Syllabus for PhD (FT) in Food Process Engineering

Entrance Examination- 2026

Unit 1: Basics of Food Preservation and Processing

Basics of food science and technology. Methods of food preservation such as heat processing, pasteurization, canning, dehydration, freezing, freeze drying, fermentation, microwave, irradiation and chemical additives. Refrigerated, modified and controlled atmospheric storage. Aseptic preservation, hurdle technology. Use of non-thermal technologies - microfiltration, bacteriofugation, high voltage electric fields, pulse electric fields, high pressure processing, irradiation, harmonization, alternate-thermal technologies - ohmic heating, dielectric heating, microwave, RF, infrared technologies -antimicrobial enzymes and bacteriocinsin food processing. Intermediate moisture food products, low acid foods, high acid foods and shelf stable foods. Food spoilage microorganisms. Thermal death time and process time calculations. Microbial spoilage of foods - Assessing microbial load in foods. Thermal death time and process time calculations.

Unit 2: Engineering Properties

Importance of engineering properties of biological materials; physical characteristics *viz*. shape, size, volume, density, porosity, surface areas, Frictional characteristics *viz*., rolling resistance, angle of repose. Properties of bulk particulate solids *viz*. specific surface area, meandiameter, flow rate. Aerodynamics characteristics *viz*. drag coefficient and terminal velocity. Thermal properties, *viz*. specific heat, thermal conductivity, thermal diffusivity. Dielectric properties *viz*. dielectric and microwave radiation, dielectric constant and energy absorption. Optical properties; transmittance and reflectance. Rheological properties and stress-strain-time relationship, rheological models, visco-elasticity.

Unit 3: Food chemistry

Proximate analysis of food constituents. Carbohydrates: structure and functional properties of mono-, oligo- & polysaccharides including starch, cellulose, pectic substances and dietary fibre, gelatinization and retrogradation of starch. Proteins: classification and structure of proteins in food, Lipids: classification and structure of lipids, rancidity, polymerization and polymorphism. Pigments: carotenoids, chlorophylls, anthocyanins, tannins and myoglobin. Food flavours: terpenes, esters, aldehydes, ketones and quinines. Enzymes: specificity, simple

and inhibition kinetics, coenzymes, enzymatic and non-enzymatic browning. Nutrition: balanced diet, essential amino acids and essential fatty acids, protein efficiency ratio, water soluble and fat-soluble vitamins, role of minerals in nutrition, co-factors, anti-nutrients, nutraceuticals, Chemical and biochemical changes during processing and storage. Measurement techniques and instruments for food quality determination, destructive and non-destructive quality evaluation

Unit 4: Heat and Mass Transfer

Basic laws of thermodynamics, thermo4dynamic properties and processes, energy equations, heat, work, heat engine, heat pump, refrigeration and steam tables. Introduction to heat and mass transfer and their analogous behavior, steady and unsteady state heat/mass transfer, analytical and numerical solution of unsteady state heat/mass transfer, use of various charts in solving problems. Convective heat transfer in food processing systems involving laminar and turbulent flow- heat transfer in boiling liquids - regimes of boiling, heat transfer between fluids and solid foods, natural & forced convection, boundary layer diffusion equations and convention regimes. Design of heat exchanger, radiation heat transfer, black bodies, grey bodies, combined radiation and convection heat transfer - radiation surface coefficient, applications in food processing. 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 – applications in food processing.

Unit 5: Unit operations of food processing

Technology &equipment for grading, cleaning, washing, sorting, shelling, cyclone separation, centrifugal separation, dehusking, decortication, milling, polishing, pearling, drying, heating, cooling, freezing, pasteurization and sterilization of foods, size reduction, cryogenic grinding, granulation, crystallization, membrane separation processes; Evaporation, Distillation, Mixing, coagulation, mechanical separation processes, *viz.* sedimentation, clarification, filtration, pressing, expelling, leaching, extraction, extrusion. Unit operations involved in processing of grains, spices, plantation crops, fruit and vegetables. Unit operations involved in processing of Dairy products. Unit operations

involved in processing of meat, poultry and marine products.

Unit 6: Machinery for Process Technology, Material Handling and Storage

Pre-milling, conditioning, process technology and machinery for cereals, pulses, oil seeds, fruits, vegetables, spices, condiments, plantation crops, meat, fish and poultry products. Emerging techniques- Thermal and non-thermal processing, hybrid drying technologies, nondestructive quality evaluation, high pressure processing, ohmic heating, ultraviolet light, pulsed electric field, pulsed light field, ozone processing, RF treatment, plasma techniques, nano techniques in food processing, ultrasound treatment, encapsulation of food ingredients and Hurdle technology. Agricultural by-products/residue utilization and Waste disposal of food processing plants.

Bulk conveying equipment, *viz*. belt conveyors, screw/auger conveyors, bucket elevators, drag/chain Conveyors and Pneumatic conveyors. Estimation of energy requirement and capacity, Operation and maintenance of conveying equipment. Food grain storage practices and structures – Traditional, improved and modern. Controlled and modified atmospheric storage. Cold storage design & operations and cooling load calculations.

Unit 7: Food Packaging Technology and labelling

Packaging terminologies. Functions of food packaging. Packaging requirements for different environments. Basis for selection of packaging material. Metal and Glass – Manufacturing, properties and its applications. Paper and polymers films as food packaging material-types, properties, manufacturing and its applications. Filling systems. Labels and bar coding - printing on packaging materials. Aseptic packaging, vacuum packaging, MAP, CAP, biodegradable packaging materials. Nano composite as packaging materials. Testing of packaging materials and instruments.

Unit 8: Plant layout, Design, Instrumentation and process control

Computers aided design and analysis of machines and machine components. Plant design concepts and general design considerations, plant location, product and process design, process flow charts, equipment selection, plant layout. Design and selection of machinery for handling utilities like water, steam, fuel etc. and disposal of effluents and

residues. Static and dynamic characteristics of instruments, Transducers elements, intermediate elements, indicating and recording elements. Measurement of motion, force, torque, power, temperature, humidity, pressure and flow. Physical and chemical sensors, biosensor.-plant sanitation and waste disposal, CIP.

Unit 9: Principles of Food Safety and Quality Management

Food Sanitation and safety: Factors contributing to physical, chemical and biological contamination in food chain, prevention and control of food borne hazards, definition and regulation of food sanitation, sources of contamination, personal hygiene-food handlers, cleaning compounds, sanitation methods, waste disposal strategy (solid and liquid waste) and pest control. Food adulteration: common adulterants, simple tests for detection of adulteration. Food additives- classification, functional role and safety issues. Quality systems and tools used for quality assurance including control charts, acceptance and auditing inspections, critical control points, reliability, safety, recall and liability. Food adulterations & detection techniques. Measurement techniques and instruments for food quality determination. National Food laws and standards - FSSAI, PFA, FPO, BIS, AGMARK, APEDA.International standards and organizations – FDA, ISO, GRAS, EU, CAC, TQM, GMP, GAP, HACCP. International standards for export and quarantine requirements for export of Agricultural and Horticultural produce.

Unit 10: Research Methodology

Types of Research Design and Stages Selection and Formulation of Research Problem, Objective(s) and Hypothesis Developing Research Plan – Exploration, Description, Diagnosis, Experimentation, Determining Experimental and Sample Design. Sources of Data – Primary and Secondary Types of Data – Categorical (nominal and ordinal), Numerical (discrete, continuous, ratio and interval) Methods of Data Collection: Survey, Interviews (in-depth or Key Informant interviews), Focus Group Discussion (FGD), Observation, Records or Experimental Observations. Statistical analysis: Mean, median, T-test, F-test, P value and ANOVA. Statistical Graphics – Histograms, Dotplots, Stemplots, Bar Graphs, Pareto Charts, Pie Charts.