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. COMPUTER APPLICATIONS & INFORMATION TECHNOLOGY (IT)

Unit 1: Computer Organization and Architecture

Computer Organization and Architecture – Boolean Algebra, Minimization of Boolean Functions, Number System, Basic concepts of floating point number system, Sequential and Combinational Circuits, Flip flops – types, Race Condition and Comparison. Input/Output Unit, Memory Organization, ALU and Control Unit, Instruction and Execution Cycle in CPU, Introduction to Microprocessors, Interrupts, CISC and RISC Architecture.

Unit 2: Programming Languages & Data Structure

Programming Languages (Java, C++), Computer Algorithms, Flow Charts, Encapsulation, Inheritance, Polymorphism, Building Blocks, Control Structures, Arrays, Dynamic Memory Allocation, File management. Internet Programming – Hyper Text Markup Language (HTML) and XML, Building Static and Dynamic Web Pages, Client Side and Server Side Scripting Languages (JSP,.NET,PHP), Interaction with Database.

Data Structure-Representation of Character, String and their Manipulation, Linear List Structure, Stack, Queue, Heaps, Linked list, Arrays. Tree: Representation of Tree Structures and Different Tree Traversal Algorithms, Graph, Sorting and Searching Algorithms.

Unit 3: Software Engineering

Software Engineering Definition; Requirement Analysis and Specification; Software Development: Phases, Process Models, Project Structure, Project Team Structure, Types of Metrics, Measurement, Software Quality Factors. Planning and Software Project : Requirement analysis, Cost Estimation, Project Scheduling, Quality Assurance Plan and Project Monitoring Plans, Gantt Charts, PERT and CPM, Coding Tools and Techniques, Testing Maintenance, CASE Tools, Object Oriented Analysis and Design, UML Modeling and Diagrams.

Unit 4: Networking & Operating System

Types of Networks, Network topology. Data Communication: Concepts of Data, Signal, Channel, Bandwidth, bit-rate and baud rate. Maximum Data-Rate of Channel; Analog and Digital Communications, Asynchronous and Synchronous transmission. ISO-OSI Reference Model, TCP/IP Reference Model – Data Link Layer Function and Protocols: Framing, Error Control, flow control; sliding window protocol, IP-v4 & IP-v6, Dual Stack. Internet standards and Services, Cryptography, Authentication and firewalls, Adhoc networks.

Operating system – Process Management: Inter-Process Communication, Process Scheduling; Memory management: Swapping, Virtual Memory, Paging and Segmentation; Device Management: Deadlocks, Semaphores; File systems – Files, directories, Security and Protection Mechanisms: Basics of Unix/Linux/Windows Server Configuration.

Unit 5: Compiler Construction

Compilers – Regular Expression, Finite automata, Formal languages, Finite State Machines, Lexical Analysis, Semantic Analysis, Parsing Algorithms, Symbol tables, Error Handling, Types of Languages.

Unit 6: Data Base Management System
Definition and Features, Data Models, Relational Database: Logical and Physical Structure, Relational Algebra, Relational Calculus, Database Design, Normalization, Concurrency Control, Security and Integrity, Query Processing and Optimization, Backup and Recovery; Distributed Databases – Concepts, architecture, Design; Structured Query Language (SQL), Concepts and Principles of Data Warehousing, Data Warehousing Design and Schema, GIS Concepts and Principles, Big Data Concepts & Architecture.

Unit 7: Computer Graphics
Raster Scan and Random Scan Graphics; Continual Refresh and Storages Displays; Display Processors and Character Generators; Colour Display Techniques. Frame Buffer and Bit Operations, Raster graphics, Points, Lines and Curves, Scan Conversion; Line-Drawing Algorithms; Circle and Ellipse Generation; Polygon Filling; Conic-Section Generation. Anti-Aliasing; Two-dimensional viewing; Basic Transformations; Co-ordinate systems; Windowing and Clipping; Segments; Interactive Picture-Construction Techniques; Interactive Input/Output Devices. Three-Dimensional Concepts: 3-D Representations and Transformations; 3-D Viewing; Algorithm for 3-D Volumes, Spline Curves and Surfaces.

Unit 8: Artificial Intelligence and Soft Computing
Introduction to Artificial Intelligence (AI); Games, Theorem Proving, Natural Language Processing, Robotics, Expert System. Knowledge: General Concept of Knowledge, Knowledge Based System, Representation of Knowledge, Knowledge Organization and Manipulation, Acquisition of Knowledge, Ontologies. Symbolic Approach: Syntax and Semantics for Prepositional Logic (PL) and First Order Predicates Logic (FOPL), Properties of Well-Formed Formulas (wffs), Conversion to clausal form, Inference Rules, Resolution Principle, Non deductive inference methods. Search and Control Strategies: Blind Search, Breadth-first search, Depth – First search, Hill Climbing Method, Branch and Bound Search. Machine Learning: Concept of Learning, Supervised and Unsupervised Learning, Neural Networks, Genetic Algorithms, Fuzzy Logic. Expert Systems: Introduction to Expert System, and its Characteristics, Application and Importance, Rule Based System Architecture; Software Agents.

Unit 9: Statistics, Modeling and Simulation
Frequency distribution, Measures of Central Tendency, Dispersion, Skewness and Kurtosis. Theory of Probability. Random variable and mathematical expectation. Correlation and regression. Basic Principles of Design of Experiments. Analysis of Variance. Completely randomized design (CRD), Randomized complete block design (RCBD), Latin Square Design (LSD), Split Plot and Strip Plot Design. Probability Distributions: Binomial, Poisson, Normal Distributions and their Applications. Concept of sampling, Sampling vs. Complete Enumeration, Sampling from a Finite Population, Simple Random Sampling. Generation and Testing of Random Numbers, Simulation of Stochastic Events and processes, Discrete Event Simulation.

Unit 10: Bioinformatics

Basics of Bioinformatics, Basic Molecular Biology; Introduction to the Basic Principles of Structure/Function Analysis of Biological Molecules; Genome Analysis; Different Types and Classification of Genome Databases (HTGS, DNA, Protein, EST, STS, SNPs, Unigenes etc.) Role of Bioinformatics in Genomics; Nature of Genomic Data; Overview of Available Genomic Resources on the Web; NCBI/ EBI/ EXPASY etc; Nucleic Acid Sequence Databases; GenBank/EMBL/ DDBJ; Database Search engines: Entrez, SRS. Overview/Concepts in Sequence Analysis; Pairwise Sequence Alignment Algorithms: Needleman & Wunsch, Smith & Waterman; BLAST, FASTA; Scoring matrices for Nucleic Acids and Proteins: PAM, BLOSUM, Dynamic Programming Algorithm, Multiple Sequence Alignment: PRAS, CLUSTALW. Sequence Based Gene Prediction and its Function Identification, Use of Various Derived Databases in Function Assignment, Use of SSR, SNPs and Various Markers for Identification of Genetic Traits, Gene Expression. Phylogenetic Analysis Algorithms; Maximum Parsimony, Distance based: UPGMA, Neighbour-Joining.

53. LAND AND WATER MANAGEMENT ENGINEERING

Unit 1: Groundwater Development, Wells and Pumps

Water resources of India. Irrigation potential and contribution of groundwater, utilizable groundwater resources and level of groundwater development in the country, scope of groundwater development. Aquifer types and parameters. Principles of groundwater flow, interaction between surface and groundwater, natural and artificial groundwater recharge. Hydraulics of fully and partially penetrating wells. Design, construction and development of irrigation wells. Water lifts, pumps and prime movers, well and pumps characteristics, performance evaluation and selection of pumps. Energy requirement in groundwater pumping. Design of centrifugal pumps. Groundwater pollution. Salt water intrusion in inland and coastal aquifers. Application of groundwater models for groundwater development and management. Conjunctive use of surface and groundwater.

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

Soil and water as vital resources for agricultural production. Water retention by soil, soil moisture characteristics, field capacity, permanent wilting point, plant available water and extractable water. Soil irrigability classifications, factors affecting profile water storage. Determination of soil water content, computation of soil water depletion, soil water potential and its components, hydraulic head. Field water budget water gains and water losses from soil, deep percolation beyond root zone, capillary rise. Evapotranspiration (ET) and irrigation requirement, critical stages of crop growth in relation to irrigation. Irrigation scheduling. Plant water relations, concept of plant water potential, significance of osmotic adjustment, leaf diffusive resistance, canopy temperature, canopy temperature depression (CTD). Water movement through soil plant atmosphere system. Uptake and transport of water by roots. Development of crop water deficit, crop adaptation to water deficit, morpho physiological effect of water deficit. Drought tolerance, mechanisms of drought tolerance, potential drought tolerance traits and their measurements. Management strategies to improve crop productivity

under limited water supplies. Contingent crop plans and other strategies for aberrant weather conditions. Cropping patterns, alternate land use and crop diversification in rain fed regions.

Unit 4: Hydrology and Soil and Water Conservation

Hydrologic cycle, precipitation, infiltration and surface runoff. Measurement and analysis of hydrologic data. Application of statistics in hydrology. Probability concepts. Distributions and application. Intensity duration frequency analysis. Hortonian and saturation overland flow theories, partial source area concept of surface runoff generation. Rainfall and run off relationships, stream gauging and runoff measurement. Different methods of surface runoff estimation, hydrographs, S-hydrograph, IUH, unit hydrograph theory and its application, Flood routing methods and calculations. Soil erosion and types of erosion. Soil loss measurement and 128 estimation. Universal soil loss equation and subsequent its modifications, soil and water conservation structures and their design. Gully control structures and their

design. Design and construction of farm pond and reservoir. Seepage theory. Design of earthen dams and retaining walls, stability analysis of slopes. Mathematical models and simulation of hydrologic processes. Application of GIS in soil and water conservation.

Unit 5: Watershed Management

Watershed concept, Identification and characterization of watersheds. Hydrological and geomorphological characteristics of watersheds. Land capability and irritability classification and soil maps. Principles of watershed management. Development of watershed management plans, its feasibility and economic evaluation. Land levelling and grading, machineries and equipments for land levelling.

Unit 6: Irrigation Water Management

History of irrigation in India. Management of irrigation water. Major irrigation projects in India. Crop water requirements. Soil water depletion, plant indices and climatic parameters. Crop modeling , water production function. Methods of irrigation, surface methods, overhead methods, Pressurized irrigation system such as drip and sprinkler irrigation. Merits and demerits of various methods. Hydraulics of furrow, check basin and border irrigation, Hydraulics and design of pressurized irrigation systems. Irrigation efficiency and economics of different irrigation systems. Application and distribution efficiencies. Agronomic considerations in the design and operation of irrigation projects, characteristics of irrigation and farming systems affecting irrigation management. Irrigation legislation. Irrigation strategies under different situation of water availability, optimum crop plans and cropping patterns in canal command areas. Quality of irrigation water and irrigation with poor quality water. On farm water management, socio-economic aspects of on farm water management. Scope for economizing the use of water.

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

Problem soils and their distribution in India. Water quality criteria and use of brackish waters in agriculture. Excess salt and salt tolerant crops. Hydrological imbalances and their corrective measures. Concept of critical water table depths for crop growth. Contribution of shallow water table to crop water requirements. Management strategies for flood prone areas and crop calendar for flood affected areas. Crop production and alternate use of problematic soils and fish production. Agricultural field drainage and theory of flow in saturated soil. Flow net theory and its application. Drainage investigations. Drainage characteristics of various type of soils. Water table contour maps and isobaths maps. Drainage coefficient. Design and installation of surface and subsurface drainage system. Interceptor and relief drains and their design. Drain pipe and accessories. Pumped drainage. Drainage requirements of crops. Drainage in relation to salinity and water table control. Reclamation of ravine, waterlogged, swampy areas and polders. Salt-affected soils and their reclamation. Command area development organizational structures and activities. River valley projects, interstate disputes. Water rights and legal aspects. Irrigation water users association concept and responsibilities. Environmental considerations in land and water resources management.

54. BIOINFORMATICS

UNIT-I: Concepts in Computing

Fundamentals of Computing, Introduction to Operating Systems, WINDOWS, UNIX/Linux operating systems, Batch Processing, Multi-programmed Batch System, Time Sharing System, Distributed System, Real Time System, Dead lock, CPU scheduling, Computer Security, Computer Graphics: Visualization techniques, Interactive Graphics, Viewing in three dimension, Raster algorithms, Rendering, Animation, Image Processing with emphasis on biological systems, Computer Networking, Security of the network, Fire-walls, Network, Network topologyand architecture, Hierarchical networks, TCP/IP family of protocols, Parallel & High performance computing, Cloud computing

UNIT-II: Programming Languages

Programming in C, Arrays and Pointers, Variables, Procedures and functions, Standard Controls, Flow control and loops, string operators, Declaration and definition of user defined functions, Call by value, Call by references, File handling in C, Overview of Object Oriented Programming, Class and Objects, function and operator overloading, inheritance, Introduction to PERL, Overview,Syntax, Data types,Operators and Regular expressions in PERL, BioPerl modules

UNIT-III: Database Systems and Biological Databases

Definition, purpose of database system, Advantages of Database System, Components of Database System, Data Models-Relational, Network, Hierarchical, Three level Architecture for Database System –internal, conceptual and external levels, Data independence, Data Abstraction, Mapping, Data Definition Language, Data Manipulation Language, Role of Schemas, Client/Server architechture, Relational Databases- Relational data models (binary, ternary, quaternary & n-ary relations), Important terms in relational database system, Primary and secondary keys, Structured Query Language, Primary, secondary and derived biological databases, submitting sequence to the Database and retrieval, Data mining & Knowledge discovery in Biological databases, Supervised and unsupervised learning, machine learning techniques, Artificial Neural Network, Support Vector Machine and genetic algorithms

UNIT-IV: Mathematics and Statistics

Introduction to Probability and Statistics, Conditional probability, Bayes' theorem, Random variable, mathematical expectation, Probability Distributions, Binomial, Multinomial, Poisson and Normal Distribution, Introduction and properties of 't', Chi-square and F distribution, Principles of random sampling, Frequency distributions-Graphical representations and Descriptive measures, Standard Probability Distributions, Correlation and regression analysis. Hypothesis testing, Markov Models, Cluster Analysis- Hierarchical and Non-Hierarchical methods, Coordinate geometry with basic concepts of 2D and 3D geometry, Vector algebra– Addition and subtraction of vectors, Dot and cross product, Scalar triple product, Matrix algebra- basic definitions, matrix operations, transpose of a matrix, inverse of matrix, Eigen values, Boolean algebra. Geometric, Arithmetic and Harmonic Progression

UNIT-V: Biochemistry and Molecular Biology
Scope and importance of biochemistry in agriculture, hydrophobic, electrostatic and van der Waals forces, General introduction to physical techniques for determination of structure of biopolymers, Historical developments in molecular biology, Nucleic acids as genetic material, Genetic code, Genome organization and regulation in prokaryotes and eukaryotes, DNA replication, transcription and translation, recombinant DNA technology, Site directed mutagenesis, molecular mechanism of mutation, RNA editing, RNA processing, Structure, properties and functions of amino acids, proteins, and nucleic acids, Anatomy of Proteins - Secondary structures, Motifs, Domains, Tertiary and quaternary structures, Classification of Protein topologies, Helices and sheets, Helix-coil theory, Conformation of polypeptides and side chains, Ramachandran plot, Hinge motions in proteins, Algorithms in predicting secondary structure of proteins- Chau-Fasman algorithm, The Protein folding energy landscape, molten globules, enzymes and folding pathways

UNIT-VI: Genomics and Proteomics
Whole genome analysis and comparative genomics, classical ways of genome analysis, large fragment genomic libraries, Physical mapping of genomes, Genome sequencing strategies, Sequence assembly and annotation, exome sequencing, Genome structural and functional annotation, Functional genomics and proteomics, mass spectrometry, protein database and MS data analysis, peptide identification and protein interface, Candidate gene identification, Metabolomics for elucidating metabolic pathways, Linkage analysis, genotyping analysis, Applications of genomics and proteomics in agriculture, Evolution of sequencing technology, Microarrays analysis and applications, Next generation sequencing technologies, Sequencing by synthesis, ligation, single molecular sequencing, emerging NGS technologies

UNIT-VII: Analytical Bioinformatics
Bioinformatics- introduction, origin and history, Applications of Bioinformatics in agriculture, Information retrieval from Biological databases, Analysis of protein and nucleotide sequences, Basic concepts of sequence similarity, Introduction to sequences alignments- local and global alignment, pairwise and multiple sequence alignment, Dynamic programming-Needleman and Wunsch, Smith-Waterman algorithms, Scoring matrices: PAM & BLOSUM, Motifs and Patterns, Phylogenetic analyses, Types of phylogenetic trees, Tree-Building Methods, Character-based and Distance-based methods, Maximum-likelihood, Maximum parsimony, Unweighted Pair Group Method with Arithmetic Mean (UPGMA), Neighbor-Joining (NJ), Fitch-Margoliash (FM), Minimum Evolution (ME), Tree Evaluation, Bootstrapping, Introduction to systems and network biology

UNIT-VIII: Molecular Modelling
Concepts of Molecular Modelling, Molecular mechanics, Force Fields, Local and global energy minima, Techniques in MD and Monte Carlo Simulation for conformational analysis, DFT and semi-empirical methods, Simulated annealing, RNA Secondary Structure prediction techniques, Algorithmic perspective of RNA folding, Protein structure prediction: *ab initio*, homology modeling and fold recognition methods, Receptor-based and ligand-based drug design, Design of ligands, docking, Classical SAR/QSAR, COMFA & COMSIA, Molecular descriptors, Pharmacophore mapping and applications

UNIT-IX: Algorithms and Data structures in Bioinformatics

Algorithms and complexity, Iterative and recursive algorithms, Fast versus slow algorithms, Big-O Notation, Algorithm design and analysis techniques, Greedy Algorithms, Randomized Algorithms, Divide-and-Conquer approach, Searching and Sorting algorithms, Linear and non-linear data structure, Stack, Queues, Linked list, Trees-Terminologies, Binary trees, Tree traversal (Pre-order, In-order, post-order), AVL trees, Graph theory, Depth-first search and Breadth-first search algorithms, Shortest Superstring Problem

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, thermosonication), 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

(a) Fruits and Vegetable Processing: Post harvest handling and storage of fresh fruits and vegetables. Preparation of fruits and vegetables for processing. Minimally processed products. Cold chain logistics. ZECC (Zero Energy Cool Chambers), CCSR (Charcoal cool storage Rooms) Thermal processing and process time evaluation for canned products, process optimization, aseptic canning, methods for canning of different fruits, and vegetables; Dehydration and associated quality changes during drying and storage of dehydrated products. Solar drying. Intermediate moisture foods. Preparation and utilization of fruits and vegetables juices in non-fermented/ fermented/ aerated beverages, health drinks. Membrane technology. Chemistry and manufacture of pectin, role in gel formation and products like jellies and marmalades. Technology of preservatives, pickles, chutney's and sauces. Nature and control of spoilage in these products. Re-structured fruits and vegetables. By products utilization of fruits and vegetable processing industry. Processing methods of frozen fruits and vegetables, IQF products, packaging, storage and thawing. Role of Pectinases. Tomato products such as juice, puree, paste, soup, sauce and ketchup. Other convenience foods from fruits and vegetables. Beverages, tea, cocoa and coffee processing. Medicinal and aromatic plants: their therapeutic values. Spice Processing viz. cleaning, grading, drying, grinding, packaging and storage. Oleoresins and essential oils.

(b) Food grain Processing: Structure, composition of different grains like wheat, rice, barley, oat, maize and millets. Anti-nutritional factors in food grains and oilseeds. Milling of grains. Wheat flour/semolina and its use in traditional/non-traditional foods like breads, biscuits, cakes, doughnuts, buns, pasta goods, extruded, confectionary products, breakfast and snack foods. Rheology of wheat and rice flour. Preparation of vital wheat gluten and its utilization. Instant ready mixtures. Enzymes (amylases and proteases) in milling and baking. Milling and parboiling of rice; by-products of rice milling and their utilization. Processed products from rice. Pearling, malting, brewing and preparation of malted milk feeds from barley. Significance of β-glucans. Milling of oats and its processing into flakes, porridge and oatmeal. Wet and dry milling of corn, manufacture of corn flakes, corn syrup, corn starch, corn steep liquor and germ oil. Structure and composition of pulses and their importance in

Indian diet. Milling and processing of pulses viz. germination, cooking, roasting, frying, canning and fermentation. Use in traditional products, protein concentrates and isolates. Modified starches and proteins. Oilseeds: edible oilseeds, composition and importance in India. Oilseed processing. Oil extraction and its processing, by-products of oil refining. Production, packaging and storage of vanaspati, peanut butter, protein concentrates, isolates and their use in high protein foods. Export of oilseed cakes. International market and consumer preferences for quality in cakes for use in textured vegetable proteins. Millets: composition, nutritional significance, structure and processing. Dairy analogues based on plant milk. Spices Processing: Oleoresin and essential oil extraction

Unit 3: Technology of Foods of Animal Origin

(a) Technology of Milk and Milk Products: Milk and Milk production in India. Importance of milk processing plants in the country. Handling and maintenance of dairy plant equipment. Dairy plant operations viz. receiving, separation, clarification, pasteurization, standardization, homogenization, sterilization, storage, transport and distribution of milk. Problems of milk supply in India. UHT, toned, humanized, fortified, reconstituted and flavoured milks. Technology of fermented milks. Milk products processing viz. cream, butter, *ghee*, cheese, condensed milk, evaporated milk, whole and skimmed milk powder, ice-cream, butter oil, *khoa, channa, paneer* and similar products. Judging and grading of milk products. Cheese spreads by spray and roller drying techniques. EMC (Enzyme modified cheese), Enzymes in dairy processing. Insanitization *viz.* selection and use of dairy cleaner and sanitizer. In plant cleaning system. Scope and functioning of milk supply schemes and various national and international organizations. Specifications and standards in milk processing industry. Dairy plant sanitation and waste disposal.

(b) Technology of Meat / Fish / Poultry Products: Scope of meat, fish and poultry processing industry in India. Chemistry and microscopic structure of meat tissue. Ante mortem inspection. Slaughter and dressing of various animals and poultry birds. Post mortem examination. Rigor mortis. Retails and wholesale cuts. Factors affecting meat quality. Curing, smoking, freezing, canning and dehydration of meat, poultry and their products. Sausage making. Microbial factors influencing keeping quality of meat. Processing and preservation of fish and its products. Handling, canning, smoking and freezing of fresh water fish and its products. Meat tenderization and role of enzymes in meat processing. Utilization of by-products. Zoovosic diseases. Structure and composition of egg and factors effecting quality. Quality measurement. Preservation of eggs using oil coating, refrigeration, thermo stabilization and antibiotics. Packing, storage and transportation of eggs. Technology of egg products viz. egg powder, albumen, flakes and calcium tablets. Industrial and food user physiological conditions and quality of fish products.

Unit 4: Food Quality Management

Objectives, importance and functions of quality control. Quality systems and tools used for quality assurance including control charts, acceptance and auditing inspections, critical control points, reliability, safety, recall and liability. The principles and practices of food plant sanitation. Food and hygiene regulations. Environment and waste management. Total quality management, good management practices, HACCP and codex in food. International and National food laws. US-FDA/ISO-9000 and FSSAI. Food adulteration, food safety. Sensory evaluation, panel screening, selection methods. Sensory and instrumental analysis quality control. Quality control of food at all stages and for packaging materials. Non-destructive food quality evaluation methods.

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, flavours. 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

Socio-cultural, psychological and economical consideration for food appearance, domestic and export marketing. Consumer trends and their impact on new product development. Product development *viz.* to conceive ideas, evaluation of ideas, developing ideas into products, test marketing and commercialization. Role of food in human nutrition. Nutritional disorders, natural contaminants and health hazards associated with foods. Diet therapy. Therapeutic / Engineered / Fabricated and Organic foods/ Nutraceutical and functional foods.

56. AGRICULTURAL STRUCTURES & PROCESS ENGINEERING

Unit 1: Heat and Mass Transfer

Basic laws of thermodynamics, thermodynamic properties and processes, energy equations, heat, work, heat engine, heat pump, refrigeration and steam tables. EMC, sorption and desorption isotherms, water activity and psychrometry. Modes of heat transfer, heat exchanger. Mass transfer and mass-heat-momentum transfer analogies. Fluid statics, fluid dynamics, continuity equation and Bernoulli's theorem. Dimensional analysis and simulation. Simulation models and mathematical modeling. Finite difference analysis, Finite element analysis.

Unit 2: Farm Structures and Farmstead Planning

Farmstead planning, survey and data collection for information bank. Analysis of data, Lay outs. Cost estimation and appraisal. Project development. Time, motion and input analysis, Flow charts & drawings, Case studies. Farm electrification, load estimation and selection of equipment. Standby power units, their selection, maintenance and operation. Electrical fencing, Safety devices including fire-fighting. Benefit-cost analysis. House hold electrical wiring. Illumination, transmission and distribution of electricity. Rural water supply and sanitary structures, sceptic tank design, Brooderhouse and incubation structures. Road culverts and nallah structures, Rat proof godowns, piggery, poultry and other livestock structures. Feed stuff storage structures, Farm workshop, Machinery and implement sheds. Fuel and chemical storage, biogas plant. Green house construction, environment control, operation and maintenance. Economics of green house production.

Unit 3: Storage Engineering

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

Unit 4: Material Handling Packaging and Transport

Bulk conveying equipments *viz.* belt conveyors, screw/auger conveyors, bucket elevators and drag/chain conveyors. Estimation of energy requirement, damage to products during mechanical handling. Operation and maintenance of conveying equipment. Packaging material characteristics and selection. Packaging techniques and equipment for liquid, powder and granular materials, and horticultural produce. Transportation of agro-produce by bullock-carts, trailers, trucks, rail wagons and containers. Refrigerated containers and trucks for perishable foods. Safety standards in handling, packaging and transport of agricultural produce. Types of packaging materials, barrier properties, CFB Boxes, modified atmosphere packaging, smart and active packaging, Edible films, Antioxidant and anti microbial packaging, Micro and nano-encapsulation cold chain management. Refrigerated containers and trucks for perishables. Damage and losses during transportation.

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

Unit 6: Processing Technology and Processing Equipment Design
Pre-milling/conditioning treatments. Theory of grain drying, thin layer and deep bed drying, Process technology and machinery for cereals, pulses, oil seeds, fruits, vegetables, flowers, spices, condiments, plantation crops, animal products, sea-foods, fiber crops, animal feed, natural resins and gums, Bioprocess engineering, enzyme reaction kinetics, Industrial fermentation and processing, down-stream processing, bio-separation. Minimal processing of fruits and vegetables, high pressure processing, Ohmic heating, ultraviolet light, pulsed electric field, pulsed light field, micro and nano encapsulation of food ingredients, Food nanotechnology, Seed processing and technology, Agricultural byproducts/residue utilization, Waste disposal of food processing plants, different methods and equipment.

Design of grain cleaners, graders, dryers, parboiling plants, size reduction machines, bioreactors, fermenters, centrifuges, cyclones, heat-exchanger, evaporators, filters, extrusion cookers. Computer aided design and analysis of machines and machine components. Materials, manufacturing processes, design of elements and selection of standard parts (pulley, chains, sprockets, bearings, belts, fasteners, hydraulic components, pipes, hoses).

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

Unit 8: Agri-Project Planning and Management

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.

Unit 9: Aquaculture Processing Technology & Structures Design

Inland fish farming and associated considerations, Site selection for aquaculture design of dykes, sluice, channels etc, Fish Physiology and micro-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. Recirculation of water, Reuse systems, water exchange, Design of re-use systems. Inlet and outlet structures, water treatment plants.

Unit 10: Dairy Engineering, Instrumentation and Process Control

Principles of dairy equipment design, Design of Vessels, Design of milk storage tank, Design considerations for Heat exchangers, Design of reaction vessels, evaporators, pasteurizers, cream separators, Homogenizers, Butter churn, Drum dryer, Spray dryer.

Vapour compression refrigeration system, Vapour absorption refrigeration system, Heat pumps, Design of refrigeration equipment, Design of cold storage and air conditioning system. Advanced dairy processes, their operations & design, UHT processing, Adsorption and Sorption processes, Electrodialysis, Aeration and gas transfer, Dairy plant maintenance.

Static and dynamic characteristics of lnstruments, Transducer 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, Data loggers, Data Acquisition systems (DAS). Introduction to Direct digital Control (DDC), supervisory control and Data Acquisition Systems (SCADA), Virtual Instrumentation.