

SYLLABUS FOR Paper-II- SPECIFIC PAPER

(as per Rule (6)(1)(a)(ii) of the Karnataka Civil Services (Direct Recruitment)
(General) Rules, 2021)

POST: Agricultural Officer (15%) and Assistant Agricultural Officer (15%)

Qualification: B.Tech(Food Science and Technology)/ B.Tech(Food Technology) or B.Sc. Agriculture Marketing and Co-operation)/ B.Sc.(Hons.) Agri Marketing and Co-operation)/ B.Sc.(Hons.) Agri Business Management or B.Sc. (Agri bio-technology)/ B.Tech (Bio-technology)/ or B.Sc (Agricultural Engineering)/ B.Tech (Agricultural Engineering)

1. AGRICULTURAL MARKETING

Definition and concepts, market and marketing- Input, output and agricultural marketing – Evolution and development of marketing. Concept of marketing, Importance and Significance of Marketing.

Classification of Markets: According to nature of commodities- On the basis of location:- On the basis of Area Coverage, on the basis of Time Span, on the basis of Nature of Transactions, on the basis of degree of competition, on the basis of Stage of Marketing, on the basis of extent of public intervention-Approaches to study marketing problems of agricultural commodities-Functional, Institutional, Commodity, Behavioral system, Structural and Managerial approach.

Marketing Functions: Meaning and classification. Exchange Function- Buying and selling, Sales of Agricultural commodities- Under cover method, by open auction, by private agreement by quoting samples, Dara sales method, Close tender system and Moghum sale- Types of buying: Buying for consumption and buying for sale. Physical Function: Transportation, Storage, Processing & Warehousing. Transportation- Storage, Processing: packaging and warehousing-grading and standardization-financing. Management of marketing risks: Economic risk, natural, human, business, price, and credit risks, Minimization of risks.

Management Information: Meaning, importance, types of market information. Market intelligence and news - Criteria for good marketing information. Agricultural Marketing Research Institutions: DMI, SAMBs, ICAR, NCAER, SAUs, International Institutions: CAM and ISAM. Marketing Institutions: Agencies and Marketing Channels. Definition of market structure, conduct and performance, efficiency, marketing cost, margin, price spread and integration. Producers' surplus of agricultural commodities: Marketable and marketed surplus. Regulation of agricultural marketing: Objectives, importance, characteristics of good markets, and ideal system of agricultural marketing. Scientific Marketing of Farm products.

Concepts of retailing, concept of traditional retailing, concept of modern retailing, advantages and disadvantages.

2. INPUT MARKETING

Nature, scope and significance, Input marketing and output marketing. Theoretical framework of factor pricing under different market types, Demand for and supply of Agri inputs, owned inputs and purchased inputs.

Fertilizer marketing - production, consumption and distribution Types-Nutrients-NPK, Marketing channels, MARKFED, Import of fertilizer materials and fertilizer, Government policies, retention price, subsidy, decontrol and pricing policies.

Seed Marketing- Types of seeds, production, contract seed production, seed certification, labeling, packing and distribution, private and public sector seed COs, MNCs. Institutional arrangements, State Seed Farms Corporation, NSC, state seeds corporation. Demand supply, forecasting, government policies., Import and Export. National seed policy.

Plant Protection Chemicals - Types, Pesticides, insecticides and fungicides, production and consumption, Industry structure, Brands, quality, Distribution, Government polices.

Groundwater Marketing-factors affecting groundwater markets, power pricing, equity and sustainability, pricing of groundwater.

Labour Market- Types, wage differentials, supply and demand. Farm machineries- Types, pre harvest and post harvest, production, Market structure, Marketing channels, constraints to mechanization, pricing. Government Policy.

3. PRINCIPLES OF MANAGMENT

Introduction to Management: Managing and Managers- Types of managers- Managerial roles- Management skills.

Evolution of Management theory: Classical Management Theory- Scientific Management- Administrative Management- Human Relations School-Systems Theory- Contingency Theory.

Ethics and Social Responsibility: Meaning-managing company ethics and social responsibility Management Process Planning: Essentials of Planning. Essential of decision making Organizing: Organizational design and organizational structure. Power and distribution of Authority.

Human Resource Management. Managing organizational change and innovation Leading: Motivation- theories of motivation. Leadership-theories of leadership. Communication. Controlling: Essential Element of Controlling.

4. MARKETING MANAGEMENT

Introduction: Concept and Scope of marketing management, Marketing Management tasks- Philosophies of marketing management-Developing marketing strategies and plans-Analyzing macro environment - Company objectives, growth strategy and portfolio plan. Forecasting and demand measurement - Analyzing consumer markets -Identifying market segments and targets. Creating Brand Equity. Brand positioning - Dealing with competition Product Management and strategy- Developing pricing strategies programmes -Designing and managing value networks and channels - Managing Retailing, wholesaling and logistics - Direct marketing and personal selling- Advertising, sales promotion, events and public relations.

Introducing new market offerings.

Developing marketing strategies and plans-Gathering information and scanning the environment.

5. PRINCIPLES AND PRACTICE OF CO-OPERATION

Concept of cooperation-Origin of cooperative movement-Principles of cooperation-Main features of cooperative organizations – Historical development of cooperative movement- Recent trends.

Agricultural and Non Agricultural cooperative- Primary Agricultural Credit Societies (PACS) – Farmers Service Societies (FSS) – Large Sized Agricultural Multi Purpose Societies (LAMPS) – District Central Cooperative Banks-State Cooperative Banks – PCARDBs- Cooperative Marketing Societies – Processing Cooperatives Dairy Cooperatives – Consumer Cooperatives- Urban Cooperative Banks- Industrial Cooperatives.Cooperative education and training – Need and purpose – Training – organizational structure – NCUI-NCCE-NCCT-VMNICM-RICM-ICM and other institutions.

The State and the Cooperative Movement – An overview – evolution of relationship in Western and developing countries – Basis of future relationship.

Cooperative legal system – Karnataka State Cooperative Societies Act 1959, Karnataka Souhardha Sahakari Act, 1997 – Multi State Cooperative Act, 2002 – Review of important provisions of state cooperative societies Act and Rules.

Cooperative movement in retrospect – achievements – crisis in the movement – The agenda for the future.

6. SOIL AND WATER ENGINEERING

Building Materials: Rocks, Stones, Bricks Properties and varieties of Tiles, Lime, Cement, Concrete, Sand. Glass, Rubber, Plastics, iron, Steel, Aluminium, Copper, Nickle. Timber. Building components: Lintels, Arches, stair cases, Different types of floors, Finishing: Damp Proofing and water proofing, Plastering, pointing, white washing and distempering – Painting, Building design, Design procedures, Technology, building construction, Types of agricultural buildings and related needs, application of design theory and practice to the conservation, sloped and flat roof buildings, construction economics: Preliminary estimates, Detailed Estimates of Buildings source of cost information, use of cost analyses for controlling design, Factors affecting building costs; cost evaluation of design and planning alternatives for building and estate development, Measurement and pricing, Economic methods for evaluating investments in buildings and building systems: cost-in-use, benefit-to-costs and savings-to-investment ratios, rate of return, net benefits, payback.

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.

Introduction of soil mechanics, field of soil mechanics, phase diagram, physical and index properties of soil, classification of soils, effective and neutral stress, elementary concept of Boussinesq and Westergaard's analysis, new mark influence chart. Shear strength, Mohr stress circle, theoretical relationship between principal stress circle, theoretical relationship between principal stress, Mohr coulomb failure theory, effective stress principle. Determination of shear parameters by direct shear test, triangle test & vane shear test. Numerical exercise based on various types of tests. Compaction, composition of soils standard and modified proctor test, abbot 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 exercises. Stability of slopes: introduction to stability analysis of infinite and finite slopes friction circle method, Taylor's stability number.

Surveying: Introduction, classification and basic principles, Linear measurements. Chain surveying. Cross staff survey, Compass survey. Planimeter, Errors in measurements, their elimination and correction. Plane table surveying. Levelling, Leveling difficulties and error in levelling, Contouring, Computation of area and volume. Theodolite traversing. Introduction to setting of curves. Total station, Electronic Theodolite. Introduction to GPS survey.

Watershed - introduction and characteristics. Watershed development - problems and prospects, investigation, topographical survey, soil characteristics, vegetative cover, present land use practices and socio-economic factors. Watershed management - concept, objectives, factors affecting, watershed planning based on land capability classes, hydrologic data for watershed planning, watershed codification, delineation and prioritization of watersheds - sediment yield index. Water budgeting in a watershed. Management measures - rainwater conservation technologies - *in-situ* and *ex-situ* storage, water harvesting and recycling. Dry farming techniques - inter-terrace and inter-bund land management. Integrated watershed management - concept, components, arable lands - agriculture and horticulture, non-arable lands - forestry, fishery and animal husbandry. Effect of cropping systems, land management and cultural practices on watershed hydrology. Watershed programme - execution, follow-up practices, maintenance, monitoring and evaluation. Participatory watershed management - role of watershed associations, user groups and self-help groups. Planning and formulation of project proposal for watershed management programme including cost-benefit analysis.

7. FARM POWER AND MACHINERY ENGINEERING

Introduction to various carpentry tools, materials, types of wood and their characteristics and Processes or operations in wood working; Introduction to Smithy tools and operations; 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.

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, 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, single phase induction motor: construction, operation, 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, various methods of three phase power measurement; power factor, reactive and apparent power.

Concept and limitation of Renewable Energy Sources (RES), Criteria for assessing the potential of RES, Classification of RES, Solar, Wind, Geothermal, Biomass, Ocean energy sources, Comparison of renewable energy sources with non renewable sources. Solar Energy: Energy available from Sun, Solar radiation data, solar energy conversion into heat through, Flat plate and Concentrating collectors, different solar thermal devices, Principle of natural and forced convection drying system, Solar Photo voltaics: p-n junctions. Solar cells, PV systems, Stand alone, Grid connected solar power station, Calculation of energy through photovoltaic power generation and cost economics. Wind Energy: Energy available from wind, General formula, Lift and drag. Basis of Wind energy conversion, Effect of density, Frequency variances, Angle of attack, Wind speed, Types of Windmill rotors, Determination of torque coefficient, Induction type generators, Working principle of wind power plant.

Introduction to farm mechanization. Classification of farm machines. Unit operations in crop production. Identification and selection of machines for various operations on the farm. Hitching systems and controls of farm machinery. Calculation of field capacities and field efficiency. Calculations for economics of machinery usage, comparison of ownership with hiring of machines. Introduction to seed-bed preparation and its classification. Familiarization with land reclamation and earth moving equipment. Introduction to machines used for primary tillage, secondary tillage, rotary tillage, deep tillage and minimum tillage. Measurement of draft of tillage tools and calculations for power requirement for the tillage machines. Introduction to tillage machines like mould-board plough, disc plough, chisel plough, sub-soiler, harrows, cultivators, Identification of major functional components. Attachments with tillage machinery. Introduction to sowing, planting & transplanting equipment. Introduction to seed drills, no-till drills, and strip-till drills. Introduction to planters, bed-planters and other planting equipment. Study of types of furrow openers and metering systems in drills and planters. Calibration of seed-drills/ planters. Adjustments during operation. Introduction to materials used in construction of farm machines. Heat treatment processes and their requirement in farm machines. Properties of materials used for critical and functional components of agricultural machines. Introduction to steels and alloys for agricultural application. Identification of heat treatment processes specially for the agricultural machinery components.

Bio-energy: Pyrolysis of Biomass to produce solid, liquid and gaseous fuels. Biomass gasification, Types of gasifier, various types of biomass cook stoves for rural energy needs. Biogas: types of biogas plants, biogas generation, factors affecting biogas generation and usages, design consideration, advantages and disadvantages of biogas spent slurry. An overview of aerobic and anaerobic fermentation processes and their industrial application. Heat transfer processes in anaerobic digestion systems, land fill gas technology and potential. Biomass Production: Wastelands, classification and their use through energy plantation, selection of species, methods of field preparation and transplanting. Harvesting of biomass and coppicing characteristics. Biomass preparation techniques for harnessing (size reduction, densification and drying). Thermo-chemical degradation. History of small gas producer engine system. Chemistry of gasification. Gas producer – type, operating principle. Gasifier fuels, properties, preparation, conditioning of producer gas. Application, shaft power generation, thermal application and economics. Trans-esterification for biodiesel production. A range of bio-hydrogen production routes. Environmental aspect of bio- energy, assessment of greenhouse gas mitigation potential.

8. PROCESSING AND FOOD ENGINEERING

Classification and importance of engineering properties of Agricultural Produce, shape, size, roundness, sphericity, volume, density, porosity, specific gravity, surface area of grains, fruits and vegetables,

Thermal properties, Heat capacity, Specific heat, Thermal conductivity, Thermal diffusivity, Heat of respiration; Co-efficient of thermal expansion, Friction in agricultural materials;

Static friction, Kinetic friction, rolling resistance, angle of internal friction, angle of repose, Flow of bulk granular materials, Aero dynamics of agricultural products, drag coefficients, terminal velocity. Rheological properties; force, deformation, stress, strain, elastic, plastic and viscous behaviour, Newtonian and Non-Newtonian liquid, Visco-elasticity, Newtonian and Non-Newtonian fluid, Pseudo-plastic, Dilatant, Thixotropic, Rheopectic and Bingham Plastic Foods, Flow curves. Electrical properties; dielectric loss factor, loss tangent, A.C. conductivity and dielectric constant, method of determination. Application of engineering properties in handling processing machines and storage structures.

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. Carnot cycle, Carnot theorem. Entropy, physical concept of entropy, change of entropy of gases in thermodynamics process. Otto, diesel and dual cycles. Principles of refrigeration, - units, terminology, production of low temperatures, air refrigerators working on reverse Carnot cycle and Bell Coleman cycle. Vapour refrigeration-mechanism, P-V,

P-S, P-H diagrams, vapor compression cycles, dry and wet compression, super cooling and sub cooling. Vapour absorption refrigeration system. Common refrigerants and their properties. Design calculations for refrigeration system. Cold storage plants. Thermodynamic properties of moist air, perfect gas relationship for approximate calculation, adiabatic saturation process, wet bulb temperature and its measurement, psychometric chart and its use, elementary psychometric process. Air conditioning – principles – Type and functions of air conditioning, physiological principles in air conditioning, air distribution and duct design methods, fundamentals of design of complete air conditioning systems – humidifiers and dehumidifiers – cooling load calculations, types of air conditioners – applications.

Importance of processing of fruits and vegetables, spices, condiments and flowers. Characteristics and properties of horticultural crops important for processing, Peeling: Different peeling methods and devices (manual peeling, mechanical peeling, chemical peeling, and thermal peeling), Slicing of horticultural crops: equipment for slicing, shredding, crushing, chopping, juice extraction, etc., Blanching: Importance and objectives; blanching methods, effects on food (nutrition, colour, pigment, texture), Chilling and freezing: Application of refrigeration in different perishable food products, Thermophilic, mesophilic & Psychrophilic micro-organisms, Chilling requirements of different fruits and vegetables, Freezing of food, freezing time calculations, slow and fast freezing, Equipment for chilling and freezing (mechanical & cryogenic), Effect on food during chilling and freezing, Cold storage heat load calculations and cold storage design, refrigerated vehicle and cold chain system, Dryers for fruits and vegetables, Osmo-dehydration, Packaging of horticultural commodities, Packaging requirements (in terms of light transmittance, heat, moisture and gas proof, micro organisms, mechanical strength), Different types of packaging materials commonly used for raw and processed fruits and vegetables products, bulk and retail packages and packaging machines, handling and transportation of fruits and vegetables, Pack house technology, Minimal processing, Common methods of storage, Low temperature storage, evaporative cooled storage, Controlled atmospheric storage, Modified atmospheric packaging, Preservation Technology, General methods of preservation of fruits and vegetables, Brief description and advantages and disadvantages of different physical / chemical and other methods of preservation, Flowcharts for preparation of different finished products, Important parameters and equipment used for different unit operations, Post harvest management and equipment

for spices and flowers, Quality control in Fruit and vegetable processing industry. Food supply chain.

9. BASIC ENGINEERING

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.

Semiconductors, P-n junction, V-I characteristics of P-n junction, diode as a circuit element, rectifier, clipper, clamper, voltage multiplier, filter circuits; Diode circuits for OR and AND (both positive and negative logic). Bipolar Junction Transistor (BJT): Operating point, classification (A, B and C) of amplifier, various biasing methods (fixed, self, potential divider); Coupling of amplifiers, 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 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 adder, D/A converter and generalized instrumentation, measurement of displacement, temperature, velocity, force and pressure using potentiometer, resistance thermometer, thermocouples.

10. FOOD SCIENCE AND NUTRITION

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 and 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, functions and changes during cooking. Meat, poultry and fish - kind, structure, composition, pigments, factors affecting tenderness, postmortem changes and changes during cooking. Sugars - types, composition, manufacturing process, effect of heat and acid, functions in cookery. Honey - classification, composition, physical and chemical properties, purity standards, food and nutritional value, handling, processing, testing and storage. Royal jelly - production, composition, food and nutritional value. Fats and oils - kinds, composition, effect of heat, functions in cookery, processing techniques and rancidity of fats. Brief overview of beverages. Condiments and spices - importance in daily life. Introduction to processed and convenience foods - precooked, ready to eat, frozen, dehydrated foods and instant food mixes.

Sources, types and perishability of foods; Causes and types of food spoilage; Scope and benefit of food preservation; Methods of food preservation; Preservation by salt and sugar: Principle, method and effect on food quality. Preservation by heat treatment: Principle and equipment for blanching, canning, pasteurization, sterilization; Preservation by use of low temperature: Principle, methods, equipment; Preservation by drying, dehydration and concentration: Principle, methods, equipment; Preservation by irradiation: Principle, methods, equipment; Preservation by chemicals-antioxidants, mould inhibitors, antibiotics, acidulants, etc.; Preservation by fermentation: Principles, methods, equipment; Non thermal preservation processes: Principles, equipment – Pulsed electric field

and pulsed intense light, ultrasound, sonication, dielectric heating, ohmic and infrared heating, high pressure processing, microwave processing; Quality tests and shelf-life of preserved foods.

Intentional and unintentional food additives, their toxicology and safety evaluation; Naturally occurring food additives; Food colors and dyes: Regulatory aspects of dyes, food colors (natural and artificial), pigments and their importance and utilization as food color; Processing of natural and artificial food colorants; Food preservatives and their chemical action. Role and mode of action of salts, chelating agents, stabilizers and thickeners; Humectants/ polyhydric alcohol, anti-caking agent, firming agent, flour bleaching and maturing agents, antioxidants, nutritional and non-nutritional sweeteners; Production of enzymes, leavening agents, fat substitutes, flavor and taste enhancers in food processing; Acidity regulators; Emulsifiers.

11. FOOD PROCESSING TECHNOLOGY

Historical development of dairying in India; Production and utilization of milk; Composition and properties of milk; Liquid milk collection, preservation, processing, packaging and storage; Equipment for milk processing: bulk milk cooler, milk chilling unit, milk reception equipment, filtration unit, clarifier, milk tank/silo, pasteurizer, sterilizer, centrifuge, homogenizer, packaging and filling machines and CIP units; Hygienic design concepts, sanitary pipes and fittings, corrosion process and its control. Adulteration in milk and its detection; Types of milk: reconstituted/rehydrated milk, recombined milk, standardized milk, skim milk, sterilized milk and flavoured milk. Quality defects in milk, causes and prevention. Cream: definition, classification, processing and manufacture of different types; Fermented milk products: Processing, manufacture, storage and packaging of dahi / cultured buttermilk, acidophilus milk and yoghurt; Bio chemical changes occurring during manufacture offermented milks, factors affecting these changes and effects of these changes on the quality of finished products.

Food packaging in India and world; Need for packaging; Package requirements and functions; Packaging materials: Paper – manufacture and types of paper, advantages of corrugated and paper board boxes; Glass–manufacture, advantages, disadvantages; Metal (Aluminium / tin / SS) – manufacture, advantages, disadvantages; Plastic – classification of polymers, properties and uses of plastics; Classification of packages; Lamination; Coating on paper and films; Moulding – injection, blow, extrusion; Aseptic packaging: need, advantages, process, materials used, comparison with conventional packaging; Permeability: theoretical considerations, permeability of gases and vapours, permeability of multilayer materials, permeability in relation to packaging requirement of foods; Transport properties of barrier materials; Simulations of product: package environment interaction; Packaging of specific foods; Mechanical and functional tests on package.

12. FOOD SAFETY AND QUALITY

Evolution and scope of microbiology; History of microbiology; Microbial classification, nomenclature and identification; Taxonomic groups; General methods of classifying bacteria; Microscopy and microscopes: Smears and staining; Morphology and fine structure of bacteria; Cultivation of bacteria, nutritional requirements; Bacteriological media; Nutritional classification of bacteria; Phototrophs, chemotrophs, autotrophs and heterotrophs; Obligate parasites; Growth of bacteria, Stages of growth curve; Generation time; Reproduction of bacteria; Introduction to fungi, algae and protozoa and virus; Nutrient transport phenomenon: Passive diffusion, facilitated diffusion; Group translocation, active transport. Microbial genetics; Bacterial recombination; Bacterial conjugation, transduction; Bacterial transformation; Mutations: Types of mutations, mutagenesis;

Mutation rate, repair of mutations; Phenotypes of bacterial mutants; Designation of bacterial mutants; Destruction of microorganisms: Physical agents and chemical agents; Chemotherapeutic agents and chemotherapy; Characteristics of antibiotics; Mode of action of antibiotics; Pure culture: Methods of isolation of pure cultures; Maintenance and preservation of pure cultures; Culture collections.

History of industrial microbiology; Primary and secondary metabolites produced by the microorganisms; Screening of microorganisms; Organizations involved in microbiological work; Fermentation media, Industrial sterilization; Definition, thermal death time, media heat sterilization, advantages of continuous sterilization, Fermentor: Components of a fermentor, parts of fermentors, peripheral parts and accessories, additional accessories and peripherals. Types of fermentors: Types of fermentations; Submerged liquid fermentation and solid state fermentation; Importance of fermentation in food industry, types of food fermentations. Industrially important secondary metabolites; and microorganisms involved; Probiotics: Importance, role in fermented foods, organisms involved, beneficial effects; Bacteriocins; Nisin: Production of microbial enzymes; Downstream processing of enzymes; Cell disruption methods: Mechanical disruption methods and non-mechanical disruption methods; Extraction; Purification; Concentration; Product recovery.

13. FOOD PROCESS ENGINEERING

Basic concepts: definitions, approaches, thermodynamic systems, thermodynamic properties and equilibrium, state of a system, state diagram, path and process, different modes of work, Zeroth law of thermodynamics, concept of temperature, heat; First law of thermodynamics: Energy, enthalpy, specific heats, applications of first law, Second law of thermodynamics: Kelvin-Planck and Clausius statements, reversible and irreversible processes, thermodynamic temperature scale, entropy, availability and irreversibility; Properties of Pure Substances: Thermodynamic properties of pure substances in solid, liquid and vapor phases, P-V-T behaviour of simple compressible substances, phase rule; Thermodynamic cycles: Carnot vapour power cycle, ideal Rankine cycle, Rankine Reheat cycle, air standard Otto cycle, air standard Diesel cycle, air-standard Brayton cycle, vapor-compression refrigeration cycle; Psychrometry: thermodynamic properties of moist air, perfect gas relationship, absolute humidity, relative humidity, percentage humidity, humid volume, total heat, enthalpy, dry bulb temperature, wet bulb temperature, dew point temperature, adiabatic processes, wet bulb depression, humid heat, specific volume, heating, cooling, dehumidifying, sorption isotherms, three stages of water, phase diagram for water, vapour pressure temperature curve for water, heat requirement for vaporization, measurement of humidity, Properties of steam: Wet, dry saturated, superheated steam, use of steam tables.

Principles of refrigeration: Definition, background with second law of thermodynamics, unit of refrigerating capacity, coefficient of performance; Production of low temperatures: Expansion of a liquid with flashing, reversible/ irreversible adiabatic expansion of a gas/ real gas, thermoelectric cooling, adiabatic demagnetization; Air refrigerators working on reverse Carnot cycle: Carnot cycle, reversed Carnot cycle, selection of operating temperatures; Air refrigerators working on Bell Coleman cycle: Reversed Brayton or Joule or Bell Coleman cycle, analysis of gas cycle, polytropic and multistage compression; Vapour refrigeration: Vapor as a refrigerant in reversed Carnot cycle with p-V and T-s diagrams, limitations of reversed Carnot cycle; Vapour compression system: Modifications in reverse Carnot cycle with vapour as a refrigerant (dry Vs wet compression, throttling Vs isentropic expansion), representation of vapor compression cycle on pressure-enthalpy diagram, super heating, sub cooling; Liquid-vapour regenerative heat exchanger for vapour compression system, effect of suction vapour super heat and liquid sub cooling, actual vapour compression cycle; Vapour-absorption

refrigeration system: Process, calculations, maximum coefficient of performance of a heat operated refrigerating machine, Common refrigerants and their properties: classification, nomenclature, 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 and systems of ice production, Treatment of water for making ice, brines, freezing tanks, ice cans, air agitation, quality of ice; Food freezing: Introduction, freezing point curve for food and water, freezing points of common food materials, Principles of food freezing, freezing time calculation by using Plank's equation; Freezing systems; Direct contact systems, air blast immersion; Changes in foods; Frozen food properties; freezing time, factors influencing freezing time, freezing/thawing time; Freeze concentration: Principles, process, methods; Frozen food storage: Quality changes in foods during frozen storage; Freeze drying: Heat mass transfer during freeze drying, equipment and practice; Cold storage: Cold store, design of cold storage for different categories of food resources, size and shape, construction and material, insulation, vapour barriers, floors, frost heave, automated cold stores, Refrigerated transport: Handling and distribution, cold chain, refrigerated product handling, refrigerated vans, refrigerated display; Air-conditioning: Meaning, factors affecting comfort air-conditioning, classification, sensible heat factor, industrial air-conditioning, problems on sensible heat factor; Winter/summer/year round air-conditioning, unitary air-conditioning systems, central air-conditioning, physiological principles in air-conditioning, air distribution and duct design methods; design of complete air-conditioning systems; humidifiers and dehumidifiers; Cooling load calculations: Load sources, product cooling, conducted heat, convected heat, internal heat sources, heat of respiration, peak load; etc.

14. FOOD BUSINESS MANAGEMENT

Introduction to economics: Definitions, nature, scope, difference between microeconomics and macroeconomics; Theory of demand and supply, elasticity of demand, price elasticity and income elasticity; Markets: Types of markets and their characteristics; National income: GDP, GNP, NNP, disposable personal income, per capita income, inflation; Theory of production: Production function, factors of production. Law of variable proportions and returns to scale; Cost: Short run and long run cost, fixed cost, variable cost, total cost, average cost, marginal cost, opportunity cost; Break even analysis; Management definitions, management principles, scientific principles, administrative principles; Maslow's Hierarchy of needs theory; Functions of management: Planning, organizing, staffing, directing, controlling; Organizational structures, principles of organization; Types of organization: Formal and informal, line, line and staff, matrix, hybrid; Finance management: Definition, scope, objective; Time value of money and its accounting, Different systems of accounting: Financial accounting, cost accounting, management accounting; Human resource management: Definitions, objectives of manpower planning, process, sources of recruitment, process of selection; Corporate social responsibility: Importance, business ethics.

Communication –Meaning, definition, models, elements and their characteristics, types. Barriers in communication. Communication skills: Structural and functional grammar, meaning and process of communication, verbal and non-verbal communication. Role of ICT in communication, recent advances in communication- internet, cyber cafe, video and tele conference, Kisan call Center and e-governance. Meaning and definition of personality, theoretical perspectives on personality- Behavioural trait and humanistic personality pattern; moulding the personality patterns. Personality development –self perception, self esteem and gender stereotyping, persistence and changes in personality determinants (physical, intellectual, emotional, social, educational and family).

15. PLANT BIOTECHNOLOGY

Origin and evolution of cell; Introduction to microscopy; Sub-cellular structure of prokaryotic and eukaryotic cells; Membrane structure and function: plasma membrane, cell wall and extracellular matrix; Structural organization and function of intracellular organelles and organelle biogenesis: Nucleus, mitochondria, endoplasmic reticulum, Golgi apparatus, lysosomes, peroxisomes, plastids, vacuoles. Membrane modifications in functioning cell to cell interaction – gap junction desmosomes, tight junctions, plasmodesmata. Cell surface component and their role in cell recognition and function of cytoskeleton and its role in motility; Cell membrane transport; Introduction to cell signaling; Cell growth, cell cycle and its control; Cell death and cell renewal.

History, definitions, concepts, scope and importance of Biotechnology: Plant, microbial, animal, medical, environmental, industrial, Marine, Agricultural and food Biotechnology; Nanobiotechnology. Introduction to recombinant DNA technology and its applications: Vectors, DNA restriction and modifying enzymes, gene cloning; Introduction to genomics and proteomics: Molecular markers, DNA sequencing; Genetic transformation and transgenic organisms; Bioinformatics. Biosafety guidelines.

History of molecular biology; Central dogma of life; Structure of DNA and RNA; Gene structure and function; DNA replication; transcription; Genetic code and translation in prokaryotes and Eukaryotes; Structure of prokaryotic and eukaryotic nuclear and organelle genomes; Gene regulation in prokaryotes: Lac operon concept, tryp concept. Biosynthesis of purines pyrimidines and their regulation. Introduction to microbial genetics; conjugation, transformation and transduction; Tools in molecular biology: Role of enzymes in molecular biology; Principles of Polymerase Chain Reaction; Electrophoresis; PCR and hybridization based molecular markers.

History of plant tissue culture; concept of totipotency; Concept of aseptic culture practices; Components of *in vitro* culture media and role of different macro and micro nutrients, vitamins, plant growth regulators and growth supplements; Sterilization techniques. Various plant cell, tissue and organ culture techniques and uses; Somatic cell cultures; morphogenesis: organogenesis and somatic embryogenesis; Micropropagation: *In vitro* grafting, meristem culture; Anther, pollen, embryo, ovule, ovary culture; Protoplast culture and somatic hybridization; Somaclonal variation.

16. MICROBIAL AND ENVIRONMENTAL BIOTECHNOLOGY

Food Biotechnology: Introduction, history and importance; Applications of biotechnology in food processing: Enzymes for food processing such as beta-galactosidase, chymosin, glucose isomerase and α -amylase. Recent developments and application of biotechnology in quality and quantity improvement of functional foods from plant sources–Vitamin, carotene, anthocyanin, proteins, Starch and oil, risk factors and safety regulations; Food spoilage and preservation process; Food and beverage fermentation: Alcoholic and non alcoholic beverages, food additives and supplements. Industrial use of micro organisms; Commercially exploited microbes: *Saccharomyces*, *Lactobacillus*, *Penicillium*, *Acetobactor*, *Bifidobacterium*, *Lactococcus* and *Streptococcus*; Dairy fermentation and fermented products; Prebiotics and probiotics; Genetic engineering for food quality and shelf life improvement; Bioactive peptides; Labelling of GM foods.

17. BIOCHEMISTRY

Biochemistry- Introduction and importance, Plant cell- Structure and organellar functions. Biomolecules–Structure, properties and reactions: amino acids, peptides and proteins, lipids,

carbohydrates, nucleotides and nucleic acids. Enzymes- Factors affecting the activities, classifications, immobilization and other industrial applications. Metabolism – Basic concepts. glycolysis, citric acid cycle, pentose phosphate pathway -oxidation of fatty acids, electron transport and oxidative phosphorylation. General reactions of amino acids degradation. Metabolic regulation. Secondary metabolites- terpenoids, alkaloids, phenolics.

Principles and techniques of Chromatography - adsorption, partition, and ion-exchange, affinity. Gas chromatography, HPLC and their application. Precipitation of biomolecules- salt, solvent, pH, Dialysis. Centrifugation techniques and their application – Differential, density gradient and ultra centrifugation. Principle of electrophoresis, AGE, Native PAGE, SDS-PAGE, Iso-electric Focusing Amino acid analysis and Protein sequencing, Nucleic acid sequencing, Blotting techniques- Southern, Northern and Western Blotting.

18. BIOINFORMATICS

Introduction to bioinformatics; scope of bioinformatics; Importance of computers in biological data processing local and remote-server based data processing. Physical and virtual links to remote data servers, Different Internet protocols for remote data access. Major biological data resources accessible through World Wide Web. Introduction to biological database and different data structures, Primary databases: Nucleotide sequence databases (GenBank, EMBL), protein sequence databases; Secondary databases: SwissProt/ TrEMBL, conserved domain database, Pfam; Macro molecule Structure databases: Protein Data Bank (PDB), MMDB, SCOP, CATH; File formats: Genbank, EMBL, Fasta, PDB, Flat file, ASN.1, XML. Introduction to sequence alignment and its applications: Pair wise and multiple sequence alignment, concept of local and global alignment; Algorithms: Dot Matrix method, dynamic programming methods (Needleman–Wunsch and Smith–Waterman); Tools of MSA: ClustalW, Toffee; Phylogeny; Introduction to BLAST and FASTA.