Course Title with Credit Load
M.Tech. in Processing Technology

Major Courses

Course Code	Course Title	Credit Hours
FPT 501	Emerging Technologies in Food Processing*	2+1
FPT 502	Emerging Technologies in Food Packaging*	2+1
FPT 503	Industrial Manufacturing of Food and Beverages*	2+1
FPT 504	Food Material and Product Properties	2+1
FPT 505	Cocoa and Chocolate Processing Technologies	2+1
FPT 506	Spices, Herbs and Condiments	2+0
FPT 507	Meat, Poultry, Fish and Egg Processing	2+1
FPT 508	Nutraceuticals and Specialty Foods	2+1
FPT 509	Frozen and Concentrated Foods	1+1
FPT 510	Aseptic Processing and Packaging	2+1
FPT 511	Traditional Foods	2+1
FPT 512	Technologies of Convenience Foods	2+1
FPT 513	Food Powders and Premixes	2+1
FPT 514	Food Ingredients and Additives	2+1
FPT 515	Flavour Chemistry and Technology	2+1
FPT 516	Bioprocessing and Separation Technology	2+1
FPT 517	Enzymes in Food Processing	2+1
FPT 518	Food Process Automation and Modelling	2+0
FPT 519	Zero Waste Processing	2+0
FPT 520	Special Problem/ Summer Internship	0+2

*Compulsory Rest of the courses will be decided by the students advisory committee keeping the minimum limits set for award of degree.

Minor Courses

Course Code	Course Title	Credit Hours
FPE 502	Engineering Properties of Food Materials	3(2+1)
FPE 504	Bioprocessing and Down Stream Engineering	3(2+1)
FPE 506	Numerical Technique and Stimulation	2(1+1)
FPE 508	Food Safety and Storage Engineering	3(2+1)
FSQ 503	Advanced Food Chemistry	3(2+1)
FSQ 504	Global Food Laws and Regulations	2(2+0)
FSQ 506	Process and Products Monitoring for Quality Assurance	2(2+0)
FSQ 508	Management of Food By-products and Waste	3(2+1)

Supporting Courses

Course Code	Course Title	Credit Hours
BSH 501	Research Methodology	2+0
BSH 502	Food Informatics	1+1
FBM 501	Post-Harvest Management	2+1
FBM 502	Food Business Management	2+0
FBM 503	Food Processing Entrepreneurship and Start up	0+1
FPE 505	Energy Management and Auditing in Food Industry	2+1
FSQ 521	Food Safety Management Systems and Certification	2+1
FSQ 523	Quality Concepts and Chain Traceability	2+0
FPE 510	Operation Research	2+1

Common Courses

S. No.	Course Title	Credit Hours
1.	Library and Information Services	1
2.	Technical Writing and Communications Skills	1
3.	Intellectual Property and its Management in Agriculture	1
4.	Basic Concepts in Laboratory Techniques	1
5.	Agricultural Research, Research Ethics and Rural Development Programmes	1

These courses are available in the form of e-courses/MOOCs. The students may be allowed to register these courses/similar courses on these aspects, if available online on SWAYAM or any other platform. If a student has already completed any of these courses during UG, he/she may be permitted to register for other related courses with the prior approval of the HoD/BoS.

Seminar

Course Code	Course Title	Credit Hours
1	Seminar	1+0

Course Contents
M.Tech. in Processing Technology

I. Course Title : Emerging Technologies in Food Processing
II. Course Code : FPT 501
III. Credit Hours : 2+1

IV. Theory

Unit I

Membrane Technology: Pressure activated membrane processes: MF, UF, NF and RO and their industrial application. Membrane distillation. Supercritical fluid extraction: Concept, property of super critical fluids SCF, extraction methods, application in food processing.

Unit II

Microwave and radio frequency processing: Advantages, mechanism of heat generation, application in food processing: microwave blanching, sterilization and finish drying. Hurdle technology: Concept and Principle, Preservation techniques as hurdles and their principles, hurdle tech foods.

Unit III

High Pressure processing: Concept, equipment for HPP treatment, mechanism of microbial and enzyme inactivation and its application in food processing, effect on food constituents.
Ultrasonic processing: Properties of ultrasonic, types of equipment, application of ultrasonic as processing technique.

Unit IV

Newer techniques in food processing*:* principle and application of High intensity light, pulse electric field, ohmic heating, IR heating, inductive heating, cold plasma, and pulsed X-rays in food processing and preservation, Cryo-processing of foods Nanotechnology: Principles and applications in foods.

V. Practical

- To evaluate the characteristics of treated water using RO system
- To study production and characteristics of treated water using, microfiltration, UF, NF and RO system
- To study the effect of ultrafiltration process on fruit juices quality
- To study suitability and production of fruit juices using ultrafiltration
- To study the effect of microfiltration process on milk quality
- To study super critical fluid extraction system and to carry out extraction of bioactive compound from selected samples
- To carry out extraction of lycopene from tomato using SCFE system
- To study microwave system and to evaluate the effect of different power on drying characteristics of selected vegetable products

- To study microwave blanching of vegetable and determination of blanching efficacy
- To study the ultrasonicator and evaluate the effect of ultrasonication on micro-organism in sample
- To study the ultrasonicator and to evaluate the effect of ultrasonication on extracted juice yield from fruit pomace
- To evaluate the different pre-treatment on oil yield from oil seed cake
- To prepare nano emulsion and study of their characteristics
- To study ohmic heating system and to study the processing of fruit pup using ohmic heating system
- To visit food industries utilizing advance food processing techniques
- To study the effect of different drying techniques/ hybrid drying techniques on fruits and vegetables.

VI. Suggested Reading

- Gould GW, 2000. *New Methods of Food Preservation*, CRC Press.
- Barbosa-Canovas, 2002. *Novel Food Processing Technologies*, CRC Press.
- Dutta AK &Anantheswaran RC. 1999. *Hand Book of Microwave Technology for Food Applications*, CRC Press.
- Sun DW, 2015. *Emerging Technologies for Food Processing*, Elsevier Ltd.
- Kudra T and Mujumbar AS, 2009. *Advanced Drying Technologies*, CRC Press.
- Nema PK, Kaur BP and Mujumdar AS, 2018. *Drying Technologies for Foods: Fundamentals and Applications*, CRC Press

I. Course Title : Emerging Technologies in Food Packaging

II. Course Code : FPT 502

III. Credit Hours : 2+1

IV. Theory

Unit I

Active and intelligent packaging: Active Packaging Techniques and intelligent Packaging Techniques, current use of novel Packaging Techniques, consumers and novel Packaging Oxygen, ethylene and other scavengers: Oxygen scavenging technology, selecting right types of oxygen scavenger, ethylene scavenging technology, carbon dioxide and other scavengers.

Antimicrobial food packaging: Antimicrobial agents, constructing antimicrobial packaging systems, factors affecting the effectiveness of antimicrobial packaging.

Unit II

Non-migratory bioactive polymers (NMBP): Advantages of NMBP, Inherently bioactive synthetic polymers: types and application, Polymers with immobilized bioactive compounds and their applications.

Time Temperature labels and indicators (TTIs): Defining and classifying TTIs, Requirements for TTIs, development of TTIs, Maximizing the effectiveness of TTIs, Application of TTIs- to monitor shelf-life, and optimization of distribution and stock rotation, leakage indicators, oxygen indicators, micro indicators etc.

Freshness indicator in packaging: Compounds indicating the quality of packaged food products, freshness indicators, pathogen indicators, other methods for spoilage detection.

Self-heating/rehydrating packages.

Unit III

Packaging-flavour interaction: Factors affecting flavor absorption, role of food matrix, role of differing packaging materials, flavour modification and sensory quality, Study of packaging materials compatibility with foods.

Developments in modified atmosphere packaging (MAP): Permeability properties of polymer packaging, measurement of permeability – water and gases. Selection criteria of packaging films, Novel MAP gas, testing novel MAP applications, applying high oxygen MAP.

Recycling packaging materials: Recyclability of packaging plastics, improving the recyclability of plastics packaging, testing safety and quality of recycled materials, uses of recycled plastics in packaging.

Unit IV

Green plastics for food packaging: Problems of plastic packaging wastes, range of biopolymers, developing novel biodegradable materials.

Edible Films and Coatings: Properties, types, sources, applications, advantages, disadvantages, theories of plasticization, challenges and opportunities.

PFS machine, seal and closures.

Safety and legislative aspects of packaging: Regulatory considerations, plastic, metal, paper and glass packaging.

V. Practical

- Determination of WVTR in different packaging materials
- Determination of GTR in different packaging materials.
- Study of different ethylene scavengers and their analysis
- Study of different oxygen scavengers systems and their analysis
- Application of anti-microbial packaging for moisture sensitive foods
- Evaluation of chemical residue migration from package to food
- Application of MAP packaging in selected foods
- Study of TTI label, leakage indictors etc.
- Determination of oxidative changes in packaged foods
- Comparative evaluation of flexible and rigid packages for fragile foods
- Packaging of foods under inert atmosphere.
- To study textural characteristics of selected fruit/ vegetable under MAP storage
- Shelf life evaluation and mode up of packaged food product.
- Determination of oil and grease resistant test for packaging films
- Determination of respiration rate in fresh fruits and vegetables
- Determination of shelf life of fresh fruits and vegetables by using edible coating and films.
- Effect of edible coating and films on respiration behaviour, chemical, physical and sensory characteristics of fresh fruits and vegetables.
- Visit to food packaging material manufacturing industry

VI. Suggested Reading

- Ahvenainen R, 2001. *Novel Food Packaging Techniques*, CRC Press.
- Robertson GL, 2012. *Food Packaging*, CRC Press.
- Hanlon, JF, Kelsey RJ and Forcinio H. 1998. *Handbook of Package Engineering*, CRC Press.
- Painy FA, 1992. *A Handbook of Food Packaging*, Blackie.
- Rooney ML, 1988. *Active Food Packaging*, Chapman & Hall.
- Coles R and Kirwan M, 2011. *Food and Beverage Packaging Technology*, Wiley-Blackwell.
- Han J and Han J, 2005. *Innovations in Food Packaging*, Academic Press.

• Yam K and Lee D, 2012. *Emerging Food Packaging Technologies*, Woodhead Publishing.

I. Course Title : Industrial Manufacturing of Food and Beverages
II. Course Code : FPT 503
III. Credit Hours : 2+1

IV. Theory

Unit I

Grain products: Industrial manufacturing of grain based products: formulation, processes, machinery and material balance of baked, rolled, shredded, puffed, flaked, roasted products.
Extrusion technology: Importance and applications of extrusion in food processing; Pre and post extrusion treatments; Manufacturing process of extruded products; Change of functional properties of food components during extrusion. Breakfast cereals, RTE/RTC foods, instant premixes, functional foods.

Unit II

Fruit and vegetable products: Industrial manufacturing of fruit and vegetable based products: formulation, processes, machinery and material balance of minimally processed, Retorted products, IMF, high moisture stable foods, IQF; Machines and equipment for batch and continuous processing of fruit and vegetable products.

Unit III

Chocolates and candies: Coating or enrobing of chocolate (including pan-coating); Maintenance, safety and hygiene of bakery plants.
Fats and oils processing: Technology of refined oil, winterized oil, hydrogenated fat, texturized fat, by-products of fat/oil processing industries – oil seed protein isolates; Quality standards of fats and fatty foods; Antioxidants and its mechanism of application.

Unit IV

Beverages: Production technology of beer and wine
Non-alcoholic beverages: Carbonated beverages: carbonation equipment, -ingredients-preparation of syrups-Filling system-packaging-containers and closures. Non-carbonated beverage: Coffee bean preparation-processing-brewing-decaffeination- instant coffee, Tea types-black, green, Fruit juices and beverages,. Flash pasteurization, Aseptic Packaging of beverages Tea/coffee and cocoa beverages, Grain based and malted beverages.
Packaged drinking water: types, manufacturing processes, quality evaluation and raw and processed water, methods of water treatment, BIS quality standards of bottled water; mineral water, natural spring water, flavoured water, carbonated water.

V. Practical

- Preparation of cereals based fried snack foods
- Preparation of cereal, pulses based ready-to-eat snack food by extrusion cooking their quality evaluation
- Preparation of cereal grain based puffed products
- Development of instant food premixes
- Preparation of cereal and legume based roasted snack
- Preparation of flaked rice product

- To study the effect of roasting time and temperature on quality of pop-corn
- Determination of shelf-life and packaging requirements of snack food products
- Preparation of fruits/vegetable based ready to serve beverages and quality evaluation
- Heat classification of milk powders.
- Determination of degree of browning-chemical/physical methods.
- Determination of quality of packaged drinking water.
- Preparation of wine and beer
- Preparation of soy milk.
- Determination of quality of canned food.

VI. Suggested Reading

- Edmund WL, 2001. *Snack Foods Processing*, CRC Press.
- Gordon BR. 1990. *Snack Food*, Springer US.
- Frame ND, 1994. *Technology of Extrusion Cooking*, Springer US
- O'Brien RD, 2008. *Fats and Oils: Formulating and Processing for Application*, CRC Press.
- Davis B, Lockwood A, Alcott P and Pantelidis L, 2012. *Food and Beverage Management*, CRC Press.
- Kunze W, 2010. *Technology: Brewing and Malting*, VLB.
- Dhillon PS and Verma S, 2012. *Food and Beverage: Production Management for Hospitality Industry*, Abhijeet Publications.
- Bamforth CW, 2006. *Brewing: New Technologies*, Woodhead Pub.

I. Course Title : Food Material and Product Properties

II. Course Code : FPT 504

III. Credit Hours : 2+1

IV. Theory

Unit I

Introduction: Biomaterials and their properties in relation to processing and product development.

Physico-chemical characteristics: Shape, sphericity, size, volume, microstructure, density, porosity, surface area, coefficients of friction and angle of repose and influence of constituents on processing.

Unit II

Mechanical and rheological properties: Flow behaviour of granular and powdered food materials, rheological models, creep phenomenon, stress – strain - time effects and relationships, and techniques of model fitting, Elastic vs. textural characteristics and textural profile analysis of food products.

Unit III

Thermal, electrical and optical properties: Specific heat, thermal conductivity, phase transition, thermodynamics-basic principles and laws, Thermodynamic properties of moist air, kinetics of water absorption, heat capacity, thermal diffusivity, electrical resistance and conductance, dielectric constant, reflectivity, transmittivity and absorptivity of incident rays.

Food microstructure: Methods and systems for food microstructure, determination of light microscopy, transmission electron microscopy, scanning electron microscopy, other instrumentation and techniques, image analysis: image acquisition, image processing, measurement analysis.

Unit IV

Functional properties: Dextrinization, Gelatinisation, Crystallisation, gelation, foaming, coagulation, denaturation and syneresis, foaming, emulsification.
Sensory attributes: Sensory properties and correlation with objective indices, microstructure and its relation to texture from their mechanical models and its examination.
Sorption behaviour of food: sorption isotherm, modelling.

V. Practical

- To determine physical dimension and shape for suitability of processing and packaging of food materials
- To determine bulk, true density and porosity of samples
- To determine the angle of repose using rough and smooth surface
- Analysis of powder characteristics using powder flow analyser.
- To determine the mixing and strength characteristics of wheat flour using faringograph/ mixograph/ mixolab
- To determine the amylolytic activity using falling number of wheat flour
- Development of stress and strain curve and to study viscosity of Newtonian and non-Newtonian fluid
- Effect of temperature on viscosity profile of a food sample
- Texture profile analysis of foods samples.
- Effect of temperature on textural profile of food
- Determination of thermal properties of foods using DSC.
- To estimate dielectric constant of foods
- Organoleptic evaluation of food materials
- TEM and SEM, image analysis and image processing techniques
- To determine water activity of food
- To determine colour value of food, viz. Lab, whiteness index, yellow index, browning index

VI. Suggested Reading

- Rao MA and Rizvi SSH, 1986. *Engineering Properties of Foods*, Marcel Dekker.
- Aguilera JM & Stanley DW, 1999. *Microstructural Principles of Food Processing and Engineering*, Springer.
- Mohsenin NN, 1986. *Physical Properties of Plant and Animal Materials*, Gordon & Breach Science.
- Bourne MC, 1981. *Food Texture and Viscosity; Concept and Measurement*, Academic Press.
- Steffe JF, 1992. *Rheological Methods in Food Process Engineering*, Freeman Press.
- Aguilera JM, 1999. *Micro Structure: Principles of Food Processing Engineering*, Springer.
- Rahman MS, 2009. *Food Properties Handbook*, CRC Press.
- Serpil S & Sumnu SG, 2006. *Physical Properties of Foods*, Springer-Verlag.
- Pomeranz Y, 1991. *Functional Properties of Food Components*, Academic Press

I. Course Title : Cocoa and Chocolate Processing Technologies
II. Course Code : FPT 505
III. Credit Hours : 2+1

IV. Theory

Unit I

Introduction: Cocoa, Occurrence, chemistry of the cocoa bean, analysis of cocoa

beans, processing of raw bean, changes taking place during fermentation of cocoa bean

Cocoa processing: processing of cocoa bean- Cleaning, roasting, alkalization, cracking and fanning; Nib grinding for cocoa liquor, cocoa butter and cocoa powder; processing of roast bean; chemical changes during various stages of processing

Unit II

Chocolates: Types, ingredients, chemistry of chocolate manufacture, Mixing, Refining, Conching, Tempering, moulding etc. to obtain chocolate slabs, chocolate bars. Dark, milk and white chocolate and their manufacturing processes

Unit III

Enrobed and other confectionary products: Compound Coatings & Candy Bars, Tempering technology, Chocolate hollow figures, Chocolate shells, Enrobing technology, Manufacture of candy bars, Presentation and application of vegetable fats. Production of chocolate mass

Unit IV

Packaging, quality and storage of chocolates.

V. Practical

- Anatomical structure of cocoa beans
- Effect of fermentation on cocoa beans
- Roasting of cocoa beans
- Effect of roasting on cocoa beans
- Effect of packaging on quality of cocoa beans
- Production of cocoa liquor
- Production of cocoa butter
- Effect of crunching on chocolate
- Effect of tempering on chocolate
- Fat expulsion during chocolate storage
- Production of milk chocolate
- Production of dark chocolate
- Effect of packaging on quality of chocolate
- Effect of storage temperature on chocolate quality

VI. Suggested Reading

- Minifie, BW, 1999. *Chocolate, Cocoa and Confectionery Technology*. Springer Science & Business Media.

I. Course Title : Spices, Herbs and Condiments

II. Course Code : FPT 506

III. Credit Hours : 2+0

IV. Theory

Unit I

Introduction: Status and scope of spice processing industries in India; Spices, Herbs and seasonings: sources, production, selection criteria, classification on the basis of origin, physical characteristic.

Major spices: Post-Harvest Technology composition, processed products of following spices (1) Ginger (2) Chilli (3) Turmeric (4) Onion and garlic (5) Pepper (6) Cardamom

Unit II

Minor spices, herbs and leafy vegetables: All spice, Annie seed, sweet Basil, Caraway seed, Cassia, Cinnamon, Clove, Coriander, cumin, Dill seed, nutmeg, mint, Rose merry, saffron, sage

Processing technology of Spices: Chemical composition, processing methods, equipment's used; recent developments in processing

Unit III

Processing effect on spice quality: Effect of processing on spice quality, contamination of spices with micro-organisms and insects

Unit IV

Spice Essential Oils: methods of extraction, isolation, and encapsulation,
Spice Oleoresins: method of extraction, isolation, separation equipment
Spices quality evaluation: Criteria for assessment of spice quality

V. Suggested Reading

- Reineccius G. 2005. *Flavour Chemistry and Technology*. CRC Press.
- Heath HB, 1986. *Flavour chemistry and Technology*. AVI Publ.
- Piggott JR, Paterson A. 1994. *Understanding Natural Flavours*. Springer US

I. Course Title : Meat, Poultry, Fish and Egg Processing
II. Course Code : FPT 507
III. Credit Hours : 2+1

IV. Theory

Unit I

Meat Industry: Meat and meat products in India-an Industrial profile. Meat production and trade practices. Prospects and problems in production of fresh meat in India, Research and Development activities on meat, fish and poultry products. Gross and microstructure of muscle. Mechanism of muscle contraction and relaxation: Organization of skeletal muscle from gross structure to molecular level. Muscle Communication (sarcolemma, sarcoplasmic reticulum, Innervation). Muscle metabolism. Different types of connective tissues and their relevance to properties of meat. Myofilament proteins and their major functions. Nervous tissue, nerves and the nature of stimuli, membrane potential in nerve and muscle, Events that occur during relaxation and contraction.

Unit II

Cattle and beef, sheep and mutton, pig and pork and their fabrication: Breeds, Pre-slaughter care, ante and post mortem, slaughter, handling of offal (edible and inedible). Cuts of beef, pork and mutton.

Meat inspection and grading: Application and Enforcement of inspection laws, elements of inspection (sanitation, antemortem inspection, post-mortem inspection, condemnation, product inspection, laboratory inspection, labelling). Identification of inspected products, product inspection, types of grades, factors used to establish quality grades, conformation, fleshing and finish.

Unit III

Properties of fresh meat: Perception of tenderness, Factors effecting tenderness, connective tissue, collagen, sarcomere contractile state, Myofibrillar tenderness,

marbling. Methods to improve tenderness (Electrical stimulation, aging, Meat colour, Pigments associated with colour, Chemical state of pigments, methods to improve meat colour. Water holding capacity (Net charge effect and stearic effect) Molecular Techniques in meat products, cultured meat etc.

Poultry meat: Kind of poultry, processing of poultry. Special poultry products, Breaded poultry, Smoked turkey, packagedprecooked chicken, Freeze dried poultry meat.

Egg and egg processing: Egg quality, egg preservation, egg powder production

Unit IV

Meat analogues and restructured meat products: Textured plant proteins, processes for preparation of meat analogues and restructured meat products.

Fish processing and fish products: Chemical/Nutritional composition of Fish, Fish in human diet: protein, carbohydrates, lipids, vitamins etc. Selection of raw material for processing of streaking and filleting of fish; production of fish paste, fish oils, sauce, fish protein concentrates. Irradiation of fish and fisheries products, packaging of fish products, quality control and quality assurance. Allergens, toxins and infectious diseases from meat, poultry and fish products.

V. Practicals

- To study the effect of low and high oxygen atmosphere on meat colour.
- To study the chemistry of myoglobin as it relates to the colour of the molecule.
- To understand and compare the action of two meat tenderizing enzymes by applying the technique of electrophoresis.
- To study the structure of the muscle under compound microscope.
- Perform the slaughtering of the poultry birds.
- Identification of different internal organs of poultry birds and their utilization for product preparation.
- Dressing of Fish.
- Determination of total volatile acids in fish,
- Determination of buffering capacity of fish muscle.
- Rapid estimation of hypoxanthine concentration in chill stored fish.
- Determination of glycine in fish muscle.
- Determination of protein fractions in fresh fish.
- Cut out test for canned fishery products.
- Determination of glycogen in fish muscle.
- Industrial visit to meat industry.

VI. Suggested Reading

- Henricksons. 1978. *Meat Poultry and Sea Food Technology*/ Prentice Hall
- Robert RJ. 2012. *Fish Technology*/ Wiley-Blackwell
- Mountney GJ. 1988. *Poultry Meat and Egg Production*/ Springer, Netherlands
- Kerry J, Kerry J. 2002. *Meat Processing*/ Woodhead Publishing and David Ledwood
- Levie A. 1979. *Meat Hand Book*, Avi Pub
- Weiss GH. 1971. *Poultry Processing*. Noyes Data Corporation
- Wheaton FW and Lawson TB. 1985. *Processing of Aquatic Food Products* John Wiley & Sons.
- Mead G. 2004. *Poultry meat processing and quality* Woodhead Publishing
- Sinha R. 2017. *HACCP in Meat, Poultry and Fish Processing*/ Random Publications
- Sahoo J and Chatli MK. 2015. *Textbook on Meat, Poultry and Fish Technology*/ Daya Pub. House.

- Badapanda KC. 2012. *Basics of Fisheries Science*/ Narendra Publishing House
- Sahoo J, Sharma DK and Chatli MK. 2016. *Practical Handbook on Meat Science and Technology*/ Daya Pub. House

I. Course Title : Nutraceuticals and Specialty Foods

II. Course Code : FPT 508

III. Credit Hours : 2+1

IV. Theory

Unit I

Introduction: Defining nutraceuticals and functional foods. Nature, type and scope of nutraceutical and functional foods. Nutraceutical and functional food applications and their health benefits. Nutraceutical compounds and their classification based on chemical and biochemical nature, Innovations in Functional Food Industry for Health and Wellness, Development of biomarkers to indicate efficacy of functional ingredients.

Nutraceuticals and Functional foods: Nutraceuticals/ food components for specific disease such as cancer, heart disease, diabetes, obesity, anti-aging, arthritis, Prebiotics and probiotics; Omega 3 and omega 6 fatty acids, Isoflavones, phenolic compounds, catechins, lycopene, glucosinolates.

Unit II

Specialty Foods: Design of food for infants, children and old age.

Functional Beverage: Selection of ingredients, health benefits and production.

Extraction and delivery system: Non-thermal techniques, bioprocessing techniques, dehydration techniques, effect on bioactive ingredients. Delivery system and controlled release of nutraceuticals

Unit III

Packaging, Storage, labelling: Packaging requirements, storage and storage kinetics on quality of nutraceuticals, interactions of various environmental factors.

Marketing and safety aspects: Marketing and safety and regulatory issues for functional foods and nutraceuticals.

Unit IV

Nutrigenomics: concept of personalized medicine. Use of nanotechnology in functional food industry.

Biological functionality of cruciferous vegetables, tropical, subtropical and temperate fruits, herbs and spices.

V. Practical

- Determination of antioxidant activity of given food sample by different techniques, viz. DPPH, FRAP, ABTS, FRAP.
- Determination of total phenolic content of given food sample.
- Estimation of dietary fibres of given food sample.
- Estimation of lycopene in tomato.
- Estimation of carotenoids of given food sample.
- Determination of total flavonoid content of given food sample
- Effect of heat processing on ascorbic acid
- Determination of vitamins A.

- Estimation of pectic substances in plant sample
- Determination of beta carotene of given food sample.
- To determine gas chromatography for bioactive components analysis.
- To study the effect of drying on bioactive components of food sample
- To study the packaging requirement of functional foods.
- Determination and qualifications of some nutraceutical and functional food compounds by HPLC
- Estimation of â- glucan
- To study the storage kinetics of nutraceutical.
- Estimation of soluble/insoluble fibres of given food sample.

VI. Suggested Reading

- Chadwick R Henson S and Moseley B, 2003. *Functional Foods*, Springer-Verlag.
- Jeffrey Hurst W, 2008. *Methods of Analysis for Functional Foods and Nutraceuticals*, CRC Press.
- Shi J, Mazza G and Maguer M, 2002. *Functional Foods*, CRC Press.
- Wildman REC, 2006. *Handbook of Nutraceuticals and Functional Foods*, CRC Press.
- Vattem DA and Maitin V, 2016. *Functional Foods, Nutraceuticals and Natural Products*, DEStech publications.
- Grumezescu AM, 2016. *Nutraceuticals: Nanotechnology in the Agri-Food Industry*, Elsevier Inc
- Rizvi SSH, 2010. *Separation, Extraction and Concentration Processes in the Food, Beverage and Nutraceutical Industries*, Woodhead Publishing.
- Tomar SK, 2011. *Functional Dairy Foods Concepts and Applications*, Satish Serial Publishing House.
- Gupta RK, Bansal S and Mangal M, 2012. *Health Food Concept, Technology and Scope*, Biotech Books.

I. Course Title : Frozen and Concentrated Foods

II. Course Code : FPT 509

III. Credit Hours : 1+1

IV. Theory

Unit I

Freezing: Glass transitions in frozen foods and biomaterials, Microbiology of frozen foods, Thermo-physical properties of frozen foods, Freezing loads and Freezing time calculation, Innovations in freezing process, freezing methods and equipment. Facilities for the Cold Chain: Cold store design and maintenance, Transportation and storage of of frozen foods, Retail display equipment and management.

Unit II

Quality and safety of frozen foods: Quality and safety of frozen meat and meat product, poultry and poultry products, eggs and egg products, fish and shellfish, and related products, frozen vegetables and fruits, frozen dairy products, frozen ready meals and confectioners.

Unit III

Packaging of frozen foods: Selection of packaging materials, Plastic and paper packaging of frozen foods, Shelf-life prediction of frozen foods.

Unit IV

Concentrated milk: Production and quality of evaporated and condensed milk.

Concentrated juice products: Production and quality of fruits and vegetable juice concentrate, puree and paste, tomato juice concentrates, mango pulp etc.

V. Practical

- Measure the glass transition temperature of food
- Calculate freezing load of food sample
- Calculate freezing time of a frozen foods
- Effect of cold chain on quality of fruits and vegetables
- Effect of cooling on egg quality
- Effect of chilling on meat quality
- Effect of freezing on meat quality
- Production of concentrated milk and check its quality
- Production of evaporated milk and check its quality
- Effect of clarification n juice quality
- Effect of juice concentration on juice concentrate
- Effect of cold and hot break on tomato pulp quality
- Production tomato puree and paste and check its quality

VI. Suggested Reading

- Erickson MC & Hung YC, 1997. *Quality in Frozen Foods*, Springer.
- Hui YH, Legarretta IG, Lim, MH, Murrell KD & Nip WK, 2004. *Handbook of Frozen Foods*, CRC Press.
- Kennedy C J, 2000. *Managing Frozen Foods*, Elsevier.

I. Course Title : Aseptic Processing and Packaging

II. Course Code : FPT 510

III. Credit Hours : 2+1

IV. Theory

Unit I

Introduction: present and future of aseptic processing, Advantages and disadvantages, processing of semi-solid and fluid and particulate foods.
Aseptic processing operations: pre-sterilization, loss of sterility, water-to-product and product-to-water separation, cleaning, control, CIP.

Unit II

Quality Assurance: Effect of aseptic processing on nutrients, microorganisms, in-process and post-process assurance, HACCP, regulatory aspects of processing and packaging, Shelf life modules.

Unit III

Sanitary design and Equipments requirements: Pumps, Heat exchangers, homogenizers, aseptic process and packaging system for retail and institutional packages.

Unit IV

Packaging of aseptic processed foods: Packaging materials characteristics, aseptic filling, sterilization of packaging materials, package design, aseptic packaging system, type of pack and equipments: Fill and seal, Form, fill and seal, Erect, fill and seal, Thermoform, fill, sealed, Blow mold, fill, seal; geometry, materials and size of retail and bulk package, seal and closures.

V. Practical

- Effect of aseptic processing on microbial quality of juice based beverage
- Effect of aseptic processing on vitamins in selected foods.
- Effect of aseptic processing on minerals in selected foods.
- Effect of aseptic processing on colour pigments in selected foods.
- Effect of aseptic processing on browning of milk
- Effect of aseptic processing on viscosity of milk
- Effect of aseptic processing on proteins in selected foods
- Effect of different chemical sterilant on microbial quality of packaging material
- To estimate chemical sterilant residue on packaging materials
- Estimation of package integrity and leakage
- Shelf life models and prediction.

VI. Suggested Reading

- Robertson GL, 2012. *Food Packaging: Principles and Practices*, CRC Press.
- David JRD, Graves RH and Szemplenski T, 2016. *Handbook of Aseptic Processing and Packaging*, CRC Press.
- Reuter H, 1993. *Aseptic Processing of Foods*, CRC Press.
- Willhoft EM, 1993. *Aseptic Processing and Packaging of Particulate Foods*, Springer.

I. Course Title : Traditional Foods
II. Course Code : FPT 511
III. Credit Hours : 2+1

IV. Theory

Unit I

Present status of traditional food products, Globalization of traditional food products; Plans and policies of the Government and developmental agencies.
Overview of heat-desiccated, coagulated, fried, fermented traditional food products
Process technology for Indian bread (chapatti), paratha, stuffed paratha, panipoori
Process technology for Indian fried foods- poori, samosa, sev, fafda, chorafali, Jalebi
Process technology for fermented traditional food and its improvement- pickle, idli, khaman, nan, dahi, dhokla, Spiced buttermilk etc.
Process improvement in production of Indian sweets (Halwasan, kajukatli, carrothalwa, Rabdi, chocolate burfi, Chikki etc).
Process improvement in production of puffed cereals and grains by microwave technique

Unit II

New products based on fruits, vegetables and cereals
Application of membrane technology; microwave heating, steaming, extrusion for industrial production of traditional food products (Shrikhand, Dhokla, wadi, murukku/chakri, Patra, Khandvi)
Utilization and scope of legumes and grains in India for novel food products development like- flour, ready to eat products, flour mixes etc (puranpoli, Idlimix,Wada mix, Gotamix)
Process technology for convenience traditional food products (ready to eat and serve -Curried vegetables, pulses and legumes), chutneys, paste
Use of natural and permitted synthetic preservatives and new packaging systems for traditional food products.

Unit III

Techno-economic aspects for establishing commercial units for traditional products. Introduction to traditional foods of India, composition and nutritive values, microbial and biochemical diversity, quality and food safety challenges Processing& Preservation methods of Sweets & Desserts**:** Kulfi, Falooda, Kheer, khurchan, khoa/mawa, Rabri,jalebi, imarti, Gulab jamun, Peda, petha, rewdi, gajak, milk cake, balushahi, bal mithai, singoni, Ras-malayi,Gulqand, ghevar, rasgolla, chamcham, son halwa, son papri, several varieties of halwa, laddu, barfi & rasgolla.

Unit IV

Traditional fermented foods: Idli, dosa, Vada, khamman dhokla, Dahi (Curd), Srikhand.Processing & Preservation methods of Snacks**:** Gujiya, kachauri, samosa, mirchibada, kofta, potato chips, banana-chips, mathri, bhujiya, fried dhals, bhujia, shakarpara, pakora, vada.

Processing & Preservation methods of Baked Products: Biscuits, Toast, Candies, Cookies, Breads, Roti, Naan, Tandoori Roti, parantha, kulcha, puri, bhatura.

Processing & Preservation methods of Preserves & Beverages: Murabba, sharbat, pana, aampapad, sharbat,

Coconut water, milk (khas, rose), Alcoholic Beverages

Industrialization, Socioeconomic Conditions and Sustainability of Traditional Foods.

V. Practical

- To study the effect of different combination of salt and oil in quality of traditional fermented food product (pickle)
- To study the effect of different starter culture on taste and texture of idli
- To evaluate the shelf life of stuffed paratha under different storage conditions
- To study the effect of time and temperature on quality of fried food products (poori/ panipoori etc.
- To study effect of sugar and Artificial sweeteners in the preparation of kajukatli
- To study the microwave heating in drying of khaman/ dhokla
- To study the effect of cold extrusion on mixing of vermicelli
- To prepare instant carrot halwa mix
- To study the effect of different packaging material on shelf life of traditional Indian food products
- To study the effect of different natural food preservatives in traditional sweets
- Preparation of spiced buttermilk
- Preparation of puffed cereals and grains
- Preparation and quality evaluation of Instant Premixes (Puranmix)
- Preparation of quality evaluation of dried malted moth bean powder
- Preparation of Indian traditional confections (chikki)
- Visit to ethnic food industry (Instant mixes/Pickle making)

VI. Suggested Reading

- Steinkrus KH. 1995. *Handbook of Indigenous Fermented Foods*. CRC Press
- Wickramasinghe P. 2007. *The Food of India OM Book Service*
- Aneja RP, Mathur BN, Chandan RC and Banerjee AK. 2002. *Technology of Indian Milk Products*, India Year Book Publications
- Mangal R. 2013. *Fundamentals of Indian Cooking: Theory and Practice*

I. Course Title : Technologies of Convenience Foods

II. Course Code : FPT 512

III. Credit Hours : 2+1

IV. Theory

Unit I

Overview of grain-based snacks: whole grains – roasted, toasted, puffed, popped and flakes

Coated grains- salted, spiced and sweetened

Flour based snack– batter and dough-based products; *savoury* and *farsans*;formulated chips and wafers, papads.

Fruit and vegetable-based snacks: chips, wafers, papads etc.

Coated nuts – salted, spiced and sweetened products- *chikkis, fried groundnut pakora,*

Unit II

Technology of ready- to- eat baked food products, drying, toasting, roasting and flaking, coating, chipping

Extruded snack foods: Formulation and processing technology, flavouring and packaging

Unit III

Ready-to-cook food products- different puddings and curried, Vegetables, meat and meat food products etc. Technology of instant cooked rice, carrot and other cereals-based food products

Technology of ready to eat instant premixes based on cereals, pulses etc.

Technology for RTE puffed snack- sand puffing, hot air puffing, explosion puffing, gun puffing etc.

Unit IV

Equipment for frying, baking and drying, toasting, roasting and flaking, popping, blending, coating, chipping.

V. Practical

- Preparation of cereals based fried snack foods
- Preparation of legume based fried snack foods
- Preparation of cereal, pulses based ready-to-eat snack food by extrusion cooking and their quality evaluation
- Preparation of cereal grain based puffed products
- To study the effect of frying time and temperature on potato chips
- Development of instant food premixes
- Preparation of cereal and legume based roasted snack
- Preparation of flaked rice product
- To study the effect of roasting time and temperature on quality of pop-corn
- Determination of shelf-life and packaging requirements of snack food products
- Preparation of cereal and legume based roasted snack foods by vacuum frying
- Visit to industries manufacturing snack foods.

VI. Suggested Reading

- Edmund WL 2001. *Snack Foods Processing.* CRC Press
- Frame ND 1994. *Technology of Extrusion Cooking*, Blackie Academic.

- Gordon BR 1997. *Snack Food* AVI Publ.
- Samuel AM. 1976. *Snack Food Technology*. AVI Publ.
- Manley D. 2000. *Technology of Biscuits*, *Crackersand Cookies* CRC Press
- Deny AV and Dobraszczyk BJ. 2001. *Cereals and Cereal Products*, Aspen Publishers
- Ram S and Mishra B. 2010. *Cereals: Processing and Nutritional Quality*, New India Publishers

I. Course Title : Food Powders and Premixes

II. Course Code : FPT 513

III. Credit Hours : 2+1

IV. Theory

Unit I

Food powder properties: Particle size, shape, particle size distribution, density, Crystalline and amorphous microstructure of powders, cohesive forces in powders, adhesive forces and surface energies, stickiness of powders, surface structure of powders, fluidity of powders, compressibility of powders, mixing property of powders, segregation of powder particles, flow and packing properties

Handling of food powders: Basic flow patterns in storage vessels, storage vessel design, mass-flow operation, the Jenike silo design method, the flow-no flow criterion, Powder conveying: Belt, screw, chain, pneumatic

Unit II

Size reduction and enlargement: Principles, equipment, criteria for selecting comminution process, aggregation and agglomeration, instantization

Encapsulation: Principles, methods of encapsulation, viz. spray drying, coacervation, extrusion, co-crystallization

Unit III

Powder Production: Spray, drum and freeze-drying process and equipments

Undesirable properties: Attrition, segregation, caking, dust explosion hazards, laboratory testing to assess explosion characteristics of dust clouds, safety from dust cloud explosion hazards

Food powder rehydration: Principles of powder rehydration- wettability and sink ability, dispersibility, solubility, improvement of rehydration properties

Surface composition of food powders: Microscopy and spectroscopy techniques for analysing the surface of food powder, factors affecting food powder surface composition, impact of powder surface composition on powder functionality.

Unit IV

Packaging and Storage: Packaging requirements, design of package, effect of environmental factors on quality of food powders, shelf life test and prediction

Food Premix: Formulation, processing and packaging of Vitamin premix, mineral premix, fibres premix for food supplements

V. Practical

- Estimation of bulk properties: bulk density, true density, porosity
- Estimation of reconstitution powder properties: wettability, dispersibility, solubility
- Effect of moisture on lump formation and caking
- Estimate flowability of food powders
- Estimate hygroscopicity of powder

- Estimate glass transition and sticky point temperature of food powder
- Effect of bulk properties on packaging
- Measurement of particle size using particle size analyser
- Measurement of surface properties of food powder using SEM
- Packaging of food powders
- Effect of storage on quality of food powders
- Production of various vitamin premix and its application
- Production of various mineral premix and its application

VI. Suggested Reading

- Hong Yan. 2005. *Food Powders: Physical Properties, Processing, and Functionality*/ Springer US.
- Bhandari BS, Bansal N, Zang M, Schuck P. 2013. *Handbook of Food Powders-Process and Properties*/ Woodhead Publishing
- Yasuo Arai. 1996. *Chemistry of Powder Production* Springer Netherlands
- Masuda H, Higashitani K and Yoshida H. 2006. *Powder Technology: Fundamentals of Particles, Powder beds, and Particle Generation*/ CRC Press

I. Course Title : Food Ingredients and Additives

II. Course Code : FPT 514

III. Credit Hours : 2+1

IV. Theory

Unit I

Introduction: Role of food ingredients and additives in food processing, functions, classification, intentional and unintentional food additives, toxicology and safety evaluation of food additives, beneficial effects of food additives, food additives generally recognized as safe (GRAS), tolerance levels and toxic levels in foods-LD 50 values of food additives.

Preservatives: General mechanism of action; basis of selection; classes; Chemical preservatives: characteristics, antimicrobial spectrum, mechanism of action, toxicology, regulations, application in food.

Unit II

Antioxidants: Characteristics, types/classes/groups, mechanism of action/ working of antioxidants, functions, sources, application in food, limits and toxic effects of synthetic antioxidants, synergistic effects of antioxidants, role of free radicals in human body, Natural antioxidants.

Flavouring agents: Flavour functions, selection; forms; sources; process of flavour creation; natural and synthetic flavouring; extractions methods; production process; application in food.

Emulsifiers and Stabilizers: Characteristics/ functional properties; functions; basis of selection; types; mechanism of emulsion formation; mechanisms of emulsion stabilization and destabilization; application in food.

Unit III

Hydrocolloids: Definition: function and functional properties: sources; application in food.

Sweeteners: Characteristics; classification/types; applications in food; Limits and toxicology of non-nutritive sweeteners.

Colouring agents: Properties; functions; classification; sources of natural and

synthetic colours: extraction; applications in food, levels of use, misbranded colours, colour stabilization.

Unit IV

Starch, protein, and lipids, fibres and fructo-oligosaccharides: As functional ingredients; their isolation, modification, specifications, functional properties and applications in foods.

Humectants, clarifying agents, Stabilizers and thickeners, Bleaching and maturing agents, Humectants, Sequestrants/ chelating agents, Anti-caking agents, Buffering agents, Acidulants: definition; characteristics; sources; functions and their application in food processing.

V. Practical

- Determination of benzoic acid in food samples
- Estimation of sulphur dioxide in food samples
- Estimation of sorbic acid in cheese and yoghurt
- Determination of nitrate and nitrites in foods
- Detection and determination of aspartame by thin layer chromatography
- Liquid chromatographic determination of caffeine, benzoate and saccharin in soda beverage
- Identification of natural colours
- Isolation, identification and estimation of synthetic food colours
- TLC detection of antioxidants in fats and oils
- TLC detection of emulsifiers
- Detection of alginates in foods (chocolate, ice cream)
- GC determination of menthol in mentholated pan masala
- Isolation and modifications of protein, starch, lipids, fibres from the raw and processed food samples
- Estimation of various additives mentioned in unit IV

VI. Suggested Reading

- Branen AL, Davidson PM and Salminen S. 2001. Food Additives, Marcel Dekker.
- George AB. 1996. *Encyclopaedia of Food and Colour Additives*, CRC Press.
- Nakai S and Modler HW. 2000. *Food Proteins: Processing Applications*, Wiley VCH.
- Gerorge AB. 2004. *Fenaroli's Handbook of Flavour Ingredients*, CRC Press.
- Branen AL, Davidson PM, Salminen S and Thorngate JH, 2001. *Food Additives*, Marcel Dekker.
- Madhavi DL, Deshpande SS and Salunkhe DK. 1996. *Antioxidants: Technological, Toxicological and Health Perspective*, Marcel Dekker.
- Stephen AM. 2006. *Food Polysaccharides and Their Applications*, CRC Press.
- Smith J and Shum LH. 2011. *Food Additives Data Book*, Wiley-Blackwell.
- Baines D and Seal R. 2012. *Natural Food Additives, Ingredients and Flavorings,* Woodhead Publishing

I. Course Title : Flavour Chemistry and Technology

II. Course Code : FPT 515

III. Credit Hours : 2+1

IV. Theory

Unit I

Introduction: classification of food flavour, chemical compounds responsible for

flavours, difficulties of flavour chemistry research. Anatomy of chemical senses. Chemical compounds classes and their flavour response. Flavour intensifiers: Flavour intensifiers and their effects, Chemistry and technology of various flavour intensifiers.

Flavour Extraction: Methods of flavour extraction, isolation, separation and equipments.

Unit II

Flavour development during biogenesis: Flavour Compounds from Carbohydrates and Proteins, Lipid oxidation. Flavour formulation: Creating and formulating flavour, Synthetic flavours, Blended flavouring, flavour, creation for new products, Delivery of flavours from food matrices.

Flavouring compounds during food processing: Volatile and non-volatile flavouring compounds, non-enzymatic browning reactions.

Unit III

Flavour analysis: Sensory evaluation, discrimination analysis, descriptive analysis, Instrumental analysis (Absorption Spectroscopy (W/VIS), chromatography, mass spectrometry)

Food Flavours in different food products: Principal components and properties, baked products, cheese, milk, meat, fish, wine, coffee, tea, chocolate, fruit and vegetable products and fermented foods

Unit IV

Flavour encapsulation and stabilization: Principles and techniques of flavour encapsulation, types of encapsulation, factors affecting stabilization of encapsulated flavour and their applications in food industry, Packaging and flavour compounds interaction, packaging and storage

V. Practical

- Qualitative identification of different flavouring compounds
- Extraction of essential oil/ flavouring compound of basil leave by hydro distillation
- Extraction of essential oil/ flavouring compound of basil leave by SCFE
- Comparison of the quality of flavouring component obtained by hydro distillation and SCFE
- Extraction of essential oil/ flavouring compound of ginger by SCFE
- Effect of storage conditions on flavouring compound of ginger
- Preparation of flavour emulsions and their stability
- To study effects of staling on food flavours and its adverse effects
- Separation, purification and identification of some flavouring compounds by GC/ MS.
- Sensory evaluation of different flavours
- To check effect of cooking on flavour of food sample
- To check effect of fermentation on food flavour
- To study sugar caramelization reaction for flavour development
- Development of blended food flavour-based products
- To study effects of storage conditions on food flavour
- Encapsulation of flavouring compounds
- To study effects of overdoses of flavours
- To study flavour development on roasting/ baking

VI. Suggested Reading

- Reineccius G. 2005. *Flavour Chemistry and Technology*/ CRC Press
- Heath HB. 1986. *Flavour Chemistry and Technology*/ AVI Publ.
- Piggott JR, Paterson A. 1994/ *Understanding Natural Flavours*. Springer US
- Morton ID, Macleod AJ. 1990. *Food Flavour* Elsevier Science
- Ashurst PR. 1994. *Food Flavourings* Blackie
- Taylor AJ and Linforth RST. 2010. *Food Flavour Technology*/ Blackwell Publishing Ltd
- Hui YH. 2010. *Handbook of Fruit and Vegetable Flavours* Wiley & Sons, Inc
- Bruckner B and Wyllie SG. 2008. *Fruit and vegetable flavour: Recent advances and future prospectus* CRC Press.
- Ferreira V and Lopez R. 2013. *Flavour Science* Academic Press

I. Course Title : Bioprocessing and Separation Technology

II. Course Code : FPT 516

III. Credit Hours : 2+1

IV. Theory

Unit I

Introduction to various separation processes, Gas-Liquid, Gas–Solid, Liquid-Liquid, Liquid-Solid separation; Concept of phase equilibrium, Stage equilibrium, Stage efficiency, Equilibrium concentration; Single stage contact equilibrium, counter-current multiple contact stages, Concept of equilibrium line and operating line, Determination of optimum number of contact stages by analytical and graphical method; Rate of extraction, Rate of gas absorption, Individual and over all mass transfer coefficient; Calculation of tower height for gas absorption for both dilute and concentrated solution. Construction and working mechanism of different extraction equipments like single stage extraction, Multiple stage static bed system, Bollmann extractor, Hildebrandt extractor, Rotocell extractor.

Unit II

Various separation processes Solid Separation Process, Introduction, Concept of size, Shape, Cut-size, Sieving, Magnetic separation, Eddy-current separation, Wet separation, Ballistic separation, Colour separation, Wet Separation Process, liquid-solid and liquid- liquid separation by hydro cyclones, Surface velocity classifier, Elutriators, Impingement separator, Electrostatic precipitation, Distillation: Introduction, boiling point diagram, differential or simple distillation, Flash or equilibrium distillation, Continuous rectification with and without reflux, Reflux ratio, Optimum reflux ratio, Batch distillation, Application of distillation in food processing.

Unit III

Membrane Separation Technology: Introduction to micro-filtration, Ultrafiltration, Reverse osmosis, Electro dialyses, dialyses, physical characteristics of membrane separation, Factors affecting reverse osmosis process, Concentration polarization, Design of reverse osmosis and ultra-filtration systems, Operation layout of the modules, Electrodialysis, per vaporization, Fabrication of membranes, Application of membrane technology in food industry.

Unit IV

Powder Technology: Classification of powder, Separation of powder, Sieving, Air

classification, Factors affecting air classification, Cyclone application, Air separation, Particle size distribution,

Supercritical Fluid Extraction: Introduction, Properties of SCF, Food application, Application of SCFE in analytical technique, Pharmaceutical application.

V. Practical

- Determination of contact equilibrium in counter current and multiple contact model systems.
- Determination of rate of extraction in gas-liquid, gas-solid, liquid-liquid and liquid-solid systems.
- Study of working mechanisms of different extraction equipments.
- Evaluation of physical separation techniques based on size, shape and densities, magnetic, eddy current, ballistic and colour separation,
- Use of air classification, hydyocyclones, electrostatic and distillation techniques for fractionation and separation, application studies on Microfiltration, Ultrafiltration, reverse osmosis and dialysis.

VI. Suggested Reading

- Saravacos GD and Maroulis ZB. 2011. *Food Process Engineering Operations* CRC Press
- Smith PG. 2011. *Introduction to Food Process Engineering* Springer

I. Course Title : Enzymes in Food Processing

II. Course Code : FPT 517

III. Credit Hours : 2+1

IV. Theory

Unit I

Introduction: General Characteristics of Enzymes, Classes and Nomenclature of Enzymes, Enzymatic Reactions, Factors affecting enzyme activity, Enzyme Kinetic, Enzyme Inhibition

Enzyme Production: Selection and sources of commercial Enzymes, Advantages of microbial enzymes, rDNA in enzyme engineering, Problems of scale up, Enzyme extraction and purification

Unit II

Immobilization: Techniques, Advantages and disadvantages, use of immobilized biocatalysts in food processing

Enzymes for protein modification (hydrolysates and bioactive peptides), Enzymes for Lipid modification

Enzymes in cereal processing: Application of enzymes in process of malting, brewing, milling, baking (fungal –amylase for bread making; maltogenic – amylases for anti-staling xylansandpentosanes as dough conditioners; lipases or dough conditioning; oxidases as replacers of chemical oxidants; synergistic effect of enzymes), production of high fructose corn syrup, glucose syrups

Unit III

Enzymes in fruit processing: Applications of enzyme in fruit juice clarification, removal of haziness and bitterness, Uses of enzymes in wine production

Enzymes in meat, fish and milk processing: Meat tenderization and flavour development, fish processing (De-skinning, collagen extraction etc.,) Egg processing, Cheese processing,

Unit IV

Flavour production: Role of enzymes (enzyme-aided extraction of plant materials for production of flavours, production of flavour enhancers such as nucleotides, MSG; flavours from hydrolysed vegetable/animal protein)

Enzymes in the processing of fats and oils: specificity, stability and application of lipases and related enzymes Role of enzymes in hydrolysis of triglycerides, interesterification and randomization. Enzyme allergy.

V. Practical

- To investigate some of the kinetic properties of invertase
- To study time course of the reaction catalysed by alkaline phosphatase.
- To investigate the thermal stability of horseradish peroxidase
- Quantitative estimation of endoglucanase
- Quantitative estimation of exoglucanase
- Quantitative estimation of â galactosidase
- Quantitative estimation of Pectinase
- Quantitative estimation of Protease
- Quantitative estimation of Lipase
- Immobilization of amylase by sodium alginate and comparative evaluation with native enzyme
- To immobilize yeast cells and demonstrate its biological activity by invertase assay
- To carry out amylase fermentation
- To carry out protease fermentation
- To carry out lipase fermentation

VI. Suggested Reading

- Palmer T. 2008. *Enzymes: Biochemistry, Biotechnology and Clinical Chemistry*. East West
- Laskin AI. 2007. *Enzymes and Immobilized Cells in Biotechnology Benjamin*/ Cummings Pub. Co.
- Mansi ME and Bryce C. 2011. *Fermentation Microbiology and Biotechnology* CRC Press
- Price NC and Stevens L. 2000. *Fundamentals of Enzymology* Oxford University Press
- Reed G. 2007. *Enzymes in Food Processing* Academic Press
- Whitehurst RJ and Oort MV. 2010. *Enzymes in Food Technology* Blackwell Publ
- Bayindirli A. 2010. *Enzymes in Fruit and Vegetable Processing: Chemistry and Engineering Applications* CRC Press.

I. Course Title : Food Process Automation and Modelling

II. Course Code : FPT 518

III. Credit Hours : 2+0

IV. Theory

Unit I

Principles of modelling: Linear programming-concepts, graphical and algebraic solution; Simplex method; Duality theory; Post-optimality analysis; Sensitivity analysis; Transportation and assignment models; Computer applications to LP, queuing theory; Project scheduling and management by PERT-CPM; Integer programming; Non-linear programming; Simulation; Goal programming; Decision theory; Markov chains; Sequencing problem.

Food process modelling: The principles of modelling, kinetic modelling, the modelling of heat and mass transfer; introduction diffusion equation, the Navier-stokes

equations, heat and mass transfer in porous media Luikov's equation. Modelling thermal processes: cooling and freezing, modelling product heat load during cooling & freezing. Modelling foods with complex shapes, numerical solution of the heat conduction equation with phase change. Modelling thermal processes: heating, introduction, processing of packed and solid foods, continuous heating and cooling processes, Modelling food quality and microbiological safety. Case Studies in Modelling, Control in Food Processes.

Unit II

Food process equipment design: Design considerations of agricultural and food processing equipment. Design of food processing equipment, Dryers, design of dryers. Determination of heat and air requirement for drying grains. Types of heat exchanger. Design of heat exchangers and evaporators. Design of material handling equipment like belt conveyor, screw conveyor, bucket elevator and pneumatic conveyors.

Digital image processing: digital representation of image, morphological image processing – dialation, erosion, opening and closing, line and edge detection, thresholding, segmentation, techniques for finding length, breadth, perimeter, surface area, eccentricity and surface roughness of solids. Machine Vision-Based Measurement Systems for Fruit and Vegetable Quality Control in Postharvest.

Genetic algorithm optimization: traditional optimization techniques and their limitations, non-traditional method, fitness function in biological evolution, computational procedure for optimization of independent parameters using Genetic algorithm.

Artificial neural network modelling: Developing predictive model between independent and dependent parameters by using Artificial neural network –Neural network architecture, weights and bias values of neurons, least square method for NN parameters optimization, matrix representation and computation of the values of NN parameters.

Unit III

Automation in different unit operations of food processing: Raw food material sorting, grading, size reduction, mixing and agitation, thermal processing, dehydration, packaging, CIP, quality control. Bottle Washing Machine Automation, Bottling Plant Drive System, Demineralization Plant Control System, Labelling Machine Control system, Charger level automation, Reverse Osmosis plant automation, Thermal plant automation, Dehydration and freezing plant automation.

V. Suggested Reading

- Najim K. 1989. *Process Modeling and Control in Chemical Engineering* - CRC Press
- Das H. 2005. *Food Processing Operations Analysis*. Asian Books Private Limited
- Ahmed J and Rahman S. 2012. *Handbook of Food Process Design*.Wiley-Blackwell
- Tijskens LMM, Hertog MLATM and Nicolai BM. 2001. *Food Process Modelling*. Woodhead Publishing
- Bernd H. 2017. *Measurement, Modeling and Automation in Advanced Food Processing*. Springer International Publishing
- Moreira RG. 2001. *Automatic Control for Food Processing Systems* Aspen publishers

I. Course Title : Zero Waste Processing

II. Course Code : FPT 519

III. Credit Hours : 2+0

IV. Theory

Unit I

Introduction: Food processing waste and by-product, ISO 14000 for environmental management system, biochemical and nutritional aspects of food processing by-products. Waste minimization: Chain management issues and good housekeeping Procedures, minimise energy use in food Processing, minimise water use in food processing.

Unit II

Food waste separation: microbiological risk management, Effects of postharvest changes in quality on the stability of plant co-products, Separation technologies for food wastewater treatment and product recovery.

Unit III

Co-product recovery techniques: Enzymatic extraction and fermentation for the recovery of food processing products, Supercritical fluid extraction and other technologies for extraction of high-value food processing co-products, Membrane and filtration technologies, recovery of nutraceuticals, micronutrients, functional ingredients, Natural dyes.

Unit IV

Waste management and co-product recovery: Meat, cereal, dairy, fish, fruit and vegetable, vegetable oil, plantation crops processing, waste management of food packaging. Food processing waste water treatment and gas production from solid food processing

V. Suggested Reading

- Waldron K. 2009. *Handbook of Waste Management and Co-product Recovery in Food Processing* Woodhead Publishing
- Arvanitoyannis IS. 2007. *Waste Management for the Food Industries* Academic Press
- Nout MJR and Sarkar PK. 2013. *Valorisation of Food Processing By-Products* CRC Press