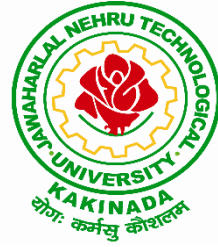


M. Tech (Food Processing Technology)



SCHOOL OF FOOD TECHNOLOGY

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY KAKINADA

KAKINADA-533003, Andhra Pradesh, India

M. Tech. (FPT) –IstSEMESTER

FOOD PROCESS ENGINEERING – I

UNIT-I Fluid mechanics: Types of fluids, rheology of foods, transportation of fluids, Mass, momentum and energy balances, Bernoulli's equation, fluid flow through pipes, boundary layer, flow regimes, dimensional analysis and Reynolds number, friction losses in pipe and pipe fittings, flow measurement. Characteristics of pumps, Types of Pumps, compressors and blowers used in food industry and their selection and applications.

UNIT-II Heat Transfer: Conduction: Fourier's law, conduction through flat walls and cylindrical pipes. **Convection:** Newton's law of cooling, natural, forced convection, heat transfer coefficient, overall heat transfer coefficient, heat transfer in boiling and condensation, heat transfer in Non-Newtonian fluids, unsteady state heat transfer in jacketed kettles, design of heat exchangers, counter current and co-current flows, LMTD concept, dimensional analysis and correlation for heat transfer coefficients, importance of Nusselt number and Grashof number, types of heat exchangers, selection and applications. **Radiation:** Stefan-Boltzmann law, Kirchhoff's law, black body, radiation between two bodies, radiation from surroundings, applications of radiation.

UNIT-III Size reduction: Basic principles of size reduction, types, Particle size distribution, size reduction equipment and methods, disintegration of fibrous materials, cryogenic grinding. **Screening:** Types of screens, revolving screen/cylinder sorter-shaking, rotary, vibratory & horizontal, Screen openings, perforated & wire mesh screens, ideal & actual screens, effectiveness of screens. **Extrusion:** Basic principles of extrusion, types, chemical and nutritional changes in food during extrusion, and extruders in food industry. **Frying, Baking and Roasting:** Theory, principles, equipment, Applications in food processing.

UNIT-IV Filtration: Theory, principles, filter cake resistance, cake thickness, equation for flow through constant rate filter, constant pressure filter, cake compressibility, filter aid, filtration methods, filtration equipment and Applications in food processing. Membrane filtration and Reverse osmosis. **Sedimentation:** Theory and Principles of sedimentation, minimum area for continuous sedimentation. Applications in food industry. **Centrifugation:** Basics of centrifugal separation, centrifuge effect or g number. Different types of centrifuges-basket, tubular bowl, decanting, disc bowl, desludging bowl centrifuge, and nozzle centrifuge and their Selection.

UNIT-V Mixing: Characteristics of mixtures, measurement of mixing, mixing index, rates of mixing, mixing time. Types of mixing equipment for solids (powder and particle) and pastes, liquids and gases, power required for mixing, selection and applications. **Separation/Grading:** Theory and Principles: Types of separators-Disk, Indent cylinder, spiral, & specific gravity, stone, inclined belt, Pneumatic & aspirator separators-separation based on fluidization technique-magnetic, cyclone & color separator. Coating: Enrobing, dusting and pan coating; soft, hard & chocolate coating.

TEXT BOOKS:

1. D. G. Rao, Fundamentals of food engineering, Prentice-Hall of India, New Delhi, 2010
2. K.M. Sahay& K.K. Singh, Unit Operations of Agricultural Processing, 2nd Edition, Vikas Publishing House pvt ltd, 2012.
3. R. Paul Singh and Dennis R. Heldman, Introduction to Food Engineering, 4th Edition, Academic Press, 2009.
4. Z. Berk, Food Process Engineering and Technology, Food Science and Technology, 1st Edition, International Series, Elsevier, 2009.

REFERENCE BOOKS:

1. John Metcalfe Coulson, R. K. Sinnott, John Francis Richardson, Chemical engineering, 1 to 6 V, Butterworth-Heinemann, 2005.
2. P.G. Smith, Introduction to Food Process Engineering, 2nd Edition, Lincoln, UK, 2010.
3. Romeo T. Toledo, Fundamentals of Food Process Engineering, 3rd Edition, 2007.
4. Warren Lee McCabe, Julian Cleveland Smith, Peter Harriott, McCabe Smith, Unit operations for chemical engineering, 7th Edition, 2005.

PLANT FOOD TECHNOLOGY-I

UNIT-I Wheat: Composition, criteria of flour quality, composition and functionality of wheat flour components. Milling, basic approach to dough rheology, influence of flour constituents in dough rheology. Technology of bread manufacture. Technology of biscuits, cookies and crackers manufacture.

UNIT-II Rice: Chemical composition, distribution of nutrients and effect of processing, physiochemical properties of rice, viscosity, gelatinization, gel consistency, solid loss, water uptake and volume expansion, cooling quality of rice. Rice milling: factors effecting milling quality and degree of milling, parboiling of rice. Modern rice milling: unit operations involved in modern rice milling, by products of rice milling and their benefits.

UNIT-III Maize, barley and oats: Composition, nutritive value, methods of use, processing methods and their products. Ragi, sorghum and other millets: Chemical composition, nutritive value, methods of use, processing methods of ragi, sorghum and other millets, health benefit of millets.

UNIT-IV Legumes: Composition, nutritive value, method of use, processing methods of commonly used legumes-Bengal gram, red gram, green gram, black gram, chick peas and horse gram and other legumes. Value added products.

UNIT-V Oilseeds: Composition, nutritive value, method of use, processing methods of groundnut, oil palm, sunflower, sesame, mustard, cottonseed. Soya bean technology, soya products, protein isolates, concentrates and byproducts. Value added products.

TEXT BOOKS:

1. N. L. Kent and A. D. Evers, "Kent's Technology of Cereals: An Introduction for students of Food Science and Agriculture", 4th E., Woodhead Pub. Ltd., Cambridge, UK, 1994.
2. 2001 Samuel A. Matz, The Chemistry and Technology of Cereals As Food and Feed, CBS Publishers & Distributers, 2nd edition, New Delhi, 2004.
3. VijayaKhader, "Textbook of Food Storage and Preservation", Kalyani publications, 2000.
4. VijayaKhader and V. Vimala "Grain quality and processing", ATPA, Udaipur,

REFERENCE BOOKS:

1. E.J.Pyler and L.A. Gorton, Baking science and Technology, SoslandPublilshing company, 4th E, 2008.
2. Normon N Potters, Josheph. H. Holchkirs. "Food Science" CBS Publishers, 2009.
3. Y. Pomeranz, Wheat chemistry and technology, American Association of Cereal Chemists, USA, 1971.

UNIT-I Plant location: Site selection criteria, factors influencing plant location, General design considerations for location of food plants. **Basics of layouts:** Basic concepts of plant layout, Types of layout and its applicability, factors influencing plant layout, understanding of equipment layout.

UNIT-II Process design: Selection of process, flow sheet, material & energy balance, selection of equipment, process schedule, PERT, CPM, GANTT, equipment design & design of other accessories.

UNIT-III Layout: Plant Foods: Plant layout and design of bakery and biscuit industries, fruits and vegetables processing industries including beverages. **Animal Foods:** Plant layout and design of Fish & Meat industries, milk and milk products. Miscellaneous aspects of plant layout and design like provision for waste disposal, safety arrangements etc.

UNIT-IV Project cost: Cost of land, building, equipment and utilities. Fixed capital cost, working capital cost, pre-operative expenses, total capital investment. **Cost of manufacture & Profitability:** Raw material cost, packaging material cost, manpower cost, utilities, administrative expenses, maintenance cost, depreciation cost, interest, taxes, estimation of total manufacturing cost, profitability, breakeven analysis and payback period.

UNIT-V Plant maintenance: Role of maintenance staff and plant operator's Preventive maintenance; Guidelines for good maintenance & safety precautions; Lubrication & lubricants; Work place improvement through '5S'. **Sanitation:** Hygiene and sanitation requirement in food processing and fermentation industries; CIP methods, sanitizing & disinfection, pest control in food processing; storage and service areas.

TEXT BOOKS:

1. Antonio Lopez-Gomez, Gustavo V. Barbosa-Canovas, Food plant design, CRC press 2005.
2. George D. Saravacos and Zacharias B. Maroulis, Food Plant Economics, CRC Press 2007.
3. Greg A. Baker, Orlen Grunewald, William D. Gorman, Introduction to Food and Agribusiness Management, 1st Edition, Prentice Hall, 2002.

REFERENCE BOOKS:

1. Charley, Food science, 2nd Edition, John Willey and sons, New York, 1982.
2. James M Moore, Plant Layout and Design, 1st Edition, McMillan & Co., 1959
3. Peters and Timmehaus, Plant Design and economics for chemical Engineers, 4th Edition, McGraw-Hill, Inc., 1989.
4. Ronald M Scott, Basic Concepts of Industrial Hygiene, 1st Edition, CRC Press, 1997.

ANIMAL FOOD TECHNOLOGY

UNIT-I Meat: Importance of meat in national economy. Chemical composition and microscopic structure of meat. Slaughtering of animals, inspection and grading of meat. **Meat Processing:** Factors affecting post-mortem changes, properties and shelf life of meat. Meat quality evaluation. Mechanical deboning, meat tenderization. Aging, pickling and smoking of meat. Meat plant sanitation and safety, byproduct utilization.

UNIT-II Poultry: Classification, composition, preservation methods, slaughtering and processing. Composition, nutritive value and functional properties of eggs and its preservation by different methods. Processing of egg products. Factors affecting egg quality and its measures.

UNIT-III Fish: Types of fish, composition, structure, post-mortem changes in fish. Handling of fresh water fish. Canning, smoking, freezing and dehydration of fish. Processing of fish products, fish sausage. Quality control of processed fish. Value added products: fish meal, fish protein concentrate, fish liver oil and fish sauce and other important byproducts.

UNIT-IV Milk: Milk processing flowsheet-Filtration/clarification, Storage of milk, Standardization, Homogenization, pasteurization – types of pasteurization process. Different types of milk, Quality control of milk. Equipment used in each process-Cream separating centrifuges, Pasteurizers (Heat Exchangers), Homogenizers, Bottle and pouch fillers, Milk Chillers, Plant piping. Milk & product plant hygiene and sanitation. Cleaning in place – bottle and can washing, cleaning of tankers and silos-Detergents and sanitizers used.

UNIT-V Milk products: Manufacture of Cream, Butter, Ghee, Milk powder, Cheese – types and defects in cheese. Quality aspects of these products. Equipment used for manufacture of each product like butter, churn, ghee. Manufacture of Ice cream – Chemistry and technology – Microbiology of ice cream – Quality aspects. Manufacture of paneer, Khoa. Fermented products – Yoghurt, curd, acidophilus milk, butter milk and other milk products; – Quality aspects.

TEXT BOOKS:

1. B.D.Sharma, Meat and Meat Products Technology, 1st Edition, Jaypee Brothers, New Delhi, 1999.
2. Developments in Dairy Chemistry – Volume 1 & 2; Fox PF; Applied Science Pub Ltd, 1982.
3. Lampert LH, Modern Dairy Products, Chemical Publishing Company, 1970.
4. VijayaKhader, A Textbook of Food Science and Technology, ICAR, New Delhi, 2001.

REFERENCE BOOKS:

1. Early, R. Guide to quality management system for food industry blackie, Academic press, 1995.
2. Herrington BL, Milk & Milk Processing, McGraw-Hill Book Company, 1948.
3. Lawrie, R.A., Meat Science, 2nd E., Pergamon Press, Oxford, UK, 1975.
4. Sukumar De, Outlines of Dairy Technology, Oxford University Press, 2013.

INDUSTRIAL FERMENTATION

UNIT-I Industrial Fermentation: Fundamentals involved in the production of industrial Microbial products such as details of the fermenters/Bioreactors, types of fermenters, Types of fermentation – solid state and submerged; Design and working of batch, fed-batch and continuous fermenters. Synthetic and natural medium, precursors, Sterilization methods.

UNIT-II Enzymekinetics: Michaelis-Menten Constant, Competitive, Non-competitive, inhibitions, Lineweaver- Burke Plot, Regulation of enzymes. Growth Kinetics: Modeling and optimization techniques. Scale up of Bioreactors.

UNIT-III Alcoholic and non-alcoholic beverages: Production of Alcoholic beverages like Beer, Brandy, Whisky and Wine. Production of non-alcoholic beverages like tea, coffee and cocoa. A detailed study of 'Ethanol' production by fermentation, using black strap molasses, starchy substances and cellulose substrates like waste sulphate liquor and purification methods for production of absolute ethyl alcohol.

UNIT-IV Products: Substrates for fermentative production of Vinegar, Lactic Acid, Citric Acid, Amino acids, Vitamins. Milk based fermented Foods, cheese and other dairy products. Single cell proteins: Production of single cell proteins. (SCP), Yeast and its uses

UNIT-V Downstream processing: Importance, need for downstream processing, unit operations for downstream processing (cell harvesting and disruption, Filtration, Centrifugation, Extraction, Adsorption, chromatography, Electrophoresis, Membrane separation & Drying) and their importance.

TEXT BOOKS:

1. A. H. Patel, Industrial Microbiology, Macmillan Publishers India, 2000.
2. J. E. Bailey and D. F. Ollis, Biochemical engineering fundamentals, McGraw Hill Book Co., 1986.
3. Paul A. Belter, E. L. Cussler & Nei Shou Hu, Bio-separation – Downstream processing for biotechnology, Wiley-Interscience Publication, 1988.
4. Wulf Creuger & Anneliese Creuger., A Textbook of Industrial Microbiology, Sinauer, 2005.

REFERENCE BOOKS:

1. Conn, J. M and Schick W.A, food processing on industrial power house in transition, John Wiley and sons, New York, 1997.
2. H.J. Peppler and D. Pulman, Microbial Technology Volume 1 & 2, Academic Press, 1979.
3. Vine R.P., Commercial wine making process and controls, Chapman & Hall, London, New York, 1978.

ADVANCED FOOD CHEMISTRY

UNIT-I Introduction to chemistry of foods: Factors affecting the composition of foods, **Water:** structure, water-solute interaction, water activity and relative vapor pressure, moisture sorption isotherms. **Plant pigments and acids:** Plant pigments, their occurrence, chemistry, functions and changes during processing.

UNIT-II Carbohydrates: Mono-saccharides, their occurrence and classification, principles of structure determination, diagrammatic representation of optical isomers, absolute configurations, properties of sugars, sugar derivatives, Caramelization, Disaccharides and tri-saccharides, their classification and commercial sources, Chemistry of starches, isolation and other polysaccharides, Gel formation and starch retro-gradation.

UNIT-III Proteins: Chemistry of amino acids and proteins, Classification of proteins, chemical and physical properties of proteins, Structure of proteins and techniques used in elucidation of protein structure, Forces involved in protein conformation, functional properties of proteins in foods, hydrolysis of proteins, major food proteins and their sources, Changes in proteins during processing, Determination of proteins in foods.

UNIT-IV Fats and other lipids: Oils and fats, their chemistry, occurrence, classification, composition Physical and chemical properties of fats, rancidity and flavor reversion, Processing of oil bearing materials, refining of oils and fats, Technology of edible fats and oils -Fat hydrolysis and interesterification, hydrogenation, shortenings and spreads. Emulsions, Definition, theory of emulsions, properties and types of emulsions, emulsifying agents.

UNIT-V Vitamins: Chemistry, Food Sources and Importance, Changes during processing. Interactions with other nutrients, physiological/pharmacological/therapeutic effects and toxicity. **Minerals:** Mineral composition of foods and their effect in processing. **Analysis of foods:** Instrumental methods of food analysis, Colorimetry, Spectrophotometry, Fluorimetry, Atomic absorption spectroscopy, Chromatographic methods.

TEXT BOOKS:

1. H. D. Belitz, W. Grosch, P. Schieberle, Food Chemistry, Springer, 2009
2. L. Mayer, Food chemistry, 1st Edition, Reinhold Pub. Corp., 1960.
3. Owen R. Fennema, Food Chemistry, 3rd Edition, Marcel Dekker, Inc., 1996.
4. R. K. Owusu, Apenten, Introduction to food chemistry, CRC Press, 2005.

REFERENCE BOOKS:

1. Bell.L.W, Experimental cooking. John Willey and sons, INC, New York, 1955.
2. Hans-Dieter Belitz, Werner Grosch, Peter Schieberle, Food chemistry, 3rd Edition, 2004.
3. John M. DeMan, Principles of Food chemistry, 3rd Edition, Springer, 1999.
4. Lillian Hoagland Meyer, Food chemistry, Reinhold Pub. Corp, 1960.
5. S. A. Iqbal and Y. Mido, Food chemistry, Discovery Publishing House, 2005.

FOOD ENGINEERING LAB

Experiments are conducted on the following unit operations (Virtual labs, wherever methodologies are available, are conducted before the real experiments).

Fluid Flow
Heat Transfer
Drying
Centrifugation
Sedimentation

Grinding
Screening
Grading
Washing
Filtration
Leaching
Liquid-liquid Extraction
Evaporation
Mixing
Extrusion
Crystallization

M. Tech. (FPT) -II SEMESTER

FOOD PROCESS ENGINEERING -II

UNIT-I Humidification: Theory and Principles, Properties of dry-air, Properties of water-vapor. The psychometric chart: Use of psychometric chart to evaluate complex air conditioning processes. Applications in food industry. **Refrigeration:** Basic concepts, Selection of a Refrigerant, Components of a Refrigeration System, Joule Thomson effect, various refrigerants, Effect of temperature on food spoilage, Sources of refrigeration, equipment and methods, load of refrigeration, refrigeration types, cryogenics. Application of refrigeration and cryogenics in food processing. **Steam generation and utilization:** Properties of steam, steam tables and their applications, classification and types of boilers, criteria for choice of boiler, utilization of steam in food processing.

UNIT-II Evaporation: Theory and Principles, Boiling point elevation, Hydrostatic Head, Types of Evaporators-Tubular Type, Short-Tube Evaporator, Long-Tube Vertical Rising Film, Long-Tube Vertical Falling Film, Forced Circulation, Scraped Surface Thin Film, Plate Evaporators, Centritherm Evaporator. Evaporators in the food industry and their selection, Effect of evaporation on food quality and Typical Applications in the Food Industry. Multiple effect Evaporation-Types of feeding, Selection; Vapour recompression systems. **Drying:** Drying of solids, principles of drying, EMC-RH data, bound & unbound moisture, Critical moisture, drying curve, Constant rate & falling rate, drying equipment for food materials and their selection. Recent Developments in drying Technology. Applications in food processing.

UNIT-III Mass Transfer: Principle and theory of diffusion, role of diffusion in mass transfer, Theories of mass transfer: film theory, penetration theory, surface renewal theory, Determination of mass transfer rates, Diffusion of gases/vapours through solid films. Applications of mass transfer in food processing. **Distillation:** Theory and principles, concept of ideal stages, calculation of ideal stages, McCabe-Thiele method, Ponchon&Savarit method, various types of distillations and distillation columns, viz batch, steam, flash, azeotropic and continuous distillations. Application of distillation in food processing. **Gas absorption:** Theory and principles, concept of HTU and NTU, absorption equipment. Applications of gas absorption in food processing.

UNIT-IV Extraction: Solid-liquid extraction: leaching, theory and principles, different types of leaching processes and various equipment used in food processing. Application of leaching in food processing. **Liquid-liquid extraction:** theory and principles, counter current and cocurrent extractions, batch and continuous extractions and Applications to the food industry. **Super critical fluid extraction:** Basic principles, Supercritical fluids as solvents, Super critical extraction systems and its applications. **Crystallization:** Theory and principles, crystallization kinetics-nucleation and crystal growth, Dissolution, crystallization equipment and processes in the food industry, application of crystallization in food processing.

UNIT-V Material handling and Storage: Materials Handling Efficiency, Types, selection and design of Materials Handling Equipment: Conveyors-Belt, Slat, Roller, Chain, Chutes, Vibratory, Screw, bucket elevators; Trucks; Pallets; Bulk Handling; and pneumatic conveyors, transportation of solids. Various methods of storage, viz silos, bins, hoppers. **Washing and Peeling:** Types of peeling:Flash peeling, Steam peeling, Knife peeling, Abrasion peeling, lye peeling, and Flamepeeling. Selection of equipment's for washing and peeling.

TEXT BOOKS:

1. Albert Ibarz and Gustavo V. Barbosa-Cánovas, Unit Operations in Food Engineering, CRC Press, 2003.
2. D.G. Rao, Fundamentals of food engineering, Prentice-Hall of India, New Delhi, 2010
3. R. L. Earle, Unit operations in food processing, 2nd Edition, Pergamum Press, 1983.
4. R. Paul Singh and Dennis R. Heldman, Introduction to Food Engineering, 4th Edition, Academic Press, 2009.

REFERENCE BOOKS:

1. C. J. Geankoplis, Transport Processes and Separation Process Principles, 4th Edition, PHI learning private limited, New Delhi, 2012.
2. P.G. Smith, Introduction to Food Process Engineering, 2nd Edition, Lincoln, UK, June 2010.
3. Romeo T. Toledo, Fundamentals of Food Process Engineering, 3rd Edition, 2007.
4. Warren Lee McCabe, Julian Cleveland Smith, Peter Harriott, McCabe Smith, Unit operations for chemical engineering, 7th Edition, 2005.

PLANT FOOD TECHNOLOGY–II

UNIT-I Fruit and Vegetables Processing: Postharvest field operations including methods to reduce the post-harvest losses, Precooling, In-house packing, cold storage etc., General methods of preservation of fruits and vegetables. **Canning of fruits and vegetables:** Canning unit operations and machinery - Blanching: Method and its Importance. Precautions in canning, Spoilage of canned foods. **Preservation by hurdle technology.**

UNIT-II Fruit and Vegetables Products: Jams, Jellies, Marmalades, Fruit beverages, Fruit Bars, Fruit Powders, Candies, Preserves, Crystallized fruit, Pickles, etc. Products from Jamun, Tamarind, Jack fruit, Wood apple, Tomato, Potato and Mushroom. **Fruit juice concentrates:** Methods of concentration, aroma recovery.

UNIT-III Plantation crops: Primary and secondary processing of Coffee, Tea, Cocoa, Cashew nut, Areca nut & Vanilla, Value added products.

UNIT-IV Spices: Classification of Spices, Primary and secondary processing of spices like Pepper, Ginger, Turmeric, Cardamom, Chilies, Cinnamon, Coriander, Saffron etc. **Value added products:** Spice powders, Curry powders, Sterilized spices, Enriched Spices, Encapsulation, aqueous flavourants. **Spice Oils & Oleoresins:** Flavor extraction from spices by different methods. Estimation of principle constituents in spices & spice products, residual solvent in spice oleoresins.

UNIT-V Herbs: Classification of herbs, Processing of Coriander, Curry leaves, Rosemary, Sage, Mint, Dill, Spearmint, Basil, Borage, Thyme, etc and their health benefits. **Natural**

Colors:Extraction techniques and color estimation from plant materials like Red beet, Safflower, blue grapes, Red chilies, Turmeric, Annatto etc. Food application and Stability studies of flavourants&colorants.

TEXT BOOKS:

- 1 A.K. Thompson., Fruit and Vegetables: Harvesting, Handling and Storage, Blackwell publishing, 2003.
- 2 Dauthy, M. E., Fruit and Vegetable Processing. FAO Agricultural Service Bulletin, 1st Edition, International Book Distributing Co. Lucknow, India, 1997.
- 3 J. S. Pruthi, Spices & Condiments National Book Trust, 5th Edition, New Delhi, 2001.
- 4 R.P. Srivastava&Sanjeev Kumar., Fruit and Vegetable Preservation, 3rd revised & enlarged edition, IBDC, 2010.

REFERENCE BOOKS:

1. D.K. Salunkhe& S.S. Kadam., Handbook of Fruit Science and Technology: Production, Composition, Storage and Processing, 1st Edition, CRC Press, 2013.
2. J. W. Parry.,Spices: Morphology, History, Chemistry, Volume II, 2nd Edition, Chemical Publishing Co., New York 1969.
3. VijayaKhader, Preservation of Fruits and vegetables, 2nd Edition, Kalyani Publications, 2000.
4. W.V. Cruess, Commercial Fruit and Vegetable Products, 3rd Edition, AGROBIOS, India, 2011.

ADVANCES IN FOOD SCIENCE AND TECHNOLOGY

UNIT-I Nutraceuticals: Definition, scope, current status, future trends, Classifying Nutraceutical factors and functional foods, Food and Nonfood Sources of Nutraceutical Factors, Nutraceutical Factors in Specific Foods, Mechanism of Action, Classifying Nutraceutical Factors Based on Chemical Nature. Legal requirements and Regulations about nutraceuticals; Effect of food processing parameters on the efficacy of nutraceuticals, and functional bioactive in deriving desirable benefits.

UNIT-II Functional Foods:Basis to identify functional components in varied sources and their use in foods and food ingredients; Legal requirements and Regulations about functional foods; Effect of food processing parameters on the efficacy of functional bioactive compounds in deriving desirable benefits. **Prebiotics and Probiotics:** Prebiotics – definition, nomenclature & Significance Non digestible higher polysaccharides; Categories of prebiotics, Probiotics – definition, nomenclature, selection criteria & attributes; Protocols for commercial probiotic preparations; therapeutic attributes; Safety of probiotics and food applications.

UNIT-III Dietary Supplements: Definition, characteristics and scope; Status in selected countries across the globe; health benefits; Performance and functionality. Legal requirements and Regulations about Dietary Supplements; Effect of food processing parameters on the efficacy of Dietary Supplements in deriving desirable benefits. **Convenience and wellness foods:** Ready-to-prepare (cook) foods based on cereals and legumes; Ready-to-eat shelf stable thermally (retorting) processed foods. Emerging trends – frozen dough and healthy bakery foods; Meat emulsions, sausages and comminuted meat products; Cured meat products; Fermented (including traditional) meat and fish products;

UNIT-IV Thermal Processing: Preservation of foods by high temperature, Basic principles in thermal destruction of microorganisms - D, Z, F₀ values; Thermal processing, sterilization classification U.H.T. systems and recent advances, factors affecting spoilage of different types of food products and design of thermal processes. Survival curves, thermal death curves, analysis of thermal resistance data, process time evaluation. Heat transfer considerations in thermal processing, methods and equipment.

UNIT-V Newer Techniques in Food Processing: Application of technologies of high intensity light, pulse electric field, Ohmic heating, Micronization in food processing and preservation, use of microwave energy in foods, High pressure processing of foods, Ultrasonic in food processing.

TEXT BOOKS:

1. Brain Lockwood, Nutraceuticals, 2nd Edition, Pharmaceutical Press, 2007.
2. Geoffrey P. Webb, Dietary supplements & functional foods, Black well publishing, 2006.
3. N.A. Michael Eskin and Snait Tamir, Dictionary of Nutraceuticals and Functional Foods, CRC, Press 2006.

REFERENCE BOOKS:

1. Heyers, R.A., Molecular Biology and Biotechnology: A Comprehensive Desk Reference, VCH, 1995
2. M.Karel, O.R.Fennema and D.B.Lund, Marcel Dekkar Inc, "Principles of Food Science-Part-II": Physical Method of Food Preservation, 1996.
3. Moo-Young, M. et al., Comprehensive Biotechnology, 2nd Edition, Elsevier Publications, 2011.
4. Phaneesh, K.R., Management and Entrepreneurship. Sudha Publications, Bangalore, 2009.
5. Purse glove, J.W., Brown, F.G., Green, C.L. and Robbins, C.L. Spices, Vol. 1 & 2. Tropical Agricultural Series, 1981.

ADVANCED FOOD PACKAGING

UNIT-I Introduction: Principles of food packaging, Functions of packaging; Type of packaging materials; Selection of packaging material for different foods. Methods of packaging and packaging equipment. Interactions between packaging material and foods. Barcodes and Labelling. Properties of different packaging materials, Shelf life testing, Food packaging and laws.

UNIT-II Active and intelligent packaging techniques: Active packaging techniques, intelligent packaging techniques, Current use of novel packaging techniques, Applications of active packaging in foods. **Oxygen, ethylene and other scavengers:** Oxygen scavenging technology, selecting the right type of oxygen scavenger, Ethylene scavenging technology, Carbon dioxide and other scavengers. **Antimicrobial food packaging:** Antimicrobial agents, constructing an antimicrobial packaging system, Factors affecting the effectiveness of antimicrobial packaging

UNIT-III Non-migrating bioactive polymers (NMBP) in Food Packaging: Advantages of NMBP, Inherently Bioactive synthetic polymers: types and application, Polymers with immobilized bioactive compounds, Applications of polymers with immobilized bioactive compounds. **Time-temperature indicators (TTIs):** Defining and classifying TTIs, Requirements for TTIs, The development of TTIs, Maximizing the effectiveness of TTIs, Using TTIs to monitor shelf-life during distribution. **The use of freshness indicator in packaging:** Compounds indicating the quality of packaged food products, Freshness indicators, Pathogen indicators other methods for spoilage detection.

UNIT-IV Packaging-flavor interactions: Factors affecting flavor absorption, the role of the food matrix, the role of differing packaging materials, Flavor modification and sensory quality. **Moisture regulation:** Silica gel, Clay, Molecular sieve, Humectant salts, Irreversible adsorption. **Recycling packaging materials:** The recyclability of packaging plastics, improving the recyclability of plastics packaging, Testing the safety and quality of recycled material, using recycled plastics in packaging.

UNIT-V Green Plastics for food packaging: The problem of plastic packaging waste, the range of biopolymers, developing novel biodegradable materials. **Integrating intelligent packaging, storage and distribution:** The supply chain for perishable foods, The role of packaging in the supply chain, Creating integrated packaging, storage and distribution: alarm systems and TTIs. **Testing consumer responses to new packaging concepts:** New packaging techniques and the consumer, Methods for testing consumer responses, Consumer attitudes towards active and intelligent packaging.

TEXTBOOKS:

1. Aaron L. Brody, Eugene R. Strupinsky, Lauri R. Kline, Active Packaging for food applications, CRC Press, 2002.
2. F A Paine and H Y Paine, A handbook of Food Packaging, 2nd Edition, Blackie & Sons Ltd., Glasgow, UK, 1983
3. R. Ahvenainen., Novel Food Packaging Techniques, CRC Press, 2003.
4. Jung H. Han, Packaging for Non thermal Processing of Food, 1st Edition, IFT Press, 2007.
5. Richard Coles, Derek McDowell, Mark J. Kirwan, Food Packaging Technology, 1st Edition, Blackwell Publishing, CRC Press, 2003.

REFERENCE BOOKS

1. H.B Ajmera & M.R Subramanian, Plastics in packaging, A.P. Vaidya, Secretary IIP, E2, MIDC, 1988.
2. Modern Food Packaging, Published by Indian Institute of Packaging, Mumbai 1998.
3. Vijaya Khader, A Textbook of Food Science and Technology, ICAR, New Delhi 2001.

FOOD SAFETY, STANDARDS & REGULATIONS

UNIT-I Concepts and trends in food legislation: History & trends in Food Adulteration and Role of Traders/Manufacturers, consumers & Rulers/Governments in evolution of Food regulations in Europe, USA and rest of the world. **GATT, WTO, TBT, FAO:** Overview of Organization structure, objectives and functions.

UNIT-II International Standards ISO: Origin, Members, Governance, Committees, Procedure employed in development and issue of standards. ISO/TC 34 Food Products. ISO 9000 series, FSMS – 22000:2005. Introduction to the family of ISO 22000 standards, Comparison of ISO 9001:2008 vs. ISO 22000:2005 **Codex Alimentarius:** Origin & meaning, Membership, Procedure employed in development and issue of standards, Role of CAC and its committees. **HACCP:** Terminology, Principles, Identification of CCPs, Application of HACCP System and the logic sequence involved.

UNIT-III Indian Food Laws - FSSAI: Food Safety and Standards Act-2006: Scope; Definitions; Food Safety & Standards Authority of India Composition and functions of Central Advisory Committee, Duties and functions of Food Authority, (Brief Review of PFA Act, Powers of Central and State governments to make rules; Penalties; FPO and MPO: Rules, Definitions) **AGMARK:** AGMARK Act & Rules: Scope, definitions, Certification policy & Procedure, laboratory approvals, Action on noncompliance. **BIS:** Evolution of BIS, Scope, Definitions, Power & Functions of BIS, Licensing procedure.

UNIT-IV Legislation in Europe: EU Treaties (Definition & significance); EU Legislations (Meaning and nature of each type of legislation); Introduction to EU General Food law (EC 178/2002); Approval Process for Food Additives; Nutritional Labeling (Claims allowed & requirements) Food legislation in UK: Main Features of The Food Safety Act 1990 (Imports & Exports, Safety, Traceability, Labeling, Product withdrawal & recall), Enforcers of Food Laws, National Control Plan for UK. **US Food Regulations:** Federal Meat Inspection Act (1906): Brief introduction to aspects related to Inspection requirements; Adulteration & Misbranding; Meat processors and related industries. Federal Food Drug and Cosmetic Act (1938): Evolution of this Act, Introduction to various Chapters of the Act, Overview of various sections of Chapter IV (Food) of the Act. Fair Packaging and Labeling Act (1966): Awareness of various aspects such as scope of prohibition, Exemptions, Requirements of Label contents, Promulgating Authority and Enforcement. **Legislations in other countries:** viz Australia and New Zealand.

UNIT-V Intellectual Property & Rights: Concept of Intellectual Property, History and evolution of Intellectual Property Rights (IPR), types of protection of IPR (Patents, Trademark, Industrial design, Trade secret, and Copy right); Distinction among various forms of IPR. Geographical indication and Industrial design. IPR laws in India: Various IPR laws currently in force in India. Rights protection and procedure; Infringement and Remedies against infringement; Role of India in International IPR scenario.

TEXT BOOKS:

1. Cynthia A. Roberts, The Food Safety information Handbook, Oryx Press, 2001
2. Ronald H. Schmidt, Gary E. Rodrick, Food Safety Handbook, John Wiley & Sons, 2005.
3. Suresh Chandra Babu, Economic Reforms and Food Security: The Impact of Trade and Technology in South Asia, Haworth Press, 2005.
4. F. H. Erbisch, K. M. Maredia, Intellectual property rights in Agricultural Biotechnology, CABI, 2010.

REFERENCE BOOKS:

1. A. N. Tripathi, Human Values, New Age International, 2011.
2. S. K. Chakraborty, Values and Ethics in Organization, OUP, 2001.
3. Santaniello, Evenson, Ziberman, Carlson, Agriculture and Intellectual Property Rights, Univ. Press, 1998.

ELECTIVES

FOOD BUSINESS MANAGEMENT

UNIT-I Management: Definitions, scope and importance, Types of managers, Managerial roles and functions, Management - Science or Art? Internal and External environment, managing for competitive advantage-the challenges of management, Corporate Social Responsibility, Managerial ethics.

UNIT-II Financial Management: Nature of capital budgeting, decisions-techniques of capital budgeting: pay back method, average rate of return and Time adjusted methods: IRR and NPV, profitability index, and excess present value index. Advanced problems and cases in capital budgeting. Statement of Changes in Working Capital, Funds flow and cash flow statement.

UNIT-III Human Resource Management: Definition and functions of HRM, Significance of HRM, Evolution of HRM, Role of HRM to increase firm performance, Role and position of HR department, HRM at global perspective, Changing dynamics of HRM in globalized scenario. Importance of recruitment and selection, Nature and Significance of Human Resource Development, human resource accounting practices and standards-problems- HR audit-process-HRIS-methods.

UNIT-IV Marketing Management: Introduction to marketing: needs, wants, demands, products, exchange, transactions, market, marketing, production concept, Indian marketing environment, role and functions of marketing department, Marketing mix and significance of 4Ps, product life cycle stages,

skimming and penetration pricing strategies, Market segmentation and targeting- factors affecting effective segmentation, essentials of effective segmentation, Identification of market segments-marketing strategies. Positioning functional strategies, Need for international marketing, nature and significance of international trade, Trends in international business, Balance of payments-nature-causes for disequilibrium in balance of payments.

UNIT-V Company laws: Company Act, 1956: Nature and Types of companies-formation-memorandum of association-articles of association-kinds of shares-duties of directors-winding up.

TEXT BOOKS

1. Greg A.Baker, Orlen Grunewald, William D. Gorman, Introduction to food and agribusiness management: Prentice Hall, 2002.
2. K.Aswathappa, Human Resource and Personnel Management, Tata McGraw Hill, 2002
3. M.Y.Khan, P.K.Jain, Financial Management – Text and problems, Tata McGraw Hill, 2010.
4. P.SubbaRao, International business- Text and cases, Himalaya publishing house, 2012.
5. RajanSaxena, Marketing Management, Tata McGraw Hill, 2011
6. S.S Gulshan, G.K. Kapoor, Business law including company law, New age Publishers, 2008
7. Wehrich and Aryasri, Principles of Management: Koontz, Tata McGraw Hill, 2004.

REFERENCE BOOKS

1. BiswanthGhosh, Human Resource Development and Management, Vikas Publishing, 2010.
2. Gary Dessler, Human Resource Management, PHI Private Limited, New Delhi, 2007
3. Jawaharlal, Advanced Management Accounting, S.chand and Company Limited, New Delhi, 2010.
4. K. Aswathappa, Essentials of business environment, Himalaya publishing, 2000.
5. Philip Kotler, Marketing Management, Prentice Hall/ Pearson Education, 2011.
6. Sundaram and Black, International Business Environment, Text and cases, PHI Private Limited, 2012.

FROZEN FOOD TECHNOLOGY

UNIT-I Fundamentals of Freezing: Physical chemical principles in freezing, glass transition in frozen food systems, refrigeration cycles, microbiology of frozen foods, thermo physical properties of frozen foods, mathematical modeling of freezing process

UNIT-II Facilities for the cold chain: Freezing methods and equipment, cold store design and maintenance, transportation of frozen foods, retail display equipment and management, monitoring and control of cold chain.

UNIT-III Freezing Technology: The freezing process, freezing capacity, mechanical refrigeration, cryogenic refrigeration systems, freezing time calculations, freezer selection, economics of freezing, freezing equipment, belt freezers, fluidized bed freezers, contact freezers, cryogenic freezers, liquid carbon dioxide freezers, form freezing, physical storage and distribution of frozen foods, frozen food supply chain.

UNIT-IV Emerging technologies of food freezing: Ultra sound accelerated freezing, high pressure shift freezing, electro static field assisted food freezing, antifreeze proteins.

UNIT-V Packaging of frozen foods: Introduction to frozen food packaging, plastic packaging of frozen foods, packaging of frozen foods with other materials, active and intelligent packaging, vacuum packaging, edible coatings and films and their applications on frozen foods.

TEXT BOOKS:

1. De wan sun, Handbook of Frozen food processing and packaging 2nd Edition, CRC Press, 2012.
2. Judith A. Evans, Frozen Food Science and Technology, Blackwell publishing ltd, 2008.

REFERENCE BOOKS:

1. Mallett. C. P., Frozen Food Technology, Blackie Academic and Professional, 1993.
2. Pruthi. J. S., Quick Freezing Preservation of Foods, Volume II, ISBN, 1999.

DAIRY ENGINEERING

UNIT-I Milk Processing Equipment: Heat exchanger: Plate chiller, HTST Pasteurizers-shell and tube heat exchangers, construction codes, general design considerations, U-tube heat exchangers, double pipe exchanger, scraped surface exchanger, spiral tube exchangers, joints; welded tube joints, baffles and tube bundles, tube sheet, double tube sheet construction, plate type heat exchanger; air cooled heat exchangers. Computer software for design of heat exchanger, batch pasteurization and Spiro flow heat exchangers. Homogenizers: single stage, double stage, double stage with micro gap, valves to reduce power consumption. Cream separators: clarifiers, cream concentrators.

UNIT-II Evaporation: Classification, design of single effect and multiple-effect evaporator, temperature distribution, boiling point elevation, operation, feeding methods, condensate and air removal, scale formation and removal, heat and mass balance, vapor recompression. **Drying:** Spray dryer and its components, different types of atomizers, air heaters, roller, tray, flat type and conical driers, selection and design of auxiliary equipment.

UNIT-III Milk and Milk products equipment: Ultra high temperature sterilizers and packing machines for aseptic packing, form fill and sealing machines, continuous butter making machine, butter churners and cup packing machine for curd and lassie. **Bulk milk cooling units:** Direct expansion type and ice bank tank type bulk milk cooling units.

UNIT-IV Safety and hygiene: Cleaning in place- cleaning system for process equipment, safety equipment, disposal of effluents. **Quality:** Milk constituents- Fat, SNF and water and etc. Chemical behavior and Properties of milk.

UNIT-V Emerging areas: Clean and green technologies, conservation of energy, water management system, membrane technology for cold concentration of milk, process control and instruments.

TEXT BOOKS:

1. Charm SE. 1971. The Fundamental of Food Engineering. AVI Publ.
2. Heldman DR & Singh R.P. 1984. Food Process Engineering. The AVI Publ.

REFERENCE BOOKS:

1. Mohsenin NN. 1986. Physical Properties of Plant and Animal Materials. Gordon & Breach Science Publ.
2. Rao MA & Rizvi SSH. 1986 Engineering Properties of Foods. Marcel Dekker.
3. Watson EL & Harper IC. 1989. Elements of Food Engineering. AVI Publ.

CONFECTIONERY TECHNOLOGY

UNIT-I Introduction:Raw Materials for Confectionery Manufacture, Comprehensive understanding of raw materials used in the confectionery manufacturing and processing industry, including quality control methods. cocoa, Sugar, Dried milk products, Special fats, Emulsifiers, Nut kernels, Alcoholic ingredients, The production of cocoa liqueur from the cocoa bean, Dark, milk and white chocolate, manufacturing processes.

UNIT-II Chocolate: Production of chocolate mass.Chocolate Processing Technology, Tempering and fat crystallization effects on chocolate quality, fat bloom formation and development in chocolate process. Enrobing technology,Compound Coatings, Chocolate hollow figures, Chocolate shells, Manufacture of candy bars, Presentation and application of vegetable fats.

UNIT-III Sugar Confectionery:General technical aspects of industrial sugar confectionery manufacture, Manufacture of high boiled sweets– Ingredients, Methods of manufacture–Types–Center–filled, lollipops, coextruded products. Manufacture of gums and jellies–Quality aspects.

UNIT-IVMiscellaneous Products:Caramel, Toffee and fudge– Liquorices paste and aerated confectionery, Lozenges, sugar panning and Chewing gum, Count lines Quality aspects, fruit confections.

UNIT-V Flour confectionery: Ingredients and flour specification-Types of dough– Developed dough, short dough, semi-sweet, enzyme modified dough and batters- importance of the consistency of the dough. Indian flour confections manufacture–Flour specification–ingredients–manufacturing process–types of chemically aerated goods.

TEXT BOOKS:

1. Emmanuel OheneAfoakwa, 2011. Chocolate Science and Technology 1st Edition. John Wiley & Sons.
2. Steve T. Beckett, 2011. Industrial Chocolate manufacture and use 4th Edition. John Wiley & Sons.
3. Bent A, Bennion EB &Bamford GST. 1997. The Technology of Cake Making. 6th Ed. Blackie.
4. Jackson EB.1999. Sugar Confectionery Manufacture. 2nd Ed. Aspen Publ.

REFERENCE BOOKS:

1. Junk WR &Pancost HM. 1973. Hand Book of Sugars for Processors. Chemists and Technologists. AVI Publ.
2. Manley DJR.1983. Technology of Biscuits, Crackers, and Cookies. Ellis Horwood.
3. Matz SA. 1992. Bakery Technology and Engineering. 3rd Ed. Chapman & Hall.
4. Pomeranz Y. 1987. Modern Cereal Science and Technology. MVCH Publ.

EXTRUSION AND SNACK FOOD TECHNOLOGY

UNIT-I Extrusion: Introduction to extruders and their principles, types of extruders. **Extruders in the food industry:** History and uses of extruders in the food industry. **Single screw extruder:** principle of working, net flow, factors affecting extrusion process, co-kneaders. **Twin screw extruder:** Feeding, screw design, screwspeed, screw configurations, die design, barrel temperature and heat transfer, adiabatic operation, heat transfer operations and energy balances. Problems associated with twin screw extruder.

UNIT-II Pre-conditioning of raw materials used in extrusion process: Pre-conditioning Operations and benefits of pre-conditioning and de-volatilization. Interpreted-flight expanders - extruders, dry extruders. Chemical and nutritional changes in food during extrusion. **Practical considerations in extrusion processing:** pre-extrusion processes, cooker extruder profiling. Practical considerations in extrusion processing: Addition and subtraction of materials, shaping and forming at the die, post extrusion processes

UNIT-III Breakfast cereals: introduction, type of cooking - High shear cooking process, Steam cookers, low shear, low pressure cookers and continuous steam pre-cooking, Available brands Breakfast cereal processes: traditional and extrusion methods, classification of breakfast cereals - flaked cereals, oven puffed cereals, gun puffed cereals, shredded products. **Texturized vegetable protein:** Definition, processing techniques, and foods Snack food extrusion: Direct expanded (DX) and third generation (3G) Snacks: types, available brands, co- extruded snacks and indirect-expanded products

UNIT-IV Technology for grain based snacks: whole grains – roasted, toasted, puffed, popped, and flakes, coated grains- salted, spiced and sweetened. Flour based – batter and dough products; savory and farsons; formulated chips and wafers, papads, instant premixes of traditional Indian snack foods.

UNIT-V Technology for fruit and vegetable based snacks: Chips, wafers; Technology for coated nuts- salted, spiced and sweetened chikkis. Extruded snack foods: Formulated and processing technology, colouring, flavouring and packaging. Equipment's for frying, baking and drying, toasting, roasting and flaking, popping, blending, coating, chipping.

TEXT BOOKS:

1. Harper J.M. Extrusion of Foods. Vol. 1&2 (1991) CRC Press, Inc; Boca Raton, Florida.
2. O'Connor C. Extrusion Technology for the Food Industry. (1987) Elsevier Applied Science, New York.
3. Edmund WL. Snack Foods Processing. AVI Publ.
4. Frame ND .1994. The Technology of Extrusion Cooking. Blackie Academic.

REFERENCE BOOKS:

1. Richardson P. Thermal Technologies in Food Processing. Wood head Publishers, Cambridge.
2. Guy R. Extrusion Cooking, Technologies and Applications. Wood head Publishing Limited, Abington, Cambridge.
3. Fast R.B. and Caldwell E.F. Breakfast Cereals and How they are made. (2000) American Association of Cereal Chemists., St. Paul, Minnesota.
4. Frame N.D. The Technology of Extrusion Cooking. (1994) Blackie Academic & Professional, New York.

NEW PRODUCT DEVELOPMENT

UNIT-I Concept of product development:Product success and failure, factors for success, process of product development, managing for product's success. **Innovation strategy:**Possibilities for innovation, building up strategy, product development programme.

UNIT-II The knowledge base for product development technology: Knowledge and the food system, knowledge for conversion of product concept to new product, technological knowledge (product qualities, raw material properties, processing, packaging requirement, distribution and marketing).**The product development process:** Product strategy, product design and process development, product commercialization, product launch and evaluation.

UNIT-III Managing the product development process:Principles of product development management, people in product development management, designing the product development process, key decision points, establishing outcomes, budgets and constraints, managing and organizing product development process.

UNIT-IV Methodologies of new product development: Innovation funnel, stage-Gate method. Legal aspects of new product launch. **Quality and safety aspects:** Quality control, sensory analysis in product development, shelf life testing, building food safety in new products, optimizing food product design and development-statistical design, experimental units.

UNIT-V Role of consumers in product development:Consumer behaviour, food preferences, avoiding acceptance, integration of consumer needs in product development and sensory needs. **Improving the product development process:**Key message, innovative matrices, striving for continuous improvement, improving success potential of new products, market exploration and acquisition, Legal aspects of new product launch.

TEXT BOOKS:

1. John B. Lord & Aaron L. Brody, 2000. Developing new food products for a changing marketplace, CRC Press.
2. Jacqueline H. Beckley et al, 2007. Accelerating New food product design and development, 1st Edition, Blackwell publishing ltd, UK.
3. Howard R. Moskowitz et al, 2008. An integrated approach to new food product development, CRC Press.
4. Gerry Katz, NPDP, Applied Marketing Science Inc. Rethinking The Product Development Funnel.

REFERENCE BOOKS:

1. Clarke & Wright W. 1999. Managing New Product and Process Development. Free Press.
2. Earle and Earle 2001. Creating New Foods. Chadwick House Group.
3. Earle R, Earle R & Anderson A. 2001. Food Product Development. Woodhead Publ.
4. Fuller 2004. New Food Product Development - from Concept to Market Place. 3rd Edition, CRC.

SPICE PROCESSING & PRODUCTS

UNIT-I Spices in History: History of the Spice Trade, Early Use of Spices in the Americas, The Asian Spice Emporium, The First Spice Traders, Spice Use in the rest of the world. Trends in the World of Spices Today, Spices and Flavorings of Popular, Authentic Ethnic Cuisines, Natural and Organic Spice Trends.

UNIT-II Functions of Spices: primary functions – flavor, taste aroma and color, secondary functions, spices as preservatives, antimicrobials, antioxidants. Emerging functions - spices as medicines, traditional and modern medicines. **Spice forms-** fresh whole spices, dried spices, spice extractives, essential oils, oleoresins, other spice extractives.

UNIT-III Spice Preparation: Global Equipment Used in Spice Preparation, Spice Applications: Marinades, Rubs, and Glazes Spice Blends, Seasonings, and Condiments. **Emerging Spice Blends and Seasonings:** Asian Spice Blends - Regional Cuisines of Asia, South Asia, Southeast Asia, East Asia, Popular East Asian Spice Blends, Popular South Asian Spice Blends, and other continent Spice Blends, Global Spice Blends- Popular Global Spice Blends.

UNIT-IV Commercial Spice Blend and Seasoning Formulations: Mexican Red Mole Seasoning for Chicken, Jamaican Jerk Seasoning for Meats, Brazilian Pineapple Seasoning for Pork, Chicken, or Fish, Thai Red Curry Seasoning for Shrimp, Vietnamese Fish Sauce Seasoning for Condiment, South Indian Spice Blend for Lentil (or Dal) Curry. **Emerging Flavor Contributors** - Root/Tuber/Rhizome Flavorings, Flower Flavorings, Wrapper Flavorings, Seafood Flavorings, Fruit Flavorings, Vegetable Flavorings, Legume Flavorings, Nut Flavorings, Sweet and Bitter Flavorings, Flavorings from Preparation and Cooking Techniques

UNIT-V Spice Labeling, Standards, Regulations, and Quality Specifications: Spice Labeling, Spice Authenticity and Quality Concerns Spice Quality Specifications, Maintaining Spice Quality.

TEXT BOOKS:

1. Kenneth T. Farrell, Spices, Condiments and Seasonings, 2nd Edition, Aspen Publishers.
2. J. S. Pruthi, Spices & Condiments National Book Trust, 5th Edition, New Delhi, 2001.

REFERENCE BOOKS:

1. K. V. Peter, Hand book of Herbs and Spices Vol 2, CRC Press, 2004.
2. Susheela Raghavan, Handbook of Spices, Seasonings and Flavours, 2nd Edition, CRC Press, 2007.

THERMAL PROCESSING

UNIT-I Introduction: Thermo-physical properties of foods, Heat and mass transfer in Thermal food processing, processing systems: In pack processing- Retort system, Inline processing- Heat exchangers. **Quality and safety of thermally processed foods:** Thermal processing of: Meat products, Poultry products, Fishery products, Dairy products, canned foods, Ready meals, Vegetables, UHT thermal processing of milk.

UNIT-II Modelling and Simulation: Direct calculation of survival ratio and iso thermal time equivalent in heat preservation processes, computational fluid dynamics in thermal processing. **Optimization, Control of Thermal processes for Shelf-Stable Products:** Regulatory considerations, Critical factors related to the design of thermal treatments for the products packaged prior to treatment, Critical factors related to the design of thermal treatments for the products packaged prior to aseptic packaging, Qualification of heat stabilization equipment, Design and validation of thermal treatments, Heat destruction parameters and sterilization value.

UNIT-III Measurement and validation of thermal processes: Setting the target process value, Validation methods: Objectives and Principles, Temperature measurement approaches, Process establishment methods, Process calculation methods. **Online control and automation:** Online control and strategies- batch processing, plant automation for automatic batch retort systems.

UNIT-IV Developments in packaging formats for retort processing: Introduction: requirements for low and high acid foods, Developments in packaging formats: the metal can, plastic can, pot and bottle, retort pouches: construction, sealing, processing and packaging, methods for improving glass packaging, Future trends.

UNIT-V Innovations in Thermal Food Processes: Ohmic heating in Food processes, radio frequency dielectric heating, infrared heating, and pressure assisted thermal processing, pH assisted thermal processing, time-temperature integrators for thermal process evaluation, and laser based packaging sterilization in aseptic processing.

TEXT BOOKS:

1. Sandeep. K. P., Thermal Processing of Foods, Blackwell publishing, 2011.
2. Tucker. G & Susan. F., Essentials of Thermal Processing, 1st Edition, Wiley-Blackwell, 2011.

REFERENCE BOOKS:

1. Da-Wen Sun, Thermal Food Processing, CRC Press, 1st Edition, 2006.
2. Philip Richardson, Improving the Thermal Processing of Foods, 1st Edition, CRC Wood head publishing limited, 2004.
3. Ricardo Simpson, Engineering aspects of thermal food processing, CRC Press, 2009.

ANALYTICAL METHODS FOR FOODS

UNIT-I Introduction: Introduction to food analysis, Government regulations and recommendations related to food analysis, sampling and sample preparation, evaluation of analytical data, reporting results and reliability of analysis.

UNIT-II Chemical composition and characteristics of foods: Titratable acidity, moisture and total solids analysis, ash analysis, mineral analysis by traditional methods, carbohydrates analysis, fiber analysis, crude fat analysis, fat characterization, protein analysis, protein separation and characterization, protein quality tests, vitamin analysis, pigment analysis, analysis of pesticide, mycotoxin and drug residues in foods, analysis for extraneous matter, determination of oxygen demand.

UNIT-III Spectroscopy: Basic principles of spectroscopy, ultraviolet, visible and fluorescence spectroscopy, infrared spectroscopy, flame photometry, atomic absorption and emission, mass spectrometry, nuclear magnetic resonance and electronic spin resonance.

UNIT-IV Chromatography: Definition and classification, Basic principles of chromatography gas chromatography: theory and instrumentation. Liquid chromatography in columns: introduction, classification of HPLC modes, instrumentation, Quantitation: detectors and methods, Chromatography with mass spectral detection: GC/MS and LC/MS.

UNIT-V Other methods and instrumentation: The pH meter and the use of ion selective electrodes, application of enzymes in food analysis, immunoassays, thermal analysis: DSC, texture analyzer, Other Non-destructive methods: Bio sensors, Electronic nose, Image analysis.

TEXT BOOKS:

1. Ranganna .S, Handbook of Analysis and Quality Control for Fruits and Vegetables, 2nd Edition, Tata McGraw-Hill, 2011.
2. S. Suzanne Nielsen, Introduction to the chemical analysis of foods, CBS Publishers & Distributors pvt Ltd, 2002.

REFERENCE BOOKS:

1. James. M. Miller, Chromatography: Concepts and Contrasts, Wiley, 2005.
2. Pomeranz. Y & Clifton. E. M., Food Analysis: Theory and Practice, 3rd Edition, Springer, 2000.
3. SemihOtlés., Handbook of Food Analysis Instruments, CRC Press, 2009.

FOOD BIOTECHNOLOGY

UNIT-I Preservation Technology: Role and significance of microorganisms in foods. Intrinsic and Extrinsic Parameters of Foods that affect microbial growth. Role of microorganisms in manufacture and spoilage of fermented products, Cereals, Pulses, Nuts and Oil seeds, Fruits and Fruit products, Vegetables and Vegetable Products, Fish and Meat products. Probiotics, prebiotics and synbiotics.

UNIT-I Production Technology: Mechanism of enzyme functions and reactions in process techniques: Enzyme in bakery and cereal products, Enzymes in fat/oil industries. Cold active enzymes in Food processing. Starch and sugar conversion process or baking by amylases; cheese making by proteases. Utilization of food waste for production of valuables: whey; molasses; starch substances and other food wastes for bioconversion to useful products.

UNIT-III Technologies for improved processes: Technologies used for microbial production of food ingredients, production of carotenoids by gene combination, microbial biotechnology of natural food flavor and color production and polysaccharides in foods, Biotechnology of non-nutritive sweeteners, Biotechnological approach to improve nutritional quality and shelf life of fruits and vegetables, Biotechnological approaches (enzymes/proteins & effective processing parameters) towards reducing / modifying anti-nutritional factors in foods and food ingredients; Anti-nutritional factors in cereals and legumes.

UNIT-IV Application of Biotechnology in testing: Testing Application of microbial molecular techniques to food system. Impact of biotechnology on microbial testing of food, current/traditional methodology and new approaches (use of gene probes, RDT, Bioluminescence).

UNIT-V Quality and Safety Aspects of Foods derived from biotechnology: Safety and applicability of modified foods and food ingredients, Safety evaluation of genetically engineered enzyme/novel food products. International Aspects of the quality and safety assessment of foods derived by modern biotechnology.

TEXT BOOKS

1. Angold, Beech and Taggart. 1989. 'Food Biotechnology' Cambridge University Press New York
2. Kalidas S., Gopinadhan P., Anthony P., Robert E. L., 2006. 'Food Biotechnology', CRC Press, New York.

REFERENCE BOOKS:

1. Roger, A., Gordon, B. and John, T. 1989. 'Food Biotechnology'. Cambridge University Press, New York.
2. W.C. Frazier, 1968. 'Food Microbiology (II edition or later), McGraw Hill Book Company, New York.

FRUIT AND FRUIT PRODUCTS

UNIT-I Introduction to fruit processing: Post harvest handling, Factors influencing processing, controlling factors in the ripening of fruit, Ethylene production, Biosynthesis of flavors, Flavor formation, Physiological and biochemical aspects, Factors influencing fruit quality, External factors affecting fruit quality threats and opportunities.

UNIT-II Processing Technology: Fruit Processing: Principles of Heat Treatment, Fruit Freezing Principles, Fruit Drying Principles, Thawing, Canning of fruits, Non-Thermal Pasteurization of Fruit Juice Using High Voltage Pulsed Electric Fields, Minimally Processed Fruits and Fruit Products and Their Microbiological Safety, Food Additives in Fruit Processing, Aroma recovery, Vacuum frying of fruits application in fruit processing, membrane applications in fruit processing, freeze concentration applications in fruit processing, Dehumidified drying, Aseptic processing.

UNIT-III Products Manufacturing: Manufacturing Jam, Jelly, Marmalade and Fruit cheese, Preserve, Candied, Glazed and Crystallized fruits, Tomato processed products, Fruit chips, bar, sticks, French fries, and spoon able fruit smoothie, Fresh-Cut Fruits, Manufacturing Fruit Beverages: Fermented and unfermented, Concentrated fruit juices, concentrates and purees, Dried/Dehydrated fruits.

UNIT-IV Commodity Processing: Apples, Apricots, Citrus Fruits, Oranges and Citrus Juices, Sweet Cherries, Cranberry, Blueberry, Currant, and Gooseberry, Date Fruits Processing, Grapes and Raisins, Grape and Wine processing, Olive Processing, Peach and Nectarine, Pear Drying, Plums and Prunes, Processing of Red Pepper Fruits (*Capsicum annum L.*), Papaya, Banana, Mango, and Passion Fruit, Prickly Pear Cladodes and Fruits: Processing Technology Experiences and Constraints.

UNIT-V Emerging techniques: Ultraviolet light for processing fruits and fruit products, high pressure processing, Ultrasound application in fruit processing, Applications of ozone in fruit processing, Irradiation, enzyme maceration, edible coatings.

TEXT BOOKS:

1. David. A, Philip. R. A., Fruit Processing, Springer, 1996.
2. Hui. Y.H., Handbook of fruits and fruit processing, Blackwell publishing, 1st Edition, 2006.
3. Rodrigues. S & Fabiano. A. N. F., Advances In Fruit Processing Technologies, CRC Press, 2012.

REFERENCE BOOKS:

1. Srivastava. R. P., Fruit and Vegetable Processing, 3rd revised and enlarged edition, IBDC, 2000.
2. Olga. M. B & Robert. S. F., Advances in Fresh-Cut Fruits and Vegetables Processing, CRC Press, 2011.

FOOD TECHNOLOGY LAB

Experiments are conducted on development of products, new products and their quality:

Jam / Jellies/Spreads/Marmalades

Spice powders/Masala powders

Pickles

Murrabs/Candy/Crystallised fruits

Tea/Coffee concentrate

Soup mixes

Ice cream

Curd/Cheese/Yoghurt

Panner

Khova

Fortification

Instant Mixes

Biscuits and Cakes

Bread- Sponge & Straight Dough

Chips

Squash/Beverages/Juices/Nectars

Tomato Paste/Ketchup/Puree