milk. d) Chemical tests for grading raw milk. e) Microbiological tests for grading raw milk. Reception and treatment (pre-processing steps) of milk in the dairy plant: a) Reception, chilling, clarification and storage: General practices. b) Homogenisation: Definition, pretreatments, theories, synchronization of homogenizer with operation of pasteurizer (HTST) c) Effect of homogenization on physical properties of milk. d) Bactofugation: Theory and microbiology. Thermal processing of milk: a) Principles of thermal processing: kinetics of microbial destruction, thermal death curve, arrhenius equation, D value, Z value,  $F_0$  value,  $Q_{10}$  value. b) Factors affecting thermal destruction of micro-organisms. c) Definition and description of processes: Pasteurization, thermisation, sterilization, UHT Processing. d) Microbiology of pasteurised milk, thermized, sterilized & UHT milk. e) Product control in market milk plant. f) Defects in market milk. g) Manufacture of special milks: toned, doubled toned, reconstituted, recombined, flavoured, homogenized vitaminised and sweet acidophilus milk. h) Manufacture of sterilized milk. i) Distribution systems for market milk. Quality and safety aspects in dairy food chain, good manufacturing practices (GMP) in dairy processing. UHT processing of milk : a) Relevance of UHT processing in the tropical climate b) UHT plants: Description. Direct, Indirect, with upstream and downstream homogenization, third generation UHT plants. c) Aseptic packaging, types and systems of packaging, sterilizing packages, filling systems. d) Technical control in the UHT plant. Training of personnel. Plant hygiene. e) Shelf life of UHT milk and tests for UHT milk. Nutritive value of milk. Effect of heat processing on nutritive value. Efficiency of plant operation: product accounting, setting up norms for operational and processing losses for quantity, fat and SNF, monitoring efficiency. Maintaining plant hygiene & HACCP.

**Practical :** Familiarization with equipments for reception of milk in plant; Pretreatments: Chilling, clarification, filtration. Standardization and numericals relating to it. Cream separation: parts of separator and the process. Operation of LTLT, HTST pasteurizer, laboratory steriliser. Sampling and chemical examination of pasteurized, sterilized and UHT processed milk. Sampling and routine microbiological examination of microbiological examination of pasteurized and sterilized milk. Preparation of special milks; toned, double toned, standardised, flavoured, sterilised. Cleaning of storage tanks, cream separators, HTST plants; manual cleaning and CIP. Detection of adulterants and preservatives in milk. Assessment of homogenisation efficiency in milk. Strength of common detergents and sanitizers used in market milk plant.

## **2. Traditional Dairy Products**

**3(2+1)**

Status and significance of traditional milk products in India. Khoa: Classification of types, standards methods of manufacture and preservation factors affecting yield of khoa. Physico-chemical changes during manufacture and storage of khoa. Mechanization in manufacture of khoa. Confectioneries made from Khoa-Burfi, peda, Milkcake, Kalakhand, Gulabjaman and their compositional profile and manufacture practices. Rabri and Basundhi: Product identification, process description, factors affecting yield physico-chemical changes during manufacture. Channa: Product description, Standards method of manufacture, packaging and preservation. Chhana-based sweets, Rasogolla, Sandesh, Ras-malai. Mechanization of manufacturing process. Paneer: Product description standards method of manufacture packaging and preservation. Physico-chemical changes during manufacture and storage. Mechanization of paneer manufacturing/packaging process. Srikhand: Chakka-product description, standards method of manufacture, small scale and industrial, packaging and preservation aspects. Shrikhand-save as chakka. Physico-chemical changes and quality assurance during manufacture and storage. Sandesh: Product description method of manufacture and packaging process. Misti dahi : Product description method of manufacture and packaging process. Kheer and Payasam: Product description methods of manufacture, innovations in manufacturing and packaging processes. Microbiology of indigenous milk products, predominance of spoilage & pathogenic organisms in Khoa, Chhanna, Paneer, Shrikhand, their spoilages, control measures & legal specifications. Biopreservative principles in enhancing the self-life of indigenous milk products including active packaging.

**Practical :** Preparation of khoa from cow, buffalo and concentrated milk. Analysis of khoa, chhanna and paneer for total solids, moisture, fat and acidity. Preparation of kheer. Preparation of chhana from cow and buffalo milk and mixed milk. Preparation of paneer from cow and buffalo milk and mixed milk. Preparation of misti dahi, chhaka and srikhand. Preparation of khoa and chhana based sweets. Microbiological examinations of traditional dairy products: Khoa, paneer, spore counts, coliform counts yeast, molds counts etc. Field trip

## **3. Fat-Rich Dairy Products**

**4(3+1)**

Status of fat-rich dairy products in India and abroad. Cream: a) Definition & Legal standards, Efficiency of cream separation and factors affecting it; control of fat concentration in cream. b) Planning and operating a cream production unit) neutralization, standardization, pasteurization and cooling of cream. c) Preparation and properties of different types of cream; table cream, sterilized cream, whipped cream, plastic cream, frozen cream and chip-dips (cultured cream), UHT processing of cream. d) Bacteriology of cream including defects, factors affecting quality of cream; ripening of cream e) Packaging storage and distribution, defects (non-microbial) in cream and their prevention.

Butter: a) Introduction to the butter making process; theory of churning, Legal standards. b) Technology of Butter manufacture, Batch and continuous methods. Over-run in butter; control of fat losses in butter-milk; packaging and storage; transportation; defects in butter; rheology of butter; uses of butter. Microenvironment in cream and butter, impact of critical process factors on entry of spoilage and pathogenic organisms in cream & butter, their spoilages & control measures. Legal microbiological specifications of cream & butter. Butter making equipment: Construction, operation, care and maintenance of cream separators, coolers and vacreator, factory butterchurn and continuous butter making machine. Special butters and related products: a) Manufacture, packaging, storage and properties of whey butter, flavoured butter, whipped butter, renovated butter / fractionated and polyunsaturated milk fat products, vegetable oil-blended products and low-fat spreads. b) Manufacture, packaging, storage and characteristics of margarine of different types. Ghee and butter oil: a) Methods of ghee making-batch and industrial processes, innovations in ghee production, procedure, packaging and preservation of ghee; utilization of substandard milk. b) Ghee: Composition and changes during manufacture fat constants.

**Practical:** Microbiological examination of cream: Direct microscopic count, Dye reduction tests. Microbiological examination of cream: a) Total viable count b) Lipolytic count c) Coliform count. Standardization, neutralization, pasteurization and cooling of cream. Preparation of sterilized cream. Study of construction and cooperation of the power operated butter churn and butter packaging machine. Preparation of cooking butter by the hand-operated churn. Preparation of desi butter. Manufacture of table butter using the power-driven churn. Preparation of ghee from cream and butter. Study and operation of continuous ghee plant. Sampling, determination of melting/slip point, moisture by gravimetric method, B.R. Index and Baudouin Test. Acidity, Helphen Test for the presence of cotton-seed oil. R.M. value and Polenske value. Saponification value. Iodine value. Peroxide value. Detection of animal body fats and vegetable oils. Examination of the quality of sodium chloride for butter making.

#### 4. Cheese Technology

5(3+2)

Origin and history of development of cheese manufacture, status and scope in India and abroad. Definition, standards and classification of cheese. Milk quality in relation to cheese making. Treatment of milk; Physical and chemical. Cheese additives and preservatives. Role of starter culture in relation to cheese quality. Rennet preparation and properties, rennet substitutes. Action of rennet on milk in relation to cheese making. Manufacture of different varieties of cheese: Cheddar, Gouda, Swiss, Mozzarella, Cottage. Microbiological changes during preparation ripening in cheese. Role of milk constituents and changes during manufacture and ripening in cheese. Factors affecting yield of cheese. Packing, storage and distribution of cheese. Accelerated ripening of cheese. Microbiological defects in cheese; their cause and prevention. Manufacture of processed cheese, cheese spread and processed cheese foods. Mechanization and automation in cheese processing. Microbiological critical control of cheese cold store.

**Practicals:** Familiarization with equipments, accessories and standardization numericals. Study of factors affecting rennet action. Manufacture of Cheddar cheese. Manufacture of Gouda cheese. Manufacture of Mozzarella cheese. Manufacture of Swiss cheese. Manufacture of Cottage cheese. Manufacture of Processed cheese. Manufacture of Processed cheese spread. Manufacture of processed cheese food. Analysis of cheese; proximate composition. Determination of ripening index.

## 5. Ice-Cream And Frozen Desserts

4(2+2)

History, development and status of ice cream industry, History, development and status of ice cream industry, Definition, classification and composition of ice cream and other frozen desserts, Stabilizers and emulsifiers-their classification, properties and role in quality of ice-cream, Technological aspects of ice cream manufacture, Thermodynamics of freezing and calculation of refrigeration loads, Types of freezers, refrigeration control / instrumentation, Types of freezers, refrigeration control / instrumentation, Hygiene, cleaning and sanitation of ice cream plant, Effect of process treatments on the physico-chemical properties of ice-cream mixes and ice cream, Processing and freezing of ice-cream mix and control of over run, Packaging, hardening, storage and shipping of ice-cream, Defects in ice cream, their causes and prevention, Physico-chemical properties of ice-cream and compositional standards., Microenvironment in ice cream, microbiological quality of ingredients, critical process factors & their impact on entry of pathogen in ice cream, their survival during storage, food poisoning out breaks, food safety & legal standards, Recent advances in ice-cream industry and plant management, Technology for preparation of dried ice-cream milk mix. and Nutritive value of ice-cream.

**Practical:** Calculation of standardization of ice-cream mixes. Manufacture of plain and fruit flavoured ice-cream. Manufacture of chocolate, fruit and nut ice cream. Preparation of sherbets/ices. Preparation of soft served and filled ice-cream. Manufacture of kulfi. Study of continuous and batch type freezers. Manufacture of ice-cream by continuous process. Compositional analysis of ice-cream. Microbiological examination of ice-cream and other frozen desserts; SPC, coliform, staphylococci & Salmonella. Field trips.

## 6. Condensed And Dried Milk

5(3+2)

History, status and scope in India and abroad, Definition and legal standards: Condensed milk, sweetened condensed milk and evaporated milk., Manufacturing techniques;a) Manufacture of evaporated milk including pilot sterilization test b) Manufacture of sweetened condensed milk c) Recombined sweetened condensed milk. Grading and quality of raw milk for condensed and evaporated milk, Physico-chemical changes taking place during manufacture of condensed milk, Heat stability of milk and condensed milk, Physico-chemical properties of condensed milk and role of stabilizers in the stability of condensed milk, Chemical defects in condensed milk, their causes and prevention., Microbiological qualities of condensed milks, preservative used in evaporated, condensed & dried milks, a) Type of microorganisms occurring in condensed milks b) Survival and growth of microorganisms during manufacture and storage.c) Microbiological standards, d) Type of spoilage and their prevention. Recent advances with reference to freeze concentration and membrane concentration, Dried Milks: History and status in India and abroad, Grading and quality of raw milk for dried milks, Manufacture of skim milk powder (SMP), whole milk powders and heat classified powders, Physico-chemical changes taking place during manufacture of dried milks, Physical properties of dried milks, Defects in dried milk during manufacture and storage, their causes and prevention, PFA, BIS and International Standards for dried milk, Manufacture of infant foods, malted milk foods and other formulated dried products, Microbiological quality of various dried milks including infant foods and Management of condensed and dried milk industry.

**Practical :** Manufacture of plain skim concentrated milk. Chemicals and microbiological examination of concentrated and dried milks for (a) Moisture, T.S., Fat, lactose, sucrose, bulk density, solubility index, and (b) SPC, coliforms, yeasts and molds, toxins etc. Manufacture

of SCM. Manufacture of EM. Concentration of milk by membrane processing. Manufacturing of SMP by spray drying/roller drying. Manufacture of instant milk powder.

## **7. By Product Technology**

**4(3+1)**

Status, availability and utilization of dairy by-products in India and Abroad. Associated economic and pollution problems., Physico-chemical characteristics of whey, butter milk and ghee residue, By-products from skim milk: a) Casein: types of commercial casein, their specifications, manufacturing processes with basic principles involved. b) Industrial and food uses of caseins c) Manufacture of sodium and calcium caseinates their physico-chemical and functional properties and food applications d) Manufacture of casein hydrolysates and its industrial application e) Coprecipitates: types, their specifications, manufacturing processes with basic principles involved, functional properties and food applications. Whey processing: a) Fermented products from whey, b) Beverages from whey c) Deproteinized and demineralized whey d) Condensed whey e) Dried whey, types and their specification, manufacturing techniques. f) Utilization of whey products. Whey protein concentrates: a) Methods of isolation with basic principles involved, physico-chemical properties of whey proteins concentrates b) Functional properties and food applications of WPC. Lactose: methods for the industrial production of lactose, refining of lactose, uses of lactose and hydrolysis of lactose. Butter milk processing: a) Condensed butter milk b) Dried butter milk c) Utilization of butter milk products Ghee residue. Composition, processing and utilization. Nutritional characteristics of by products.

**Practical:** Manufacture of edible casein from cow and buffalo milk. Manufacture of rennet casein. Manufacture of sodium caseinate. Manufacture of calcium caseinate. Manufacture of co-precipitate. Chemical analysis of whey, buttermilk, casein, casein and co-precipitates. Isolation of whey proteins by cold precipitation technique. Manufacture of whey proteins, concentration by ultra filtration process. Manufacture of whey drinks. Manufacture of dried whey. Manufacture of lactose. Chemical analysis of whey protein concentrates and lactose. Microbiological analysis of casein and dried whey. Incorporation of whey protein concentrates in processed cheese foods. Manufacture of coffee whitener.

## **8. Judging of Dairy Products**

**3(2+1)**

Introduction, definition and importance of sensory evaluation in relation: to consumer acceptability and economic aspects; factors affecting food acceptance. Terminology related to sensory evaluation. Design and requirements of sensory evaluation laboratory.

Basic principles: Senses and sensory perception, Physiology of sensory organs, Classification of tastes and odours, threshold value factors affecting senses, visual, auditory, tactile and other responses. Fundamental rules for scoring and grading of milk and milk products. Procedure: Types of tests – difference tests (Paired comparison, due-trio, triangle) ranking, scoring, Hedonic scale and descriptive tests. Panel selection, screening and training of judges. Requirements of sensory evaluation, sampling procedures. Factors influencing sensory measurements. Milk: Classes of raw and processed milks, defects associated with them; milk score card and its use. Judging and grading of milk. Fermented milks: Desirable and undesirable characteristics of fermented milks, sensory evaluation of dahi, yoghurt, chakka, srikhand, lassi and other fermented drinks. Cream: Desirable attributes and defects in cream, Score card for cream, Judging and grading of different types of cream. Butter: Specific requirements of high grade butter, undesirable attributes of butter, butter score-card, sensory evaluation of butter. Ghee: Grades of ghee, special requirements of quality ghee, defects in ghee, sensory evaluation of ghee. Frozen dairy products: Desirable and undesirable characteristics of frozen dairy products. Sensory evaluation of ice cream, kulfi and milk

sherbets. Cheese: Quality attributes of some common cheese varieties and their defects, score card for cheese. Sensory evaluation and grading for cheddar, cottage and other varieties of cheeses. Dried dairy products: Desirable and undesirable characteristic of dried milks. Judging and grading of dry milk products. Concentrated milks: Desirable attributes and defects. Judging and grading of evaporated and condensed milk. Heat desiccated Indian milk products: Desirable and undesirable characteristics. Sensory evaluation of khoa and khoa based sweets. Acid coagulated Indian milk products: desirable and undesirable characteristics. Sensory evaluation of paneer, chhana and chhana based sweets. Consumer acceptance studies: Objectives. Methods, types or questionnaires, development of questionnaires, comparison of laboratory testing and Consumers studies, limitations. Interrelationship between sensory properties of dairy products and various instrumental and physico-chemical tests. Preparation of milk and milk products with defects, techniques for simulation.

**Practical:** Determination of threshold value for basic tastes. Determination of threshold value for various odours. Selection of judging panel. Training of judges, for recognition of certain common flavour and texture defects using different types of sensory tests. Judging of milk and cream. Judging of butter and ghee. Judging of condensed and evaporated milk. Judging of milk powders. Judging of cheese and related products. Judging of frozen products. Judging of khoa and khoa-based sweets. Judging of chhana and chhana based sweets. Judging of dahi and fermented dairy products.

## 9. Food Technology-I

4(3+1)

Status of food processing industries in India and abroad, magnitude and inter-dependence of dairy and food industry, prospects for future growth in India. Harvesting, transportation and storage of fruits and vegetables. Post harvest processing of fruits and vegetables. Peeling, sizing, blanching, Canning of fruits and vegetables, Drying and freezing of fruits and vegetables. Juice processing- General steps in juice processing, role of enzymes in fruit. Juice extraction, equipments and methods of fruit juice extraction, preservation of fruit juices, fruit juice clarification, concentration of fruit juices, fruit juice powders. Fruit juice processing ; Orange and tangerine, Lemon and lime juice, Apple juice, Grape juice, Nectars, pulpy juices, tropical blends, Vegetable juices. Jam, Jelly, Marmalade, Pectin: Chemistry & technology. Fruits and vegetable preserves, Glazed, Crystallized fruits. Tomato base products: Juice, puree, paste, sauce, ketchup. Pickles: Principle of pickling, technology of pickles. Beverages – Classification, scope, carbonated non-alcoholic beverages and its manufacture. Fruit beverages and drinks, additives for fruit based beverages. Coffee: Production practices, structure of coffee/cherry, Coffee processing including roasting, grinding, brewing extraction, dehydration, aromatization, instant coffee. Tea- Tea leaf processing, green, red, yellow, instant tea. Technology of confectionery foods- Candies, Chewing gums and bubble gums, Toffees, Caramels, Standards of confectionery products. Chocolate products: Cocoa bean processing, chocolate liquor, Standards of confectionery products. Functional foods: Introduction, Phytochemicals, Milk ingredients as nutraceuticals, fiber-rich food products etc.

**Practicals:** Manufacture of toffees and caramels, Testing the efficacy of blanching process, Drying of fruits and vegetables, Preparation of fruit based drinks and beverages: Ready-to-serve drink, Nectar, Squash, Whey-fruit based beverages. Manufacture of fruit jam. Manufacture of fruit jelly. Manufacture of chocolate confections. Manufacture of tomato ketchup/tomato sauce. Manufacture of soups. Manufacture of fruit preserve. Manufacture of candied fruits. Manufacture of fruit bar; Manufacture of pickles

## 10. Packaging of Dairy Products

3(2+1)

Introduction, Importance of Packaging, History of Package Development, Packaging materials, a) Characteristics of basic packaging materials: Paper (paper board, corrugated paper, fibre board), Glass, Metal, Plastics, Foils and laminates, retort pouches, Package forms, Legal requirements of packaging materials and product information. Packaging of milk and dairy products such as pasteurized milk, UHT-sterilized milk, aseptic packaging, fat rich products-ghee and butter, coagulated and desiccated indigenous dairy products and their sweetmeats, concentrated and dried milks including baby foods. Modern Packaging Techniques; Vacuum Packaging, Modified atmosphere packaging (MAP), Eco-friendly packaging, Principles and methods of package sterilization, Coding and Labelling of Food packages, Aseptic Packaging (AP), Scope of AP and pre-requisite conditions for AP, Description of equipments (including aseptic tank) and machines- Micro-processor controlled systems employed for AP, Package conditions and quality assurance aspects of AP, Microbiological aspects of packaging materials. Disposal of waste package materials, Packaging Systems.

**Practical:** Identification of packaging materials, Flame Hot wire test, Testing of papers/paperboards: Percentage moisture, Grease resistance, Water absorptiveness, Grammage, Tearing resistance, Bursting strength. Testing of glass bottle – resistance to thermal shock. Testing of plastics and laminates – Thickness, Water vapour transmission rate (WVTR), Grease resistance. Packaging of different dairy products by using prepak and vacuum packaging machines. Microbiological evaluation of packaging materials (SPC, Y & M, spore count).

## 11. Dairy Plant Management and Pollution Control

2(1+1)

Production Management. Definition, Function and structure of Production Management, Production planning & Control, Work study and measurement motion and time study, Plant Operations. Efficiency factors losses, Financial and Managerial efficiency Provision for Industrial Legislation in India, Particularly in dairy industry, Personnel Management. Manpower planning, recruitment, training, transfer, promotions policies, Job specifications, Job evaluation, Job enhancement, Job enrichment, MBO, working conditions. Safety hazards, hazards prevention security for plant machinery and the employees, Plant Maintenance. Prevention & Break-down maintenance Spare parts inventory, tools & lubricants etc. Food hygiene, personnel hygiene, plant hygiene, water quality etc. Cleaning and Sanitation – different type of cleaning and sanitizing agents, Effluent treatment: Type, degree and treatment of waste.

**Practical :** Flow process charts of different milk products. Identification of steps of material losses on Dairy plants. Identification of hazardous processes and equipments, safety and precautions. Identification and uses of common lubricants. Waste Utilisation processes. Various treatments in waste disposal. Analysis of cleaning agents and sanitizers. Reports and records maintenance of dairy plant. Operational precautions. CIP cleaning.

## 12. Food Technology-II

3(2+1)

Cereal grains, legumes and oilseeds; Structure and composition of cereals, legumes and oilseeds, Milling of paddy, quality factors of rice grains, processing of rice bran oil, Instant rice, quick cooking rice, canned rice, Milling technology of wheat, Criteria of wheat flour quality, improvers for wheat flour, Types of wheat flour, Milling technology of maize, wet milling of corn, Milling technology of barley, malting of barley and its utilization in

manufacture of value added food products including malted milk foods, Alcoholic beverages, Dehulling and processing technology of important pulses, Dehulling and extraction of oil in major oilseed crops like soy bean, mustard, sunflower, ground nut, Vegetable protein concentrates / isolates, Utilization of oil cake in food formulation. Bakery and Snack technology :Technology of bread, biscuits, crackers and cakes, Technology of manufacturing process of Pasta foods- Macaroni, Noodles and Spaghetti., Technology of breakfast cereals: corn flakes, puffed, extruded snacks, Potato chips. Meat, fish and egg technology ; Development of meat, poultry, egg and fish industry in India , Pre-slaughter care, handling and ante-mortem inspection of animal, Stunning and slaughtering techniques, Postmortem inspection, rigor mortis and conversion of muscle to meat, Processing of meat and meat products: curing, smoking, e deboning and comminuted, Slaughterhouse sanitation, meat hygiene and zoonotic diseases, Processing of poultry meat, Egg and egg products – Processing of albumen, yolk and whole egg, drying and freezing of egg, quality assessment of egg, Types, handling, transportation and marketing of fish, Preservation of fish., Manufacturing process of fish protein concentrate, fish sausages, dehydrated fish and fish pickles. Cleaning and sanitation, Waste management of food processing plants.

**Practicals:** Manufacture of barley malt. Determination of cooking quality of rice. Manufacture of bread and bun. Manufacture of biscuits. Preparation of noodles. Preparation of cake. Manufacture of potato chips. Preparation of malt based food products. Manufacture of sausages. Preparation of salami. Preparation of chicken soup. Manufacture of chicken pickle. Preparation of fish stick and fish keema.

## 4. DAIRY CHEMISTRY

### 1. Physical Chemistry of Milk

3 (2+1)

Constituents and gross composition of milk of different species and breeds of milch animals, Colloidal State : Distinction between true and colloidal solution, lypophilie & lypophobic solution, properties of colloidal system. Properties of colloidal systems, Gels-their formation and properties. Milk as a colloidal system and its stability. Elementary idea about emulsion. Density : Density and specific gravity, pyknometer method, hydrometer lactometer. Density and specific gravity of milk, effect of various processing variables on the density and specific gravity of milk. Liquid State : Surface tension, surface energy interfacial tension. Surface tension of mixtures. Surface tension of milk and the factors affecting it. Viscosity- Definition of viscosity, Newtonian and Non-Newtonian liquids, Stokes Law, influence of temperature and concentration of solute on viscosity. Viscosity of milk, evaporated milk and condensed milk. Refractive index. Colligative Properties of Dilute Solution : Vapour pressure, Raoult's Law, Depression of freezing point, Elevation of boiling point. Freezing point and boiling point of milk. Osmosis and Osmotic pressure. Inter-relation of colligative properties. Aqueous solution of Electrolytes : Electrolytes ; non-electrolytes, ionic mobility, electrical conductance, Ostwald Dilution Law, Kohlrausch Law, Electrical conductance of milk. Ionic Equilibria : Dissociation of water, ionic product of water, concept of pH and pOH and their scale. Acids and bases : Bronsted Lewis concepts of acids and bases, dissociation constants of acids and bases. Salt-their hydrolysis. Buffer solutions. Derivation of Henderson – Hasselbach equation and its application, buffer capacity and buffer index, milk as a buffer system. Equilibrium of electrolytes. pH indicators. Oxidation- Reduction : Redox potential, Nernst equation, electrochemical cells. Hydrogen, glass and calomel electrodes. Redox system of milk. Nuclear Chemistry : The nature of isotopes, radio isotopes. Half life period of radio isotopes. Some of the important radio isotopes. Occurrence of radio nuclide in milk & milk products. Molecular Spectroscopy : The spectrum of electro magnetic radiation, the laws

of Lambert and Beer, visible, and ultra-violet Spectroscope. Mention of mass, NMR spectroscopy.

**Practical:** Determination of density and specific gravity of milk using pycnometer, hydrometer and lactometer. Determination of viscosity of milk using Ostwald viscometer. Determination of surface tension of milk using Stalagmometer. Interfacial tension between water-oil phase. Determination of freezing point of milk. Preparation of a buffer solution. Determination pH of buffer solution and milk electrometrically. Determination of acidity of milk electrometrically. Determination of electrical conductance of milk. Determination of redox potential of milk. Coagulation of milk using electrolytes. Determination of refractive index of skim milk and whey. Titration of amino acid in the presence and absence of formaldehyde. Determination of PKa1 PKa2 and PL. Verification of Lambert Beer Law.

## 2. Chemistry of Milk

3(2+1)

Definition and structure of milk, factors affecting composition of milk, Nomenclature and classification of milk proteins, Casein: Isolation, fractionation and chemical composition, physico-chemical properties of casein, Whey proteins: Preparation of total whey proteins:  $\alpha$ -Lactalbumin and  $\beta$ -Lactoglobulin. Properties of  $\alpha$ -Lactalbumin and  $\beta$  lactoglobulin, Immunoglobulin and other minor milk proteins and non proteins nitrogen constituents of milk, Hydrolysis and denaturation of milk proteins under different physical and chemical environments, Estimation of milk proteins using different physical and chemical methods, Importance of genetic polymorphism of milk proteins, Milk enzymes with special reference to lipases, Xanthine Oxidase, phosphates, proteases and lactoperoxidase, Milk carbohydrates their status and importance. Physical and chemical properties of lactose, Sugar amine condensation, amadori re arrangement, production of hydroxyl methyl furfural (HMF), Processing related degradation of lactose, Definition, general composition and classification of milk lipids. Nomenclature and general structure of glycerides, factors affecting the fatty acid composition. Milk phospholipids and their role in milk products, Unsaponifiable matter and fat soluble vitamins, Milk Salts: Mineral in milk (a) major mineral (b) Trace elements, physical equilibria among the milk salts and Milk contact surfaces and metallic contamination.

**Practical:** Sampling techniques of chemical examination of milk. Determination of pH and titratable acidity of milk. Determination of fat in milk by different methods. Determination of total solids and solids not fat in milk. Determination of total milk proteins by Kjeldahl method. Determination of casein, whey proteins and NPN in milk. Estimation of alkaline phosphatase and lipase in milk. Determination of lactose in milk. Determination of ash in milk. Determination of phosphorus and calcium in milk. Determination of chloride in milk. Determination of temporary and permanent hardness of water. Estimation of available chlorine from bleaching powder.

## 3. Chemical Quality Assurance

3(2+1)

Importance of chemical quality control in dairy industry ; setting up quality control laboratories and testing facilities: mobile testing laboratories. Sampling procedures ; labeling of samples for analysis : choice of analytical tests for milk and milk products for chemical analysis; instrumental methods of analysis. Calibration of dairy glassware including butyrometer, pipettes, burettes, hydrometers, lactometers and freezing point thermometer. Preparation and standardization of reagents required in the analysis of milk and milk products. Application of PFA, AGMARK, BIS and codex related to dairy products for the

quality control of milk and milk products. Preservatives, neutralizers and adulterants in milk and milk products and their detection. Accreditation of analytical laboratories ; Hazard analysis and critical control points (HACCP). Prediction of shelf life behavior of milk and milk products. Milk contact surfaces, metallic contamination, environmental contaminants such as pesticides, antibiotics, heavy metals in dairy products: methods of estimation. Soft and hard water, temporary and permanent hardness, softening of hard water.

**Practical :** Calibration of dairy glassware such as pipette, burette, volumetric flasks, hydrometer, butyrometers. Preparation and standardization of dairy reagents such as acids, alkalis, sodium thiosulfate, silver nitrate, Fehlings. EDTA solutions etc. Detection of adulterants, preservatives, and neutralizers in milk and milk products. Chemical analysis of permissible additives used in milk and milk products. Chemical analysis of detergents and sanitizers. Preparation and testing of Gerber sulfuric acid used in fat determination. Testing the amyl alcohol used for fat determination. Analysis of market samples of milk and milk products.

#### 4. Food Chemistry

3(2+1)

Water: Water binding and chemical reactions mediated by water. Food Proteins: Classification, physico-chemical properties, Reaction involved in processing, Reactions with alkali, Enzyme catalysed reactions involving hydrolysis and proteolysis, Theories of formation of texturised proteins. Lipid : Reactions involved during deep frying of food viz., autoxidation of saturated acyl lipids and polymerization. Lipoprotein and membrane ; definition, classification and involvement in the formation of biological membranes. Unsatifiable matter contents in various fats and oils. Edible fats and oils, classification and chemical composition. Carbohydrates: Legumes, jellies polysaccharide viz. linear, branched and modified. Properties and utilization of common polysaccharides, viz. cellulose, glycogen, hemicellulose and pectin. Enzymatic degradation of polysaccharides, viz. agar, alginate. Carrageenan, gums and starch. Production of dextrans and malto dextran. Food Enzymes: Hydrolases and lipases, utilization in food industry, effect of inhibitors, pH and temperature. Minerals in foods: Main Elements, trace elements in eggs, cereal and cereal products, vegetables and fruits. Aroma compounds in foods: Threshold value, off flavours. Food additives: Vitamins, amino acids, minerals. Aroma substance flavour enhancers-monosodium glutamate, nucleotides. Sugar substitutes, sorbitol. Sweeteners-saccharin, cyclamate. Food colours. Anti-nutritional factors and Food contaminant : Toxic-trace elements, radio nuclides. Cereals and cereal products : Individual constituents, like proteins, lipids, carbohydrates and vitamins in cereals flour and their relationship in dough making. Type of flours, bread making and non-bread making: chemical composition, influence of additives/minor ingredients on baking properties. Physical, chemical changes during baking. Legumes : Classification composition and physico-chemical properties. Vegetables and fruits : Classification, general composition, chemical changes during ripening and storage. Jams, jellies and pickles : Classification, composition and preservation. Beverages: Classification, Coffee, Tea and Cocoa-gradation, composition, chemical changes during processing, volatile compounds. Preservation of Foods: General principles of food preservation, chemical preservation, preservation through irradiation.

**Practical:** Determination of moisture, acidity and gluten content in flour. Determination of total ash and acid insoluble ash in flour. Determination of starch in flour. Determination of total nitrogen in cereal products. Determination of acidity and vitamin C in citrus fruits. Analysis of tomato ketchup for total solids, acidity, ash and salt. Determination of total sugar in tomato ketchup. Determination of total ash and alkalinity of soluble ash in tea. Determination of water extractive in tea leaves. Determination of presence of Chicory in

coffee powder. Determination of reducing sugars in Jam. Determination of iron in infant foods.

## 5. Biochemistry & Human Nutrition

3(2+1)

*Biochemistry:* Enzymes Ribozymes, isozymes, allosteric enzymes, zymogens, regulatory, Classification and mechanism of enzyme action, Factors affecting rate of enzyme catalyzed reaction, enzyme inhibition, Enzymes coenzymes and co-factors immobilization of enzymes, Nucleic acids and Bioenergetics : Structure and function, definition and composition. Structure of RNA & DNA-Anabolism and Catabolism of carbohydrates, lipids and proteins. Vitamins and Hormones : Structure & functions, general description. Relationship between vitamins and hormones in terms of their biological role. Elementary knowledge of milk synthesis in mammary gland.

*Human Nutrition:* Theory and definition, Scope of Nutrition : Functions of the various nutrients in body. Digestion, absorption and assimilation of nutrients. Comparative requirements and nutritional requirement of different age groups. (WHO and ICMR standard) Methods of evaluation of nutritive value of foods Nutritional value of cow, buffalo and human milk. Milk intolerance: lactose deficiency and protein hyper sensitivity. Safety aspects of food additives, toxic elements, radionuclides, pesticides and antibiotic residues in milk and milk products. Institutional feeding of workers. Planning and implementation of national food and nutrition policies and programme. Regulatory aspects of nutrition, IDF code on nutrition, nutrition facts under NLEA, Nutrient descriptors, serving size and nutritional claims.

**Practical:** *Biochemistry* Estimation of alkaline phosphatase and the effect of temperature and pH on its activity. Estimation of catalases and the effect of temperature and pH on its activity. Determination of the Michaelis constant of an enzyme. Estimation of RNA by colorimetric method Estimation of DNA by colorimetric method. Measurement of proteolysis. Lipolysis, Amylase activity. Estimation of vitamin 'A' in ghee. Estimation of ascorbic acid in milk. Estimation of vitamin D in milk. Estimation of proteins by Lowry's method. Buret method. Estimation of Lipids and Lipids analysis by TLC. Estimations of cholesterol in milk. Estimation of denaturation of proteins in heated milk by dye binding method. Estimation of HMF content in food.

## 6. Organic Chemistry

3(2+1)

Hydrogen bonding: Concepts of hydrogen bonding inter and intra molecular hydrogen bonding in alcohol, carboxylic acids and other molecule. Hydrophobic interactions: Elementary idea of hydrophobicity and its importance in the structure of proteins. Alcohols: Important properties of mono, di and trihydric alcohols (Glycol and Glycerol) Aldehydes and Ketone : Reactions of aldehydes and ketones. Importance of carbonyl compounds in food flavors. Carboxylic acids: Ionization constant and strength of carboxylic acids. Important reactions of carboxylic acid, Derivatives: Esters, Amides, Lactones their preparation and reactions. Amines: Basic character of amines, important reactions. Phenols: Acidic character of phenols and effect of nuclear substituents on it. Reactions in phenols. Substituted carboxylic acid: important reactions of halogen substituted, Keto and Hydroxy acids. Zwitter-ion forms, its properties viz. melting point and volatility. Amino Acids and Peptides: Synthetic and natural amino acids General properties of amino acids. Definition and classification of proteins. Primary, secondary, tertiary and quaternary structure of Proteins. Carbohydrates: Definition, Classification and isomerism. Derivation of structure of Glucose, open chain and ring structure, evidences for ring structure stereochemistry and stability of anomers. Reactions of monosaccharides. Fatty acids and Lipids: Definition and classification.

Important reaction of fatty acids (saturated and unsaturated) Structure and properties of Neutral lipids, phospholipids and cholesterol.

**Practicals:** Systematic identification of Organic Compounds: Aliphatic and Aromatic character, Instauration, Detection of elements (Nitrogen, Sulphur and Halogens), Detection of functional groups (Alcoholic, Phenolic, Carboxylic, Carbonyl, Aldehyde, Ketonic esters, Amino, Amide, Nitro etc.). Preparation of derivatives: Dinitrophenylhydrazone, Oxime and Osazone. Qualitative test for Amino Acids and Proteins: Biuret test, Million's test, Nitroprusside Test, Ninhydrin test, Xantho proteic test, Hopkin's cole reaction. Detection of Carbohydrates (reducing & non reducing sugars) by : Molisch/ Orcinol/ Resoreinol/ Silvermirror test. Detection of lipids and phospholipids.

## 5. DAIRY BUSINESS MANAGEMENT

### 1. Economic Analysis

2(2+0)

Basic concepts-wants, goods, wealth, utility, consumption, demand and supply, Consumer behaviour-law of diminishing marginal utility and equi-marginal utility, cardinal and ordinal utility approach for consumer's behaviors. Theory of demand-law of demand, demand schedule, demand function, determinates of demand, individual consumer demand and market demand, demand forecasting, elasticity of demand, price elasticity, income elasticity and cross elasticity, Consumer's surplus. Theory of production- concepts of firm and industry, basic factors of production and their role, production function for a single product, nature of production function, laws of returns. Concepts of costs-fixed and variable costs, short run and long run costs, average and marginal costs, economics and diseconomies of scale. Concept of market- types of market, pricing and output under different market situations, market price and normal price, price determination under perfect Competition, monopoly, oligopoly and monopolistic competition. National income – GDP, GNP, NNP, disposable personal Income, per capita income, inflation. Economic features and characteristics of dairy sector in India. Dairy development strategy with special emphasis in post- independence era and Operation Flood Programme.

### 2. Financial Management and Cost Accounting

4(3+1)

Introduction: Definition, scope and objectives of financial management. Different Systems of Accounting: Financial Accounting, Cost accounting, Management Accounting. Doubles entry system of Book-Keeping. Preparation of Accounting Records: Journal, Purchases and Sales Book and Posting in Ledger, Cash Book. Preparation of Final Accounts and adjustments at the end of trading period. Preparation of Trial Balance Banking Transactions and Bank reconciliation statements. Statements of Financial Information: Accounting system: A source of financial statements, Classification of capital and revenue expenditure, Balance Sheet, Profit and Loss Account, Statement of changes in the financial position, funds flow statements, cash flow statement, uses of funds flow and cash flow statements in financial decision making. Financial Analysis : Nature and uses of financial analysis, Liquidity ratios, Leverage ratios, Activity ratios, Profitability ratios, Utility of Ratio analysis. Cost Volume – Profit analysis and operating leverage, Break-even analysis, Profit analysis and operating analysis, Utility of CVP analysis. Capital Structure: C.S Planning, risk return trade off, financial leverage. Cost of capital: Management of cost of capital, cost of debt, debentures, preference share capital, equity share capital & retained earning, overall cost of capital. Investment decision : Time value of money, Net present value, Investment evaluation criteria, NPV method, Internal rate of return method, Profitability index method, Pay back period method, Accounting rate of return method. Capital budgeting: Complex Investment

Decisions: Investment timing & duration Investment decisions under inflation, Investment decisions under capital rationing. Project Report; Feasibility Report Valuation. Working capital management- Concept & determinants of working capital, Estimating working capital needs. Depreciation – Concept and method. Introduction, Definition, Objectives, Common terms. Costing : Essentials of sound costing system. Different methods of costing, elements of cost : Labour- recording of time, idle time, methods of remunerating labour, Premium & Bonus Plans, Materials, Overheads. Cost classification : Direct and Indirect expenses, fixed and variable costs. Various methods of apportioning indirect expenses. Inventory Management: Planning, control and costing. Stores & storekeeping, scope & importance, purchase procedure, types of purchase, location of stores & materials, procedure for the movement of stores, different methods of pricing materials, store records. Cost Sheets- Different methods, Statement of cost and statement of profit estimates, Tenders or Quotations. Contract or Terminal costing. Process Costing: Process losses and inter-process profits, joint products and by products costing. Ascertainment of cost of milk production. Preparation of Cost Account Information for managerial decisions.

**Practical:** Preparation of Profit and Loss account. Preparation of Balance Sheet. Preparation of Cash flow statements. Preparation of Funds flow statements. Problems on Ratio analysis. Problems on Break-Even Analysis. Problems on Profit analysis. Problems on Operating Analysis. Problems on Financial leverage. Problems on Cost of Capital. Problems on Investment decisions. Problems on Capital budgeting.

### **3. Operation Research**

**2(2+0)**

Introduction – Elementary concepts, objectives of operations research, Applications of OR in decision-making. Modeling in Operation Research. Linear Programming : Introduction, mathematical formulation of the problem, Graphical solution, Simplex technique for solving simple LP problems. Inventory Control – Introduction and general notations, Economic lot size models with known demand.

### **4. Industrial Statistics**

**3(2+1)**

Definition and scope; sources of animal husbandry and dairy statistic. Measures of central tendency, Measures of dispersion, Mome skewness and kurtosis. Elementary notions of probability, Laws of addition and multiplication probability. Theoretical frequency distributions : Binomial distributions and applications, Poisson distribution and is applications, Nor distribution and its applications. Concepts of sampling methods- Simple random sampling, stratifyrandom sampling, cluster sampling, systematic sampling. Introduction to testing of hypotheses, Tests of significance-Z,  $t^2$ , a, F tests, and their application in the field of dairying. Analysis of variance- One way and two way classification. Simple correlation coefficient and its test of significance, Line regression, rank correlation. Basic concepts of statistical quality control, Control charts for variables and attributes, Fundamental concepts of acceptance sampling plan.

**Practical :** Measures of central tendency. Measures of dispersion, Moments. Skewness and Kurtosis Filling of bionomical and Poisson distribution. Selection of random sample. Application of ‘Z’ test for one and two sample problems. Application of ‘t’ test for one and two sample problems. Application of Chi-square test and F-test. Correlation and regression. Rank correlation coefficient. Control chal for variables & attributes.

## 5. Marketing Management and International Trade

2(2+0)

Concept of marketing ; Functions of marketing ; concepts of marketing management ; scope of marketing management ; marketing management. Process ; concepts of marketing- mix, elements of marketing- mix. Market Structure and Consumer Buying Behaviour: Concept of market structure, marketing environment, micro and macro environments. Consumers buying behaviour, consumerism. Marketing Opportunities Analysis: Marketing research and marketing information systems; Market measurement- present and future demand ; Market forecasting; market segmentation, targeting and positioning. Allocation and marketing resources. Marketing Planning Process. Product policy and planning : Product-mix; product line; product life cycle. New product development process. Product brand, packaging, services decisions. Marketing channel decisions. Retailing, wholesaling and distribution. Pricing Decisions. Price determination and pricing policy of milk products in organized and unorganized sectors of dairy industry. Promotion-mix decisions. Advertising; How advertising works; Deciding advertising objectives, advertising budget and advertising message; Media Planning; Personal Selling, Publicity; Sales Promotion. Food and Dairy Products Marketing. International Marketing and International Trade. Salient features of International Marketing. Composition & direction of Indian exports; International marketing environment; Deciding which & how to enter international market; Exports- Direct exports, indirect exports, Licensing, Joint Ventures, Direct investment & internationalization process, Deciding marketing Programme; Product, Promotion, Price, Distribution Channels. Deciding the Market Organization; World Trade Organization (WTO).

## 6. Communication Skills and Entrepreneurship Development

2 (1+1)

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. 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. Globalisation 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 horticulture sector. Venture capital. Contract farming and joint ventures, public-private partnerships. Overview of horti inputs industry. Characteristics of Indian horticultural processing and export industry. Social Responsibility of Business.

**Practical:** 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.

## 7. IT in Dairy Industry

2(1+1)

Importance of Computerization and IT in dairy industries. Computers, Operating Environments and Information Systems for various types of dairy Industries, Principles of communication. Role of Computer in Optimization; Introduction to Operation. Research. A Computer Oriented Algorithmic approach: Queuing systems and waiting models, PERT CPS and CPM. Dairy Process Modeling and Simulation. Introduction to SCADA & INTELUTION. CAD and CAM in Dairy Industries : Instrumentation, Process control, Inventory control, Automation, Robotics, Expert Systems and Artificial Intelligence, Instrumentation.

**Practical:** Applications of MS Excel to solve the problems of dairy technology: Statistical quality control, Sensory evaluation of food. Chemical kinetics in dairy processing. Use of word processing software for creating reports and presentation. Familiarization with the application of computer in dairy industries : Milk plant, Dairy units, Fruit & Vegetable processing unit. Familiarization with software related to dairy industry. Visit to Industry and knowledge of computer application in the same.

## 8. Dairy Extension Education

2(1+1)

History, need definition, philosophy, principles, approaches and objectives of extension education, Present status of extension and rural Development programmes. Teaching/learning process, Extension Teaching Methods, classification and selection of teaching methods. Nature and importance of communication. Key elements of communication. Models of communication, process, feedback and problems in communication. Importance of audio-visual aids in extension education. Classification, planning and selection of A.V.Aids. Identification of rural leaders, their characteristics, roles and functions in rural development, training of rural leaders. Definition of groups, natural types, principles of working with groups and their mobilization. Need, principles and steps of programme planning. Evaluation of extension programmes. Diffusion of innovations and categories of farmers. Conceptual orientation about different terms, like- PRA, RRA, IVLP/TAR, ATMA, ATIC, PTD etc.

**Practical:** Acquiring skill in use of audio-visual & other aids: Overheads Projector, Slide Projector, Use of VCR and PA system, Camera handling. Preparation and use of visual aids and printed material; Poster and chart, Flash card and flannel Graph, Circular letter, leaflet, pamphlet, folder. Group Discussion Technique, Developing Communication and Overall Skills, Brain-storming Technique for developing the Decision making Process, Interview-technique(s), Identification of problems of village farmers through interview method, Writing a radio script.

## 9. Environmental Studies

3(2+1)

Environmental Science : An introduction, Ecosystem : kinds, structure, characteristics, functioning, Biochemical cycles, Natural resources and their managements, Environmental pollution, Air pollution, Water pollution, Solid waste pollution, Noise pollution, Soil pollution, Radio active pollution, Food processing industry waste and its management, Management of urban waste water, Recycling of organic waste, Recycling of factory effluent, Control of environmental pollution through low, Composting of biological waste and Sewage, uses of water disposal effluent treatment, microbial examination.

**Practical :** Environment and its analysis, Water quality parameters, collection of sample for pollution study, Determination of pH/acidity/alkalinity from sample, Estimation of dissolved

oxygen, Estimation of BOD, Estimation of COD, Estimation of nitrates, Estimation of phosphates, Estimation of pollutant elements, Estimation of heavy/toxic elements, Estimation of lead/ mercury, Visit to industrial sewage disposal unit.

## **10. Milk Production Management & Dairy Development**

**3(2+1)**

Introduction to Animal Husbandry. Distinguishing characteristics of Indian and exotic breeds of dairy animals and their performance. Systems of breeding and methods of selection of dairy animals. General dairy farm practices- identification, dehorning, castration, exercising, grooming, weighing. Care of animals at calving and management of neonates. Management of lactating and dry cows and buffaloes. Methods of milking, milking procedure and practices for quality milk production. Dairy farm records and their maintenance. Systems of housing dairy animals and maintenance of hygiene and sanitation at dairy farm premises. Common disease problems in dairy animals, their prevention and control. Feed nutrients required by animal body. Feed resources for milk production and their nutritive values. Digestive system of ruminants. Measures of feed energy. Nutrients requirements for growth and milk production. Feeding standards. Structure and function of mammary system. Milk secretion and milk let-down. Male and female reproductive system. Estrus to reproductive cycle. Ovulation, fertilization, gestation, parturition, pregnancy diagnosis. Artificial insemination and embryo transfer and their role in animal improvement. Introduction to biotechniques in dairy animal production. Socio-economic and geographical features of Indian dairying. Traditional Systems of cattle keeping, estimates of milk production, utilization and sale; cattle & buffalo population and its distribution; trends in population growth, annual milk production and per capita availability; productivity profile of indigenous dairy stock, industrial by-products of livestock industry. Five year plans and dairy development; resource inadequacy, post partition pressure; catalytic action of international air; major aided dairy projects; public sector milk supply schemes; co-operative dairy organizations, Anand pattern and perspectives; milk products manufacture in private sector, import substitutions in dairy products. Strategy of cattle improvement; pioneering role military dairy farm; key village scheme and its limitations, intensive cattle development programme concept, approach and achievements. Public sector dairy schemes, Economic burden performance analysis, National Dairy Development Board-aim and objectives, policy orientation in dairy development. Operation Flood-I,II,III : programmes & Outlay, implementation, success, achievements, integrated infrastructure of milk production, improvements of dairy co-operative organization, Dairy development Corporations, Co-operative Dairy Federations, Self-reliance in dairy development, income & employment potential. Conversion of milk into products, utilization pattern indigenous & western products. Dairy problems and policies.

**Practical :** Handling and restraining of dairy animals. External body parts and judging of cows and buffaloes. Feeding and management practices of calves. Identification of common feeds and fodders. Preparation of rations for adult animals. Milking of dairy animals and cleaning and sanitation of milking equipments. Identification of reproductive and digestive organs. Demonstration of semen collection, processing and artificial insemination.

## **11. Computer Programming**

**3 (1+2)**

Problem solving with computers, flowchart and algorithm development, Data types variables, constants, arithmetic and logical expressions, input/output statements, conditional statements, control structures, arrays, functions, structures, unions.

**Practical :** Understand different Components of Computer System. Write a C program to calculate volume of a prism having trapezoidal base. Write a program, which can input a

positive integer ( $\leq 10000000$ ) and print it in reverse order. For example 9875674 to 4765789. Write a program to calculate sum of squares of all odd integers between 17 to 335. Exclude integers divisible by 7. Ohm's law is  $I=V/R$ , Write a program to calculate I from given n sets of V and R. Write a program e to generate the Cartesian coordinates of points (x,y for the values of ranging from 0,5,10,15 ----- 90. title and label the output. Write a program to calculate the resultant focal length f, when f1 and f2 are placed in contact. Used formula is  $f= (f1+f2)/(f1xf2)$ . Compute for following pairs of local lengths. f1= 10,-8,-6,-1 ..... +8, +10; f2= 0.5,-0.4, ..... +0.4, +0.5 Write a program to sort an array of N elements in ascending order.

Write a program to evaluate following series to calculate  $\cos x$   
 $\cos x= 1 - \frac{x^2}{2!} + \frac{x^4}{4!} - \frac{x^6}{6!} + \dots$  Compare the calculated value with the one by using library function. Write a program which reads in indefinite number of Name, Marks1, Marks2, Marks3 from keyboard and store them in a file along with total marks, Percentage marks and Grade in a file.

**Syllabus**

**For**

**B. Tech. (Food Technology)**

# FOOD TECHNOLOGY

## 1. FOOD TRADE AND BUSINESS MANAGEMENT

### 1. Principles of Economics

2 (2+0)

Basic terms and concepts of Economics, Meaning and nature of Micro and Macro Economics, nature and scope of Agricultural Economics, its role and importance, characteristics of factors of production, measures to improve land productivity, Government policies Labour – division of labour, problems of unemployment under employment and disguised unemployment, capital formation in agriculture, forms of business organizations, Demand - law of demand – types of supply, law of supply – factors influencing supply, elasticity of supply. Price determination under different market situations. –Government policy Characteristic features of developed and under developed economics. International trade in Agriculture – exim policy – role of W.T.O., International Trade in Agriculture. Financial institutions and their role; RBI, IDBI, IMF, NABARD, SIDBI.

### 2. Cooperation, Marketing And Finance

3(2+1)

Co-operation–philosophy and principles: History of Indian Co-operative movement, Co-operative credit structures in regional level and their study and singly window systems. Marketing – importance in economic development. Classification of Markets, Marketing functions, Market functionaries. Marketable and Marketed surplus, Marketing costs, margins and price spread, problems in marketing of agricultural commodities – perishables, grains, oilseeds and processed foods. Remedial measures for problems in Agricultural marketing. Agricultural marketing institutions, Regulated markets, Co-operative marketing societies, MARKFED, NAFED, Ware Housing Corporation, Food Corporation of India, Nature of agricultural product prices, Agricultural price policy and need for price stabilization. Methods of fixation of MSP for agricultural commodities. Commission on agricultural costs and prices. Finance–nature and scope: Credit – meaning, definition and classification. Credit analysis and 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, ADB, World Bank. Insurance and credit guarantee corporation of India. Crop Insurance. Contract farming – strategy and scope.

**Practical:** Study of a regulated market, Study of a vegetable market, Study of a fruit market, Study of a cattle market, Computation of market costs, margins and price spread, Study of Andhra Pradesh State Warehousing Corporation, Study of Central Warehousing Corporation, Study of Food Corporation of India, Study of MARKFED, Study of functioning of a commercial bank, Study of a regional rural bank, Study of food processing enterprise, Formulation of project reports for financing food Industry, Working out repayment plans, Study of Primary Agricultural Credit Society, Study of Farmers' Service Society.

### 3. IT Application in Food Industries

2(1+1)

Importance of Computerization and IT in Food Industries: Computers, operating environments and information systems for various types of food industries, Principles of Communication. Role of Computer in Optimization; Introduction to operation Research. A Computer Oriented Algorithmic approach; Queuing systems and waiting models, PERT, CPS and CPM. Food Process Modeling and Simulation, Introduction to SCADA and

INTELUTION, CAD and CAM in Food Industry; Instrumentation, Process Control Inventory Control: Automation, Robotics, Expert system and artificial intelligence, Instrumentation.

**Practical:** Applications of MS Excel to solve the problems of food technology: Statistical quality control, Sensory evaluation of food, Chemical kinetics in food processing. Use of word processing software for creating reports and presentation. Familiarization with the application of computer in food industries: Milk plant, Dairy units, Fruit & Vegetable processing unit Familiarization with software related to food industry, Ergonomics application in the same, Visit to Industry and knowledge of computer.

#### **4. Business Management And International Trade**

**3(3+0)**

Business Management; introduction, theories and functions, Food industry management; Purchase management, production management, Financial management, marketing management and Human resource development, personnel management. Sectors in food industry and scale of operations in India. International trade; Basics, classical theory, Theory of absolute advantage, theory of comparative advantage modern theory, free trade – protection, methods of protection quotas, bounties, exchange control, devaluation, Commercial treaties, terms of trade balance of payments, exim policy, foreign exchange, mechanics of foreign exchange, GATT, WTO. World Trade Agreements Related With Food Business, Export Trends And Prospects Of Food Products In India. World Consumption of Food; Patterns and Types of Food Consumption across the Globe. Ethnic Food Habits of Different Regions. Govt. institutions related to international food trade; APEDA, Tea Board, Spice Board, MOFPI etc. Management of export import organization, Registration, documentation, export import logistics, Cases Studies.

#### **5. Entrepreneurship Development and Communication Skills**

**2 (1+1)**

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. Globalisation 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 horticulture sector. Venture capital. Contract farming and joint ventures, public-private partnerships. Overview of food industry inputs. Characteristics of Indian food processing industries and export. 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.

**Practical:** 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.

## 6. Food Laws & Regulations

3 (2+1)

Introduction to subject, Need of enforcing the laws and various types of laws. Mandatory food laws; The food safety and standards bill 2005, Establishment of the authority, composition of authoring functions of chief executive officer, scientific part, General principles to be followed in administration of act, General provisions as to articles of food, special responsibility as to safety of food, analysis of food offences of penalties. Preventions of Food adulteration act; Definition, object of act, central committee for food standards; public analysis, food inspector, duties of Food inspectors, Report of Public analyst, sealing, fastening and dispatch of samples, powers of court. Other Mandatory acts. Standard weight of measure act, essential commodity act, consumer protection act, Environmental protection act insecticide act. Export (quality control & inspection) act. Various food orders; Fruit product order, Milk & Milk product order, plant food seed (Regulation of imports in India) order, edible oil package order meat food products order. Optional food standards; Scope of these standards, their need, procedure to obtain that standard, Agmark, Bureau of Indian Standards. Codex Standards; Scope of codex standards, codex standards for cereals, pulses, fruit & vegetables, Meat & Poultry products, Recommended international code of hygiene for various products.

**Practical:** Examination of Cereals & pulses from one of godown and market shop in relation to FPO & BIS specification. Examination of Ghee for various standards of Agmark & BIS. Examination of honey for various Agmark and BIS standards. Examination of spices for Agmark & BIS standards. Examination of milk & Milk products for BIS, of milk product order- standards. Examination of fruit Jam of two to three different companies for FPO specifications. Examination of two different industries squash for FPO specifications. Examination of ketchup of two to three different Companies for FPO specifications. Visit to BIS Laboratory, Visit to Agmark laboratory, Visit to quality control laboratory and Food processing industry.

## 2. FOOD CHEMISTRY AND NUTRITION

### 1. Biochemistry

3(2+1)

Biochemistry & its scope, Cellular Biochemistry, Carbohydrates- Occurrence, Classification & Structures, Physicochemical and Metabolic functions Metabolism, Proteins - Occurrence, Classification & Structures, Physicochemical & Metabolic functions, Metabolism, Lipids- Occurrence, Classification & Structure, Physicochemical and metabolic functions, Metabolism. Nucleic Acids- Properties, structure & Metabolism. Vitamins and Minerals- Chemistry and Metabolic functions. Enzymes - Chemical Nature and nomenclature. Classification, sources and properties, Mechanism of action, coenzyme and prosthetic groups.

**Practical:** Safety measures in the laboratory. Preparation of various solutions and buffers. Qualitative & quantitative determination of carbohydrates. Qualitative & quantitative determination of Amino acids. Qualitative & quantitative determination of Proteins. Qualitative & quantitative determination of Lipids. Qualitative & quantitative determination of vitamins. Isolation of enzymes from various sources. Isolation of DNA from Plant sample.

### 2. Human Nutrition

3(2+1)

Concepts and content of nutrition: Nutrition agencies, Nutrition of community, Nutritional policies and their implementation, Metabolic function of nutrients. Water and energy balance; Water intake and losses, Basal metabolism- BMR, Body surface area and factors

affecting BMR. Formulation of diets ; Classification of balanced diet; Preparation of balanced diet for various groups, Diets and disorders. Recommended dietary allowances; For various age group, According to physiological status, Athletic and sports man, Geriatric persons. Malnutrition; Type of Malnutrition, Multi-factorial causes, Epidemiology of under nutrition and over nutrition, Nutrition infection and immunity, Nutrition education. Assessment of nutritional status; Diet surveys, Anthropometry, Clinical examination, Biochemical assessment, Additional medical information. In-born error of metabolism; Blood constituents, Nutrients, Hormones and enzymes, Miscellaneous disorders. Food fad and faddism. Potentially toxic substance in human food.

**Practical:** Role of various national and international agencies in field of human nutrition. Calculation of BMR and body surface area. Preparation of balance diets, evaluation of energy value and techno economical feasibility. Anthropometric measurements. Techniques in animal feeding experiments. Biochemical analysis of urine and blood. Nutritional survey. Determination of energy value; Bomb Calorimeter, on basis of composition. Computation of Energy requirements; On the basis of Physical activity, ACU unit.

### 3. Food Chemistry – I

3(2+1)

Nature Scope and development of food chemistry: Moisture in foods; Role and type of water in foods, Functional properties of water, water activity and sorption isotherm, Molecular mobility and foods stability. Dispersed systems of foods; Physicochemical aspects of food dispersion system, a) Sol b) gel c) foam d) emulsions. Rheology of diphase systems. Carbohydrates; Functional characteristics of different carbohydrates, Changes of carbohydrates on cooking, Modification of carbohydrates, Dietary fibres and carbohydrates digestibility. Proteins in foods; Functional characteristics of proteins and amino acids, Pure proteins of plant and animal origin with their functional characteristics, Processing induced, physical, chemical and nutritional changes in protein, Chemical and enzymatic modification of protein. Lipids in foods: Role and use of lipids /fat, Physicochemical aspects of fatty acids in natural foods, crystallization and consistency, Chemical aspects of lipdysin antioxidantation, thermal decomposition, Chemistry of frying Technology of fat and oil processing; a) Refining, b) Hydrogenations c) Inter etherification d) Safety use of oils and fats in food formulation. Lipids in foods: Role and use of lipids /fat, Physicochemical aspects of fatty acids in natural foods, crystallization and consistency, Chemical aspects of lipdysin antioxidantation, thermal decomposition, Chemistry of frying Technology of fat and oil processing; a) Refining, b) Hydrogenations c) Inter etherification d) Safety use of oils and fats in food formulation. Lipids in foods: Role and use of lipids /fat, Physicochemical aspects of fatty acids in natural foods, crystallization and consistency, Chemical aspects of lipdysin antioxidantation, thermal decomposition, Chemistry of frying Technology of fat and oil processing; a) Refining, b) Hydrogenations c) Inter etherification d) Safety use of oils and fats in food formulation. Lipids in foods: Role and use of lipids /fat, Physicochemical aspects of fatty acids in natural foods, crystallization and consistency, Chemical aspects of lipdysin antioxidantation, thermal decomposition, Chemistry of frying Technology of fat and oil processing; a) Refining, b) Hydrogenations c) Inter etherification d) Safety use of oils and fats in food formulation. Enzymes in food industry; Carbohydrases, Proteasase, Lipases.

**Practical:** Determination of moisture content of foods using different methods. Studies of absorption isotherms of different foods. Swelling and solubility characteristics of starches. Rheological properties of diphase systems. Determination of crude proteins by microkjeldhal method. Determination of essential amino acids i.e. Lysine, tryptophan, methionine etc. Isolation of egg and milk protein. Preparation of protein isolate and concentrate of plant

proteins. Determination of acid value, saponification value and iodine number of fat/ oil. Assay of amylases, papain and lipases.

#### 4. Food Chemistry - II

3(2+1)

Chemistry of food flavour; Philosophy and definitions of flavour, Flavourmatics / flavouring compounds, Sensory assessment of flavour, Technology for flavour retention. Food additives and Technology; General attributes, Buffer systems/ salts / Acids, Chelating agents and sequestrants, Antioxidants, Antimicrobial agents, Non-nutritive and low calorie sweeteners, Stabilizer and thickeners, Fat replacers, Texturizers and improvers. Pigments in animal and plants kingdoms; Heme pigments, Chlorophyll, Carotenoids, Phenolic and flavonoids, Betalains, Effect of processing on pigment behavior Technology for retention of natural colours of food stuffs. Food colorants; Regulatory aspects, Properties of certified dyes, Use of regulatory dyes, Colour losses during thermal processing. Vitamins and minerals; Requirements, Allowances, Enrichment, Restorations, Fortifications, Losses of vitamins and minerals Optimization and retention of vitamins and minerals. Food toxicology ; Inherent toxicants, Terms in toxicology, Safety evaluation using traditional and modern approach, Contaminants, Pesticidal residues, Toxicology and public health. Modification of food using enzymes; Role of endogenous enzymes in food quality, Enzymes use as processing aid and ingredients.

**Practical:** Preparation of mineral solution by using ash and tri acid method (dry and wet oxidations), Estimation of calcium, Determination of phosphorus, Determination of iron, Estimation of magnesium, Estimation of tannins and phytic acid from food, Determination of vit. A (Total carotenoids), Determination of ascorbic acid by dye method, Determination of Thiamin and Riboflavin, Determination of food colors, Assessment of hydrocolloids as food additives, Assessment of various pectinases from fruits and vegetables.

#### 5. Techniques in Food Analysis

3(1+2)

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, fluorescence, Infrared spectro, Atomic absorption and emission, Mass spectroscopy, Nuclear magnetic resonance and electron spin resonance. Chromatography –Adsorption, Column, Partition, Gel-filtration, Affinity, Ion-exchange, Size-exclusion method, Gas liquid, High performance liquid chromatography. Separation techniques-Dialysis, Electrophoresis i) Paper ii) DS gel electrophoresis iii) Immuno electrophoresis Sedimentation, ultrafiltration, ultracentrifugation, Iso-electric focusing, Isotopic techniques, Manometric techniques. Principles and methodology involved in analysis of foods ; Rheological analysis, Textural profile analysis of foods. Immuno assay techniques in food analysis; Isotopic and Non-isotopic immuno assay, Enzyme-immuno assay. Evaluation of analytical data ; Accuracy and precision, Statistical significance, Co-relations regression, Computers for data analysis and result interpretation. Sensory analysis of food; Objective method, Objective method.

**Practical:** Analysis of heavy metal using atomic absorption spectrophotometer. Estimation of physico acid using spectrophotometer. Separation of amino acids by two-dimensional paper chromatography. The identification of sugars in fruit juice using TLC. Separation of pralines by Ion-exchange chromatography. Molecular weight determination using sephadox-gel. Identification of organic acids by paper electrophoresis. Gel-electrophoresis for analytic techniques. Quantitative determination of sugars and fatty acid profile by GLE. Quantitative make-up of water and fat soluble vitamins using HPLC.

### 3. FOOD AND INDUSTRIAL MICROBIOLOGY

#### 1. Fundamentals of Microbiology

3(2+1)

Evolution and scope of Microbiology. General morphological, cultural characteristics and Reproduction of bacteria, yeasts, fungi, actinomycetes, algae, protozoa, and rickettsia. Nutrient transport phenomenon, physiology of microorganisms. Genetic recombination, transduction, transformation and bacterial conjugation, mutation and mutagenesis. Growth curves: Physical and chemical factors influencing growth and destruction of microorganisms (including thermal death time, Z, F & D values). Viruses: Structure and replication with particular reference to food borne viruses, growth and destruction of microorganisms. Control of Microorganisms by physical and chemical agents, antibiotics and other chemotherapeutic agents. Preservation of microbial cultures.

**Practical:** Microscopy, Micrometry, Cleaning and sterilization of glassware, Preparation of nutrient agar media and techniques of inoculation, Staining methods (monochrome staining, negative staining, capsule-staining, flagella staining and endo spore staining). Pure culture techniques (streak plate/pour plate). Introduction to identification procedures (morphology and cultural characteristics). Growth characteristics of bacteria: Determination of microbial numbers, direct plate count, generation time. Factors influencing growth: pH, temperature, growth curves for bacteria. Methods of microbial culture preservation for bacteria and yeasts. Anaerobic culture methods.

#### 2. Food Microbiology

3(2+1)

Microbial spoilage of foods, Chemical changes caused by microorganisms, Principles of Food Preservation. Control of microorganisms by use of low and high temperature. Asepsis, water activity, drying, preservatives, radiation and pressure for control of microorganisms. Microbiology of milk and milk products. Sources of contamination, spoilage and prevention. Microbiology of fruits and vegetables. Sources of contamination, spoilage and prevention. Microbiology of cereal and cereal products. Sources of contamination, spoilage and prevention. Microbiology of meat and meat products. Sources of contamination, spoilage and prevention. Microbiology of fish and other sea foods. Sources of contamination, spoilage and prevention. Microbiology of poultry and eggs. Sources of contamination, spoilage and prevention. Microbiology of sugar and sugar products. Sources of contamination, spoilage and prevention. Microbiology of salts and spices. Sources of contamination, spoilage and prevention. Microbiology of canned foods. Sources of contamination, spoilage and prevention.

**Practical:** Isolation of molds from foods. Microbial examination of cereal and cereal products. Identification, isolation and confirmation. Microbial examination of vegetable and fruits. Identification, isolation and confirmation. Microbial examination of meat and meat products. Identification, isolation and confirmation. Microbial examination of fish and other sea foods. Identification, isolation and confirmation, Microbial examination of Eggs and poultry. Identification, isolation and confirmation. Microbial examination of milk and milk products. Identification, isolation and confirmation. Microbial examination of sugar, salts and spices. Identification, isolation and confirmation. Thermal Death Time determination.

#### 3. Fermentation and Industrial Microbiology

3(2+1)

Microbes as friend's primary secondary screening and the organizations involved microbiological work. Industrially important secondary metabolites, organic acids, citric acid,

antibiotics, probiotics, therapeutic and medicinal value. Bacteriocins Nisin, biocolours carotenoids, B-carotene, lycopane, Ang kak, plant growth regulators from microbes gibberlins, IAA etc. hormones, production of microbial enzymes Downstream processing of enzymes and application of microbial enzymes. Microbial polysaccharides, types of polysaccharides and their applications xanthan, Dextran and pullulan, production of amino acids, vitamins, bioinsecticides. Plant cell cultures and metabolites, production of SCP, Safety of SCP, bakers yeast. Fermentation Technology – Types, Food based fermented products, Biochemical changes, Microbial standards. Industrial fermentors and accessories. Economic feasibility studies of few products advances in strain improvements of for high yields of metabolites, Blue green algae. Mushrooms – production, preservation and quality.

**Practical:** Standardization of physical factors for higher yields of citric acid. Production and assay of antibiotics. Isolation, identification of cultures producing biocolours. Production and assay of  $\beta$ -carotene. Production of Ang kak (Red rice) and estimation of colouring compounds. Production, purification and assay of fungal analyses / proteases. Production of xanthan / pullulan. Production and assay of amino acids. Plant cell culture. Production and assay of nisin from Lactic acid bacteria. Single Cell Protein production. Bakers yeast effect in Bread Preparation. Mushroom Production. Preparation of food based fermented product.

#### 4. Food Bio-Technology

3 (2+1)

Prospectus of Bio-Technology. Molecular genetics i.e. fundamentals of molecular biology with special reference to chemistry and biology and DNA. (Primary secondary and tertiary) structures. Biological role of DNA in cell metabolism. Genetic recombination mechanisms and technique used for improvement in microbial strains. Applications of genetical control mechanism in industrial fermentation process, (Induction, manipulation and recombination). Recombinant-DNA technology (plasmids and cloning): Cell and tissue culture. Continuous cultures. Secondary metabolites synthesis. Expression of foreign genes. Promoter (Enzyme). Biomass production by using various micro organisms. Application of Biotechnology in food (Food industries), pharmaceuticals and agriculture. Bio-gas plant.

**Practical:** Study of auxotroph, Micropropagation through tissue culture, Strain improvement through U.V. mutation for lactose utilization, Chemical mutagenesis using chemical mutagens (Ethidium bromide), Determination of survival curves using physical and chemical mutagens. Isolation and analysis of chromosomal / genomic DNA from *E.coli* and *Bacillus cereus*. Separation of protoplast using cellulytic enzymes. Production of Biomass from fruit and vegetable waste. Introduction of ELISA / Southern blot / DNA finger printing etc. Agarose gel electrophoresis of plasmid DNA. Pesticide degradation by *pseudomonas spp*.

#### 5. Food Safety and Microbial Standards:

3(2+1)

Dietary Toxins: Naturally occurring in food- Endogenous toxin, Exogenous toxin. Microbial toxins ; i) Bacterial, ii) Mold. Intrinsic toxin produced during processing and storage. Metal as toxin – sources, conditions, causes and Elimination. Pesticidal residues as toxin ; i) chlorinated ii) Non – chlorinated. Non – Permitted food additives. Microbial standards of processed and preserved foods. Risk assessment and management during food preparation.

**Practical :** Estimation bacterial toxins from food samples.(Different types of foods). Estimation of fungal toxins from food samples. (Different types of foods).Heavy metal detection (lead) .Risk assessment and management determination. HACCP for food industries by taking few models. Study of national and international microbial quality standards. Visit to export oriented food processing industry.

## 4. FOOD ENGINEERING

### 1. Engineering Drawing

1(0+1)

Drawing of lines, lettering and dimensioning types of lines, types, types of lettering, types of dimensioning. Drawing of scales. Plain scale, diagonal scale, comparative scale and Vernier scale. Drawing of projections. Orthographic projections, methods of projections. Drawing of screw threads. Types of threads and terminologies used in it. Screw fastening Types of nuts, types of bolts, stud, locking arrangements for nuts and foundation bolt. Drawing of rivets and riveted joints forms of rivet heads, types of riveted joints, failure of riveted joints. Drawing of welded joints. Forms of welds, location and dimensions of welds. Drawing of keys, cotter joint, pin joints types of keys, types of cotter joints, pin joints. Drawing of shaft couplings. Rigid couplings, loose couplings, flexible couplings universal coupling. Drawing of shaft bearings. Journal bearings, pivot bearings, collar bearings.

### 2. Workshop Practice

2(0+2)

Simple exercises on wood working tools and their use, Carpentry and pattern making, mould material and their applications, heat treatment processes: hardening, tempering, annealing, normalising etc. Metal cutting. Soldering & Brazing, Electric arc welding, Gas welding, Smithy and forging operations, bench: Flat surface filing, Chipping, Scraping Marking out, Drilling and Screwing. Use of jigs and fixtures in production. Simple exercise on:(a) Lathe (b) Milling machine (c) Shaper and planer (d) Drilling and boring machines (e) Grinder.

**Practical:** Simple exercises in Filing and Fitting, Chipping and Hack sawing Chiseling, Tapping and Smithy practice. Simple exercises in Arc, Gas, & Argon welding. Simple exercises in Soldering, Brazing, Basic joints in carpentry.

### 3. Principles of General Engineering

2(1+1)

Alternating current fundamentals: Electromagnetic induction magnitude of induced E.M.F. Alternating current, R.M.S. value and average value of an alternating current. Phase relations and vector representation. A.C. series and parallel circuits, Concept of resonance, polyphase alternating current circuits, three-phase concept, Star and delta connections, star delta transformation, Energy measurement. Transformers: Fundamental of transformer, Theory, vector diagram without load and with load, Losses, voltage regulation and efficiency of transformer, auto-transformer. Induction motors : Fundamental principles, production of rotating fields, construction, Rotor winding-squirrel cage and phase wound rotors, Analysis of current and torque, starting of induction motors, Motor housing, selection of motor and its controls. D.C. Machines & AC machines : Construction and operation of D.C A. C. Motors, Types of generators, Various characteristics of generator, D.C. motors, torque-speed characteristics of D.C. motors, Starting and speed control of D.C. motors. Electric Power Economics: Electrification and load estimation Maximum demand charge, Load factor and power factor correction. Strength of Material – engineering materials, material science, use of various metals, including plastic glass, etc in food industry, selection and specification – material design, concepts and manufacturing of various equipments and machineries for food processing plant – Characteristics properties and uses of common building materials i.e. stone, brick, lime, cement, paints and varnishes, etc.

**Practical:** Study of voltage resonance in L.C.R. circuits at constant frequency. (a) Star connection-study of voltage and current relation (b) Delta connection-study of voltage and current relation. Measurement of power in 3-phase circuit. (a) For balanced loads. (b) For

unbalanced loads, by wattmeter and energy meters Polarity test, no-load test, efficiency and regulation test of single phase. Voltage and current relation in a 3-phase transformer of various kinds of primary and secondary connection systems. Starting of induction motor by the following starters : (i) D.O.L. (ii) Manual star-delta (iii) Automatic star-delta (iv) Manual auto-transformer. Starting of slip-ring induction motor by normal and automatic rotor starters. Test on 3-phase induction motor, determination of efficiency, line current, speed, slip, power factor at various outputs. To determine relation between the induced armature voltage and speed of separately excited D.C. generator. Magnetization characteristic of D.C. generator. Study the starter connection and starting reversing and adjusting speed of a D.C. motor. Studies of building material, property and characterization. Studies on engineering materials, construction and properties. Studies of machine design of food processing plant.

#### **4. Food Processing Equipment – I**

**3 (2+1)**

Material handling: Material handling machines and conveyors. Pretreatment unit operations : Cleaning, Dehulling and Dehusking, Sorting & Grading, Peeling, Mixing and Forming. Size reduction and separation. Agitation and Mixing. Bread moulders, Pie and biscuit formers, confectionery moulders. Extrusion : Extrusion cookers, cold extrusion, single and twin screw extrusion. Low pressure and high pressure extrusion. Engineering properties of Food materials. Its significance in equipment design, processing and handling of food products. Hygienic design of Food processing equipment. Sanitary requirement, Sanitary pipes and fittings. Rheology and texture of food materials: Concept of rheology, elastic, plastic and viscous behaviour, viscoelasticity, rheological models and constitutive equations. methods of texture evaluation, subjective and objective measurements. Aerodynamic and hydrodynamic characteristics. Application to separation, pneumatic handling and conveying. Evaporation : Principles of evaporation, types and selection evaporators, mass and energy balance. Design of single and multiple effect evaporators, recompression heat and mass recovery and vacuum creating devices. Fouling of evaporators and heat exchangers. Drying : Principles of drying, drying rate kinetics, Classification, mass and energy balance. Different types of dryers and components - roller, spray, tray, compartment, fluidized bed etc. Introduction of biochemical Engineering : Kinetics, product yield. Engineering of Gas liquid mass transfer in microbial system. Concept of thermo bacteriology : Arrhenius analogy, its application in design. Determination of heat resistance of micro organisms. Analysis of Thermal Resilience Duration mathematics of conduction heating. Thermal processing: Blanching, Pasteurizations and Sterilization - principles, different methods and equipments. Processing in containers, process time, T-evaluation, Design of batch and continuous sterilization. Design and analysis of fermenter.

**Practical:** Study of Instron type texture analyzer and its working. Stress-strain behavior of different food materials. Determine flow parameters of Newtonian, non newtonian food products by :Capillary tube, viscometer, Hakke's viscometer, Rotational viscometer and Falling Ball viscometer. Determine electric conductance of a given Food sample. Study of evaporator, dryer, sterilizer. Design problems on evaporators. Design problems on Dryers. Design problems on Freezers. Numerical problem on Thermo bacteriology (D, Z, & F).

#### **5. Refrigeration Engineering and Cold Chain**

**3(2+1)**

Definition of refrigeration and air conditioning, necessity of refrigeration and air conditioning. History of refrigerants, Refrigerants, definition, classification, nomenclature, methane and ethane series. Desirable properties of refrigerants- physical, chemical, safety, thermodynamic and economical. Azeotropes. Components of vapour compression refrigeration system, evaporator, compressor, condenser and expansion valve. Ice

manufacture, principles of ice production, different systems. Treatment of water for making ice, Brines, Freezing tanks, ice cans, air agitation, quality of ice. Applications of refrigeration in different food products – fruit and vegetable products, meat products, fish, poultry products, dairy products etc. Food Freezing: Freezing systems: indirect contact systems, plate freezers, air blast freezers, and freezers for liquid foods. Direct contact systems, air blast immersion, frozen food properties, density, thermal conductivity enthalpy, apparent specific heat and thermal diffusivity, freezing time, factors influencing freezing time, freezing rate, thawing time. Frozen food storage: Quality changes in foods during frozen storage.

**Practical:** Standard refrigeration symbols. To study vapour compression refrigeration system. Solving problems on cooling load calculations / Refrigeration load. To study the properties and performance characteristics of some commonly used refrigerants. To study the components of the refrigeration system. Freezing of foods by different methods. Determination of freezing time of a food material.

## 6. Fluid Mechanics & Hydraulics

2(1+1)

Units & dimensions, Properties of fluids. Static pressure of liquids : Hydraulic pressure, absolute and gauge pressure, pressure head of a liquid. Pressure on vertical rectangular surfaces. Compressible and non compressible fluids. Surface tension, capillarity. Pressure measuring devices, Simple, differential, micro, inclined manometer, mechanical gauges, Piezometer. Floating bodies : Archimedis principle, stability of floating bodies. Equilibrium of floating bodies. Metacentric height. Fluid flow : Classification, steady, uniform and non-uniform, laminar and turbulent, continuity equation. Bernoulli's theorem and its applications. Flow through pipes : Loss of head, determination of pipe diameter. Determination of discharge, friction factor, critical velocity. Flow through orifices, mouthpieces, notches and weirs. Vena contracta, hydraulic coefficients, discharge losses. Time for emptying a tank. Loss of head due to contraction, enlargement at entrance and exit of pipe. External and internal mouthpieces, types of notches, rectangular and triangular notches, rectangular weirs. Venturimeters, pitot tube, rotameter. Water level point gauge, hook gauge. Dimensional analysis : Buckingham's theorem application to fluid flow phenomena. Froude Number, Reynolds number. Weber number and hydraulic similitude. Pumps : Classification, reciprocating, centrifugal pump. Pressure variation, work efficiency. Types of chambers, selection and sizing.

**Practical:** Study of different tools and fittings. To plot flow rate versus pressure drop with U-tube manometer. Verification of Bernoulli's theorem. Determination of discharge co-efficient for venturi, Orifice, V-Notch. Verification of emptying time formula for a tank. Determination of critical Reynold's number by Reynold's apparatus. Study of reciprocating, centrifugal and gear pump. Calibration of Rotameter. Study of different types of valves. Problems on following topics: Pressure, capillarity and surface tension. Floating bodies, Liquid flow, venturimeter, orifice, weir, flow through pipes, pumps.

## 7. Heat & Mass Transfer

2(1+1)

Basic heat transfer process, thermal conductivity, convective film co-efficient, Stefan Boltzman's constant and equivalent radiation co-efficient, Overall heat transfer co-efficient, physical properties related to heat transfer. One-dimensional steady state conduction: Theory of heat conduction, Fourier's law, Derivation of Fourier's equation in Cartesian co-ordinates, Linear heat flow through slab, cylinder and sphere. Heat flow through slab, cylinder and sphere with non-uniform thermal conductivity. Concept of electrical analogy and its application for thermal circuits, Heat transfer through composite walls and insulated

pipelines. One dimensional steady state heat conduction with heat generation: Heat flow through slab, hollow sphere and cylinder with uniform heat generation, Development of equations of temperature distribution with different boundary conditions. Steady-state heat conduction with heat dissipation to environment: Introduction to extended surfaces (FINS) of uniform area of cross-section. Equation of temperature distribution with different boundary conditions. Effectiveness and efficiency of the FINS. Introduction to unsteady state heat conduction. Convection : Forced and free convection, use of dimensional analysis for correlating variables affecting convection heat transfer, Concept of Nusselt number. Prandtl number, Reynolds number, Grashoff number, some important empirical relations used for determination of heat transfer coefficient. Radiation: Heat radiation, emissivity, absorptivity, transmissivity, Radiation through black and grey surfaces, determination of shape factors. Introduction to condensing and boiling heat transfer: Film and dropwise condensation, effect of non-condensable gases, boiling heat transfer. Heat Exchangers : General discussion, fouling factors, jacketed kettles, LMTD, parallel and counter flow heat exchangers, Shell and Tube and Plate heat exchangers, Heat exchanger design. Application of different types of heat exchangers in dairy and food industry. Mass transfer : Fick's law of diffusion, steady state diffusion of gases and liquids through solids, equimolar diffusion, isothermal evaporation of water into air, mass transfer coefficient, application in Dairy and Food industry.

**Practical :** To study various types of heat exchangers used in Dairy & Food Industry. Preparation and calibration of thermocouples. Determination of thermal conductivity : milk, solid dairy & food products. Determination of overall heat transfer co-efficient of : Shell and Tube, Plate heat exchangers Jacketed kettle used in Dairy & Food Industry. Studies on heat transfer through extended surfaces. Studies on temperature distribution and heat transfer in HTST pasteuriser. Design problems on heat exchangers.

## 8. Food Packaging

3(2+1)

Introduction to subject, Packaging situations in World, India, need of packaging, plastic consumption/use in World, India etc. Package requirements, package functions, Hazards acting on package during transportation, Storage and atmospheric package, labeling laws. Package Materials: classification packages, paper as package material its manufacture, types, advantages corrugated and paper board boxes etc. Glass as package material, Manufacture, Advantages, disadvantages. Metal as package material-manufacture, Advantages, disadvantages, Aluminum as package material,. Its advantages and disadvantages, plastic as package material classification of polymers, properties of each plastics, uses of each plastics, chemistry of each plastic such as polyethylene, Polypropylene, polystyrene, polycarbonate, PVC, PVDC, Cellulose acetate, Nylon etc. Lamination Coating and Aseptic packaging. Lamination, need of lamination, types, properties, advantages & disadvantages of each type. Coating on paper & films, types of coatings : Need of coating, methods of coatings. Aseptic packaging-Need, Advantaged, process, comparison of conventional & aseptic packaging, system of aseptic packaging and materials used in aseptic packaging. Machineries used in Packing foods. Packaging of Specific Foods. Packaging of specific foods with its properties, Like bread, Biscuits, Coffee, Milk powder, egg powder, carbonated beverages. Snack foods etc. Mechanical and functional tests on Package. Various mechanical and functional testes perform in laboratories on package boxes and package materials.

**Practical:** Classification of various packages based on material and rigidity. Measurement of thickness of paper, paper boards. Measurement of basis weight of paper and paperboards. Measurement of grammage and water absorption of paper, paper boards. Measurement of bursting strength of paper of paper boards. Measurement Tear resistance of papers.

Measurement of puncture resistance of paper and paperboard. Measurement of tensile strength of paper of paper boards. Measurement of grease resistance of papers. Determination of gas transmission rate of package films. Determination of WVTR and QTR of films. Determination of coating on package materials. Identification of plastic films. Finding chemical resistance of films. Prepackaging practices followed for packing fruits, vegetables.

## 9. Food Processing Equipment II

3(2+1)

Mechanical Separations: Centrifugation, liquid-liquid centrifugation, liquid- solid centrifugation, clarifiers, desludging and decanting machines. Filtration: Principles involved in filtration. Pressure and vacuum filtration. Expression: batch and continuous type. Baking, Roasting and Frying equipment. Extraction and Leaching, Crystallization and Distillation: Basic principles involved. Water activity and states: Raoult's Law. Water sorption Isotherms - Hysteresis. Water activity measurement method. Water binding and its effect on enzymatic and non-enzymatic reactions and food texture. Control of water activity and moisture. Permeability: Theoretical considerations. Permeability of gases and vapours. Permeability of multilayer materials. Permeability in relation to packaging requirement of foods. Shelf life : Calculation of shelf life. shelf life requirements, Deteriorative reactions. Accelerated testing. Transport properties of barriers. Simulations of product - package environment interaction. Shelf life simulation for moisture, oxygen, and light sensitive products. Freezing of Foods : Types of freezers including, ice cream freezers, Freeze concentration and freeze drying. Freezing curves, phase diagrams, methods of freeze concentration, design problems. Membrane processes : Ultra filtration, Reverse osmosis, Electrodialysis, per-evaporation and micro filtration. Cleaning and sanitation of food equipments and containers: can, crate, bottle, washing, CIP and COP cleaning. Microwave and Dielectric & Infrared heating :Physical parameters. Heat transfer phenomenon. Equipment and application. Irradiation - Principle and its equipments, Blending and pulverization equipments.

**Practical:** Lab demonstration on state of water. Demonstration of equilibrium sorption isotherms. Determination of gas transmission rate. Determination of Water vapour permeability of packages. Evaluation of properties of films to determine their suitability as containers for foods. Shelf life calculations for food products. Study of freezers. Study of CIP plant.

## 10. Energy Generation and Conservation

3 (2+1)

Basic concepts: systems, processes, cycles, energy, The Zeroth Law of Thermodynamics. Ideal gases : Equation of state, Compression and expansion of gases. The first Law of Thermodynamics : Internal energy, enthalpy. The second Law of Thermodynamics : Thermodynamic temperature scale, Carnot cycle, entropy, reversibility, availability. Renewable energy sources like solar, wind and biogas and their utilization in food processing. Related equipment and machineries to renewable energy sources. IC. Engines : Two stroke and four stroke cycles, construction, injection and ignition of fuel, Performance of IC engines. Fuels : Chemical properties, air for combustion, Calorific value and its determination, Burners, firing of fuels. Renewable energy sources. Properties of steam: Wet, dry saturated, superheated steam, Use of steam tables and Molier charts. Boiler mountings and Boiler accessories. Draught : Natural, forced, fan, jet, Measurement of Height of chimney. Condensers. Layout of pipe-line and expansion joints. Boiler trial : Codes, Indian Boiler Regulation acts. Air Compressors : Reciprocating, Single and two stage air compressors.

**Practical:** Application of thermodynamics in engineering problems. Study of 2-stroke engine and 4-strokes engines. Performance tests on I.C. engines. Determination of dryness fraction of steam. To study the boiler installed in Model Plant, Water softening plant, Lancashire boiler, Locomotive boiler, Babcock & Wilcox boiler, Electrode boiler, Boiler mounting and steam-line layout and steam traps. Visit to sugar mill/rice mill or plant with steam utilization. Study of Solar water heater and biogas plants and appliances.

## 11. Biochemical Engineering

3(2+1)

Biochemical engineering & their scope: Definition, necessity, value. Engineering good manufacturing practices. Standard operating procedure, good laboratory practices. History of Biochemical Engineering: Aging and fermentation, theory of scientists Pfizer, Alexander Fleming Salman Waksman. Role of biochemical engineering in development of modern fermentor: Scale up, management of cellular process, design, operation and their problems, down stream processing. Basis for biochemical engineering in fermentation industry: Unit operation, unit process, process design, chemical reaction kinetics, process variables, biochemical properties, process control. Kinetics of microbial growth and death: Definition, fermentation kinetics rate of cell synthesis, product formation and effect of environment. Types of kinetics, Batch and continuous type, control measures. Simple enzyme kinetics: Simple kinetics model for enzyme substrate interaction. Equation of Michelin Menton, for reaction rate, product formation, calculation of  $K_m$  and  $V_{max}$  values. Complex enzyme kinetics: Oxidation - reduction form of enzymes, observed apparent rate constant, factors affecting the inhibition, competitive, non competitive inhibition, substrate interaction. Kinetics pattern of various fermentations: Classification of kinetics pattern, as per different scientists, simple, simultaneous, consecutive, stepwise, complex reactions and their examples Expression for kinetics, parameters for cellular activities: Cell concentration, expression for growth rate, exponential growth, specific growth rate, yield concept and their expression, product formation and their expression, specific rate of product formation. Media and air sterilization: Definition, thermal death time, media heat sterilization, advantages of continuous sterilization, design of sterilization, air sterilization. Effect of temperature on specific death rate, deterministic and probabilistic approach in designing of sterilizing equipments, sterilization charts. Batch sterilization and different media of sterilization. Continuous sterilization of age media, continuous plate heat exchangers. Aeration and agitation Purpose of aeration and agitation and their principles, study the velocity gradient with agitation processes, effect of fluids on agitation, liquid film resistance, physical and enzymatic consideration, critical value of dissolve oxygen concentration and  $Q$  value of oxygen. Product recovery of different process: Mass transfer resistance, extraction, leaching, drying and evaporation, sorption and storage, permeability law. Product formation for value added products using bioconversions techniques Production of single cell protein, alcohol, raw material for required for product formation, production of antibiotics, economic process, utilization of damaged grain through bioconversion, present mode of utilization and their nutritional value.

**Practical:** Instrumentation and their control in fermentation industry -physical parameter. Instrumentation and their control in fermentation industry - chemical parameter, metabolic parameters and biosensors in food industry. Study the different parts of fermentors. To study the thermal stability of peroxides enzyme in potato. To asses the amylase activity from given foods sample. To measure the microbial growth after (fermentation thermal death time). To study the mass transfer of solution by dialysis process. To study the time temperature relationship for destruction of microorganisms. To study the ethyl alcohol production through bioconversion. To study the antibiotics production through bioconversion. To study the vitamin production through bioconversion. Constant ( $k_s$ ) of yeast growth by studying the sugar up take by yeast cells.

## **12. Instrumentation and Process Control**

**3(2+1)**

Introduction, definition, recorders and monitors, panel boards. General characteristics of instruments, static and dynamic characteristics. Temperature and temp. scales, various types of thermometers - mercury-in-glass, bimetallic, pressure-spring thermometers, thermo couples, resistance thermometers and pyrometers. Pressure and pressure scales, manometers, pressure elements differential pressure. Liquid level measurement, different methods of liquid level measurement. Flow measurement, kinds of flow, rate of flow, total flow differential pressure meters, variable area meters. Transmission, pneumatic and electrical. Control elements, control actions, pneumatic and electrical control systems.

**Practical:** To study instrumentation symbols. Measurement of temperature by different thermometers. Measurement of pressure by 'U' tube manometer, (inclined tube manometer). Measurement of liquid level in the tank with the help of Bob and tape. Determination of relative humidity by wet and dry bulb thermometer. Measurement of velocity of fluid by using venturimeter/orifice meter/pilot tube. Measurement of RPM of an electric motor by Tachometer. Measurement of wind velocity by anemometer. Measurement of intensity of sun shine by sunshine recorders. Characteristic of valve, PI performance, T, P flow and level close loop control system.

## **13. Food Plant Design and Layout**

**3 (1+2)**

Overall design of an Enterprise: Plant design, sales planning for plant design. Plant Location, levels of Plant location. Location of layout : location factors, plant site selection. Location theory and models, industrial buildings and grounds. Classification of Dairy and Food Plants, farm level collection and Chilling center. Space requirement. Preparation of a Plant Layout : Plant Layout problem, importance, objectives, classical types of layouts. Evaluation of Plant Layout. Advantages of good layout. Organizing for Plant Layout, Data forms. Development and Presentation of Layout : Development of the pilot layout, constructing the detailed layout : Functional design : Sitting of different sections in a plant, Layout installations. Quantitative analysis for Plant Layout: Engineering economy. Linear programming. Queing theory. Common Problems in Plant Layout and Process scheduling. Siting of Process sections, Equipment selection and capacity determination, Arrangement of process, and service equipment. Estimation of Services and Utilities. Office layout, line balancing, Flexibility. Practical Layouts. Common materials of construction of Food plant, building. Maintenance of Food Plant Building, Illumination and ventilation, Cleaning & sanitization, painting and colour coding, Fly and insect control.

**Practicals:** Preparation of project report. Preparation of feasibility report. Layout of Food storage wares and godowns. Layout and design of cold storage. Layout of preprocessing house. Layout of Milk and Milk product plants. Low shelf life product plant. Bakery and related product plant. Fruits processing plants. Vegetable processing plants. Layout of multi product and composite food Plants Evaluation of given layout. Waste treatment and management of food plant.

## **5. FOOD SCIENCE & TECHNOLOGY**

### **1. Principles of Food Processing**

**3(2+1)**

Sources of food, scope and benefit of industrial food preservation, perishable, non perishable food, causes of food spoilage. Preservation by salt & sugar – Principle, Method, Equipment and effect on food quality. Thermal processing methods of preservation – Principle and equipments :Canning, blanching, pasteurization, sterilization, evaporation. Use of low

temperature – Principal, equipment and effect on quality. Chilling, cold storage, freezing. Preservation by drying dehydration and concentration – Principle, Methods, Equipment and effect on quality :Difference, importance of drying & dehydration over other methods of drying and dehydration, equipments and machineries, physical and chemical changes in food during drying and dehydration .Need and Principle of concentration, methods of concentration – Thermal concentration, Freeze concentration, membrane concentration, changes in food quality by concentration. Preservation by radiation, chemicals & preservatives. Definition, Methods of Irradiation, Direct & Indirect effect, measurement of radiation dose, dose distribution, effect on microorganisms. Deterioration of Irradiated foods-physical, chemical and biological; effects on quality of foods. Presentation of foods by chemicals, antioxidants, mould inhibitors, antibodies, acidulates etc. Preservation by fermentation- Definition, Advantages, disadvantages, types, equipments. Recent methods in preservation : Pulsed electric field processing, High pressure processing, Processing using ultrasound, dielectric, ohmic and infrared heating. Theory, equipments and effect on food quality.

**Practical:** Demonstration of various machineries used in processing. Demonstration of effect of blanching on quality of foods. Preservation of food by heat treatment- canning. Canning of fruits and vegetables. Preservation of food by high concentration of sugar i.e. preparation of jam. Preservation of food by using salt- Pickle. Preservation of food by using acidulants i.e. pickling by acid, vinegar or acetic acid. Preservation of food by using chemicals. Preservation of Bread, Cake using mold inhibitors. Preservation of coconut shreds using humectants. Drying of pineapple slices, apple slices in cabinet drier. Demonstration on drying of green leafy vegetables. Drying of Mango/other pulp by foam mat drying. Drying of semisolid foods using roller dryers. Drying of foods using freeze-drying process. Demonstration of preserving foods under cold v/s freezing process. Processing foods using fermentation technique i.e. preparation of saurcraut.

## 2. Post Harvest Management of Fruit and Vegetables

3(2+1)

Post harvest technology of fruits and vegetables: An over view of concept and science, importance of loss reduction, role in export, economy, and employment generation. Morphology, structure and composition of fruit and vegetable.- Physical, Textural characteristics, structure and composition. Maturity standards; Importance, methods of Maturity determinations maturityindices for selected fruits and vegetables. Harvesting of important fruits and vegetables. Fruit ripening- chemical changes, regulations, methods. Storage practices: Control atmospheric, Bead atmosphere, hypotactic storage, cool store, Zero emerge cool chamber, stores striation. Commodity pretreatments - chemicals, wax coating, prepackaging. Physiological post harvest diseases chilling injury and disease. Handling and packaging of fruits and vegetables ; Post Harvest handling system for citrus, mango, banana, pomegranate, tomato, papaya and carrot packaging house operations. Principles of transport and commercial transport operations.

**Practical:** Studies on morphological features of some selected fruits and vegetables. Studies of maturing indices. Studies of harvesting of fruits and vegetables. Determination of RQ. Studies of export of pre cooling and storage of fruits and vegetables. Studies on wax coating on apples, papaya, citrus, mango, aonla. Studies on use of chemicals for ripening and enhancing shelf life of fruits and vegetables. Studies of regulations of ripening of banana, mango, papaya. Studies on various storage systems and structures. Studies on prepackaging of fruits. Studies on prepackaging of vegetables. Studies on physiological disorders - chilling injury of Banana and custard apple. Visit to commercial packaging house – grape, mango, pomegranate. Visit to commercial storage structures- Onion, garlic, potato.

### 3. Fruits and Vegetable Processing

3(2+1)

Production and processing scenario of fruits and vegetable: India and World. Scope of Fruit and Vegetable Preservation Industry in India. Present status, constraints and prospectus. Overview of principles and preservation methods of fruits and Vegetables. Commercial processing Technology of Following fruits and vegetables. Mango: Pulp, RTS, Squash canned Mango pulp. Toffee amchur, pickle Mango Powder, bar. Banana: Wafers, puree, dried banana powder. Papaya: Jam, Candy RTS, Nectar, Squash, and Papain. Pomegranate: Juice, Squash, syrup, Anardana, Dalimbmanuka, Anargoli. Guava; Jelly, Cheese, Juice, Canned guava, Squash, Toffee. Grape: Raisin, Juice, Wine. Fig: Pulp, dried fig, Toffee Powder, bar fig. Citrus Fruits: Jelly, Marmalade RTS Squash, candy. Aonla; Preserve, Jam, Candy, Juice, Squash, powder, Dried shreds, chuyenprash, pickle, chutney sauce, sweets. Tamarind: Pulp, Powder, Toffee, Bar, RTS, Slab Jamun: Jelly, RTS, Syrup, wine, Wood apple: Jelly, Marmalade, Tomato: Ketchup, sauce, puree, soup, chutney, pickle, Ginger: Preserve, Candy, dried, Ginger pickle, RTS, Syrup. Onion: Dried Onion, Powder. Garlic: Dried Garlic, Powder, Oil. Potato: Wafer; starch, Papad, Carrot: Preserve, candy, Pickle, Jam. Cauliflower and cabbage: Dried cauliflower and cabbage, Sauerkraut, Pickle Leafy vegetables; Dried Leafy Vegetables. (Spinach, Fenugreek, Coriander leaves, Curry leaves). Bitter gourd: Pickle, Dried bitter gourd.

**Practical:** Canning of Mango/Guava/Papaya. Preparation of Fruit Jam: Apple/Mango/Guava/Papaya/Aonla/Strawberry. Preparation of fruit Jelly: Wood apple, Sweet orange/mandarin/Guava,/Tamarind. Preparation of fruit marmalade: Ginner Marmalade. Preparation of fruit preserve and candy. Preparation of fruit RTS and candy Preparation of fruit squash. Preparation of fruit syrup. Preparation of grape raisin, dried fig and dried banana. Preparation of Anardana and dalmab manuka. Preparation of papain /guava cheese. Preparation of pickle, mixed pickle. Preparation of dried ginger. Preparation of Amchur. Preparation of dried onion and garlic, Preparation of Banana and Potato wafers, Preparation of dehydrated leafy vegetable.

### 4. Legume and Oilseed Technology

3(2+1)

Present status and future prospectus of Legumes and Oil seeds Morphology of legume. Classification and types of legumes and pulses. Chemical composition and nutritional value. Anti-nutritional factors, their chemistry, methods of removal of anti-nutritional factors. Processing of legumes of Food uses: Home scale, Cottage Scale and commercial methods of dehulling. Modern techniques in Dal mills. Processing of Red gram., Bengal gram, Green gram, Black gram. Dal milling – Principle, methods, equipments and effect on quality. Principle products, Dry and Wet milling of pulses, Fermented Products of legumes. Soaking – Principles, Methods of soaking - Sprouting, Puffing, Roasting & Parboiling of Legumes, Physical and Bio-chemical changes during these processes. Cooking quality of dhal – methods, factors affecting quality of dhal and cooking of dhal. Quick cooking dhal, Instant dhal. Introduction, Present and future prospects of oil seeds, chemical composition and characters of oil seed and Oils, Anti-nutritional factors, elimination Methods. Post Harvest Technology of Oil seeds, Handling Drying, Storage, Grading, Pretreatments, cleaning, Dehulling, Size reduction and flaking. Oil extraction: Traditional Methods, Ghani, Power Ghanis, Expellers - Principle of Expeller, structure design of expeller. Solvent extraction process: Principle, Pretreatment - Breaking, Cracking, flaking. Extraction principles, factors affecting the extraction process. Desolventization. Refining of Oils - Degumming, neutralization, bleaching, filtration, deodorization, their Principles and process controls. New Technologies in oil seed processing, utilization of oil seed meals of different food uses. High protein Product, like protein concentrate and isolates.

**Practical :** Physical properties of Legumes and Oil seeds. Estimation of protein. Estimation of Fat Methods and Principles of dehulling; Application Oil & Application Red Earth slurry. Dal Milling Process. Antinutritional factors, Methods of Elimination. Soaking studies .Sprouting of legumes. Cooking quality of Dal. Fermented product of legumes- Dosa, Idli, Wada, Dhokala, etc. Extraction of oil by expeller press. Production of protein rich product. Visit to Dal Mill and oil extraction plant.

## 5. Cereal Processing

3(2+1)

Present status and future prospects of cereals (Rice, Wheat, Corn, Sorghum, Rye); Morphology of Rice: Physical properties; Density, Bulk density, Angle of repose, Hardness, asperity, porosity, stack of milling and moisture on physical properties. Chemical composition, Distribution of nutrients and Aroma of rice. Drying of paddy: general principles and methods of drying, cracking phenomenon - prevention. Methods of drying, batch type, continuous type driers. Milling of rice: i) Conventional Milling ii) Modern milling iii) Advantages and disadvantages of milling machineries. iv) By products of rice milling. Parboiling of rice: Aging of rice: Enrichment: - Need of Enrichment, Methods of enrichment, Enrichment levels, fortification of amino acids. -Processed Foods from rice: Breakfast cereals, flakes, puffing, canning and instant rice. Wheat: Morphology, Physico-chemical properties, Wheat Quality, Wheat Milling. Corn: Morphology, Physico-chemical properties, Corn milling, Milling fractions and modify starches. Barley: Morphology, Physico-chemical properties and processing (Malting) Sorghum: Morphology, Physico-chemical properties, Milling, Malting, Pearling and industrial utilization. Millets – Oat / Rye: Importance of Millet, composition, processing of millets for food uses.

**Practical:** Morphological characteristics of cereals. Physical properties of cereals. Chemical properties of cereals. Determination of colour of cereals. Parboiling of Paddy. Cooking quality of rice, Milling of rice, Conditioning of wheat. Production of sorghum flakes. Production of Popcorns Preparation of sorghum Malt. Determination of Gelatinization Temp. By amylograph. Extraction of oil from rice bran. Visit to Cereal processing unit.

## 6. Processing of Meat and Poultry Products

3(2+1)

Sources and developments of meat and poultry industries in India and importance of meat and meat industries in national economy. Muscle structure, chemical composition and physico-chemical properties of meat muscle. Abattoir design and layout. Pre-slaughter transport and care and anti mortem inspection. Slaughtering of animals and poultry, post-mortem inspection and grading of meat. Factors affecting post-mortem changes, properties and shelf life of meat. Egg structure: Composition, quality characteristics, processing and preservation of eggs. Processing and preservation of meat- mechanical deboning, aging or chilling, freezing, pickling, curing, cooking and smoking of meat. Meat tenderization. Meat emulsions. Technology of manufacture of meat and poultry products. Meat plant sanitation and safety. By-products utilization.

**Practical:** Pre-slaughter operations of meat animals and poultry birds. Slaughtering and dressing of meat animals. Study of post-mortem changes. Meat cutting and handling. Evaluation of meat quality. Preservation of meat by different methods and preparation of meat and poultry products. Evaluation of quality and grading of eggs. Preservation of shell eggs. Experiments in by-products utilization.

## 7. Bakery and Confectionery Products

3(2+1)

History, Traditional confectionary goods, Types of confectionary, classification. Basic Technical considerations, TS, TSS, pH, acidity, ERH, Sugar, Invert Sugar, Glucose syrup, RH, Crystallization. Raw Materials: Sugar, Sugar qualities, Physical, Chemical, Optical properties. Sugar grinding, Dextrose, Fructose, Lactose, caramel, maltose, Honey, sorbitol, xylitol, Iso malt, soy maltose, Polydextrose, Lactitol, Maltitol. Whipping, Release agent, thickeners, Acidulents, Flavours, for confectionery, emulsifiers and other additives, starch derivatives, colours used in confectionary. Production of glucose syrup, Acid hydrolysis, enzyme hydrolysis. Cocoa Processing: Cocoa bean, processing, roasting, Fermentation, Production of Cocoa butter Cocoa powder, its quality. Chocolate Processing: Ingredients, Mixing, Refining, Conching, Tempering, Molding, Cooling, Coating, Fat bloom. High Boiled Sweets: Introduction, Composition, Properties of high boiled sweets, preparation of high boiled sweets, Traditional, batch and continuous Method of preparation. Different types of higher boiled sweets, Recipes. -Caramel: Definition, Composition, Factors affecting quality of caramel, caramel Manufacture process, batch type, continuous types, checking of faults in caramel. Toffee: Definition, Composition, types of toffee Ingredient and their role. Batch and Continuous method of toffee. Fondant: Fudge/Creamy: ingredients, Methods, Productivity. Lozenges: Definition recipe, Method of Manufacture, Compositions, factors affecting quality, Industrial production, checklist of faults. Tablets: Definitions, recipe, composition, wet granulation, Slugging, Manufacture of Tablet, and Checklist of tablet faults. Marshmallow and. Nougat: Definition, composition, recipe, and method of manufacture. Nougat. Panning: Process, types of Panning, soft and hard panning. Quality of confectionery, Standards and regulations, Packaging requirements of confectionary, economics and marketing of confectionary goods. Bakery Products, Role of Bakery ingredients (major and minor), From Hard Wheat: Bread: Processes of bread making mainly straight and sponge, role of each ingredient, quality control. Testing of raw material. Testing of final product. Bread faults, staleness, ropyness. Baked Products from soft wheat: Cookies, crackers, Biscuits, Cakes: Types, ingredients, Process, Causes, remedy. Other bakery Products: Pizza, Pastry and its Types. Macaroni Products: Including spaghetti, Noodles, Vermicelli-Process. Nutritional improvement of bakery Products. Setting of bakery Unit, Bakery norms. Specifications for raw materials. Packaging. Marketing of Products. Project report on bakery. Visit to wheat milling Industry. Visit to Bakery.

**Practical:** Classification of wheat based on physico-chemical properties. Conditioning of wheat. Milling of wheat. Quality Testing of flour: Falling number and  $\alpha$ - amylase activity, Sedimentation value, Pelshenke value, Farinograph, Mixograph, Extensiograph, Alveograph. Manufacture of Bread, Types, Faults, remedies, shelf life bread, quality of bread Biscuits, cookies, crackers, buns: Types and quality. Other baked products- Pastry, pizza. Extruded Products from wheat: Vermicelle, noodles etc. Physical properties of sugar. Production of invert sugar. Determination of Moisture in Sugar. Determination of Reducing Sugar. Preparation of High boiled sweets. Preparation of Toffee. Preparation of Groundnut Chikki. Preparation of Candid Food. Preparation of decorative cake. Preparation of Chocolate. Preparation of Traditional Indian Confection. Visit to Confectionary Industry.

## 8. Processing of Fish and Marine Products

3(2+1)

Types of fish, composition, structure and post mortem change in fish and quality evaluation. Handling of fresh water fish. Processing and preservation of fish canning, smoking, chilling and freezing of fish. Salting, sun drying and salt curing of fish. Fish sausages. Freeze-drying of fish/shrimp. Radiation processing and safety. Fish fermented products. Fish protein

concentrates. Marine oils and fish meals. Marine algal products. Production of fish and sea foods & utilization fish by-products. MFPO and BIS specifications of fish and fish products.

**Practical:** Anatomy and dressing of fish. Quality evaluation of fish. Preparation of sun dried and salt cured fish, fish sausages. Chilling and freezing of fish. Preparations of fish protein concentrate. Preparation of fishmeal. Preparation of marine oils and various fish products. Utilization of fish by-products. Preparation of marine algal products.

## 9. Extrusion Technology

3(2+1)

Food proteins; Types, sources, Availability, need, properties etc. Food problems, Role, Means for increasing food supply. Amino acid fortification of foods ; Cereals, infant foods, bread, baked products. Legumes and oilseed foods ; Isolate, concentrate, and substitute to milk, variation in composition and nutritive value. Meat Analog; Commercial development, nutritional aspect, marketing aspect. New protein foods; TOFU, Miso, Texturized vegetable protein, hydrolyzed vegetable protein, formulation and quality control. Extrusion Technology; Importance, principles of extrusion cooking, methods of extrusion cooking. Extruders; Types of extruders, single screw, twin screw their applications, effect of dependent and independent variables on the product quality. Extruded products; Raw materials, process of manufacture, properties, quality, evaluation, packaging requirement, marketing.

**Practical:** Physicochemical properties, functional properties of proteins, protein rich products, weaning foods, beverages, Texturized Products, Protein rich bakery products, Type of food extruders, preparation of extruded products, Factors affecting extrusion cooking, Moisture content, Diameter, Temperature, Pressure, screw speed, time, quality evaluation of these products.

## 10. Food Quality

2(1+1)

Food quality and its role in food industry; Definition of Food quality, Role of food quality in Food Industry. Quality attributes; Classification of quality attributes, Color and gloss: Definition, Different colors, color measurement by spectrophotometer, muncell color system, lovibond tintometer, role in food qualities. Role of viscosity and consistency in food quality. Size and shape: Production, role in Food industry Measurements: weight, volume, weight-volume ratio, length, width, diameter, symmetry, curvature, area. Defects: Classification, Genetic- physiological defects- Structural, off color, character, Entomological Defects: holes, Scars, lesions, off coloring, curled aves, pathological defects. Mechanical defects, Extraneous or foreign material defects. Measurement of defects: Improving visibility by dilution, white background, color differences, standardization of conditions, reference standards, counts and measures, isolation of defects by floatation, elution, electronic sorting, Internal defects. Flavour: Definition and its role in food quality, Taste, classification, taste qualities, relative intensity, reaction time, effect of disease, temperature, and taste medium on taste, basic tastes, interaction of tastes. Odour : definition, Classification, neutral - mechanisms, Olfactory abnormalities, odor testing, techniques, thresholds, odor intensities, olfaction. Visual, Auditory, Tackle and other senses, Vision, audition, oral perception other than taste. Factors influencing sensory measurements: Attitudinal factors, motivation psychological errors in Judgment, relation between stimulus and perception adaptation. Correlation of sensory and instrumental analysis. Quality Measurements: Laboratory measurement: types of tests, panel selection and testing environment, serving procedures, instruction to judges, Difference tests, directional difference tests, classification of difference tests, two-sample tests, three sample tests, multisampling tests, comparison of procedures,

ranking, scoring, hedonic scaling, dilution procedures, descriptive sensory analysis, contour method, other procedures, Consumer measurement: Factors influencing acceptance and preference, objectives of consumer preference studies, information obtained from consumer study, factors influencing results from consumer surveys, Methods of approach, development of the questionnaire, types of questionnaires, serving procedures. Comparison of laboratory panels with consumer panels. Limitations of consumer survey. Quality of raw materials: Physical, Chemical and microbial quality. Quality of products during processing & after processing color, taste, texture, flavour, appearance. Factors influencing the Food qualities: Soil, field practices, harvesting practices, procedures, packaging, transportation, storage, conditions, processing conditions, packaging and storage conditions of finished products. Recording and reporting of quality.

**Practical:** Sensory evaluation of product. Quality evaluation of raw materials. Quality evaluation of product for colours, size, shape. Sensory evaluation of product for taste. Market testing of products. Evaluation of food standards. Determination of color by using lovibond tintometer. Visit to food factory to know sensory evaluation problems. Consumer study for food quality. Visit to fruit & Vegetable market for quality assessment.

### **11. Processing of Spice & Plantation Crops**

**3(2+1)**

Production and processing scenario of spice, flavour & plantation crops and its scope. Major Spices: (1) Post Harvest Technology composition, processed products of following spices (2) Ginger (3) Chill (4) Turmeric (5) Onion and garlic (6) Pepper (7) Cardamom (8) aercanut, cashew nut, coco nut. Minor Spices, herbs and leafy vegetables : tea rubber and oil palm. Spartans, Processing and Utilization All spice, Annie seed, sweet Basil. Caraway seed, Cassia, Cinnamon. Clove, Coriander, cumin, Dill seed. Fern seed nutmeg, malt, mint marjoram. Rose merry, saffron, sage. Savory, Thyme, Ajowan. Asartida, curry leaves. Tea-Types, Processing, quality control. Coffee& Cocoa: Processing. Vanilla and annatto-processing. Flavours of minor spices. Flavour of major spices. Spice oil and oleoresins. Flavours of soft drinks Baking and confectionery. Standards specification of spices. Functional packaging of spices and spice products.

**Practical:** Identification and characterization of flavouring compounds of spices. Valuable oil determination. Extraction of oil from clove, pepper, cardamom-chili. Extraction of oleoresins-Turmeric, ginger, pepper, clove. Piperine estimation in pepper oleoresin. Steam distillation of spices. Determination of curumin content in turmeric. Chemical analysis of spices moisture, valuable oil, specific gravity, refractive index ,acid value. Study of standard specification of spices. Packaging study of spices. Preparation of curry powder. Visit to spice Industry.

### **12. Processing of Milk and Milk Product**

**3(2+1)**

Milk: Definition, Composition of Milk from different species, Colostrum. Effect of heat on milk. Processing of milk. Pasteurization by L T H T and HTST and UHT – Filtration, UF & RO, Clarification, Cream separation, homogenization and heat processing. Classification of milk products. Manufacture of butter and butter oil (Ghee). Fermented milks. Preparation of Yoghurt and Cheese. Ice-cream – Method of manufacture. Manufacture of indigenous milk products – Ghee, Khoa, Channa, Paneer, Dahi and Shrikand. Indian milk confectionary – Khoa and Channa based sweets. By products of Dairy Industry – Their utilization. Packaging and storage of milk and milk products – Defects – Standards.

**Practical:** Sampling and analysis of milk – Sp.gravity physico chemical properties and composition, DMC and DYE reduction tests, presence of adulterants and preservatives. Standardization of milk for markets. Clarification and separation of milk. Heat processing of milk – Pasteurization. Preparation of butter and Ghee. Ice-cream preparation. Preparation of Dahi, Shrikhand, Lassi etc. Preparation of khoa and khoa based sweets. Preparation of channa, paneer and chana based sweets. Visit to Dairy plant.

### 13. Food Additives

3(2+1)

Intentional and unintentional food additives, their toxicology and safety evaluation. Naturally occurring food additives. Food colour (natural and artificial). Pigments their importance and utilization as food colour. Taste and flavour inducer, potentiator. Food preservatives and their chemical action. Role mode of action salt, chelating agents stabilizers and thickeners, polyhydric alcohol, anticaking agent, firming and colouring agent, flour bleaching agent, antioxidants, non-nutritional sweetness and antimicrobial agents.

**Practical:** Evaluation of GRAS aspect of food additives. Identification of food colour by TLC. Isolation and identification of naturally occurring food pigments by paper and TLC. Spectrophotometric method of total chlorophyll (A&B). Determination of diacetyl content of Butter. Role mode of action of chelating agent in fruit juice. Role and mode of action of stabilizer and thickener in frozen dairy products. (Ice-cream ). Role and mode of clarifying agent in fruit juices. Role and mode of antioxidant in frozen fish. Role of leavening agent in baked food product.

### 14. Environmental Sciences

3(2+1)

Environmental Science: An introduction. Ecosystem: kinds, structure, characteristics, functioning. Biochemical cycles. Natural resources and their managements. Environmental pollution. Air pollution. Water pollution. Solid waste pollution. Noise pollution. Soil pollution. Radio active pollution. Food processing industry waste and its management. Management of urban waste water. Recycling of organic waste. Recycling of factory effluent. Control of environmental pollution through law. Composting of biological waste. Sewage, uses of water disposal effluent treatment, microbial examination.

**Practical :** Practical to be conducted. Environment and its analysis. Water quality parameters. Collection of sample for pollution study. Determination of pH/ acidity/alkalinity from sample. Estimation of dissolved oxygen. Estimation of BOD. Estimation of COD. Estimation of nitrates. Estimation of phosphates. Estimation of pollutant elements. Estimation of heavy/ toxic elements. Estimation of lead / mercury. Visit to industrial sewage disposal unit.

### 15. Food Industry By-Products

3(2+1)

Industrial Byproducts and Waste: Potentials and prospects of developing by-products industry in India. Agricultural waste and agro based industrial waste management. By products of cereals. By products of legumes. By products of oil seeds. By products of dairy. By products of fruit and vegetables processing industries. By products of meat, poultry and eggs. By products of fish processing units. By products of plantation crops and spices. Uses of byproducts of agro based industries in various sector. Byproducts of fermentation industries. By products of sugar and bakery industries.

**Practical:** Extraction of banana fiber. Extraction of leaf proteins. Alcohol production from molasses. Use of crop residues for the production of cellulose. Use of mango kernels for starch manufacture. Pectins from organic waste. Extraction of volatile oils from organic waste.

## **16. Product Development & Formulation**

**2(1+1)**

Need, importance and objectives of formulation for new product development. Ideas, business philosophy and strategy of new product. Formulation based on sources availability and cost competitiveness for concept developments of new products. Standardization of various formulation and product design. Adaptable technology and sustainable technology for standardized formulation for process development. Process control parameters and scale-up, production trials for new product development at lab and pilot scale. Quality assessment of new developed products. Market testing and marketing plan. Costing and economic evaluation. Commercialization / product launch.

**Practical:** Market survey of existing various products. Formulation of new products based on corporate decision; Protein-energy rich, Low calorie (fat replacer), Low sodium content, Glycemic index based, Cholestromic index based, Phyto-chemical based. Product development based on above formulation depending on local sources/ technology. Quality assessment. New product development for; Infant / weaning foods, Geriatric, Physiological status, Athletes.

## **17. Specialty Foods**

**3(2+1)**

Need and scope of specialty foods: Specialty food based on ease in preparation cost health benefits; Functional foods, Convenience food, Health care and medical benefits, Nutritional status, Low cost foods. Specialty foods based on sources ; Cereals and millets, Legumes and pulses, Fruits and vegetables, Animal food sources, By product based, Non conventional foods. Specialty foods based on process ; Innovative process technology, Food additives basis, Bioactive components, Novel nutraceuticals products, Packaging techniques, Adaptable technology basis, Fast and PET foods. Specialty food based on genetics ; Genetically modified foods, Transgenic foods, Biotechnological aspects of detoxification. Proprietary foods. Supplementary foods. Therapeutic foods ; Modification of diets in disorders, feeding purposes Disease oriented of different organs ex: digestive tract, liver, cardiovascular system, kidney , metabolic disorders, allergy, endocrine disorders. Specific consumer oriented foods; Defence persons, Space / astronought, High altitude mountain climbers, Disaster situation – crises, care, maintenance. Specialty foods based on growing condition - organic , inorganic farming.

**Practical:** Preparation of specialty foods based on ; Functionality, Convenience, Low cost, Nutritional purpose. Preparation of specialty food using locally available foods crops, fruit and vegetables few products. Assessment of byproduct for preparation of value added specialty food. Isolation of phytochemical/ bioreactive agent of plant sources and their utilization in proprietary foods. Preparation of specialty food as per requirement of; Location, Nature of work, Status of worker. Evolution of food cultivated under organic conditions.

## **18. Food Production Trends and Programmes**

**2(2+0)**

Food demand and supply – Qualitative and quantitative requirements. Expected Technological advances to meet the needs. Future priorities in Food Production needs –Status

of Food Industry in India and Abroad. Magnitude and Inter dependence of Food Production and processing agencies. Food availability, production Trends – Factors of Production – Types of Foods like processed semi processed, Ready to eat Foods, Fast Foods. Food Characteristics Nutritional significance of major food groups. Present trends of consumption, Further requirements. Consumers change of aptitude in Food Products consumption. New food products developed Programmes aimed for making more food availability to increasing population and their prospects – Merits and drawbacks, prospects for future growth in India. National and International Trends and Programmes in Food handling, processing and marketing Potentials and Prospects of developing Food Industry in India. Food Losses – Factors affecting – Programmes and strategies to eliminate the losses and meet the required demand .Global demand for food. World Food Day – Importance and action plans.

### **19. Quality Assurance & Certification**

**2(1+1)**

Quality inspection, quality control, quality management and Quality Assurance. Total quality management; Good Manufacturing Practices, Good Agricultural Practices, Good Laboratory Practices, Quality Management systems QSS. Quality Circles, SQC., ISO System. HACCP, Principles, Implementation. Plan Documentation, types of records. Auditing, Surveillance; Audit, Mock audit, third party quality certifying audit, Auditors and Lead auditors. Certification, Certification procedures, Certifying bodies, Accrediting bodies, International bodies.

**Practical:** Quality Assurance procedure. T&M, GMP, GAP documentation. Preparation Quality Policy & documentation (Quality Manuals). Preparation of Laboratory manuals. Application of HACCP to Products. Preparation of documentation and records. Auditing-Surveillance, Mock audit. Visit to units implementing GMP, GAP. Visit to units with ISO systems. Visit to units with HACCP certification.

**Syllabus**

**For**

**B.F.Sc.**

# FISHERIES

## 1. AQUACULTURE

### 1. Principles of Aquaculture

2 (1+1)

Basics of aquaculture-definition and scope. History of aquaculture: Present global and national scenario. Aquaculture vs agriculture. Overview of national and international agricultural systems. Systems of aquaculture - pond culture, pen culture, cage culture, running water culture, zero water exchange system, etc. Extensive, semi-intensive, intensive and super intensive aquaculture in different types of water bodies viz., freshwater, brackishwater and inland saline water. Principles of organic aquaculture. Pre-stocking and post stocking pond management. Criteria for selection of candidate species for aquaculture. Major candidate species for aquaculture: freshwater, brackish-water and marine. Monoculture, polyculture and integrated culture systems. Water and soil quality in relation to fish production and estimation of productivity. Physical, chemical and biological factors affecting productivity of ponds. Nutrition, health management and economics.

**Practical:** Practices on pre-stocking and post stocking management. Analysis of water and soil samples. Collection, storage and analysis of livestock wastes and crop residues. Study of biogas slurry on water quality.

### 2. Freshwater Aquaculture

3 (2+1)

Major species cultured, production trends and prospect in different parts of the world. Freshwater aquaculture resources – ponds, tanks, lakes, reservoir, etc. Carrying capacity of pond. Nursery, rearing and grow-out ponds preparation and management - control of aquatic weeds and algal blooms, predatory and weed fishes, liming fertilization/ manuring, use of biofertilizers, supplementary feeding. Water quality management. Selection, transportation and acclimatization of seed. Traits of important cultivable fish and shellfish and their culture methods – Indian major carps, exotic carps, air breathing fishes, cold water fishes, freshwater prawns, mussels. Wintering ponds, quarantine ponds and isolation ponds. Sewage-fed fish culture. Principles of organic recycling and detritus food chain. Use of agro-industrial waste and biofertilizers in aquaculture. Composite fish culture system of Indian and exotic carps - competition and compatibility. Exotic fish species introduced to India and their impact on indigenous species. Culture of other fresh water species: Economics of different culture practices.

**Practical:** Study of cultivable species of finfish, shellfish. Collection, identification and control of aquatic weeds, insects, predatory fishes, weed fishes and eggs and larval forms of fishes. Algal blooms and their control. Preparation and management of nursery, rearing and grow-out ponds. Study of effect of liming, manuring and fertilization on hydrobiology of ponds and growth of fish and shell fishes. Estimation of plankton and benthic biomass. Study of contribution of natural and supplementary feed to growth.

### 3. Fish Nutrition & Feed Technology

3 (2+1)

Nutritional requirements of cultivable fish and shellfish. Feed formulation and manufacturing. Forms of feeds: wet feeds, moist feeds, dry feeds, mashes, pelleted feeds, floating and sinking pellets. Feed additives: binders, antioxidants, enzymes, pigments, growth promoters, feed stimulants. Feed storage, use of preservatives and antioxidants. Feed

evaluation - feed conversion ratio, feed efficiency ratio, protein efficiency ratio, net protein utilization and biological value. Feeding devices and methods. Non-conventional feed ingredients and anti-nutritional factors. Digestive enzymes, feed digestibility. Factors affecting digestibility. Nutritional deficiency diseases.

**Practical:** Proximate composition analysis of feed ingredients and feeds. Preparation of artificial feeds using locally available feed ingredients. Determination of sinking rate and stability of feeds. Effect of storage on feed quality.

#### **4. Culture of Fish Food Organisms**

**2 (1+1)**

Candidate species of phytoplankton and zoo-plankton as live food organisms of freshwater and marine species. Tropic potentials- proximate composition of live feed. Biology and culture requirements of important live food organisms. Green algae, blue-green algae, spirulina, diatoms, infusoria, rotifers, cladocerans, tubifex, brine shrimp, chironomids. Culture of earthworms, bait fish and forage fish.

**Practical:** Methods of isolation and identification of different live food organism. Laboratory scale culture of selected live food organisms. Evaluation of live food organisms. Decapsulation technique and hatching method of brine shrimp cysts.

#### **5. Aquaculture Engineering**

**3 (2+1)**

Land survey, area calculation of plane surface of regular and irregular shape as applied to measurement of land, trapezoidal rule, Simpson's rule, volume of regular and irregular shape as applied to the volume of stacks, sheds, heaps. Farm-types and objectives; Fresh water and coastal aquafarms. Preliminary survey, site selection, topography. Land survey – chain surveying, compass surveying, leveling, plane table surveying and contour surveying; Soil – types, properties, classification, sampling methods and texture analysis. Location, design and construction of hatcheries, race ways and farm complex. Tide-fed / pump fed farms, creeks, estuarine and marine water source utilization. Open canals and their types. Sluices and gates. Earth work calculation – ponds, dykes, canals and roads. Design and construction of ponds and dykes. Tidal influences and maintenance; Effect of seepage and evaporation and their control. Water budgeting. Water distribution system – main feeder channel, drainage channel. Water control structure – types of inlets and outlet and their construction. Computation of water intake and discharge. Aerators – principles, classification and placement. Pumps - types, total head and horse power. Filters – types and construction.

**Practical:** Evaluation of potential site for aquaculture. Land survey – chain, compass, level, plane table, and contouring; soil analysis for farm construction. Site survey: preparation of site and contour maps. Design and lay out of fresh water and brackish water farms and hatcheries. Design of farm structure: ponds, dykes, sluices and channels. Earth work calculation. Calculation on water requirement. Pumps: design and operation. Design and operation of filters and aerators. Visit to different types of farms.

#### **6. Ornamental Fish Production and Management**

**2 (1+1)**

World trade of ornamental fish and export potential. Different varieties of exotic and indigenous fishes. Principles of a balanced aquarium. Fabrication, setting up and maintenance of freshwater and marine aquarium. Water quality management. Water filtration system – biological, mechanical and chemical. Types of filters. Aquarium plants and their propagation

methods. Lighting and aeration. Aquarium accessories and decoratives. Aquarium fish feeds. Dry, wet and live feeds. Breeding and rearing of ornamental fishes. Broodstock management. Application of genetics and biotechnology for producing quality strains. Management practices of ornamental fish farms. Common diseases and their control. Conditioning, packing, transport and quarantine methods. Trade regulations and wild life act in relation to ornamental fishes.

**Practical:** Identification of common ornamental fishes and plants. Fabrication of all-glass aquarium. Setting-up and maintenance. Aquarium accessories and equipments. Conditioning and packing of ornamental fishes. Preparation of feed. Setting-up of breeding tank for live bearers, barbs, goldfish, tetras, chichlids, gauramis, fighters and catfishes. Identification of ornamental fish diseases and prophylactic measures.

## **7. Coastal Aquaculture and Mariculture**

**3 (2+1)**

An over view of sea farming and shore-based aquaculture in different parts of the world. Resources for shore-based aquaculture and sea farming in India. Traits of important cultivable fish and shellfish (seabass, mullet, milkfish, grouper, snappers, ayu, pearlspot, tiger shrimp, white shrimp, mud crab, mussel, clam, oysters (edible and pearl oyster), seaweeds, etc. Shore based aquaculture system: traditional (pokkali, bheries, gazanis, khazans), semi-intensive, intensive aquaculture practice of commercially important species of fish and shellfish. Methods of aquaculture - rafts, racks, cages, poles and ropes. Seed resources, Water and soil quality management. Estimation of growth, survival and pond productivity. Seaweed culture, Pearl culture, Sea ranching.

**Practical:** Identification of important cultivable species. Collection and identification of commercially important seed of fish and shellfishes. Types of fertilizers - Pond preparation. Seed selection, quality and acclimatization. Water quality parameters. Estimation of seed survival. Pond biomass estimation. Material, apparatus and machinery for shore based aquaculture and sea farming. Estimation of feed intake. Growth and health monitoring. Fouling organisms in cages and pens.

## **8. Finfish Breeding and Hatchery Management**

**3 (2+1)**

Fresh water and marine fish seed resources. Natural breeding of finfishes. Selection of riverine spawn collection sites, gears used and methods of collection. Temporary storage of spawn, Behaviour of spawn in relation to hydrological and hydrobiological factors. Spawn quality and quantity indices. Advantages and disadvantages of riverine seed collection. Sexual maturity and breeding season of various cultivable species. Development of gametes in male and female. Types of fish egg and embryonic development. Methods of breeding; bundh breeding - wet and dry bundhs., collection and hatching of eggs, factors involved in bundh breeding, advantages and disadvantages of bundh breeding. Induced breeding of warm water finfishes, environmental factors affecting spawning, sympathetic breeding. Hypophysation of fishes. Fish pituitary gland – its structure, collection, preservation and preparation of extract for injection, dosages and methods of injection. Broodstock management and transportation of broodfish. Synthetic hormones used for induced breeding of carps. Different types of fish hatcheries- traditional, Chinese, glass jar and modern controlled hatcheries. Causes of mortalities of eggs and spawn. Treatment of eggs. Spawn rearing techniques. Use of anesthetics in fish breeding and transport. Breeding techniques for Indian major carps, exotic carps. Mahaseer, trout, tilapia, catfishes, mullets, milk fish, pearl spot, sea bass, groupers, etc. Multiple breeding of carps. Cryopreservation of fish gametes.

**Practical:** Study of maturity stages in fish. Collection and preservation of fish pituitary gland, preparation of extract, Hypophysation. Calculation of fecundity. Broodstock maintenance and selection of breeders for injection. Histological studies of ovary and testes. Different fish hatchery systems, study of fish eggs and embryonic developmental stage. Identification of eggs, spawn, fry and fingerlings of different species. Preparation and management of fish nursery. Fish seed and brood stock transportation, use of anesthetics, disinfectants and antibiotics in fish breeding. Water quality monitoring in fish hatcheries and nurseries. Cryopreservation of fish gametes. Breeding and larval rearing of common finfishes.

## **9. Shellfish Breeding and Hatchery Management**

**3 (2+1)**

Natural seed resources, site selection and collection methods. Life cycle of important shellfish (*Penaeus monodon*, *P. indicus*, *Macrobrachium rosenbergii*, *Scylla serrata*, lobster, edible, oyster, pearl oyster, fresh water mussel, holothurians, sea horse, horse-shoe crab, *Sepia*, *Loligo*, cray fish etc.). Sexual maturity and breeding seasons of different species. Maturation stages of *Macrobrachium rosenbergii* and *Penaeus monodon*. Induced maturation in *Penaeus monodon* by eye stalk ablation. Reproductive physiology. Reproductive hormones in crustaceans. Brood stock management of *Penaeus monodon* and *Macrobrachium rosenbergii*. Breeding and hatchery management of *Penaeus monodon* and *Macrobrachium rosenbergii*. Breeding and hatchery management of crabs and bivalves. Food and feeding of larval stages of important shellfishes. Health management in hatcheries.

**Practical:** Identification of brood stock and maturity stages of important crustaceans and mollusks. Breeding and larval rearing of *Macrobrachium rosenbergii* and *Penaeus monodon*. Identification of larval stages of important crustaceans and mollusks. Demonstration of eyestalk ablation in *Penaeus monodon*. Collection, packing and transportation of shrimp/prawn seed and broodstock. Practice in the operation of shrimp and prawn hatcheries. Observations on gonadal maturation of *Penaeus monodon* and *Macrobrachium rosenbergii*. Water treatment and management in shrimp and prawn hatcheries. Different chemicals and drugs used in shrimp/prawn hatchery.

## **10. Fish Diseases and Management**

**4(2+2)**

Significance of fish diseases in relation to aquaculture. Disease development process in fish and shellfish. Defense mechanism in finfish and shellfish- specific and non specific immune system. Role of stress and host defense mechanism in disease development. Host, pathogen and environment interaction. Pathogenecity and mechanism of bacterial, viral and fungal infections of finfish and shellfish. Morphology, biology and life cycle of parasites. Infectious diseases of cultured finfish and shellfish. Important disease epizootics of wild fish population. Zoonotic diseases. OIE listed and notifiable diseases. Principles of disease diagnosis. Case history and clinical sign in diagnosis. Conventional and rapid diagnostic techniques. Microscopical, microbiological, histopathological and biochemical methods. Antibody and nucleic acid based rapid diagnostics. Health management in aquaculture. Drugs, chemicals, antibiotics and probiotics used in aquaculture and their mode of action. Preventive strategies. Principles and methods of vaccine production and fish immunization. Quarantine and health certification in aquaculture. Crop rotation, Immunostimulants, bioremediation and polyculture as strategies for health management. Fish pharmacology – drugs, chemicals, antibiotics, probiotics and their mode of action.

**Practical:** Methods of sampling fish and shellfish for disease diagnosis. Live and post mortem examination of diseased fish. Collection and identification of parasites.

Morphological, biochemical and biological tests of bacteria, virus and fungi. Immunological and molecular disease diagnostic techniques. Antibiotic sensitivity assays. Techniques in histology. Pathological changes in different organ systems associated with different pathogens. Methods of treatment.

### **11. Biotechnology and Bioinformatics**

**2 (1+1)**

DNA as genetic material, Chemistry of nucleic acids, Genetic code. Organization of genome in prokaryotes and eukaryotes. Concept of replication, transcription and translation. Recombinant DNA technology, Gene cloning and Transgenesis, Molecular and immunological techniques, Cell culture and cell lines, Development of vaccines, Hybridoma technology, Monoclonal antibody production, PCR techniques, Marine biotechnology – bioactive compounds from marine organisms, Waste water treatment, Biofilters in aquaculture, Biofertilizers, Probiotics, Biosensors, Bioprocessing. Concept of Bioinformatics - NCBI, Genebank sequence database-primary and secondary database.

**Practical:** Isolation and quantification of DNA. Electrophoresis. ELISA, Immunodots, PCR, Western blot, immunofluorescence, immunoperoxidase, DNA hybridisation, Setting of biofilters, Bioprocessing of organic wastes. Practicals on genebank sequence database.

### **12. Genetics and Breeding**

**2(1+1)**

Principles of genetics and breeding, Gene and chromosome as basis of inheritance, Mendel's law of inheritance, Gene interactions – Epistasis, Pleiotropism, Dominance, Lethal genes. Sex determination, Sex linked genes, sex influenced and sex limited traits. Hybridization. Mutation, Chromosomal structure and aberrations. Linkage and crossing over. Chromosome manipulation techniques. Cryopreservation. Introduction to population genetics. Hardy-Weinberg law and its significance. Quantitative genetics – qualitative and quantitative traits, polygenic traits, heritability. Inbreeding and its consequences. History and present status of selective breeding programs in aquaculture. Selection methods and breeding plans. Mating designs. Domestication methods. Seed certification and quarantine procedures.

**Practical:** Problems on Mendelian inheritance, linkage and crossing over, monohybrid and dihybrid ration, epistasis, pleiotropism. Mitotic and meiotic chromosome preparation. Demonstration of protocol of androgenesis, gynogenesis and polyploidy. Problems on gene and genotypic frequency. Cryopreservation protocols, Quality evaluation of fish milt.

## **2. FISHERIES RESOURCE MANAGEMENT**

### **1. Taxonomy of Finfish**

**3 (1+2)**

Principles of taxonomy. Nomenclature, types. Classification and interrelationships. Criteria for generic and specific identification. Morphological, morphometric and meristic characteristics of taxonomic significance. Major taxa of inland and marine fishes up to family level. Commercially important freshwater and marine fishes of India and their morphological characteristics. Other important groups of aquatic vertebrates. Introduction to modern taxonomic tools: karyotaxonomy, protein analysis and DNA polymorphism.

**Practical:** Collection and identification of commercially important inland and marine fishes. Study of their external morphology and diagnostic features. Modern taxonomic tools - Protein analysis and electrophoretic studies; Karyotaxonomy - chromosome preparation and

identification. DNA polymorphism; Visit to fish landing centres to identify commercially important fishes and catch composition.

## **2. Taxonomy of Shellfish**

**3 (1+2)**

Study of external morphology and meristic characteristics of crustacea and mollusca. Classification of crustacea and mollusca up to the level of species with examples of commercially important species.

**Practical:** Study of external morphology. Collection, preservation and identification of commercially important prawns, shrimps crabs, lobsters, bivalves, gastropods, cephalopods from natural habitats. Field visits for collection and identification of commercially important shellfishes.

## **3. Anatomy of Finfish and Shellfish**

**3 (2+1)**

Study of internal anatomy of important groups of shellfish and finfish. Cell structure, tissue and body organization. Study of oral region and associated structures in finfishes. Studies on Digestive system and Associated digestive glands. Circulatory system. Respiratory system. Nervous system. Urino-genital system. Endocrine system, Circulatory, Skeletal systems and Sensory organs.

**Practical:** Dissection of different shellfishes and finfishes to understand their internal organs – digestive, respiratory, excretory, nervous, circulatory and skeletal systems and also on sensory organs. Structure of endocrine glands.

## **4. Biology of Finfish and Shellfish**

**3 (2+1)**

Study of food and feeding habits of commercially important fish. Qualitative and Quantitative methods of analysis of stomach contents. Age and growth determination by direct and indirect methods. Reproductive biology – maturity stages, gonadosomatic index, pondoral index, fecundity, sex ratio and spawning. Eggs and larval stages and developmental biology of finfishes and shell fishes. Tagging and marking of finfish and shellfish.

**Practical:** Analysis of gut contents. Study of food and feeding habits of finfish and shellfish. Estimation of age and growth by direct and indirect methods. Classification of maturity stages. Estimation of fecundity. Study of developmental stages. Tagging and marking. Visit to shrimp and prawn hatcheries to study developmental stages.

## **5. Inland Fisheries**

**3 (2+1)**

Freshwater fishery regions of the world and their major fish species composition. Global inland fish production data. Inland capture fishery resources of India. Potential of inland waterbodies with reference to respective state. Problems in the estimation of inland fish catch data. Major riverine and estuarine systems of India. Major brackishwater bodies / lakes and their fisheries. Fisheries of major reservoirs / natural lakes of India. Differences between man-made and natural lakes and flood-plain wetlands as capture fishery resources, present status of their exploitation and future prospects. Cold water fisheries of India.

**Practical:** Analysis of species composition of commercial catches at landing and assembling centers, sampling and familiarization of commercially important groups. Observations and

experimental operations of selected fishing gears in inland / estuarine waters. Maintenance of records on catch data.

## **6. Physiology of Finfish and Shellfish**

**3 (2+1)**

Water as a biological medium. Gas exchange. Circulation. Excretion, Osmoregulation.. Reproductive physiology. Muscle physiology. Sense organs. Energy and nutrient status of food. Nitrogen balance. Standard and active metabolism. Energy utilization. Effect of environmental factors on physiology of fin and shellfishes. Stress related physiology changes. Structure and functions of important endocrine glands

**Practical :** Estimation of oxygen consumption, ammonia excretion and carbon-di-oxide output. Influence of temperature and salinity on metabolism. Haematology of fin and shellfishes. Histological techniques. Histochemistry of pituitary gland

## **7. Marine Fisheries**

**3 (2+1)**

Classification and definition of fishery zones and fishery resources of world. Overview of marine fisheries resources of the world and India. Major exploited marine fisheries of India, their developmental history and present status. Important pelagic - demersal fish, shellfish and seaweed resources of India. Traditional, motorized and mechanized fisheries according to major gears. Potential marine fishery resources of the India's EEZ. GIS and Remote sensing in marine capture fishery.

**Practical :** Visit to fish landing centres, observation and analysis of catches by major crafts and gears Field collection of fishes, crustaceans molluscs and seaweeds and record keeping of relevant data Participation in fishing cruises. GIS and Remote sensing in marine capture fishery.

## **8. Fish Population Dynamics and Stock Assessment**

**3 (2+1)**

The concept of population and unit stock. Biological structure of fisheries resource in space and time. Indicators of dynamics in a fishery resource. Characteristics of unit and mixed stock. Data requirements for stock assessment. Segregation of stocks. Principles of stock assessment. Population age structure. Theory of life tables. Von Bertalanffy growth parameters. Graphical models. Monte Carlo simulation model and ECCPATH model. Estimation of total fishing and natural mortality. The concept of yield, yield in number and yield in weight, yield per recruit, yield curve. Yield models. The concept of Maximum Sustainable Yield and Maximum Economic Yield. Biological symptoms of under-fishing and over-fishing. Growth over-fishing and recruitment over-fishing. Eumetric fishing. Open access fisheries. Fisheries regulations. CPUE. Trawl selection and gillnet selection. Analytical models of fish stocks.

**Practical:** Segregation of stock using direct methods. Study of analytical models: Beverton and Holt model. VBGF, Pauly's integrated methods, graphical models. Estimation of Z, F and M. estimation of net selectivity coefficient. Fitting of surplus production model: Schaeffer model, Fox model. Study of yield isopleth diagrams. Micro-computer packages ELEFAN, FISAT.

### 3. AQUATIC ENVIRONMENT

#### 1. Meteorology and Geography

2(1+1)

Nature of Atmosphere: weather and climate; composition of Atmosphere; structure of Atmosphere. Heat energy of Atmosphere: process of heat transmission; heating of Atmosphere; disposal of insulation; irregular heating of Atmosphere. Temperature: Temperature instruments; periodic, horizontal and vertical temperature variations; effects of vertical air motion on temperature. Humidity and water vapour: relationship between temperature and humidity; distribution of water vapour in atmosphere; evaporation, humidity measurements and instruments. Condensation and precipitation: process of conditions of condensation, forms of condensation; precipitation; forms of precipitation, measurement of precipitation; rainfall in India and AP. Clouds and thunderstorms: amount of cloudiness; ceiling; classification of clouds; conditions of cloud formation; reporting and identification of clouds; thunderstorms. Atmospheric pressure: meaning of Atmospheric pressure; the laws of Gases; pressure units; pressure instruments; vertical, horizontal and periodic variations; isobars and pressure gradients. Wind: characteristics of wind motion; wind observation and measurement; wind representation; factors effecting wind motion. Terrestrial or planetary winds: ideal planetary wind system; planetary pressure belts. Planetary wind system; secondary winds; monsoon winds; land and sea breeze. Tropical cyclones: storm divisions; pressure and winds; vertical structure of storm centre; hurricane, sea, swell and surge; hurricane warning. Weather forecasting: forecasting process; forecasting from local indications; role of satellite in weather forecasting; synoptic weather charts. Introduction to Geography: shape, size and structure of the earth; concepts of latitude, longitude, and great circles; model globe, maps and different types of projections; cartography; landscape.

**Practical: Meteorology:** Graphic representation of structure of atmosphere; physical layering and compositional layering. Temperature instruments: simple thermometers; six's Max-Min Thermometer; thermograph. Isotherms: world mean temperatures-January to July. India mean temperatures - January to July. Humidity measurement: hygrometer; psychrometer; relative humidity; dew point. Condensation: observation and identification of various types of clouds. Depicting sky picture. Precipitation: measurement of rainfall using rain gauge. Mapping Indian monsoons: south-west monsoon and rainfall in June, North-east monsoon and rainfall in December; isohyets. Atmospheric pressure measurement: fortin's mercurial barometer; Aneroid barometer. Isobars: India mean pressure - Jan to July. Wind observation and measurement: wind vane; cup anemometer. Ideal terrestrial/planetary pressure and wind systems: diagrammatic representation. Geography: The Earth: diagrammatic representation of shape, size, structure, zones, latitudes, longitudes and great circles. Typical landscape mapping; map reading. Geographical terms used in landscape.

#### 2. Soil and Water Chemistry

3 (1+2)

Standard solutions, dilute solutions units of concentration: standard curve; nomograph. Chemistry of water; the water molecule, properties of pure water and sea water. Composition of surface water, ground water and Sea water. Dissolved gasses. Factors affecting natural waters. Acid, base, salts; Hydrogen ions, concept of pH and buffer. Water analysis: collection and preservation of water samples. Measurement of temperature. Transparency, turbidity, determination of pH, electrical conductivity, salinity, Chlorinity, total solids (TDS, TSS, TVS, TVDS). Dissolved Oxygen, free carbon dioxide, total alkalinity, total hardness, Calcium, Magnesium, Inorganic Nitrogen (ammonium and Nitrate) and phosphorus. Water quality criteria/ requirements for Aquaculture. Soil characteristics: origin and nature of soils. Physical properties of soil; soil color. Soil texture, soil structure, pore size, bulk density,

water holding capacity, soil types and their distribution. Soil chemistry: soil colloids, cation exchange, organic Carbon, Carbon – Nitrogen ratio, soil fertility, soil reaction: Acidity, Alkalinity, Conductivity, Redox potential. Submersed soils, wet lands, fluxes between mud and water, methane and hydrogen sulphide formation. Saline soils, Alkali soils, acid sulphate soils, iron pyrites, soil reclamation. Soil analysis: collection and preparation of soil samples. Determination of soil texture, water holding capacity, pH, conductivity, organic carbon, nitrogen, phosphorus, lime requirement. Soil quality criteria/ requirements for aquaculture. Soil and water amendments: lime manures, fertilizers, micronutrients, zeolites, alum, gypsum, environmental ameliorative: chlorination, deodorizers, bacterial formulation.

**Practical:** Principles of Titrimetry, Gravimetry, Potentiometry, Conductometry, Refractometry, colourimetry, Turbidimetry, Spectrophotometry (UV, Visible, Flame, AAS), computerized instrument system. Demonstration: demonstration of laboratory glass wares and equipment used in water and soil analysis. Water analysis: measurement of temperature, turbidity, determination of pH and EC. Determination of salinity, Chlorinity, total solids, Redox potential, DO, Free CO<sub>2</sub>. Determination of total alkalinity, hardness. Determination of inorganic nitrogen, and phosphorus Soil analysis: Determination of soil texture, soil pH, conductivity, soil available nitrogen, available phosphorus, and organic carbon.

### 3. Limnology

3 (2+1)

Introduction to limnology: inland water types, their identities and distribution; ponds and lakes; streams and rivers; dynamics of lentic and lotic environments. Lakes - their origin and diversity. Famous lakes of the world and India; nature of lake environment; morphometry, physical and chemical conditions and related phenomena; biological relations: influence of physical and chemical conditions on living organisms in inland waters. Plankton: planktonic organisms; classification of plankton; distribution of plankton: geographic, vertical, horizontal and seasonal distribution of phytoplankton and zooplankton: seasonal changes of body form in planktonic organisms; food of planktonic organisms. Primary productivity; Aquatic plants: character, classification, zonation, seasonal relations, quantity produced chemical composition distribution in different waters, limnological role. Nekton: composition, distribution, movements. Benthos: classification; periphyton; zonation; distribution; movements and migration; seasonal changes in benthos, profundal bottom fauna. Biological productivity: circulation of food material; classification of lakes based on productivity; laws of minimum; biotic potential and environmental resistance; quantitative relationships in a standing crop; trophic dynamics; successional phenomena; indices of productivity of lakes; artificial enrichment. Lotic environments: running waters in general; physical conditions; classification of lotic environments, biological conditions; productivity of lotic environments. influence of currents; plant growth; plankton; nekton; benthos; temporary and head waters streams; ecological succession.

**Practical:** Morphometry of lakes, ponds and streams. Determination of physical characteristics of lentic water bodies. Determination of chemical characteristics of lentic water bodies. Determination of physical characteristics of lotic water bodies. Determination of chemical characteristics of lotic water bodies. Collection and identification of fresh water phytoplankton. Enumeration and biomass estimation of freshwater phytoplankton. Estimation of primary productivity in fresh water bodies. Collection and identification of fresh water zooplankton. Enumeration and biomass estimation of fresh water zooplankton. Collection and identification of benthos from lakes and ponds, streams and canals. Enumeration and biomass estimation of benthos from lakes, ponds, streams and canals. Collection and identification of nekton/aquatic insects from freshwater bodies. Collection and identification of aquatic plants from different fresh water bodies. Methodology for collection and identification of

bacteria in freshwater bodies. Enumeration and biomass estimation of bacteria in freshwater bodies.

#### **4. Oceanography**

**3 (2+1)**

The earth and the ocean basin, distribution of water and land; relief of sea floor; Major feature of topography and terminology; major divisions. Relief in Indian oceans. Ocean Waves: Definition and terms; classification Difference between surface and long waves; wave theories; surface wave generation; spreading growth; Beaufort Scale; spilling and breaking waves; long waves, Tsunamis, Seiches, internal waves. Ocean Tides: Definition; Tidal phenomenon, elementary tidal definition; tidal inequalities; tide producing forces types of tides tidal bores, tide prediction. Ocean Currents: Definitions and features; measurements of currents; direct and indirect methods forces acting on sea waters; drift currents Ekman spirals, upwelling, sinking, gradient currents; thermohaline circulation; characteristics; course; and significance of some major ocean currents of the world. El-Nino. Physical properties of sea water: Salinity and chlorinity; temperature; thermal properties of sea water; colligative and other properties of sea water; Residence time of constituents in seawater. Properties of sea ice; transmission of sound; absorption of radiation; eddy conductivity; diffusivity and viscosity. General distribution of temperature, salinity and density: Salinity and temperature of surface layer (SST), subsurface; distribution of temperature and salinity; The T-S diagram; water masses of Indian oceans. Chemistry of sea water: Constancy of composition; elements present in sea water; artificial sea water; dissolves gases in sea water; CO<sub>2</sub> system and alkalinity; inorganic agencies affecting composition of sea water distribution of phosphorus, nitrogen compounds, silicates and manganese in the oceans, factor influencing their distribution.

**Practical:** Operation of oceanographic instruments- Nansen reversing water sampler, Bathythermograph, Grabs, Corers, current meters, tidal gauges, echo-sounder. Determination of DO, CO<sub>2</sub> Alkalinity, Nitrates, phosphates and silicates in sea water.

#### **5. Marine Biology**

**3 (2+1)**

Introduction: Divisions of marine environment- pelagic, benthic, euphotic, aphotic divisions and their subdivisions. Life in oceans – general account of major groups of phytoplankton, sea weeds, major zooplankton groups. Environmental factors affecting life in the oceans- salinity, temperature, light, currents, waves, tides, oxygen, and carbon dioxide. Primary, secondary and tertiary production. Marine food chains and food webs. Vertical migration of zooplankton Phytoplankton-Zooplankton relationship, geographical and seasonal variation in plankton production, plankton and fisheries. Benthos- a life in rocky, sandy, and muddy shores. Mud banks. Mangroves and coral reefs. Boring and fouling organisms. Nekton- outline composition of nekton, habitats of nekton. Bioluminescence and indicator species. Red tides. Biology, significance and classification in mammals, adaptation in pinnipids and cetaceans for breeding. Whales- their different community and their characteristic features. Adaptations in marine mammals for conserving body heat and submersion for long dive.

**Practical:** Study of common instruments used for collection of phytoplankton, zooplankton and benthos. Collection, preservation and analysis of phytoplankton, zooplankton, sea weeds, nekton and benthos.

#### **6. Aquatic Ecology and Biodiversity**

**3 (2+1)**

Ecology: Definition; Ecological Hierarchy; Subdivisions of Ecology, Ecosystem: Principles and concepts; Examples of Ecosystems: The Pond, The Micro ecosystem; Production and Decomposition; Homeostasis of the Ecosystem, Energy flow: Definition; Laws of

Thermodynamics; Energy Environment ; Concepts of Productivity; Measurement of primary productivity; Trophic Levels, and Examples; Ecological Pyramids. Biogeochemical Cycles: Patterns and Basic types, cycling of Organic nutrients; Pathways, Limiting factors and governing laws. Ecological Indicators., Community Ecology: The biotic community, Ecological Dominance; community analysis; species diversity in communities; patterns in communities, ecotones, Population ecology: population group properties, population density and indices of relative abundance. Types of interaction – animal association- Symbiosis, commensalisms, parasitism, etc., Autoecology: Concepts of habitat and ecological Niche; Natural Selection; Artificial Selection. The freshwater environment and types: wetlands: dominant flora and fauna. Coastal Ecosystems coastal Zone and its classification. Estuaries- classification; physico-chemical factors; biota and productivity; example of some Indian estuaries. Mangroves- definition, mangrove plants, factors affecting distribution. Mangrove flora and fauna. The sea shore: The Inertial Zone , factors Affecting life on shore, nature of substratum , physical factors, zonation, fauna and flora on a rocky shores, sandy shore, and muddy shore. Conservation of habitats: endangered species and their conservation, fish passes for migratory fishes, protected areas, marine parks and sanctuaries, mangrove afforestation. Artificial reefs. Conservation programmes for endangered species.

**Practical:** Visit to a lake, natural pond/estuaries \swamp\marsh\river\flood plain\ reservoir and marine protected areas. Study of the habitat, biotic communities, and species diversity and their adaptive characters/ associations. Visit to a mangrove forest, collection and identification of mangrove flora and fauna. Visit to a rocky shore to study zonation and physico-chemical conditions. collection and identification of Rocky shore flora and fauna. Visit to a sandy shore shore to study zonation and physico-chemical conditions. collection and identification of sandy shore flora and fauna. Visit to a muddy shore to study zonation and physico-chemical conditions. collection and identification of muddy shore flora and fauna. Collection and identification of corals and coral reef biota. Visit to marine structures on the coast, collection and identification of Borers and Fouler organisms, assessment of the damages and appraisal of remedial measures. Visit to a marine park/sanctuary. Understanding the steps involved in protecting endangered habitats and species (Horse shoe crab, Marine turtles, sharks and marine mammals).

## 7. Aquatic Pollution and Coastal Zone Management

3 (2+1)

Classification of pollution- physical, chemical and biological classification of water pollution- description of terminologies. Sewage and domestic wastes- composition and pollution effects- sewage treatment and its reuse. Agricultural wastes- organic detritus, nutrients, Adverse effects of oxygen demanding wastes: importance of dissolved oxygen; Oxygen demand; BOD; COD; Oxygen budget; Biological effects of organic matter. Excessive plant nutrients: Eutrophication; Red tides and fish kills. Pesticide types and categories; inorganic pesticides, Organo-chlorine compounds, Organo-phosphorous compounds; Polychlorinated biphenyls (PCBs); Bioaccumulation and impact on aquatic fauna and human health; toxicology. Heavy metals: Interaction of heavy metals with water and aquatic organisms. Bioremediation and Phytoremediation. Oil pollution; Crude oil and its fractions; Sources of oil pollution; Treatment of oil spills at sea; Beach Cleaning; Toxicity of Petroleum Hydrocarbons; Ecological Impact of Oil pollution- Case studies. Microbial pollution: Types of aquatic microbes; autotrophs and heterotrophs; saprotrophs and necrotrophs; Sewage Fungus Complex; Transmission of Human Pathogenic Organisms; Zoonosis; Development of Antibiotic Resistance and its impact; Biofilms and Biocorrosion; Radioactivity and background radiation of earth: Radionuclide polluting, special effects of radioactive pollution. Thermal pollution and its effects, Physical and chemical nature of possible effluents from major industries in India. Monitoring and control of pollution:

Biological indicators of pollution. Environmental Impact Assessment for fisheries and aquaculture projects. Anthropogenic activities and their impact on coastal zones; aquaculture, waste disposal, property and infrastructure development, ports and shipping, tourism (beach and coral reef), industries (petroleum industry, heavy industry, forest industry), mining and marine excavations, water supply projects. Goals and purposes of CZM. Management methods and information: public awareness and environment policy, general coastal zone programs, shore lands management, coastal water basin protection, coastal water quality protection, harvestable resources, and ecosystem restoration. Coastal Regulation Zone (CRZ) Act. Integrated Coastal Zone Management (ICZM). International treaties and conventions. Preparation of projects based on the provided Guidelines and Standards for Coastal Projects- aquaculture, agriculture, estuarine flood protection, sewage treatment systems, solid waste disposal, Urban run off, Power plants, disasters, etc.

**Practical:** Physical characteristics of polluted waters; Colour, Odour, Turbidity. Determination of pH, salinity, alkalinity, hardness, BOD, COD, Hydrogen sulphide, Phosphates, Ammonia, Nitrates, Heavy metals and Oil and grease in water. Determination of pH, conductivity, organic carbon, nitrogen, phosphorus, heavy metals in sediments. Study of pathogenic and coliform bacteria. Bacteriological quality of water; Coliform tests, IMVIC test, standard plate count, methods of enumerating bacterial biomass in waters and waste waters. Pollution flora and fauna: indicator species- algae, protozoa and insect larva. Methods of pesticide residue analysis in waters and fish tissue; bioassay and toxicity study.

#### 4. HARVEST AND POSTHARVEST TECHNOLOGY

##### 1. Food Chemistry and Fish in Nutrition

3 (2+1)

Composition of food & nutritional value. Moisture in foods. Fish lipids in human nutrition, digestion and absorption. Metabolism of lipids, oxidation of fatty acids, lipoproteins; VLDL and HDL and their importance. Carbohydrates: Naturally occurring polysaccharides in foods, fibre in food and its role. Browning reactions-enzymatic and non-enzymatic. Glycolysis, gluconeogenesis, glycogenolysis, and glycogenesis. Biological oxidation, electron transport chain, P/O ratio; oxidative phosphorylation. Proteins in foods, role in hydration- native and denatured proteins, gel formation, functional properties of proteins, changes during heat treatment and processing, texturised proteins. Fish muscle proteins, chemical changes in muscle during contraction; Digestion and absorption of proteins; metabolism- amino acid pool; nitrogen balance; essential and non essential amino acids; deamination; decarboxylation; metabolic fate of amino acids. Protein synthesis; Chemistry of taste, flavour and odour components in foods: flavour intensifiers, synthetic flavouring substances. The taste of fish and shellfish. Food additives - types and their chemical nature. Enzymes, vitamins and amino acids, emulsifiers and antimicrobial additives, sequestrants, flavour potentiators surface active agents; non-nutritive sweeteners, colour additives in food. Assessment of quality of food by instrumental and chemical methods. Nutritive value of foods. Energy value and energy requirements and their estimation. Water, electrolytic and acid base balance. Nutritive value of proteins PER, BV digestibility coefficient, NPU values, pepsin digestibility, chemical score. Role of fibre in human nutrition.

**Practical:** Estimation of moisture, crude protein, fat, ash and carbohydrate in food sample. Determination of energy value of foods. Estimation of glucose and salt content in foods. Colorimetric method of estimation of proteins and carbohydrates. Verification of Beer-Lambert's law. Paper chromatography and thin layer chromatography. Use of pH meter. Estimation of vitamins. Estimation of quality of fish from degraded products of protein and fat.

## 2. Refrigeration and Equipment Engineering

2 (1+1)

Laws of thermo dynamics: Different types of heat involved: sensible heat, latent heat, pressure, volume and temperature; thermodynamic cycles; volumetric efficiency; enthalpy; entropy. Refrigeration – principles, methods and systems. Refrigeration cycle, compressors, condensers, receivers, evaporators, expansion valves, auxiliary equipments, oil, liquid trap systems; accumulators; non condensable gases; defrosting system, oil and refrigerant charging; study of automatic control devices; refrigerant and their properties. Layout and construction of freezing plants, cold storage, contact plate freezer, immersion freezer, tunnel freezer, air blast freezer, air lock system, anti room arrangements. Ice manufacturing unit, marine refrigerating plant; methods of defrosting; insulating material. Refrigerating effect, cooling estimate, heat load calculation, wall heat gain load, air change load, product load, miscellaneous load, refrigeration system capacity and running time. Fishing vessel auxiliary systems: Auxiliary engines, Drives - mechanical, hydraulic, pneumatic and electric. Bilge pumping systems. Deck and fish hold; Deck design: Deck design and layout. Anchors and mooring. Equipments commonly available in processing units. Different types of ice making machinery. Operation of various machinery used in freezing; canning and packaging. Special equipment for freeze-drying; irradiation and cryogenics; general maintenance of freezing plant, cold storage and ice plant.

**Practical:** Graphically represented symbols used in refrigeration, Calculation on thermodynamics, Handling and operation of refrigerants, compressors, condensers, evaporators and expansion valves. Defrosting in refrigeration system. Handling of low pressure and high pressure switches. Calculations on refrigeration effect and cooling estimate. Calculation on heat load, wall heat gain load and air change load. Studies on power transmission. Refrigeration machinery maintenance and safety precaution. Ice making and harvesting. Visit to a processing plant refrigeration unit.

Conventional representation of common engineering component and features. Visit to fishing harbour to study about deck machinery and hull equipment. Operation and maintenance of ice making machinery, canning machinery, fish products machinery and packing machinery. Study on different types of gallows. Visit to a fish processing unit to study the equipment used in different types of processing.

## 3. Freezing Technology

3 (2+1)

Introduction to freezing technology; characteristics of fish and shellfish; changes in fish after death, spoilage of fish, spoilage and pathogenic microorganisms; handling of fresh fish; sanitation in processing plants; principles of low temperature preservations. Chilling of fish – methods and equipment for chilling; icing – quality of ice, ice – making; refrigerated or chilled sea water, chilling rate; spoilage of fish during chilled storage; use of antibiotics and chemicals. Freezing of fish – fundamental aspects; heat units; freezing point depression, eutectic point; freezing rate; methods of freezing, freeze drying, physico – chemical changes that occur during freezing – mechanism of ice crystal formation; preparation of fish for freezing. Changes that occur during frozen storage – microbiological, physical and chemical changes; protein denaturation, fat oxidation, dehydration, drip; protective treatments – polyphosphate, glazing, antioxidants, packaging ; thawing of frozen fish – methods of thawing. Transportation of frozen fish, cold chain, quality control, HACCP in freezing industry.

**Practical:** Sanitation and plant housekeeping; chilling and freezing equipment, instruments; packages and product styles; methods of icing fish; cooling rate; preservation by chilled sea water; freezing and thawing curves; freezing of different varieties of fish and shellfish;

estimation of drip; determination of quality changes during frozen storage; inspection of frozen fishery products; visits to freezing plants.

#### **4. Fishing Craft Technology**

**2 (1+1)**

Introduction: History & development of fishing crafts. Traditional fishing crafts of India. Classification of fishing crafts based on fabrication, dimension, nature of fishing, depth of operation etc. History & development of mechanization of fishing crafts: Boat building materials - their preparation, seasoning, preservation & their advantages & disadvantages. Choice of construction material; comparison of mechanical properties. Boat design - Important terminologies of fishing vessel & related to fabrication: Drawing conventions in naval architecture. Form co-efficient & ratios: Design procedure: Displacement- weight equation; estimation of light weight ship; Basic mathematics & Hydrodynamics for designing of fishing vessels. Calculation of displacement, water plane area; Stability of fishing vessel – longitudinal, transverse. Various equilibrium of ships - stable, unstable and neutral. Resistance of boats. Marine engines & propellers: powering basics: wake, propeller efficiency, thrust, hull efficiency, quasi- propulsive coefficient, power margin, power rating normal HP, maximum power. Introduction to marine engines – types, components. Different types of engine systems. Outboard engines working and maintenance. Estimation of engine power for fishing vessel. Marine propeller types, characters & selection of propellers. Boat construction methods: construction of wooden boats, steel boat, fiber glass boat, aluminum & ferro-cement boat. Deck-fittings and maintenance - common fouling & boring organisms. Preservation and maintenance of various types of hull. Stern gear assembly. Deck fitting and fishing equipment. Rules and regulations for fishing vessel fabrication, operation & safety.

**Practical:** Study on Traditional crafts & various boat building materials. Introduction to engineering drawing: Lettering & dimensions. Projection & its styles. Simple projection & complex projection of an object. Drawing of traditional crafts: catamaran & Satpati, etc. Drawing of backbone assembly & U & V bottom hull of wooden boat. Lines plan drawing of small fishing vessel: body plan, profile & half breadth plan. Drawing of deck lay outs of various fishing crafts: Trawlers, gill netters, long liners, squid jiggers etc. Designing of fishing vessel from a parent vessel. Study of propeller & stern gear assembly. Study on marine fouler & borers. Visiting to harbors, boat building yards & dry docking yard.

#### **5. Canning and Fish Packaging Technology**

**3 (2+1)**

Introduction to canning principle. Historical developments. Containers- can making materials and cans, characteristics of seam. Steps in canning- raw materials, preparatory treatments. Precooking, packing, exhausting, seaming, thermal processing, cooling and storage. Thermal processing – heat resistance of microorganisms, heat penetration, graphical method of formulation. Fo- value. Canning of commercially important fishes, shellfishes and other food products- salient features. Retort pouch packing – principles and techniques; HTST process and aseptic packing- principles and techniques spoilage of canned foods- types, causes and preventive measures. Introduction to food packaging- objectives and requirements. Characteristics of various packaging materials – meats, paper and paper boards, corrugated fibre board, plastics, multi-layer lamination, testing of packaging materials and containers. Environmental aspects of food packaging.

**Practical:** Types of cans, canning equipments and layout of cannery. Canning of different varieties of fish and shell fish. Cut out test of canned products. Examination of can double seam. Heat resistance of bacteria. Heat penetration in canned food, thermal process calculation by general method, spoilage condition in canned products. Familiarization with

various packaging materials and container for fish products. Assessment of quality of packaging materials used for packaging fish and fishery products. BIS specifications for plastics for food contact applications and other regulations.

## **6. Navigation and Seamanship**

**2 (1+1)**

Navigational aids - magnetic compass, gyro compass, sextant, bearing instruments, their construction errors and use. Chart- abbreviations and symbols, type of charts and chart reading. Sounding instruments- lead lines and echo sounder, their principles and use. Measurement of speed, patent log and electric log, principle and construction. Pilot signals, distress signals and penalty for their misuse, procedure for sending distress signals by radio telephony. Fire fighting and life saving appliances to be carried on board a fishing vessel as per F.F.A and L.S.A rules 1978. Their maintenance curriculum, day and night signals for vessel engaged in fishing. Manning requirement of fishing vessel. Electronic navigation and communication aids - radar, sonar, decca, omega, loran etc; Principles of radio transmitter and receiver, direction finder, auto direction finder, V.H.F. radio telephone, DECCA navigator- parts and functioning. Sonar block diagram, functioning; Net sonde- trawl eye-trawl link radar, video, G.P.S.

**Practical:** Changing from true course to compass and from compass course to true course with or without wind. To find the course to steer time required from and to given positions. To find position reached after steering a given course and speed. To find the position of the vessel by the different methods and to find compass error and deviation by transit bearing of two shore objects. To study different types of knots and bends and their use at the sea. Operation of echo sounder, V.H.F. sonar, satellite navigator, radar, direction finder- preparation of block diagrams. Global positioning system.

## **7. Fishing and Gear Technology**

**3 (2+1)**

Introduction: History and development of fishing gears; classification of fishing gears of world and India. Factors that determine selection of fishing gears. Gears used in relation to fish and fishing area. Fishing gear materials - Classification - natural and synthetic - yarns, twines, ropes - their properties and identification methods. Yarn numbering systems Runnage, conversions. Twist in twines and ropes, braiding ropes, leaded ropes, floated ropes. Netting – types of knots, knotless netting, meshes, braiding, shaping, creasing, baiting, tailoring. Mounting of webbing – different methods, hanging coefficient, take up ratio. Accessories for fishing gear. Floats – buyos – its materials, types, properties and buoyancy. Sinkers – types, materials, properties- negative buoyancy; bobbins, tickler chain. Wire ropes – wires, strands, cores – selection of wire ropes, breaking strength, specification. Fishing accessories – thimbles, shackles, C-links, rings, G-links, Kelly’s eye, stopper, bottle screw, butterfly, chains. Hooks; types, materials, specification numbering system, jigs, spoon hooks. Maintenance and storage of gears and gear materials. Preservation of netting and other accessories. Selection of gear materials. Parts of a trawl net, purse seine, gill net and tuna long lines. FAO classification of fishing gear and methods. Modern commercial fishing methods- Operation and classification of trawling, purse seining, lampara net fishing, gill netting, line fishing. Squid jigging. Selective fishing – active fishing and passive fishing. Deck layout – trawlers, purse seiners, long liners, gill netters and combination fishing. Fishing accessories and deck equipments – types of winches, net haulers, line haulers, triple drum, gurdy, power blocks, fish pumps. Fish finder, GPS navigator, sonar, net sonde, gear monitoring equipments.

**Practical:** Handling of net braiding tools, making different knots, bends, hitches, net braiding using different knots- shaping, creasing, baiting, fly mesh tailoring – T-cuts, N-cuts, B-cuts. Calculations- joining of netting, lacing, seaming. Mounting methods, hanging, revving, direct, indirect, connected calculations- assembling of netting. Damages on the netting, mending of net, identification of synthetic and natural fibres by various methods. Calculation of bouncy, negative buoyancy – identification of fibres, twines, ropes, iron wares, fish hook. Specification of ropes, wire ropes, iron wares, rigging materials, methods. Seining, boat seines, beach seines, gill netting, drift set, trammel nets. Line fishing – pole and line, tuna long lines, squid jigging. Falling gear - cast nets. Lift nets, Chinese dip nets. Deck layout of trawlers. Purse seiners, tuna long liners, gill netters and combination fishing vessels. Fishing experience in operation of traditional and modern fishing methods. Familiarization of various fishing accessories on board.

## **8. Fish Products and By-Products Technology**

**4 (2+2)**

Principle of fish preservation and processing. Processing of fish by traditional methods – salting, sun drying, smoking, marinading and fermentation. Theory of salting, methods of salting –wet salting and dry salting. Drying and dehydration- theory, importance of water activity in relation to microbial growth .Sun drying and artificial drying- solar dryer. Packaging and storage of salted and dried fish. Different types of spoilage in salt cured fish. Quality standard for salted and dry fish. Fish preservation by smoking- chemical composition of wood smoke and their role in preservation. Methods of smoking and equipments used for smoking. Carcinogenic compound in wood and methods to remove them. Hurdle technology in fish preservation and processing. Marinaded and fermented fish products – role of acids in marinades, Fish and prawn pickles, fish sauce and Fish paste, traditional Indian fermented products. Principles and methods of preparation of various fish paste products like fish sausage, fish ham, surimi, fish cake, kamaboko etc. Fish muscle structure, myofibriller protein and their role in elasticity formation. Extruded products – theory of extrusion, equipments used, advantages of extruded products, methods of preparation of extruded products. Fish protein concentrate. Fish hydrolysate, partially hydrolyzed and deodorized fish meat, functional fish protein concentrate and their incorporation to various products. Fish meal and oil. Dry reduction and wet reduction methods. Fish maws, shark leather, Chitin, chitosan, fish glue, fish gelatin, isinglass, pearl essence, shark fin rays, beach de mer, and biochemical and pharmaceutical products. Utilization of seaweeds: agar agar, algin, carrageenan. Diversified fish products: battered and braided products-fish finger, fish cutlet, fish wafer, and fish soup powder etc and imitation products. Value addition, HACCP in safe products production.

**Practical :** Preparation of salted fish, dried fish and smoked fish by different methods. Quality assessment of salted, dried and smoked fish. Preparation of fish manure, fishmeal, fish body oil, fish liver oil, fish maws, isinglass, fish silage, ensilage, fish glue, fish gelatin, fattice, pearl essence, chitin and chitosan. Quality assessment of individual by-products. Preparation of prawn & fish pickles. Preparation of fermented fish sauce and marinaded products. Preparation of surimi and surimi based products. Preparation of seaweed products, Preparation of diversified and value added fish products.

## **9. Fish Microbiology and Quality Assurance**

**4 (2+2)**

Introduction and history of micro-organisms in foods; role and significance of micro-organisms in nature and in foods. Micro-organisms in fish; intrinsic and extrinsic parameters of fish that affect microbial growth. Psychrophiles, halophiles and thermophiles, their role in spoilage and food poisoning. Food borne human pathogens - Vibrio, E coli, Salmonella,

Listeria, Clostridia, Campylobacter, Streptococcus, Faecal Streptococcus, etc. Study of micro-organisms in food by conventional and rapid techniques. Encapsulation – endospores, formation of cell aggregates, Microbial principles of fish preservation and processing. Study of food pathogens, infections, intoxication and other biological hazards like mycotoxins, parasites, viruses, marine toxins, etc. Types of spoilage of fish, semi processed and processed fishery products, Indices of fish sanitary quality, Concept of Quality Management; TQM, SSOP, GMP; ISO and Codex Alimentarius; HACCP, Microbiological standards and criteria, BIS and codex standards for fish and fishery products. Process water quality. Fish plant sanitation. Disinfectants, detergents and cleaning schedule. CIP, Water management in fish processing industries.

**Practical:** Study of micro-organisms associated with finfish and shellfish. Spoilage micro-organisms. Isolation of pathogenic bacteria associated with fish and fishery products - Vibrio, E coli, Salmonella, Listeria, Clostridia, Campylobacter, Streptococcus, Faecal Streptococcus, etc. Effect of chemical and physical preservatives on spoilage organisms. Conventional and rapid methods for detection of microorganisms. Biochemical tests for characterization of bacteria.

Assessment of sanitation in fish processing plants, Indices of freshness and quality of fresh and processed fish. Sensory evaluation, hedonic scale, physical and chemical methods of assessment of quality of fish and fishery products. Determination of available chlorine. Visit to factory & Study of Hazard analysis Critical Control Point (HACCP) system and its implementation.

## 5. BASIC SCIENCES AND HUMANITIES

### 1. Information and Communication Technology

2 (1+1)

IT and its importance, IT tools, IT-enabled services and their impact on society; computer fundamentals; hardware and software; input and output devices; word and character representation; features of machine language, assembly language, high-level language and their advantages and disadvantages; principles of programming- algorithms and flowcharts; Operating systems (OS) – definition, basic concepts, introduction to WINDOWS and LINUX Operating Systems; Local area network (LAN), Wide area network(WAN), Internet and World Wide Web, HTML and IP; Introduction to MS Office – Word, Excel, Power Point. Audio visual aids - definition, advantages, classification and choice of A.V aids; cone of experience and criteria for selection and evaluation of A.V aids; video conferencing. Communication process, Berlo's model, feedback and barriers to communication

**Practical:** Exercises on binary number system, algorithm and flow chart; MS Word; MS Excel; MS Power Point; Internet applications: Web Browsing, Creation and operation of E-Mail account; Analysis of fisheries data using MS Excel. Handling of audio visual equipments- tape recorder, public address system, overhead projector, LCD projector. Planning, preparation, presentation of posters, charts, overhead transparencies and slides Organization of an audio visual programme; preparation and presentation of a radio script and T.V. talk.

### 2. Statistical Methods

2 (1+1)

Definitions of probability, mutually exclusive and independent events, conditional probability, addition and multiplication theorems. Random variable, concepts of theoretical distribution; Binomial, Poisson and Normal distributions and their use in fisheries. Basic concept of sampling distribution; standard error and central limit theorem, introduction to

statistical inference, general principles of testing of hypothesis – types of errors. Tests of significance based on normal, t, chi-square and F distributions. Bivariate data, scatter diagram, simple linear correlation, measure and properties; simple linear regression, equation and fitting; relation between correlation and regression, Length weight relationship in fishes; applications of linear regression in fisheries. Methodology for estimation of marine fish landings in India, Estimation of inland fish production in India and problems encountered.

**Practical:** Construction of questionnaires and schedules. Exercises on probability, Binomial and Poisson distributions, Area of normal curve confidence interval for population mean, Test of hypothesis based on normal, t, chi-square and F distributions. Simple correlation and regression. Fitting of length - weight relationship in fishes.

### 3. Fisheries Economics

3 (2+1)

Introduction to fisheries economics, basic economic terminologies – micro and macro-economics, positive and normative economics, environmental economics, resource, scarcity, farm-firm relationships, production etc. Micro-economics: theories of demand, supply; market – equilibrium price, consumption, utility, consumer's surplus. Elasticity – price, income, cross, application of elasticity in fisheries managerial decision. Farm production economics – production functions in capture and culture fisheries; Costs and returns – breakeven analysis of fish production system; concepts of externalities and social cost; factors of production, marginal cost and return, law of diminishing marginal return, returns to scale, economies of scale and scope, revenue, profit maximization, measurement of technological change, farm planning and budgeting. Preparation of enterprise budget for integrated fish farming. Macro-economics: Introduction to national income, accounting, measurement and determinants of national income, contribution of fisheries to GNP and employment; balance of payments, economic growth and sustainable development. Globalisation: dimensions and driving Forces. Introduction to GATT and WTO. WTO Framework – Key Subjects - Agreement on Sanitary and Phytosanitary Measures (SPS), Seafood Export Regulations; Non-Tariff Barriers (NTBs) and Agreement on Anti-Dumping Procedures. Fisheries Subsidies and WTO. Fisheries Trade and Environment; protests against globalisation and WTO. Intellectual Property Rights (IPR) and different forms. Patents and patenting process, Agreement on TRIPS. Bio-piracy. GMOs in fisheries. Salient features of Indian Patent (Amendment) Act 2005. Overview of Patents in Indian fisheries sector.

**Practical:** Demand and supply functions of fish market – determination of equilibrium price for fish and fisheries products, calculation of price, income and cross elasticities. Production function – production with one or two variable inputs. Economic analysis on cost, return and break even of any two production units like fish farm / shrimp farm / seed production unit / fish processing plant / export unit. Preparation of enterprise budget for integrated fish farming. Contribution of fisheries to Indian Agriculture and total GDP – a trend analysis. Pattern and Performance of India's Seafood Exports; Case studies on product and market diversification. Case studies on competitiveness of Indian fish and fish products.

### 4. Fisheries Extension Education

3 (2+1)

Introduction to extension education and fisheries extension - concepts, objectives and principles; extension education, formal and informal education; History and role of fisheries extension in fisheries development. Fisheries extension methods- individual, group and mass contact methods and their effectiveness, factors influencing their selection and use; characteristics of technology, transfer of technology process; important TOT programs in fisheries; role of NGOs and SHGs in fisheries; Fisheries co-management; Adoption and

diffusion of innovations, adoption and diffusion process, adopter categories and barriers in diffusion of fisheries innovations; Extensions program planning and evaluation - steps and importance; participatory planning process. Basic concepts in rural sociology and psychology and their relevance in fisheries extension; social change, social control, social problems and conflicts in fisheries; gender issues in fisheries; theories of learning, learning experience, learning situation.

**Practical:** Collection of socio-economic data from fishing villages; study of social issues/problems through participatory and rapid rural appraisal techniques, stake holders analysis and needs assessment; assessment of development needs of community and role of formal and non – governmental organizations through stakeholder analysis; case studies on social / gender issues and social conflicts in fisheries. Case studies on extension programs and Success stories Practical exercises on conducting fish farmers meet.

## **5. Fisheries Administration and Legislation**

**2 (2+0)**

Introduction to public administration, principles of organization and management of public enterprise. Central and State responsibilities for fisheries development, organizational set up of fisheries administration at the Centre and state levels. Functions and powers of functionaries of department of fisheries, corporations and cooperatives. Different central and state level fisheries institutions. Role of Central and State Government in the regulatory activities of Aquaculture and fisheries. Implementation of community based resource management plans. Historical review of fisheries development and management in India and world. Fisheries development over Five Year Plans. International agencies / organizations for promotion of fisheries worldwide. Fisheries legislation: Overview of fisheries and aquaculture legislations in India. Indian Fisheries Act, 1897. Environmental legislation; Water Act, Air Act and Environmental (Protection) Act. International environmental legislation and its impact on fisheries. Laws relating to conservation and management of fishery resources in marine and inland sectors. Land reforms legislation as applicable to aquaculture. Judicial judgments relating to Aquaculture. Objectives, functions and authority of fishery regulatory agencies like Coastal Regulatory Zone (CRZ) and Aquaculture Authority of India. Brackish water aquaculture act, Marine fisheries policy, Laws relating to fish products and marketing. International Law of the Seas and international commissions on fisheries and their impact.

## **6. Disaster Management in Fisheries**

**2 (1+1)**

Basic concepts: Hazard, risk, vulnerability, disaster, capacity building. Multi-hazard and disaster vulnerability of India. Types of natural and manmade hazards in fisheries and aquaculture - cyclones, floods, droughts, tsunami, El-nino, algal blooms, avalanches, pollution, habitat destruction, over fishing, introduction of exotic species, landslides, epidemics, loss of bio-diversity etc. Causes, characteristics and impact of various disasters. Management strategies: pre-disaster, during disaster and post-disaster. Pre-disaster: prevention, preparedness and mitigation; different ways of detecting and predicting disasters; early warning, communication and dissemination, community based disaster preparedness, structural and non-structural mitigation measures. During disaster: response and recovery systems at national, state and local, coordination between different agencies, international best practices. Post-disaster: Methods for assessment of initial and long term damages, reconstruction and rehabilitation. Prevalent national and global management practices in disaster management. Agencies involved in monitoring and early warnings at district, state, national and global level. Sea safety and health.

**Practical:** Methods for assessment of initial and long term damages. Preparedness in pre, during and post disasters. Acquaintance with fire-fighting devices. Life saving appliances and first-aid. Operation and usage of communication channels and media. Uses of distress signals and technologies. Relief and rehabilitation measures, trauma counseling. Field visits and case studies. Group discussion.

## **7. Financing and Marketing Management**

**2 (1+1)**

Principles and objectives of co-operation, co-operative movement in fisheries in India, structure, functions, status and problems of fisheries co-operatives management in relation to resources, production and marketing. Role of credit for fisheries development, credit requirements of fishers, source and type of credit/finance, micro-credit, indigenous and institutional finance, structure of institutional finance in fisheries; returns, risk bearing ability and recovery in fisheries sector; role of NABARD in fisheries development; role of insurance in fish and shrimp farming and industry. Basic accounting procedures, profit and loss account. Introduction to marketing management; core marketing concepts: market structure, functions and types, marketing channels and supply chain, marketing margins, marketing environment, marketing strategies, product development and product mix, consumer behaviour and marketing research. Fish markets and marketing in India, demand and supply of fish, market structure and price formation in marine and inland fish markets; cold storage and other marketing infrastructure in India; export markets and marketing of fish and fishery products; Trade liberalization and fisheries markets.

**Practical:** Developing questionnaire and conducting market surveys, analysis of primary and secondary market data. Exercises on equilibrium price for fish and fishery products; estimation of demand and supply using simple regression. Analysis of credit schemes of banks and the government. Case studies of cooperatives. Visit to co-operative societies, commercial banks and fish markets and organizations dealing with marketing of fish and fishery products.

## **8. Entrepreneurship Development and Communication Skills**

**2 (1+1)**

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. Globalisation 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 fisheries sector. Venture capital. Contract farming and joint ventures, public-private partnerships. Overview of fisheries inputs industry. Characteristics of Indian fisheries 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.

**Practical:** 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.

## 9. Principles of Biochemistry

3 (2+1)

Major biomolecules in foods and their important functions. Classification of carbohydrates. Structures, functions and properties of mono- di- and polysaccharides. Isomerism. Mutarotation. Seaweed polysaccharides – sources and uses. Glycolysis and TCA cycle. Classification, structure, function and properties of amino acids. Amino acids and polypeptide. Primary, secondary, tertiary and quaternary structure of proteins. Amphoteric property. Biuret reaction and xanthoproteic reaction. Principles of protein purification. Protein biosynthesis. Classification, structure, functions and properties of lipids. Essential fatty acids and phospholipids. Auto-oxidation, saponification value and iodine number. Peroxide value, thiobarbituric acid number, oxidative and hydrolytic rancidity. Principle of fatty acid analysis. Significance of Omega 3 and 6 fatty acids. Beta oxidation. Structure, function and importance of nucleic acids. Genetic code and recombinant DNA. Transcription; translation. Enzymes- nomenclature; classification; specificity; mechanism of enzyme action; Kinetics and regulation of enzyme activity, purification of enzymes. Steroid and peptide Hormones- Chemistry and function. Structure and functions of fat and water soluble vitamins.

**Practical:** Estimation of glucose and protein in fish tissues. Preparation of chemical solutions, buffers and reagents. Extraction and estimation of total lipids from fish tissue. Applications of paper chromatography, thin layer chromatography, ion exchange chromatography. Principles of electrophoresis. Estimation and separation of proteins by electrophoresis; Determination of saponification and iodine values. Determination of lipase activity. Gel filtration. Preparation of tissue homogenate and organelle isolation.

## 10. Fundamentals of Microbiology

4 (2+2)

History of microbiology, microbial world and their structural characters. Prokaryotes – bacteria, actinomycetes, spirochaetes, cyanobacteria, mycoplasma, rickettsiae, archaeobacteria viruses, structure, classification, characters and their economic importance. Eukaryotes – fungi, algae, protozoan – structure, classification, characters and their economic importance. Microscopy, sterilization, staining, filtration, Disinfection. Microbial nutrition-nutritional requirements, cultivation of microorganisms, types of nutrition photoheterotrophs, chemoheterotrophs, photoautotrophs, chemoautotrophd and their ecological significance. Microbial growth and metabolism – measurement of cell growth, dynamics of bacterial growth, factors affecting growth. Energy yielding reactions, respiration – aerobes, anaerobes, microaerophiles and facultative anaerobes. Enzymes – characters and their importance in microbial metabolism. Pathways of catabolism – EM, ED pathways and TCA cycle, fermentation, types of fermentation. Bacterial photosynthesis, Microbial ecology- microbial interactions, types of interaction, influence of physico-chemical factors like pH, temperature, moisture, light, osmotic pressure, organic and inorganic substances, relationship with soil, water, air, food etc. Microbial genetics; genotypic and phenotypic characters, mutation and its significance, genetic recombination, transformation, transduction and conjugation, genetic engineering and biotechnology. Pathogenicity and virulence. Sources of infection. Transmission of disease producing organisms. Portals of infection. Effect of pathogenic bacteria on the body. Symptoms and lesions. Virus, Symmetry of virus, RNA and DNA virus, classification, cultivation of virus, replication of virus. Host virus interactions. Virus-

virus interactions. Interference and interferon, control of viral infection. Immunology and serology – types of immunity, natural and acquired, cellular and humoral, antigen-antibody reactions and their significance, serological methods in disease diagnosis. Aquatic microbial groups, Role of microorganisms in the cycling of elements in water, breakdown and production of organic matter; Carbon, nitrogen, sulfur, phosphorus iron and manganese cycles. Role of bacteria and fungi in sedimentations, microorganisms and water pollution; Effluent treatment; Bacteria of extreme environment, deep sea bacteria, hydrothermal bacteria, halophilic bacteria, their physiology and nutrition.

**Practical:** Introduction to microscopy; study of different types of microscopes; wet mount and hanging drop preparations; sterilization by different methods, filtration, dry heat, moist heat, chemical use etc. staining techniques – simple, differential, structural and microchemical techniques; distribution of micro-organisms in nature; isolation, pure culture and preservation methods; enumeration of micro-organisms, environmental influences on micro-organisms; biochemical tests; observation of fungi, blue-green algae, bacteria and protozoans. Study and enumeration of coliform, iron, and sulphur bacteria, viable non-culturable bacteria. Microbiological water quality management in aquaculture, bio-remediators and probiotics. Pathogens of aquatic animals - their isolation and identifications; detection of toxic organisms in aquatic system.

## **11. Biochemical Techniques and Instrumentation**

**3 (1+2)**

Theory and applications of Spectrophotometry, Basic principles and applications of chromatographic techniques : TLC, GC, LC, affinity chromatography, HPLC, and ion exchange chromatography. Radio isotopes, Radio Immune Assay, ELISA. Gel filtration, and ultracentrifugation. Blotting: southern, northern, western techniques. Plasmid isolation and cloning, PCR, cell culture and hybridoma technology.

Practical: Analysis of glucose, amino acids / proteins fatty acids/ lipids and RNA/DNA in fish tissues by spectrophotometry. Identification of amino acids by paper chromatography. Demonstration of blotting techniques and PCR. Sub-cellular fractionation by centrifugation.

## **6. ADDITIONAL COURSES**

### **1. Fish Immunology**

**2 (1+1)**

General concepts in immunology, Evolution of immune system in invertebrates and vertebrates. Non-specific defence mechanism in fish – surface barriers, non-specific humoral and cellular factors. Leucocytes – types and function. Specific defence mechanism – lymphoid organs in fish. Ontogeny of fish immune system. B and T lymphocytes. Immunoglobulin – types and function. Monoclonal and polyclonal antibodies. Primary and secondary immune response in fish – factors affecting. Immunological memory. Immunological tolerance. Stress and immune response. Defence mechanisms in crustaceans – humoral and cellular defenses. Principles of vaccination. Methods of vaccine development. Current trends in fish vaccination. Adjuvants and immuno-stimulants.

**Practical:**Antigen-antibody reactions: Precipitation, agglutination. Immunodiagnostic assays – ELISA, western blot. Antigen preparation. Immunization of fish. Preparation of polyclonal antibody. Measurement of humoral immune response. Polyphenoloxidase assay. Haemocyte counts in shrimps.

## **2. Rural Sociology and Psychology**

**1 (1+0)**

Rural Sociology: meaning, scope and importance, features of rural society with special reference to fishers; anthropology, socio–economics and demography of fishers, migration and patterns of settlement; social groups and social classes; caste and class among fishers; value system - norms, customs, social values and culture among fishers and their importance; village level institutions and voluntary organizations - meaning, types and their role in fisheries development; leadership – meaning, identification and training, qualities and roles of leaders and use of local leaders in fisheries development; social change and social control; social problems and conflicts in fisheries; gender issues in fisheries; globalization and fisheries. Psychology: concepts, principles, scope and its importance in fisheries extension; terms in psychology-intelligence, personality types, perception; motivation - meaning, classification of needs, techniques and importance in fisheries extension; theories of learning, learning experience, learning situation.

## **3. Elementary Statistics**

**2 (1+1)**

Definition of statistics, scope of fisheries statistics. Basic concepts of population and sample, random sampling. Collection of data; census enumeration and sample surveys, their advantages and disadvantages, preparation of schedules and questionnaires; Classification of data, frequency and cumulative frequency table. Diagrammatic and graphical representation of data - bar diagrams, pie-diagram, histogram, frequency polygon, frequency curve and Ogive; Important measures of central tendency - arithmetic mean, media ;and mode, relative merits and demerits of these measures. Important measures of dispersion – range, mean deviation, variance and standard deviation, relative merits and demerits of these measures; relative measures of dispersion - coefficient of variation; Measures of skewness and kurtosis.

**Practical:** Construction of questionnaires and schedules. Collection of fisheries data. Frequency distribution tables. Diagrams and frequency graphs. Calculation of arithmetic mean, median, mode range, mean deviation, variance, standard deviation and relative measures of dispersion. Skewness and kurtosis.

## **7. NON-CREDIT COURSES**

### **1. 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. Organising seminars and conferences.

### **2. Physical Education/NSS**

Introduction to physical education: definition, scientific principles, objectives, scope, history, development and importance; physical culture, training and health; Fartlek training and Circuit training. Body mechanism and body type: Kretchmark's and Sheldon's classification. Theories of learning; Exercises for good posture; exercises to develop physical fitness - components, speed, strength, endurance, power, flexibility, agility, coordination and balance; Test and measurement in physical education: physical fitness test, motor fitness test, cardiovascular efficiency test and physical fitness index; aerobic and anaerobic exercises;

Calisthenics, weight training, circuit training, interval training, far trek training, pressure training and resistance training; Importance of Asanas and Surya namaskar. Free hand exercises and Yoga. Recreation: definition, agencies promoting recreation, camping and recreation. Governance of sport in India; Conduct of sporting event, important national events; Drawing of fixtures and organisation tournaments; Rules and regulations, Coaching and skills development of major games; Rules and regulations, coaching and skills development of athletic events. NSS: Orientation of students towards national problems-study of the philosophy of N.S.S. - fundamental rights, directive principles of the Constitution, socio-economic structure of Indian society, population and five year plans. Functional Literacy - non-formal education of rural youth, eradication of social evil, awareness programmes, consumer awareness, highlights of the Consumer Act, environment enrichment and conservation, health, family welfare and nutrition.

### **3. Swimming**

History, hazards in water and safety precautions; pool maintenance and water quality control. Learning swimming, understanding and practice of ducking the head, kicking action, holding breath under water and various strokes (free style, breast stroke, butterfly, back stroke); competitive swimming-relays and medleys, lap time practice, swimming and floating aids and their uses; diving - styles of diving, rules, regulations and precautions. Methods of life saving in water; Boating, canoeing and sailing: types, maintenance, skill development, rules and regulations and practice.

### **4. First aid Training**

Need and requirement of first aid. First Aid equipments and upkeep. Handling and transport of injured I traumatized persons. Emergency procedure for suffocation, demonstration of artificial respiration. Treatment of injuries (wounds and bleeding) -methods of dressing and bandages; first-aid procedure for injured bones. Handling unconsciousness; Treatment of burns and scalds. Emergency procedure for poisoning with special references to snake bite. Injuries I accidents in fishing, fish processing factories, chemical laboratories and their treatments. Shock injuries to muscles and joints and treatments. Sports injuries and their treatments.