TAMIL NADU PUBLIC SERVICE COMMISSION

SYLLABUS

Dairy Technology

(UG Degree Standard)

Code: 456

UNIT I:

Market Milk

Market milk industry in India and abroad: Collection and transportation of milk; a) Organization of milk collection routes b) Practices for collection of milk, preservation at farm, refrigeration, natural microbial inhibitors, lacto peroxidase system. Reception and treatment (pre-processing steps) of milk in the dairy plant: - Homogenisation: Standardization of milk – pearson square and algebraic methods Thermal processing of milk - Defects in market milk - Manufacture of special milks: toned, doubled toned, reconstituted, recombined, flavoured, homogenized, vitaminised and sweet acidophilus milk - Manufacture of sterilized milk, UHT-Distribution systems for market milk - Effect of heat processing on nutritive value.

Fat Rich Dairy Products

Cream-Butter-Ghee and butter oil Status of fat-rich dairy products in India and abroad. Cream: a) Definition & Legal standards, efficiency of cream separation and factors affecting it; control of fat concentration in cream. b) Neutralization, standardization, pasteurization and cooling of cream. c) Preparation and properties of different types of cream; table cream, sterilized cream, whipped cream, plastic cream, frozen cream and chip-dips (cultured cream) d) Factors affecting quality of cream; ripening of cream e) Packaging, storage and distribution, defects (non-microbial) in cream and their prevention.

Butter: a) Introduction to the butter making process; theory of churning, legal standards. b) Technology of Butter manufacture, Batch and continuous methods. Over-run in butter; control of fat loses in butter-milk; packaging and storage; transportation; defects in butter; rheology of butter; uses of butter. Butter making equipment: Construction, operation, care and maintenance of cream separators, coolers and vacreator, factory butter churn and continuous butter making machine.

Special butters and related products: a) Manufacture, packaging, storage and properties of whey butter, flavoured butter, whipped butter, renovated butter/fractionated and polyunsaturated milk fat products, vegetable oil-blended products and low-fat spreads. b) Manufacture, packaging, storage and characteristics of margarine of different types.

Ghee and butter oil: a) Methods of ghee making-batch and industrial processes, innovations in ghee production, procedure, packaging and preservation of ghee; utilization of substandard milk. b) Ghee: Composition and changes during manufacture fat constants. c) Butter oil: Manufacture of butter oil, packaging and storage.

Traditional Indian Dairy Products

Khoa:Khoa based sweets: Burfi, Peda, Milkcake, Kalakhand, Gulabjaman and their compositional profile and manufacture practices. Rabri and Basundi:Channa:Channa-based sweets: Rasogolla, Sandesh, Rasomalai. Paneer:Chakka/Maska and Shrikhand: Misti Dahi:Kheer and Payasam: Bio preservative principles in enhancing the shelf-life of indigenous milk products including active packaging.

UNIT II:

Condensed Milk:

Definition and legal standards: Condensed milk, sweetened condensed milk and evaporated milk, manufacturing techniques - Recombined sweetened condensed milk. Grading and quality of raw milk for condensed and evaporated milk, Physico-chemical changes taking place during manufacture of condensed milk, Heat stability of milk and condensed milk and role of stabilizers in the stability of condensed milk, defects in condensed milk, their causes and prevention.

Dried Milks:

Grading and quality of raw milk for dried milks, Manufacture of skim milk powder (SMP), whole milk powders and heat classified powders, Composition of Dried milks, Recovery of Milk powders, Manufacture of infant foods, malted milk foods and other formulated dried products, Cheese spread powder, ice cream powder, cream powder, butter powder, whey powder, Management of condensed and dried milk industry.

Cheese Technology

Definition, standards and classification of cheese. Action of rennet on milk in relation to cheese making. Manufacture of different varieties of cheese: Cheddar, Gouda, Swiss, Mozzarella, Cottage. Enzyme modified cheese (EMC), flavourings, Application of membrane processing in cheese manufacture. Factors affecting yield of cheese. Packaging, storage and distribution of cheese. Accelerated ripening of cheese. Manufacture of

processed cheese, cheese spread and processed cheese foods. Mechanization and automation in cheese processing.

Ice-cream & Frozen Desserts

Definition, classification, composition and standards of ice cream and other frozen desserts, Stabilizers and emulsifiers–calculation and figuring of ice cream mix and yield- their classification, properties and role in quality of ice cream, Thermodynamics of freezing and calculation of refrigeration loads, Types of freezers, refrigeration control/instrumentation - Hygiene, cleaning and sanitation of ice cream plant - Effect of process treatments on the physico-chemical properties of ice-cream mixes and ice cream - Processing and freezing of ice-cream mix and control of over run - Packaging, hardening, storage and shipping of ice-cream - Defects in ice cream, their causes and prevention.

UNIT III :

Packaging of Dairy Products

Characteristics of basic packaging materials: Paper (paper board, corrugated paper, fibre board), Glass, Metal, Plastics, Foils and laminates, retort pouches, Package forms, Legal requirements of packaging materials and product information. Packaging of milk and dairy products. Modern Packaging Techniques; Vacuum Packaging, Modified atmosphere packaging (MAP), Eco-friendly packaging, Principles and methods of package - sterilization, Coding and Labelling of Food packages, Aseptic Packaging (AP Microbiological aspects of packaging materials. Disposal of waste package materials, Packaging Systems. Hazards from packaging materials in food.

Sensory Evaluation of Dairy Products

Terminology related to sensory evaluation. Design and requirements of a sensory evaluation laboratory. Basic principles: senses and sensory perception. Classification of tastes and odours, threshold value. Factors affecting senses, visual, auditory, tactile and other responses. Fundamental rules for scoring and grading of milk and milk products. Procedure and types of tests – difference tests (Paired comparison, due-trio, triangle) ranking, scoring, hedonic scale and descriptive tests. Panel selection, screening and training of judges. Requirements of sensory evaluation, sampling procedures. Milk: score card and its use. Judging and grading of milk-Cream-Butter- Ghee - Fermented milk products- Frozen dairy products: Cheese: cheddar, cottage and other varieties of cheeses. Dried dairy products: Dry milk products, evaporated and condensed milk, khoa and khoa based sweets, paneer, channa and channa based sweets.

UNIT IV :

Dairy Plant Management

Production Management: Definition, Function and structure of Production Management, Production planning & Control, Work study and measurement motion and time study. Efficiency of plant operation: product accounting, setting up norms for operational and processing losses for quantity, fat and SNF, monitoring efficiency. Plant Operations: Energy conservation and Auditing, Product and process control, Control charts, Process Sigma, Efficiency factors, losses, Financial and Managerial efficiency. Provision for Industrial Legislation in India, particularly in dairy industry, Factory Act & Regulations.
Human Resource Management: Safety hazards: hazards prevention, security for plant machinery and the employees, Plant Maintenance. Prevention & Break-down maintenance: Food hygiene: personnel hygiene, plant hygiene, water quality, etc.

Waste Disposal & Pollution Abatement

Wastes discharged from dairy plants: An overview. Wastewater discharged from a) Milk reception dock, b) Liquid milk processing section, c) Butter and ghee manufacturing, d) Ice-cream and condensed milk manufacturing, e) Milk powder manufacturing, f) Cheese and paneer manufacturing, g) fermented milk products - Packaging wastes - Environmental issues in effluent discharge. Waste treatment process in a dairy processing plant: Wastewater treatment operations for a Dairy Processing Plant. Calculation of wastes discharged and the economics thereof.

UNIT V:

Dairy Engineering

Sanitization: Materials and sanitary features of the dairy equipment. Stainless steel, Sanitary pipes and fittings, standard glass piping, plastic tubing, fittings and gaskets, installation, care and maintenance of pipes & fittings. Description, working and maintenance of can washers, bottle washers. CIP cleaning and designing of system – Selection of detergents and sanitizers – Effect of the sanitizers on the surfaces of the metals - Mechanical Separation - Homogenization: -Pasteurization: Care and maintenance of pasteurizers. Sterilization: Care and maintenance of Sterilizers. Packaging machines: Pouch filling machine pre-pack and aseptic filling bulk handling system Principles and working of different types of bottle filters and capping machine, Blow molding machines, Aseptic PET bottle filling machine. Cup filling system. Care and maintenance. Mixing

and agitation: Theory and purpose of mixing. Equipment used for mixing solids, liquids and gases. Different types of stirrers, paddles and agitators.

Boilers and Steam Generation

Fuels: Renewable energy sources:- Operation and maintenance of different types of boilers - Properties of steam - Use of steam tables and Mollier charts, Analysis of energy input in steam generation and heat gain in steam consumption. Steam generators - Introduction to Indian Boiler Regulation Act. Boiler Draught - Air Compressors.

UNIT VI:

Dairy Process Engineering

Evaporation-Drying –Fluidization -Processing equipment-Mechanization and equipment used in manufacture of indigenous dairy products, Ice-cream and Cheese making equipment. Packaging equipment -milk & milk products. Membrane Processing: Ultra filtration, Reverse Osmosis and electro dialysis, Materials for membrane construction, Ultra filtration of milk, Effect of milk constituents on operation, membranes for electro-dialysis.

Refrigeration & Air-conditioning

Basic refrigeration cycles and concepts-Refrigerants:Multi-Pressure Refrigeration Systems: Applications-Multi-evaporators with single stage and multi-stage compression and expansion systems - Refrigeration Equipment and Controls: - Refrigeration Piping: Purpose, Types, Materials, Fittings and Insulation. Design and Balancing of Refrigeration System-Absorption Refrigeration Systems-Cryogenic Freezing- Psychometry – Air - conditioning Systems. Cold Storage.

UNIT VII :

Energy Conservation and Management

Introduction: Energy conservation Act 2001 and its important features, Schemes of Bureau of Energy Efficiency (BEE). Electricity Act 2003, integrated energy policy. Energy management & audit-Energy savings in transformers. Electric motor-selection and application, Energy efficient motors. Variable Speed Drives and Variable Frequency Drives (VFD) and their role in saving electric energy. Bureau of Energy Efficiency (BEE): Power saving guide with "Star Ratings" of electrical appliances: Induction Motors, Air conditioners, Refrigerators and Water Heaters. Industrial Lighting.

High efficiency boilers, improved combustion techniques for energy conservation, Fluidized Bed Combustion and multi fuel capabilities. Energy conservation in steam distribution systems, efficient piping layouts, protective & insulation coverings in utility pipes. Steam conservation opportunities. Upkeep and maintenance of steam auxiliaries and fittings. Energy conservation in Refrigeration and AC systems (HVAC). Maintenance and upkeep of Vacuum lines and Compressed air pipe lines. Conservation and reuse of water, water auditing. Energy conservation opportunities in Wastewater treatment. Improving efficiency and energy conservation opportunities in Thermal processes, Evaporation, Drying & Freezing. Role of steam traps in energy saving. Energy Savings methods in hot air generator, Thermic fluid heater, Steam radiator. Carbon credits and carbon trade: Concepts of CDM, economic and societal benefits. Cleaner energy sources: Role of automation in conservation of energy in dairy and food processing: Incorporation of enhanced PLC based computer controls and SCADA.

Dairy Plant Design and Layout

Type of dairies, perishable nature of milk, reception flexibility. Classification of dairy plants, Location of plant, location problems, selection of site. Hygienic design considerations for dairy processing plants. Planning-Dairy plant design aspects. Arrangement of different sections in dairy, sitting the process sections, utility/service sections, offices and workshop. Arrangement of equipment, milk piping, material handling in dairies, Common problems, office layouts-flexibility. Building construction materials-Other design aspects: Drains and drain layout for small and large dairies. Ventilation, fly control, mold prevention, illumination in dairy plants. Computer aided Design: Introduction to CAD software.

UNIT VIII :

Chemistry of Milk

Definition and structure of milk, factors affecting composition of milk, Casein: -Whey proteins: Hydrolysis and denaturation of milk proteins under different physical and chemical environments, Estimation of milk proteins and lactose -Importance of genetic polymorphism of milk proteins -Milk enzymes -Milk -milk lipids. Milk phospholipids -fat soluble vitamins, Milk Salts: Mineral in milk (a) major mineral (b) Trace elements- Milk Sampling techniques from different sources for chemical analysis -; Determination of titratable acidity, pH , fat percent, Total solids and SNF. Determination of casein, whey proteins and NPN in milk; Determination of lipase and phosphatase activity in milk; Determination of lactose and Ash content -

Determination of temporary and permanent hardness of water; Estimation of available chlorine from bleaching powder.

Chemistry of Dairy Products

Chemical composition and legal standards of milk products. Cream-Chemistry of creaming and factors affecting the same. Butter colour. Ghee: Physico-chemical changes during manufacture. Hydrolytic and oxidative deterioration, their causes, prevention and role of antioxidants. Physico-chemical changes in milk constituents during manufacture and storage of traditional dairy products: Khoa, Paneer, Dahi, Channa, Lassi, Chakka, and Shrikhand. Chemistry of cheese-Physico-chemical changes during preparation and storage of concentrated and dried milk products-Physico-chemical changes during processing and storage of ice cream and frozen desserts. Role and mechanism of stabilizers and emulsifiers in ice cream.

Chemical Quality Assurance

Importance of chemical quality control, quality assurance and total quality management in dairy industry. Role of national and international food regulatory systems and standards with respect to quality and safety of milk and milk products: FSSAI, PFA, AGMARK, BIS ISO, IDF, Codex, etc., Application of food safety management system (ISO: 22000). Hazard analysis and critical control points (HACCP) Setting up of testing facilities and analytical laboratories; concept of mobile testing laboratories. Accreditation of analytical laboratories. Preparation and standardization of reagents required in the analysis of milk and milk products. Sampling procedures; labeling of samples for analysis; choice of analytical tests for milk and milk products for chemical analysis and instrumental methods of analysis. Calibration of dairy glassware; including butyrometer, pipettes, burettes, hydrometers, lactometers and thermometer. Testing methods for the detection of adulterants, preservatives and neutralizers in milk and milk products. Environmental contaminants such as pesticides, antibiotics, aflatoxin, heavy metals in milk and milk products and their chemical testing methods**.** Importance of milk contact surfaces, metallic contamination in dairy industry. Chemical quality of water in dairy industry. Prediction of shelf life behavior of milk and milk products.

UNIT IX :

Microbiology of fluid milk

Microbes associated with raw milk: psychrotrophic, mesophilic, thermoduric and thermophillic bacteria **-** Microbial contaminants in raw milk, their sources during various stages of production - Microbiological changes in bulk refrigerated raw milk. Sources of contamination and microbial spoilage of raw milk- Types of microbial spoilage - Mastitis milk - Concept of clean milk production: Microbiological quality of milk produced in organized and un-organized sector in India and comparative information in developed world; Microflora of aseptically drawn milk and its natural antimicrobial systems. Microbiological aspects of fluid milk: Significance of heat resistant and post processing contaminants in fluid milk with special reference to proteases and lipase enzymes and their role in spoilage of processed milk. Bio-film -Public health aspects of fluid milk: Microbial zoonotic diseases Milk borne diseases - Microbiological grading and legal standards of raw and processed milk.

Microbiology of Dairy Products

Microbiology of Cream and Butter **-** Microbial Defects in butter - Microbiology of Condensed, Evaporated and Dried products: Microbial defects - Bacterial thickening / Mold button formation in SCM; Gassiness/bloating, Bacterial coagulation (Sour and sweet), Bitterness, Fishy flavor in evaporated milk; pre-heating/DSI temperature and their impact on microflora of dried products; Effect of reconstitution on microbial quality of milk powder including baby foods and survivability of pathogens; Regulatory microbiological standards.
Microbiology of Ice Cream and Frozen desserts:Microbiology of Indigenous Milk Products: Predominance of spoilage and pathogenic organisms in khoa and khoa based sweets – burfi, peda, gulabjamun, etc., paneer, Chhanna and Chhanna based sweets – rasogulla; kheer, shrikhand, dahi, kulfi etc; Active packaging concepts and role in bio-preservation.

Starter Cultures and Fermented Milk Products

Types, metabolism and propagation of starter cultures-Propagation of starter cultures-concentrates - direct bulk and direct vat starter cultures, - Metabolism of starter cultures (carbohydrate, protein, citrate) and production of metabolites and antibacterial substances; methods of starter distillates their merits/demerits.
Activity, Purity, Preservation of Starters and Starter Failure -Defects in starters and their control; Starter failures- effect of antibiotic residues, sanitizers and bacteriophages. Role of Starters in fermented milks: - Curd,

Yoghurt, Shrikhand, Kefir and komiss, Bulgarian milk, cultured buttermilk, Leben, Villi and Yakult; Cheese Starters; Rennet.

UNIT X :

Food Biotechnology

Chemical nature of the genetic material, properties and functions of the genetic material, organization of the genetic material in bacteria, eukaryotes and viruses; DNA replication: Replication fork, DNA polymerases, other enzymes and proteins required for DNA replication, origin of replication, replication of circular DNA molecule; Transcription and translation: RNA synthesis, types of RNA, genetic code; Mutation and DNA repair, mechanisms of repair of damaged DNA (photo reactivation, excision repair, recombination repair, SOS repair, mismatch repair), transposable elements, plasmids, Expression of foreign genes; Promoter enzymes; Recombinant DNA technology: Restriction enzymes, cloning vectors, cloning procedure, cloning of specific gene and their identification (colony hybridization, C-DNA, southern blotting, polymerase chain reaction); Gene cloning: Biosensors: -Application of biotechnology in food: Immobilization of enzymes: GM foods: Testing for GMOs, current guidelines for production, release and movement of GMOs, labeling and traceability, trade related aspects, bio-safety, risk assessment, risk management, public perception of GM foods, IPR, GMO Act 2004.

Quality and Safety Monitoring in Dairy Industry

Consumer Awareness about Microbiological Quality and Safety of Dairy Foods: FSSAI Regulation and Acts for Milk and milk products - Introduction to Food Safety Management System ISO 22000: Concepts of Quality Management System - Principles of QMS; Standard requirements for QMS; HACCP concept and principle with special reference to biological hazards in dairy foods, TQM tools and techniques - Export stipulations - Microbiological Risk Analysis Concepts: Bio-safety concepts in handling of dairy pathogens and setting up of a microbiological/ pathogen lab in a dairy plant. Rapid Enumeration Techniques: for rapid detection of pathogens like E.coli (E.coli 0157:H7), Salmonella, Shigella, Staphylococcus aureus, Bacillus cereus and Listeria monocytogenes. Role of Biosensors for monitoring hygiene and safety of dairy foods: Detection of mastitic milk, antibiotic residues in milk, aflatoxins M1 & M2 –Delvo SP, MDR test, penzyme test, charm assay, lateral flow assay (ROSA test) etc. Detection of aflatoxins, pesticides other inhibitors etc. and their public health importance in dairy foods.