51. FARM MACHINERY AND POWER

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

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

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

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

Unit 5: Ergonomics and Safety
Anthropometry in equipment design, physiological cost and effect of work on physiological responses, fatigue and comfort; ergonomics in design of farm tools; safety aspects of agricultural machinery; effect of noise and vibration on work performance; chemical hazards and control measures; operator's protective gadgets;
design of tractor controls viz., hand and foot controls, visual range and limitations, seat design etc.

**Unit 6: Soil Dynamics in Tillage and Traction**
Dynamic properties of soil and their measurements; stress-strain relationships; theories of soil failure, mechanics of tillage tools; design parameters and performance of tillage tools. Introduction to traction devices, tyre function and size, their selection, mechanics of traction devices, traction theories, slippage and sinkage of wheels, evaluation and prediction of traction performance; soil compaction - causes and methods for alleviating the effect on soil and crop responses.

**Unit 7: Energy in Agriculture**
Conventional and renewable energy sources in agriculture; solar radiation and its measurement; characteristics of solar spectrum; solar energy collection, storage and applications; solar photovoltaic conversion and SPV powered systems. Types of wind mills and their applications; thermo-chemical conversion of biomass, direct combustion, Pyrolysis and gasification, chemical conversion processes, carbonization, briquetting, pelletization and densification of biomass; bioconversion into alcohols, methyl and ethyl esters, organic acids, solvents of amino acids; types of biogas plants, biogas properties, uses and distribution, alternate fuels for IC engines.
Energy requirement in agricultural production systems, energy ratio and specific energy value, inflow and outflow of energy in unit agricultural operation, energy audit, accounting and analysis.

**Unit 8: Manufacturing Technology**
Specification of materials, surface roughness, production drawing, computer aided drawing heat treatment, workshop practices applied in prototype production, common tools and press operations, metal cutting and machining, jigs, fixtures and gauges, casting and die-casting processes; basic joining processes, welding processes, weldments testing and metallurgy.

**Unit 9: Instrumentation and Measurement Techniques**
Mechanical measurements, sensors and transducers, application of electrical strain gauges, signal transmission and processing, dynamic measurements; measurement of temperature, pressure, strain, force, torque, power vibrations etc.; determination of calorific value, fluid flow rates etc; signal conditioning and monitoring, data acquisition and storage.
52. AGRICULTURAL STRUCTURES AND ENVIRONMENT MANAGEMENT

Unit 1: Introduction
Applications, Functional and financial criteria, Material selection criteria, Status in India and abroad, functional requirements of special facilities like mandi, food park, special economic zones etc. Protected cultivation, aquaculture, live stock production, cool/cold/ control atmosphere storages, farmstead, green buildings, green energy utilization, carbon foot prints and credits.

Unit 2: Materials for different agricultural structures

Unit 3: Environment control

Unit 4: Functional planning
Rural planning, Economic planning of the farm operation. Approach to building planning, surveying and levelling, Farmstead planning, Safety aspects, Lightning conductors, Earthquake, Fire protection, Work safety.

Unit 5: Engineering of structures
a. Structural design

b. Elements of construction
Loads on building components, Footings and foundations, Concrete foundations, Walls, Floors, Roofs, Doors, Windows, Stairs and ladders, Electrical installations

c. Building construction
Methods of construction, Prefabrication, Dimensional coordination and standardization, Building legislation, Construction costing, Economic feasibility, Organization for small building constructions, Specifications, Progress chart, Inspection and control, Safety at building sites, Building maintenance
Unit 6: On-farm structures

a. Storage structures


b. Animal housing

Animal physiology, Animal environmental requirements, Cattle housing, Sheep and goat housing, Poultry, duckery and piggery, Rabbit housing, Slaughter equipment, Slaughter slabs and slaughterhouses, Design of modern structures

c. Miscellaneous farm buildings

Farm workshop facilities, Machinery and implement storage, Fuel and chemical storage, biogas plant

Unit 7: Structures related to agricultural production

a. Greenhouses

Greenhouses and greenhouse effect, Plant-environment interactions, Historical developments, Types of Greenhouses, Design of greenhouses, Environmental control, Operation and maintenance, Economics of greenhouse production.

b. Aquaculture structures

Inland fish farming and associated considerations, Fish physiology and micro-climatic considerations, Aeration & feeding systems, Design of fish rearing structures, Hatcheries, Containers for live fish, fingerlings, fish seeds. Aquaculture in recirculatory systems, oxygen and aeration, sterilization and disinfection.

Unit 8: Handling, Packaging and transportation

Bulk handling of food grains-Bulk conveying equipments viz. belt conveyors, screw/auger conveyors, bucket elevators and drag/chain conveyors. Estimation of energy requirement and damage to biomaterials during mechanical handling. Operation and maintenance of conveying equipments. Packaging requirements, techniques and equipment for liquid, powder and granular biomaterials and horticultural produce. Types of packaging material, barrier properties, CFB boxes, Modified atmosphere packaging, controlled atmosphere packaging, Nano-composite packaging, Smart and active packaging, Edible films, Antioxidant and anti microbial packaging, RFID, Time and temperature indicators, Micro and nano-encapsulation.
Transportation of agro-produce by bullock carts, trailers, trucks, rail wagons and containers. Cold chain design and operation. Refrigerated containers and trucks for perishable foods. Damage and losses during transportation.

UNIT 9: SUPPORTING INFRASTRUCTURE
a. External facilities

Introduction to simple road designs, Erosion of earth roads, Road construction – use of geo textile for rural roads, Minor river crossings, Vehicle access to farmsteads, Fencing, Types of fences, Fencing accessories, Animal handling facilities

b. Rural water supply and sanitation

Water requirements - quantity and quality, Water storage, Wells, Pumps (give reference to Irrigation chapter for selection criteria), Water purification treatment, Open channel flow, Rural sanitation

c. Farm dwellings

Space requirements, Family cultural and social requirements, Special requirements of farm dwellings, Categories of farmhouses, Function and communication schemes, Functional requirements for different rooms and spaces, Improvement of existing dwellings, Contemporary farm dwellings.

d. Farm Electrification

The use of electricity as a power sources for lighting, comfort in living, farm production and processing. Planning the Farmstead Distribution system:- Demand load for Farm Buildings, Central Metering and distribution, Capacity of main service selecting feeder conductors. Electric central and circuit protection. Electric motors: Motor rating and selection, measurement of motor characteristics. Standby Power Units: Purpose and importance, stand - by generator type selection, maintenance and operation.

e. Residue and effluent management

Handling of solid and liquid by-products, characterization, physical/chemical/biological/ biotechnological/ nanotechnology approaches for their treatment and/or utilization. Biological and chemical oxygen demand of effluents.

UNIT 10: Instrumentation and process control

Static and dynamic characteristics of instruments, Transducers elements, intermediate elements, indicating and recording elements. Measurement of motion, force, torque, power, temperature, humidity, pressure and flow. Physical and chemical sensors, biosensors, Fuzzy logic, neural networks and control. Monitoring of plant parameters through Internet, Programmable logic controller, Data loggers, Data Acquisition Systems (DAS). Introduction to Direct Digital Control (DDC), Supervisory Control and Data Acquisition Systems (SCADA), and Virtual Instrumentation.
53. LAND AND WATER MANAGEMENT ENGINEERING

Unit 1: Groundwater Development, Wells and Pumps

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

Unit 3: Soil, Plant, Water and Atmosphere Relationship

Unit 4: Hydrology and Soil and Water Conservation

**Unit 5: Watershed Management**


**Unit 6: Irrigation Water Management**


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

54. AGRICULTURAL PROCESS ENGINEERING

Unit 1: Engineering Properties and Quality of Biomaterials

Unit 2: Heat and Mass Transfer

Unit 3: Post Harvest Unit Operations
Grading, cleaning, washing, sorting, shelling, dehusking, decortications, milling, polishing, pearling, drying (evaporative, osmotic and freeze drying), pasteurization and sterilization of liquid foods, kinetics of microbial death, size reduction, cryogenic grinding, granulation, crystallization, filtration, membrane processing, microfiltration, ultra-filtration, nano-filtration, reverse osmosis, evaporation, distillation, mixing, clarification, coagulation, mechanical separation, sedimentation, pressing, expelling, leaching, extraction, palleting, extrusion and industrial fermentation and processing.

Unit 4: Process Technology and Machinery
Pre-milling/ conditioning treatments. Process technology and machinery for cereals, pulses, oil seeds, fruits, vegetables, flowers, spices, condiments, plantation crops, animal products, sea-foods, fiber crops, animal feed, natural resins and gums. Bioprocess engineering, enzyme reaction kinetics, Industrial fermentation and processing, down-stream processing, bio-separation. Minimal processing of fruits and vegetables, high pressure processing, ohmic heating, ultraviolet light, pulsed electric field, pulsed light field, micro and nano encapsulation of food ingredients, Food nanotechnology Seed processing and technology, Agricultural byproducts/residue utilization, Waste disposal of food processing plants, different methods and equipment.
Unit 5: Design of Processing Machinery
Design of grain cleaners, graders, dryers, parboiling plants, size reduction machines, bioreactors, fermenters, centrifuges, cyclones, heat-exchanger, evaporators, filters, extrusion cookers. Computer aided design and analysis of machines and machine components. Materials, manufacturing processes, design of elements and selection of standard parts (pulley, chains, sprockets, bearings, belts, fasteners, hydraulic components, pipes, hoses).

Unit 6: Material Handling, Packaging and Transport

Unit 7: Storage Engineering
Storage environment and its interaction with stored product. Factors/parameters influencing the shelf life of the stored product, climatograph and deterioration index. Modeling of metabolic activities and predication of storage life, quality deterioration mechanisms and their control. Storage practices (including fumigation) for food grains. Design of bulk storage and aeration system. Analysis of heat, moisture and gas transfer in bulk storage structures. Bag storage structures, their design and management. Storage of perishables in ventilated, refrigerated, controlled and modified atmosphere storage systems and their design, smart storage system. Quality analysis of stored produce.

Unit 8: Process Plant Design
Plant design concepts and general design considerations, plant location, product and process design, process flow charts, equipment selection, plant layout. Design and selection of machinery for handling utilities like water, steam, fuel etc. and disposal of effluents and residues.

Unit 9: Instrumentation and process control
Static and dynamic characteristics of instruments, Transducers elements, intermediate elements, indicating and recording elements. Measurement of motion, force, torque, power, temperature, humidity, pressure and flow. Physical and chemical sensors, biosensors, Fuzzy logic, neural networks and control. Monitoring of plant parameters through Internet, Programmable logic controller, Data loggers, Data Acquisition Systems (DAS). Introduction to Direct Digital Control (DDC), Supervisory Control and Data Acquisition Systems (SCADA), and Virtual Instrumentation.

Unit 10: Agri-project Planning and Management
Project development, market survey and time motion analysis. Selection of equipment, technology option, techno - economic feasibility, processing in production catchment. Product and process design, PERT, CPM, transport model, simplex, linear and dynamic programming, operation log book. Material balance and efficiency analysis, performance testing, performance indices, energy requirement and consumption. Marketing of agricultural products, market positioning. BIS/ FSSAI/ ISO standards/ guidelines on best practices, equipment and their design and operation for handling, processing and storage of food/feed.
55. FOOD TECHNOLOGY

Unit 1: Introductory Food Technology

Introduction to food technology. Food processing industries/institutions/food scientists of importance in India. Food attributes viz. colour, texture, flavour, nutritive value and consumer preferences. Causes of food spoilage, sources of microbial contamination of foods, food borne illnesses, water activity and its relation to spoilage of foods. Spoilage of processed products and their detection. Principles and methods of food preservation. Food fortification, Composition and related quality factors for processing. Methods of food preservation such as heat processing, pasteurization, canning, dehydration, freezing, freeze drying, fermentation, microwave, irradiation and chemical additives. Refrigerated and modified atmosphere storage. Aseptic preservation, hurdle technology, hydrostatic pressure technology and microwave processing. Use of non-thermal technologies [microfiltration, bacteriofugation, ultra high voltage electric fields, pulse electric fields, high pressure processing, irradiation, thermostatic heating], alternate-thermal technologies [ohmic heating, dielectric heating, infrared and induction heating] and biological technologies [antibacterial enzymes, bacteriocins, proteins and peptides] in food processing.

Unit 2: Technology of Foods of Plant Origin


Unit 3: Technology of Foods of Animal Origin


Unit 4: Food Quality Management
Unit 5: Food Engineering/Packaging and Labelling
Unit operations of food processing viz. grading, sorting, peeling and size reduction machineries for various unit operations, energy balance in food processing. Packaging materials viz. properties and testing procedures, packaging of fresh and processed foods. Shelf life studies. Recent trends in packaging, aseptic, modified atmosphere, vacuum and gas packaging. Nutritional labelling requirements of foods. Requirements and functions of containers. Principles of package design.

Unit 6: Food Microbiology & Biotechnology
Fermentation technology, fermented food products (animal and plant based), microbial spoilage of foods, bacterial growth curve, hurdle technology. Role of biotechnology in productivity of plants, livestock and microbes of improved nutrition and quality. Use of biotechnology in production of food additives viz. preservatives, colorants, flavourants. Use of biotechnologically improved enzymes in food processing industry, biomass production using industrial wastes. Single cell proteins, Food contaminants viz. aflatoxins. Food intoxication and infection. Consumer concerns about risks and values, Biotechnology and food safety.

Unit 7: Flavour Chemistry Technology
Flavour composition of foods/beverages (identification and quantitative analysis of the flavour precursors and their products, characterization of the staling reaction using stable isotopes). Flavour composition of foods/beverages in relation with maturation and microbial activity/or the processing conditions (e.g. fermented dairy products, beer, wine, honey, fruits). Analysis of odour-active compounds of food/beverages (Charm analysis). Synthesis of flavour by microorganisms and plant cells. Lipid derived flavours. Investigation of equilibrium of key flavour compounds that govern the flavour stability of beverages. Natural antioxidant constraints in spices. Role of microorganisms in flavour development. Flavor emulsions, flavour composites, essential oils and oleoresins.

Unit 8: Consumer Sciences / Food Product Development / Health Foods