DIVISION OF FOOD PROCESSING TECHNOLOGY

REVISED COURSE OBJECTIVES AND OUTCOMES

Sl. No.	Course Code	Course Name	Credits			
			L	T	P	C
1	20FP2035	Storage Engineering of Food Materials	3	0	0	3
2	20FP2025	Engineering Properties of Biological Materials	3	0	0	3
3	20FP2043	Novel Processing Techniques of Food Preservation	3	0	0	3
4	20FP2015	Food Additives	3	0	0	3
5	20FP2012	Unit Operations in Food Processing - I	3	0	0	3
6	20FP2011	Dairy Process Engineering	3	0	0	3
7	20FP2014	Fruit and Vegetable Processing Technology	3	0	0	3

Course Code	STORAGE ENGINEERING OF FOOD MATERIALS	L	T	P	C
20FP2035	(Version 1.1.)	3	0	0	3

Course Objectives:

To enable students to:

1. Acquire knowledge and improve skill-sets in the area of food storage.
2. Analyse the parameters influencing the design of storage structures for food materials.
3. Evaluate the effect of storage conditions on product quality.

Course Outcomes:

The student will be able to:

1. Identify the specific storage requirements for various food materials based on engineering properties.
2. Design cold storage for fruits and vegetables.
3. Analyze the freezing methods and evaluate the quality of frozen food.
4. Understand the effect of gas composition on shelf life of food products and model MAP systems.
5. Examine the biochemical considerations for design of controlled atmosphere storage chambers.
6. Design structures for storage of grains and understand the various control strategies used in storage structures.

Module: 1	Physico - Chemical and thermal properties of grains	7 Hours

Grain dimensions, bulk density, true density, porosity, coefficient of friction, angle of repose, thermal conductivity and aerodynamic properties. Psychrometry: humidity, relative humidity, humid heat, deterioration index, wet bulb temperature, use of psychrometric charts.

Module: 2	Cold Storage	7 Hours

Cold storage- Moist air and applied psychrometry, Estimation of cooling load, Air conditioning systems, Evaporators, Compressors, Condensers, Expansion devices, Cooling towers, Different types of refrigerants, Transmission and distribution system of cool air, Thermal and vapor insulation materials, Design of small capacity cold storage, Instrumentation and climate.

Module: 3	Frozen storage	7 Hours

Quality loses in frozen foods- Physical changes, Chemical changes in food components, Nutritional aspects of freezing, Microbiology of frozen products, Glass transitions temperature and stability of frozen foods, Temperature requirements during frozen storage, Shelf-life of frozen foods- shelf-life testing, Modelling loss of quality in frozen foods, Time-Temperature integrators, Packaging of frozen foods, Different types of freezers.

Module: 4	Modified atmospheric storage	7 Hours

Overview of Modified atmospheric storage, Gases and Vapor applied to modified atmosphere processing operations, MAP modelling- Kinetics of food deteriorative reactions, Shelf-life testing, Enzyme kinetics applied to MAP, MAP design with oxygen modelling.

Module: 5	**Controlled atmospheric storage**	**7 Hours**
Biochemical considerations of CAS, Gas exchange mechanisms, Mass balance principles, Gas generators, Equipment's for producing and regulating controlled atmosphere, Design of controlled atmosphere storage chambers.		
Module: 6	**Grain storage structures**	**9 Hours**
Storage of grains–physicochemical and biochemical changes, storage factors affecting losses, integrated pest management- Chemical and nonchemical - Fumigation; Damage caused by rodents; Storage pests, Traditional storage structures – merits and demerits, improved storage structures, modern storage structures; Farm silos: Horizontal silos, tower silos, pit silos, trench silos, bag and bulk storage– pressure distribution theories, design of silos – design consideration - size and capacity of silos, storage requirements. Central Warehouse – Regulations.		
Total Lectures		**45 Hours**
Text Books		
1.	Rao, Chandra Gopala. Engineering for storage of fruits and vegetables: cold storage, controlled atmosphere storage, modified atmosphere storage, 1st Edn.. BS Publications, ISBN-13: 978-8178003269, 2014.	
2.	Evans, Judith A., Frozen Food Science and Technology. 1st Edn., Wiley-Blackwell, ISBN-13: 978-1405154789, 2008.	
Reference Books		
1.	Sahay, K. M., and Singh, K. K. Unit Operations of Agricultural Processing. Vikas Publishing House Pvt. Ltd. ISBN: 9780706980172, 1996.	
2.	Robertson, G. L. Food Packaging: Principles and Practice. Taylor and Francis, CRC Press, ISBN: 0849337755, 2006.	
3.	Burg, S. Hypobaric Storage in Food Industry: Advances in Application and Theory. Academic Press, ISBN-13: 978-0124199620, 2014.	
Recommended by Board of Studies	**09.05.2023**	
Approved by Academic Council	03 June 2023	

Course Code	**ENGINEERING PROPERTIES OF BIOLOGICAL MATERIALS** (Version 1.1)	**L**	**T**	**P**	**C**
20FP2025		3	0	0	3

Course Objectives:

To enable students to:

1. Impart knowledge on the relevant physical properties of biological materials at different scales during processing, packing, storage and transport.
2. Analyze the impact of physical qualities on technical and technological processes.
3. Apply the knowledge gained on the measurement of physical properties to deduce structure-property relationships.

Course Outcomes:

The student will be able to:

1. Identify the different physical properties of biological materials.
2. Interpret the rheological properties of food and measurement methods.
3. Examine the various thermal properties of food and its measurement techniques.
4. Analyze the hydro and aerodynamic properties of biological materials.
5. Choose appropriate textural and electromagnetic techniques for characterization of food materials.
6. Justify use of appropriate color measuring devices for sorting of food materials using optical properties.

Module: 1	**Physical Properties of Food Materials**	**9 Hours**

Definitions and measurements- shape, size, density, porosity and surface area-Shrinkage-determination of moisture content. Frictional properties - types, coefficient of friction, angle of repose - types and its determination.		
Module: 2	**Rheological Properties of Foods**	**9 Hours**
Rheology-Types of fluids- Rheological Classification and models, Static tests for solid foods, Creep, relaxation, Dynamic testing of solid foods, stress and strain in solid foods, stress-strain diagram, visco-elastic fluids, measurement methods, Viscometers and Rheometers of different design and their applications, texture measuring instruments, Hardness and brittleness of food materials.		
Module: 3	**Thermal Properties**	**7 Hours**
Thermal properties, Definition of specific heat, enthalpy, conductivity and diffusivity, surface heat transfer coefficient. Measurement of specific heat, thermal conductivity, thermal diffusivity. Cryogenics, Calorific value of food, Bomb calorimeter. Applications of thermal properties.		
Module: 4	**Hydro and Aerodynamic Properties**	**7 Hours**
Hydrodynamic properties - Properties of fluids, surface tension, diffusion, osmosis, osmotic pressure, Reverse osmosis, separation techniques using membranes and applications. Aerodynamics-Drag Coefficient, terminal velocity, Reynolds number. Application of aerodynamics properties to agricultural products.		
Module: 5	**Textural & Electromagnetic Properties**	**7 Hours**
Types of food textures, Texture measuring instruments- Texture measuring methods- Texture Profile Analysis (TPA), Properties of food powders. Electrical properties, dielectric heating, electrical conductivity, dielectric measurements, microwave heating and other Applications.		
Module: 6	**Optical Properties**	**6 Hours**
Refractive index of food items, Abbe's refractometer, Sorting of food material using optical properties, Optical activity, Polarimeter, Spectrophotometer, Gloss, color, translucency – Definitions, measurement and applications.		
Total Lectures		**45 Hours**
Text Books		
1.	Sahin, S., and Sumnu, G. S. Physical Properties of Foods. Special Indian Edn., Springer Science and Business Media, ISBN-13: 978-1071600948, 2006.	
2.	Mohesnin, N. N. Physical Properties of Plant and Animal Materials. Gordon and Breach Science Publishers, New York, ISBN-13: 978-0677213705, 1970.	
Reference Books		
1.	Rao, M.A., and Rizvi, S.S.H. Engineering Properties of Foods. 4th Edn., CRC Press; New York, ISBN-13: 978-1466556423, 2014.	
2.	Figura, L. and Teixeira, A. A. Food physics: physical properties-measurement and applications. Springer Berlin Heidelberg. ISBN:9783540341949, 2007	
3.	Rehman, S. Food Properties Hand book, 2nd Edn., Special-Indian Edn., CRC Press, New York, ISBN-13: 978-1138627598, 2016.	
Recommended by Board of Studies	**09.05.2023**	
Approved by Academic Council	03 June 2023	

Course Code	**NOVEL PROCESSING TECHNIQUES OF FOOD PRESERVATION** (Version 1.1)	**L**	**T**	**P**	**C**
20FP2043		3	0	0	3
Course Objectives:					
To enable students to: 1. Impart basic knowledge on the methods of food preservation. 2. Understand the food safety issues regarding the novel processing of food.					

3. Study the application of advanced preservation in food industry using case studies.

Course Outcomes:

The student will be able to:

1. Recall the importance of high-pressure processing and its effect on microorganisms, enzymes, texture and nutrients in food.
2. Enumerate the fundamentals of Pulsed electric Filed and their processing conditions for safe food consumption.
3. Apply knowledge of osmotic dehydration and membrane concentration in food systems.
4. Analyze the effects of ultrasound on food systems.
5. Understand the importance of microwave heating in food systems.
6. Choose hybrid drying technologies to meet the need of the food industry.

Module: 1	**High Pressure Processing**	**8 Hours**

Principles of high-pressure processing, use of high pressure to improve food safety and stability. Effects of high pressure on food quality: Pressure effects on microorganisms, enzyme, texture and nutrients of food. Modelling HP processes. Other applications of high-pressure processing.

Module: 2	**Pulsed electric field processing**	**8 Hours**

Pulsed electric fields processing: Historical background, PEF treatment systems, main processing parameters. Mechanisms of action: mechanisms of microbial and enzyme inactivation. PEF for processing of liquid foods and beverages, PEF Processing for solid foods. Food safety aspects of pulsed electric fields. Pulsed electric field and high-pressure processing.

Module: 3	**Osmotic dehydration and membrane concentration**	**7 Hours**

Osmotic dehydration: mechanism of osmotic dehydration, effect of process parameters on mass transfer, determination of moisture and solid diffusion coefficient, application of osmotic dehydration. A thermal membrane concentration of liquid foods and colours: osmotic membrane distillation, direct osmosis, membrane modules, Applications of membrane concentration.

Module: 4	**Ultrasound processing**	**7 Hours**

Ultrasound processing: fundamentals of ultrasound, ultrasound as a food preservation and processing aid, effects of ultrasound on food properties.

Module: 5	**Microwave heating**	**7 Hours**

Microwave heating: dielectric properties of foods, heat and mass transfer in microwave processing, application of microwave processing for foods

Module: 6	**Hybrid Drying Technologies**	**8 Hours**

Hybrid drying technologies: combined microwave vacuum drying, combining microwave vacuum drying with other processes, equipment for microwave vacuum drying, product quality degradation during dehydration.

Total Lectures	**45 Hours**

Text Books

1. Sun, D. Emerging Technologies for Food Processing, Academic Press, 2005.
2. Barbosa-Canovas, G. V., Tapia, M. S. and Cano, M. P. Novel Food Processing Technologies, CRC Press, 2004.

Reference Books

1. Chen, P., S. Deng, X. L. Cheng, and L. Metzger. Case Studies in Novel Food Processing Technologies. 2010. Elsevier Science, ISBN 9780857090713.
2. Ohlsson, T. and Bengtsson, N. Minimal Processing technologies in the food industry, Woodhead Publishing Limited, 2002.

Recommended by Board of Studies	**09.05.2023**

Approved by Academic Council	03 June 2023

Course Code	FOOD ADDITIVES (Version 1.1)	L	T	P	C
20FP2015		3	0	0	3

Course Objectives:

To enable students to:

1. Gain knowledge on classification, regulations and application of food additives
2. Recall the limits of addition as prescribed by FAO/WHO and FSSAI.
3. Recognize the potential application of food additives in various food systems.

Course Outcomes:

The student will be able to:

1. Identify the importance of additives in ensuring food safety and quality.
2. Understand the role of Acidulants, Preservatives, Emulsifiers, Thickeners and Antioxidants in food systems.
3. Employ humectants within permissible limits to food applications.
4. Analyse the effect of food additives on the chemical, physical and biological properties of food products.
5. Distinguish the characteristics of additives and their specific use in foods.
6. Evaluate the chelating and antibrowning properties of food additives.

Module: 1	Classification and Regulations	6 Hours

Food additives - definition and classification (INS), food safety levels as per the Specifications, Safety Evaluation of Additives – Determination Of Acute And Chronic Toxicity Test Methods - NOAEL, ADI, LD50 value, FSSAI regulations, GRAS status & Regulations.

Module: 2	Acidulants, Preservatives, Emulsifiers, Thickeners and Antioxidants	9 Hours

Types, chemical properties, levels of additions in individual products, toxicity data of Acidulants – Preservatives – Emulsifiers and gums - Antioxidants – Limits of addition to food products.

Module: 3	Humectants	7 Hours

Types, chemical properties, levels of additions in individual products, toxicity data of Dough conditioners - flour improvers – Humectants – Limits of addition to food products.

Module: 4	Colorants, Flavourants and Fat Substitutes	6 Hours

Types, chemical properties, levels of additions in individual products, toxicity data of Colourants – Natural and artificial, Flavourants, Flavour enhancers.

Module: 5	Fat replacers / substitutes and Sweeteners	9 Hours

Fat substitutes and replacers – Cocoa butter substitutes and equivalents - Types, chemical properties, levels of additions in individual products, toxicity data of Sweeteners – Taste modifiers.

Module: 6	Chelating and Antibrowning agents	8 Hours

Natural and synthetic, Chelating agents, antibrowning agents, Nutritional additives – Levels of addition to Food products.

Food adulteration: definition, reasons for food adulteration, methods of adulteration, and methods of detection. Consumer's responsibilities, consumer organizations. The prevention of food adulteration Act, 1954. The consumer protection Act 1986, normal food adulterants in coffee, tea leaves, edible oil, milk, cereals, spice powders.

Total Lectures	45 Hours

Text Books

1.	Branen A.L., Davidson P.M., Salminen S. and Thorngate J.H. , Food additives, 2nd Edn., Revised and Expanded. Marcel Dekker Inc. USA, 2002. ISBN: 0-8247-9343-9.
2.	Sen, Mousumi. Food chemistry: role of additives, preservatives, and adulteration. Food Chemistry: The Role of Additives, Preservatives and Adulteration (2021): 1- 42.
Reference Books	
1.	Newton, D.E. Food Chemistry, Facts on File Inc., New York, ISBN-10: 0816052778, ISBN-13: 978-08160527762007.
2.	Gerorge, A.B. 2004. Fenaroli's Handbook of Flavor Ingredients. 5th Ed. CRC Press.
3.	Madhavi, D.L., Deshpande, S.S and Salunkhe, D.K. 1996. Food Antioxidants: Technological, toxicological and Health Perspective. CRC Press, USA.
4.	Baines, David, and Richard Seal, eds. Natural food additives, ingredients and flavourings. Elsevier, 2012.
Recommended by Board of Studies	**09.05.2023**
Approved by Academic Council	03 June 2023

Course Code	**UNIT OPERATIONS IN FOOD PROCESSING – I**	**L**	**T**	**P**	**C**
20FP2012	(Version 1.1)	3	0	0	3

Course Objectives:

To enable students to:

1. Impart knowledge on different unit operations and its significance in food industry.
2. Learn the operation and utilization of equipment involved.
3. Choose suitable techniques for the food processing operation.

Course Outcomes:

The student will be able to:

1. Identify the suitable screening techniques for quality gradation of agricultural materials.
2. Understand the principle and operation of different types of dryers.
3. Examine the benefits, problems and energy requirements of size reduction operations.
4. Select suitable process technology for mechanical separation in food systems.
5. Assess the application of centrifugal separation in food materials.
6. Apply mixing principles to development of mixing equipments for dry powders and low or high viscous liquids.

Module: 1	**Screening & Grading**	**9 Hours**

Screening: Definition-screen motions-screen fractions-screen specifications-Types of screens-Revolving Screen-Rotary screen-Shaking screen-Vibratory screen-Horizontal screen-Perforated metal screens- Wire mesh screens- Ideal and actual screens- Effectiveness of screens-Problems. Equipment for cleaning, grading and separation: Separation based on size- screen cleaner/grader-Air screen cleaner -Specific gravity separator-Pneumatic and aspirator separator-Separation based on fluidization technique-Cyclone separator-Colour separator.

Module: 2	**Drying**	**10 Hours**

Moisture content and its measurement methods - direct and indirect methods – Equilibrium moisture – methods of determination – Hysteresis- EMC Models – Henderson, Kelvin, PET and GAB models – importance of EMC- water activity. Drying and Dehydration- Definition-Drying theory – Drying rate – Types of drying-Mechanical Drying

Module: 3	**Size Reduction**	**6 Hours**

Definition-Benefits, Theory of size reduction-Types of size reduction-– characteristics of comminuted products – particle size distribution in comminuted products- Principles and laws of size reduction-Energy requirement- Problems- Size reduction equipments- crushers – hammer mill – Disc Mill-Ball mill-Colloidal mill

Module: 4	Mechanical Separation-I	6 Hours
Filtration: Definition- Theory of Filtration - filter media types and requirement –-constant rate filtration – constant pressure filtration – filter cake resistance – filtration equipments – filter press – rotary drum filters- Selection of filter press- Applications of filtration. **Sedimentation:** Definition-Principle of sedimentation- Terminal velocity and Stoke's law derivation-Batch sedimentation- Problems- Sedimentation equipment- Sedimentation thickener.		
Module: 5	**Mechanical Separation-II**	**7Hours**
Centrifugal separation: Principles of centrifugation-Centrifuge effect- sigma factor-separation of liquids in a centrifuge- radius of neutral zone- residence time of particle- derivation and problems-Centrifugation equipment- Tubular bowl centrifuge-Disc bowl centrifuge-Basket centrifuge- Applications of centrifugation.		
Module: 6	**Anomaly Detection and Deep Learning**	**8 Hours**
Definitions and principles- Mixing of solids and pastes: Mixing index for granular solids- rate of mixing-problems-Mixing equipment for solids and pastes-Planetary mixer- Kneader-Ribbon mixer-Double cone mixer- Applications of mixing of solids in food processing. **Mixing of Fluids:** agitation and mixing – purpose of agitation – agitated vessels – impellers – propellers – turbine –high effect impellers – impellers for high viscosity liquids-Power required for mixing.		
Total Lectures		**45 Hours**

Text Books	
1.	Branen A.L., Davidson P.M., Salminen, S., and Thorngate J. H. Food additives, 2nd Edn., Revised and Expanded. CRC Press. USA, 2002. ISBN: 0-8247-9343-9.
2.	Sen, Mousumi. Food chemistry: role of additives, preservatives, and adulteration. Food Chemistry: The Role of Additives, Preservatives and Adulteration (2021): 1-42.
Reference Books	
1.	Newton, D.E. Food Chemistry, Facts on File Inc., New York, ISBN-13: 978-08160527762007.
2.	Gerorge, A.B. 2004. Fenaroli's Handbook of Flavor Ingredients. 5th Ed. CRC Press.
3.	Madhavi, D.L., Deshpande, S.S and Salunkhe, D.K. Food Antioxidants: Technological, Toxicological and Health Perspective. CRC Press, USA, 1996.
4.	Baines, David, and Richard Seal, eds. Natural food additives, ingredients and flavourings. Elsevier, 2012.

Recommended by Board of Studies	**09.05.2023**
Approved by Academic Council	03 June 2023

Course Code	DAIRY PROCESS ENGINEERING	L	T	P	C
20FP2011	(Version 1.1)	3	0	0	3

Course Objectives:

To enable students to:

1. Impart knowledge on basic engineering principles and concepts used in various unit operations in dairy manufacturing processes.
2. Gain knowledge on milk processing, dairy product manufacturing, and process and equipment selection.
3. Operate, control and maintain the dairy processing and product manufacturing equipment.

Course Outcomes:

The student will be able to:

1. Identify the physico-chemical properties of milk and their handling equipment.
2. Understand the various techniques involved in the thermal processing of milk.
3. Evaluate the principle of operation of homogenizers and cream separators used in dairy plants.
4. Formulate and develop different dairy products such as butter and cheese.
5. Recommend the operations for the production of ice cream and milk powders.
6. Design the various membrane separation techniques for milk processing.

Module: 1	Properties and handling of milk	8 Hours
Milk – composition -Physical and chemical properties of milk—milk constituents - milk reception – cooling - principles and methods – transportation of milk - sanitary pipes and fittings – installation and maintenance - storage tanks –silos –tankers - construction details – can washers – types – construction, working principle and maintenance.		
Module: 2	**Pasteurization and filling of milk**	**8 Hours**
Pasteurization – principles and objectives – methods – batch / LTLT method -- equipments – HTST method – process and equipments – plate heat exchanger – pasteurizer controls – flow diversion valve -functions and working principles - regeneration efficiency – milk flow diagram - UHT pasteurization – principles and methods – vacreation - cleaning and sanitization - CIP cleaning - filling – principle and working of bottle fillers and cappers — form fill seal machines— aseptic filling and handling system.		
Module: 3	**Homogenization and cream separation**	**8 Hours**
Homogenization – theory - effect on milk - working principle of homogenizers — valves -- pumps – single and two stage homogenization -homogenization efficiency – power requirement cream separation – principles – gravity and centrifugal separation – types of Centrifuges - clarifiers and separators – centrifugal separator – parts – construction and working principle – separation efficiency - fat loss in skim milk—self desludging centrifuge -bactofugation.		
Module: 4	**Butter and cheese processing**	**7 Hours**
Butter – method of manufacture – churning of cream - theory of churning – Steel and wooden butter churns - operation of butter churn – churning efficiency- over run—batch and continuous methods of butter making - cheese – classification – cheddar and cottage cheese – method of manufacture - equipments – cheese vats - double O' vat – cheese mills -- cheese press—horizontal and vertical press.		
Module: 5	**Ice cream and dried milk**	**7 Hours**
freezing – Changes during freezing – soft and hardened ice cream - ice cream freezers –batch and continuous freezers - drying of milk - Milk drying systems - equipments – drum drier – principle – Heat transfer through drums- operating points- spray drier –principle- atomization –type of spray nozzles- Drying chambers- construction and working principles- Powder Recovery-cyclones – filter bags - Instantization.		
Module: 6	**Membrane processing**	**7 Hours**
Membrane separation of milk – principles- ultra filtration - reverse osmosis—membrane material and structures -Membrane materials-- cellulose, synthetic polymers – membrane structure – plate, tubular, and hollow fibre – applications in Dairy Industry.		
Total Lectures		**45 Hours**

Text Books

1.	Ahmad, T. Dairy Plant Engineering and Management. 9th Edn., Kitab Mahal, Allahabad. ISBN-13: 978-8122501186, 2003.
2.	De, S. Outlines of Dairy Technology, Oxford University Press, New Delhi. ISBN-13: 978-0195611946, 2001.

Reference Books

1.	Britz, T. J. and Robinson, R. K. Advanced Dairy Science and Technology. Blackwell Publishing Ltd, ISBN: 978-1-4051-3618-1, 2008.
2.	The Codex Alimentarius Commission, Milk and Milk Products, 1st Edn., ISBN 978-92-5-105837-4, 2007.
3.	Adnan Y. Tamime, Milk Processing and Quality Management, Blackwell Publishing Ltd. ISBN 978-1-4051-4530-5, 2009.

4.	Da-Wen Sun, Engineering Aspects of Milk and Dairy Products. CRC Press, Taylor & Francis Group, ISBN 978-1-4200-9022-2, 2010.

Recommended by Board of Studies	**09.05.2023**
Approved by Academic Council	03 June 2023

Course Code	**FRUIT AND VEGETABLE PROCESSING TECHNOLOGY**	**L**	**T**	**P**	**C**
20FP2014	(Version 1.1)	3	0	0	3

Course Objectives:

To impart knowledge on:

1. Processing techniques of fruits and vegetables.
2. Preservation and development of new fruit and vegetable products.
3. Application of various national and international standards in food industries

Course Outcomes:

The students will be able to:

1. Recall the different physical, chemical and nutritional properties of fruits and vegetables.
2. Understand the post-harvest handling operations for fruits and vegetables.
3. Apply the knowledge of unit operations to pick specific heat treatment for processing and preservation of fruits and vegetables.
4. Analyse the various products and processing techniques used in manufacture of value-added fruit products.
5. Assess the various minimal processing techniques used in food industry.
6. Identify the various statutory bodies regulating food standards in India.

Module: 1	**Introduction to fruits and vegetables (6 hours)**	**6 Hours**

Importance and current status of production and processing of fruits and vegetables, scope of fruits and vegetables preservation in India, biochemical composition, ripening and softening, senescence, reparation rate, ethylene production, climacteric and non-climacteric fruits, micronutrients in fruits and vegetables, post-harvest losses, reasons for losses, strategies for loss reduction, physiological storage disorders, chilling and freezing injury.

Module: 2	**Post-harvest handling operations and drying**	**7 Hours**

Cleaning and washing of fruits and vegetables, types of cleaners, machinery for cleaning of fruits and vegetables - air cleaners, washers, Sorting and grading: Sorting, grading, methods of grading; Grading-Size grading, colour grading, screening, equipment for grading of fruits and vegetables, grading efficiency.

Module: 3	**Juice extraction and canning**	**8 Hours**

History of juicing, types of juices extraction methods, juice extraction process, methods of juice preservation, causes of juice spoilage. Canning: Introduction, can manufacture, canning process - selection of fruits and vegetables, grading, washing, peeling, cutting, blanching, cooling, filling, exhausting, sealing, processing, cooling and storage; types of canning- pressure canning and water bath canning, common causes of spoilage in canning of foods. Retort processing, Aseptic packaging.

Module: 4	**Processing fruits and vegetable products**	**8 Hours**

Jam, Jelly & Marmalades; candied fruits, dried fruits and fruit products (eg. Aam papads, bars); soup mixes; sauces & ketchups; puree & pastes; chutneys & pickles, Specialty fruit and vegetable products, FSSAI specifications, waste management in fruits & vegetable industry. Drying: principles, merits and demerits of drying, working principles of various dryers – drum, cabinet, tunnel, freeze, spray, etc., preparation of fruit powders and dried slices, intermediate moisture foods, osmotic dehydration.

Module: 5	**Minimally processed fruits and vegetables**	**9 Hours**

Modified atmosphere packaging (MAP): Introduction, gases used in MAP, role of N2, O2 & Co2, Principles of MAP, Types of MAP - active packaging & passive packaging, factors affecting MAP, application of MAP,

effect of MAP on shelf-life, future research needed, advantages and disadvantages; and controlled atmosphere packaging (CAP): Introduction, gases used in CAP, factors affecting CAP- Temperature control, humidity control and gas control, advantages and disadvantages, Hurdle technology, Emerging technologies – PEF, HPP, ultra-sonication, pulsed light, etc.		
Module: 6	**Statutory Provisions for Quality Control**	**7 Hours**
HACCP, ISO 22000, GMP, AGMARK, Food Standardization and regulatory agencies in India: Central Committee for Food Standards - FSSAI, Central and state food departments, State Food Laboratories / Food and Drug Administration, Bureau of Indian Standards, Food Corporation of India, Army Supply Corps and Central Insecticide Board.		
Total Lectures		**45 Hours**
Text Books		
1.	Hui Y.H. Hand Book of Vegetable Preservation and Processing, 2nd Edn. CRC Press, New York. ISBN-13: 978-1482212280, 2016.	
2.	Wills, Lee, Graham, McGlasson and Hall. Post-Harvest Physiology and Handling of Fruits and Vegetables. 6th Edn., CABI Publishing. ISBN-13: 978-1786391483, 2019.	
Reference Books		
1.	Chakraverty, A., Mujumdar A.S., Raghavan G.S.V and Ramaswamy H.S. Handbook of Post-harvest Technology, CRC Press, USA. ISBN-10: 0824705149, ISBN-13: 978-0824705145, 2003.	
2.	Verma, L. R. and Joshi, V.K .. Post-Harvest Technology of fruits and vegetables. Indus Publishing Co, New Delhi. 2002.	
3.	Fellows, P. Food processing Technology: Principles and Practice, 3rd Edn.. Wood Head Publishing Limited, Cambridge, England. ISBN-13: 978-1845692162, 2009.	
4.	Brennan, J.G. Food Processing Hand book. 2nd Edn., Wiley VCH, Weinheim, Germany. ISBN-10: 3527307192, ISBN-13: 978-3527307197, 2011.	
5.	Paliyath, G., Murr, D. P., Handa, A. K., & Lurie, S. Postharvest biology and technology of fruits, vegetables, and flowers. John Wiley & Sons. ISBN-13: 978-0813804088, 2008.	
Recommended by Board of Studies	**09.05.2023**	
Approved by Academic Council	03 June 2023	

LIST OF REVISED COURSES

Sl. No	Course Code	Course Title	Teaching Hours/ Wk			Credits
			L	T	P	Total
1	23FP1001	Basics of Food Science and Technology	3	0	0	3
2	23FP1002	Bakery Beverages and Confectionery Technology	3	0	2	4
3	23FP1003	Food Product Technology Lab-I	0	0	3	1.5

Course Code	BASICS OF FOOD SCIENCE AND TECHNOLOGY	L	T	P	C
23FP1001		3	0	0	3

Course Objectives:

Enable the student to:

1. Acquire adequate knowledge on nutritive value of foods and its significance.
2. Apply the concepts of food safety in food quality management.
3. Adopt innovative technologies in food processing and preservation.

Course Outcomes:

The student will be able to:

1. Assess the nutritive value of different foods.
2. Relate the health of an individual with the prescribed dietary intake.
3. Analyze the factors influencing thermal processing of foods.
4. Evaluate the quality and safety of non-thermally processed foods.

5. Adopt food quality management systems with reference to national and international standards. 6. Implement novel trends in developing safe and nutritious food products		
Module: 1	**Chemistry Behind Foods**	**7 Hours**
Properties of foods- Physical states of foods, chemical properties of water, carbohydrates, proteins, fats, Vitamins & minerals, pigments, food flavours, browning reaction in foods, Enzymes in foods, and in the food industry.		
Module: 2	**Human Nutrition**	**8 Hours**
Definitions - Food, Health, principle components of foods, functions of foods, classification of foods, Calculation of BMR, PER, NPU - Basics of ADI, RDA, RDI -Nutritional disorders, nutrients & its significance and imbalance, bioavailability of nutrients.		
Module: 3	**Food Preservation by Thermal Methods**	**8 Hours**
Preservation by high temperature- Applications in food processing and preservation- Blanching, pasteurization, sterilization, canning, bottling, dehydration, retort pouching, freezing preservation with chemicals, mechanism of microbial inhibition and action of preservatives in processed food.		
Module: 4	**Food Preservation by Non-Thermal Methods**	**8 Hours**
Irradiation, microwave heating. High Pressure, Ohmic heating, Pulse electric field, minimal processing of Fruits and Vegetables, Hurdle Technology. Effect of processing on Nutrients.		
Module: 5	**Food Safety and Quality Control**	**8 Hours**
Quality factors in foods, Safety, hazards, risks, Food Deterioration and its control HACCP, FSSAI, ISI, Food standards, Food laws, Food Adulteration, Food safety testing. Sensory evaluation- selection of panels, preparation of samples, types of tests, judging, results. Packaging & Labelling of foods.		
Module: 6	**Recent Trends in Food Science and Technology**	**6 Hours**
Food Biotechnology, functional foods, active compounds and active ingredients, nutraceuticals, Role of food technology in preventing malnutrition-fortification and enrichment, genetically modified foods, prebiotics, probiotics, new food additives, research methods, recent advances food industry, food technology and the environment.		
Total Lectures		**45 Hours**
Text Books		
1.	Meyer L.H. “Food Chemistry”. CBS Publishers and Distributors Pvt. Ltd. 3ISBN: 978-93-907-0963-2, 2020.	
2.	Sharma A. “Textbook of Food Science and Technology”. 3rd Edition, CBS Publishers and Distributors Pvt. Ltd., ISBN - 978-9386478009, 2019.	
Reference Books		
1.	Potter, Norman N., Hotchkiss, Joseph H. (1995), Food Science, 5th Edition, ISBN 978-1-4615- 4985-7.	
2.	Fellows P.J, (2000), Food Processing Technology: Principles and Practice. Woodhead Publishing Ltd., Cambridge, England, ISBN 9780323857376.	
3.	Srilakshmi, B. (2003), Food Science, 5th Edition, New Age International (P) Publishers Ltd., Chennai, ISBN 13: 9788122427240	
4	Cheung, Peter Chi Keung, and Bhavbhuti M. Mehta, (Eds). Handbook of Food Chemistry. Vol. 11. Springer Berlin Heidelberg, 2015.	
5.	Ramaswamy, H. Marcotte, M. (Eds.), Food Processing: Principles and Applications, CRC Press, Taylor and Francis Group, Boca Raton, FL, USA, 2006, ISBN 1-58716-008-0.	
	Recommended by Board of Studies	***04/08/202***
	Approved by Academic Council	25 Aug 2023

Course Code	BAKERY, BEVERAGES AND CONFECTIONERY TECHNOLOGY	L	T	P	C
23FP1002		3	0	2	4

Course Objectives:

Enable the student to:

1. Gain knowledge in the processes involved in the manufacture of bakery, beverage and confectionery products.
2. Apply the quality standards in developing wholesome bakery, beverage and confectionery products.
3. Develop bakery, beverage and confectionery products in pilot plant scale.

Course Outcomes:

The student will be able to:

1. Evaluate the quality standards of ingredients and machinery in bakery industry.
2. Standardize the factors influencing the production of baked products.
3. Evaluate unit operations in Sugar manufacture.
4. Analyze the quality characteristics of distilled beverages.
5. Assess the process involved in the production of non-alcoholic beverages for quality control.
6. Develop newer processes and nutritious products that are economically viable.

Module: 1	Overview of Wheat Quality and Equipment for Baking	9 Hours

Wheat Milling – Quality and grades, Wheat Quality Tests-Moisture Test Grain hardness testing. Viscograph, Amylograph, Farinograph. Dough rheology. Baking Equipments Dough mixers, Dividers, rounders, Proofing, moulding, Ovens, Slicers, Packaging materials and equipment, Sanitation and safety.

Module: 2	Baking Technology	12 Hours

Bread manufacturing process – Straight dough fermentation, Sponge and dough, Bread faults and staling, Biscuit-Types of biscuit dough – Developed dough, short dough, semi-sweet, enzyme modified dough and batters- importance of the consistency of the dough- Difference between Cookies crackers and biscuits. Technology of laminated products – Wafers and Pastries manufacturing, Cake – Flour specification – ingredients – manufacturing process – Defects and quality control.

Module: 3	Sugar Manufacture	10 Hours

Types of sugars- Energy and material balance of cane sugar process. Technology of sugar manufacture – Unit operations involved in sugar manufacture –Grades of sugar – Sugar plant sanitation – Technology of 12iggery manufacture – Molasses – Recent trends in sugar cane technology.

Module: 4	Beverage Technology – Alcoholic Beverages	9 Hours

Manufacture of beer, wine and champagne – Quality characteristics, Manufacture of distilled beverages including whisky, rum and gin – Quality aspects.

Module: 5	Beverage Technology – Non-alcoholic Beverages	9 Hours

Carbonated beverages – Additives used – Sugar-free, sugarless, carbonated beverages- quality aspects and standards – Water polishing and its importance Probiotic beverages, Hydrodynamic Cavitation Assisted Vegetable beverages.

Module: 6	Confectionery Technology	11 Hours

Types of Confectionery, Principle of characterization, Structural formulae of confectionery products, - Processing of toffee, chocolates, fruit drops, hard boiled candies – Correlation of string consistency and total solids Quality aspects of confectionery products – Technology of aerated confectionery – Additives for Confectioneries. Equipment used in non-conventional / traditional methods of baking.

Total Lectures	60 Hours

List of Experiments

Expt. No. 1	Manufacture of sandwich bread
Expt. No. 2	Manufacture of fruit breads by Chorleywood process.
Expt. No. 3	Manufacture of crackers
Expt. No. 4	Manufacture of pound cakes
Expt. No. 5	Manufacture of hard-boiled candies
Expt. No. 6	Manufacture of toffees
Expt. No. 7	Manufacture of jujubes
Expt. No. 8	Manufacture of chocolates
Expt. No. 9	Manufacture of jaggery-based confectionery
Expt. No. 10	Manufacture of nectar
Expt. No. 11	Manufacture of cordial
Expt. No. 12	Manufacture of sugar-free beverages

Text Books

1.	Zhou W. and Hui Y.H. "Bakery Products Science and Technology". Wiley Blackwell UK, ISBN978-1-119-96715-6, 2014.
2.	Stanley P. Cauvain, Linda S. Young "Baked Products: Science, Technology and Practice" BakeTran, High Wycombe, Bucks, UK, ISBN1405171529, 2008.

Reference Books

1.	Sumnu S.G. and Sahin S. "Food Engineering aspects of Baking sweet goods" CRC Press, ISBN 9781420052749, 2008.
2.	Varnam A. H. & Sutherland J.P. "BEVERAGES - Technology, Chemistry and Microbiology", Springer-Science Business Media, B.V., ISBN 978-1-4615-2508-0, 1994.
3.	Edwards, W.P. "The Science of Sugar Confectionery" RSC Publishing, UK., ISBN 0-8 5404- 593-7, 2000.
4.	Pomeranz. Y. "Modern Cereal Science and Technology". MVCH Publications, New York. 2003.
5.	Samuel A., Matz., "Equipment for Bakers", Pan Tech International Publication, 2009.

Recommended by Board of Studies	04/08/2023
Approved by Academic Council	25 Aug 2023

Course Code	**FOOD PRODUCT TECHNOLOGY LAB-I**	**L**	**T**	**P**	**C**
23FP1003		0	0	3	1.5

Course Objectives:

Enable the student to:

1. Acquire adequate skills in the manufacture of bakery and fruit-based products.
2. Implement quality standards in commercial food production units.
3. Establish commercial enterprises in bakery and fruit-based products.

Course Outcomes:

The student will be able to:

1. Outline the processes involved in the production of various fruit and bakery-based products.
2. Assess the role of various ingredients in the production of fruit and bakery-based products.
3. Optimize the levels of additives used in the production of various fruit and bakery-based products.
4. Evaluate the constraints and flaws in the manufacture of products based upon quality parameters and indexes.
5. Recommend corrective actions in manufacture process.
6. Standardize protocols for manufacture of new fruit and bakery-based products.

LIST OF EXPERIMENTS

Fruit Based Products

1. Pilot scale manufacture of fruit-based RTS beverages.
2. Pilot scale manufacture of squashes.
3. Pilot scale manufacture of carbonated beverages.
4. Pilot scale manufacture of Jams and marmalade.

5. Pilot scale manufacture of fruit preserves. 6. Pilot scale manufacture of fruit spreads. 7. Pilot scale manufacture of Gummies. 8. Pilot scale manufacture of Ketchups/Sauce. **Bakery Products** 9. Pilot scale manufacture of white breads by Chorleywood process. 10. Pilot scale manufacture of French breads by sourdough method. 11. Pilot scale manufacture of hard dough biscuits. 12. Pilot scale manufacture of soft dough biscuits. 13. Pilot scale manufacture of cakes by all-in-one method. 14. Pilot scale manufacture of cakes by three stage mixing method. 15. Preparation of doughnut.

Recommended by Board of Studies	04/08/202
Approved by Academic Council	25 Aug 2023

LIST OF CERTIFICATE COURSES

S. No.	Course name	Faculties
1	Certificate course on Good Laboratory Practices (Non-clinical) for Food Industries	Dr. Sumit Sudhir Pathak and Dr. S. Gobikrishnan
2	Certificate course on Methods of Sensory Evaluation of Foods	Dr. T.V. Ranganathan and Dr. Sumit Sudhir Pathak
3	Certificate course on Shelf-life testing of Foods	Dr. T.V. Ranganathan and Er. Dayanand Peter
4	Certificate course on Advances in Drying Technology and its Applications in Food Sector	Dr. S. Gobikrishnan and Dr. Sumit Sudhir Pathak
5	Certificate course on Food Extrusion Technology	Dr. Rituja Upadhyay and Dr. Wasiya Farzana
6	Certificate Course on Spice Processing Technology- Industry Perspective	Dr. Wasiya Farzana and Dr. Rituja Upadhyay

Certificate course -I

Good Laboratory Practices (Non-clinical) for Food Industries

Course Instructor – **Dr. Pathak Sumit Sudhir**, Asst. Professor, DFPT

Co-Instructor – **Dr. S. Gobikrishnan**, Asst. Professor, DFPT

NEED FOR THE CURRENT COURSE

Good Laboratory Practice is a quality system concerned with the organizational process and the conditions, under which non-clinical health and environmental safety studies are planned, performed, monitored, recorded, archived and reported. The proposed course will benefit the students for improving their laboratory practices.

Food analysis labs are the integral part of almost all the food industries. An exclusive course that details the procedures being followed for the same is desirable for our students. Also, it adds an extra edge for our students, in terms of placements. Hence, we propose this course to be taken by the students.

Duration of the course: 30 hr (as mandated by NAAC)

Content of the course: Attached below

Eligibility criteria: B.Tech. / M. Tech./ M.Sc/ students and Ph.D. Scholars of the Department of Food Processing Technology

Maximum number of students per batch – Max.25

Good Laboratory Practices (Non-clinical) for Food Industries

Proposed Lecture Plan (36 hr.)

Lecture No.	Title

1	Introduction to the OECD (Organization for Economic Cooperation and Development) principles of GLP
2	The fundamental points of GLP
3	The OECD- GLP principles
4	Resources Management
5	Personnel Facilities
6	Buildings and equipment
7	Introduction test and test systems
8	Characterization of the test items
9	Characterization of the test systems
10	Rules for test systems
11	The protocol or study plan
12	Standard Operating Procedures (SOPs)
13	Results and result analysis
14	Raw data and data collection
15	Final report
16	Archiving
17	Indexing
18	Quality assurance
19	Protocol (or study plan) review
20	SOP review
21	Planning (master schedule, inspection plan)
22	Audits and inspections
23	Quality assurance statement
24	QA inspections of suppliers and contractors
25	Issuing and archiving of QA files and reports

Text Books:

Special Programme for Research, Training in Tropical Diseases, & World Health Organization. (2010). Handbook: good laboratory practice (GLP): quality practices for regulated non-clinical research and development. World Health Organization.

Reference Book

Weinberg, S. (Ed.). (2007). *Good laboratory practice regulations*. CRC Press.
Seiler, J. P. (2006). Good Laboratory Practice: The why and the how. Springer Science & Business Media.

Certificate course -II

Methods of Sensory Evaluation of Foods

Course Instructor – **Dr. T.V. Ranganathan**, Professor, DFPT

Co-Instructor – **Dr. Sumit Sudhir Pathak**, Asst. Professor, DFPT

NEED FOR THE CURRENT COURSE

Sensory evaluation is a niche area of its own and employed by the Food industries prior to launching of new products in the market and also for product improvement. Evaluators are trained for sensory evaluation. This is an integral part of almost all the food industries. An exclusive course that details the procedures being followed for the same is desirable for our students. Also, it adds an extra edge for our students, in terms of placements. Hence, we propose this course to be taken by the students.

Duration of the course: 30 h (as mandated by NAAC)

Content of the course: Attached below

Eligibility criteria: B.Tech. / M.Tech./ M/Sc/ students and Ph.D. Scholars of the Department of Food Processing Technology

Evaluation procedure:

S. No.	Evaluation Procedure	Marks
1.	Quiz (3 Quizzes online) after every 10 h of teaching	3x15 = 45
2.	Assignments (2)	2 x 20 = 40
3.	Final Viva Voce	15
	Total	100

Highlights of the course: More emphasis on Practical learning (**22 of the 30 hours**). It is also proposed to take the students to at least 2 food industries for a practical exposure on the sensory evaluation of specific food products

Maximum number of students per batch – Max.25

Proposed Lecture Plan

Lecture No.	Title
1	Introduction to sensory evaluation – Importance of sensory methods in Food Product development
2	Basics of sensory evaluation – Anatomy, Physiology and Functions of taste.
3	Anatomy, Physiology and Functions of smell.
04	Basic nodes of taste
05	Basic nodes of flavour
06 – 08	Measurement of sensory thresholds – Lab session
09	Basic principles of sensory analysis
10	General considerations and requirements of a sensory panelist
11	Sensory testing environment – general considerations
	Discrimination or Difference tests – Lab session
12, 13	Paired Comparison
14-15	Duo – Trio test
16-17	Triangle Test
18-19	Two – out- of- Five test
20-21	Ranking test
22-23	Descriptive Tests
	Acceptance Tests – Lab sessions
24-25	Hedonic Rating
26-27	Paired Comparison and Repeated Paired comparison (Preference) Test
28	Multisample ranking
29	Principles of Questionnaire design
30	Statistical analysis of the results and its importance in result interpretation
30-31	Tea tasting and profiling – Lab session
32-33	Flavour analysis and profiling - Lab session

Text Books:

1. Lawless HT and Heymann H (2010). Sensory Evaluation of Foods- Principles and Practices, Second Edn, Springer Science+Business Media New York. e-ISBN 978-1-4419-6488-5 (eBook)
2. Carpenter RP, Lyon DH and Hasdell TA (2000). Guidelines for Sensory Analysis in Food Product Development and Quality Control, Second Edition. Aspen Publishers. ISBN 0-8342-1642-6.

Reference Book:

Lawless HT (2013). Quantitative Sensory Analysis, Psychophysics, Models and Intelligent Design. Wiley Blackwell. ISBN 978-0-470-67346-1.

Certificate course -III

Certificate Course on Shelf-Life Testing

Course Instructor – **Dr. T.V. Ranganathan**, Professor, DFPT

Co-Instructor – **Er. Dayanand Peter**, Asst. Professor, DFPT

NEED FOR THE CURRENT COURSE

Shelf –life testing is a procedure conducted for all packaged foods to have an idea of the "best before" dates. This is an integral part of almost all the food industries. An exclusive course that details the procedures being followed for the same is desirable for our students. Also, it adds an extra edge for our students, in terms of placements. Hence, we propose this course to be taken by the students.

Duration of the course: 30 h online (as mandated by NAAC)

Content of the course: Attached below

Eligibility criteria: B.Tech. / M.Tech. students of the Department of Food Processing Technology

Evaluation procedure: **3 quizzes online** (after every 10 h) (10 marks each) + **2 assignments** / **report** to be submitted on topic related to Shelf life evaluation. (20 marks each) = Grand total – 30 + 40 = 70 marks

Lecture Plan proposed

Lecture No.	Title
1&2	Classification of Foods - Based on pH (high, medium and low) and composition
3	Concept of water activity
04, 05	Types of microorganisms and Food spoilage
06, 07, 08	Changes taking place during food processing and storage - Maillard reaction
	Oxidation of lipids - graining - fat and sugar bloom - Changes in Nutritional quality
09,10	Role of packaging on shelf life - Types of packaging material - Properties
11, 12, 13	Methods for measuring shelf life and spoilage
14-16	Verification and validation of food spoilage models
17	Natural Preservatives for Shelf life
18	Measuring lipid oxidation
19 - 21	Accelerated shelf life testing
22-23	Shelf life testing prediction Q10 value, Z value, F value
24-25	Storage and sampling design
26-27	Storage test and trial conditions
28	Kinetic reactions
29	Arrhenius model
30-31	Shelf life prediction of representative foods (Lab session)

Books:

1. Robertson GL. Food Packaging and Shelf Life - A Practical Guide. Ed. CRC Press. 2010. ISBN 978-1-4200-7844-2
2. Steele R. Understanding and measuring the shelf-life of food. Ed. R. Steele. Woodhead Publishing Ltd. 2004. CRC Press ISBN 0-8493-2556-0.
3. Man CMD and Jone AA. Shelf Life evaluation of Foods. Ed., Springer Science+Business Media Dordrecht, 1994. ISBN 978-1-4615-2095-5 (eBook)
4. Kilcast D and Subramaniam P. The stability and shelf-life of food.1st Edition, Woodhead Publishing. 2000. eBook ISBN: 9781855736580

Certificate course -IV
Advances in Drying Technology and Applications in Food Sector
Course Instructor – **Dr. S. Gobikrishnan**, Asst. Professor, DFPT, KITS
Co-Instructor – **Dr. Pathak Sumit Sudhir**, Asst. Professor, DFPT, KITS

NEED FOR THE CURRENT COURSE

Drying is an important unit operation used in numerous industries and well known as a dominant industrial consumer of fossil fuel-derived energy in developed countries. Since standard of living is rising in the developing world, energy usage for drying operations will rise along with the demand for energy-efficient, faster, environmentally friendly (minimal carbon footprint) and cost-effective drying technologies which will continue to increase worldwide. Hence it is necessary to understand the science behind this drying technology. Drying is an integral unit operation of almost all the food industries. Drying technology is an amalgamation of transport phenomena and material science as it deals not only with the removal of a liquid to produce a solid product but also with the extent to which the dry product meets the necessary quality criteria. Drying technology has a very major role and application in the post-harvest processing of fruits, vegetables and marine products. The proposed course will benefit the students for improving their knowledge in drying technology. The developed course provides a simple, convenient introduction from the basic principles to advances in the drying technology, its terminology, selection and classification of dryers, details on commonly used dryers and new developments in drying of foods, vegetables and fruits. An exclusive course that details the procedures being followed for the same is desirable for our students. Also, it adds an extra edge for our students, in terms of placements. Hence, we propose this course to be taken by the students.

Duration of the course: 30 hr (30 or more than 30 hr. as mandated by NAAC)
Content of the course: Attached below (Annexure I)

Eligibility criteria: M. Tech./ M. Sc students and Ph.D. Scholars of the Department of Food Processing Technology.

Proposed Lecture Plan

Lecture No.	Title
1	Water activity in food
2	Psychrometric of drying
3	Drying theory
4	Rate of drying, factors affecting rate of drying
5	Equilibrium moisture and Sorption isotherms study
6	Basic Process Calculations and Simulations in Drying
7	Drying kinetics
8	Modeling a drying curve
9	Solid–Liquid Separation for Pre-treatment of Drying Operation
10	Heat and mass balance techniques
11	Transport Properties in the Drying of Solids
12	Experimental Techniques in Drying
13	Analysis of Drying Systems
14	Drying systems used in Food Industry
15	Classification and selection of Dryers
16	Designing and specifications of drying systems
17	Description of Various Dryer Types
18	Drying in Various Industrial Sectors
19	Drying of Fish and Seafood
20	Grain Drying

21	Grain Property Values and their Measurement
22	Drying of Fruits and Vegetables, Reconstitution of Dehydrated Fruits and Vegetables
23	Drying of Herbal Medicines and Tea
24	Effect of drying on chemical and biochemical properties of food materials
25	Practical session on handling of various dryers
26	Hands on Training in R and D lab
27	Food safety standards and Regulations
28	Control of Industrial Dryers
29	Safety Aspects of Industrial Dryers
30	Cost-Estimation Methods for Drying

Text Books:

1. Jangam, S. V., & Law, A. S. M. C. L. (2010). Drying of foods, vegetables and fruits.
2. Mujumdar, A. S., & Xiao, H. W. (Eds.). (2019). *Advanced drying technologies for foods*. CRC press.

Reference Book

1. Hall, C. W. (1988). HANDBOOK OF INDUSTRIAL DRYING: Arun S. Mujumdar, Editor Marcel Dekker, Inc. New York and Basel, 948 p. 1987. *Drying Technology*, *6*(3), 571-573.
2. Kudra, T., & Mujumdar, A. S. (2009). *Advanced drying technologies*. CRC press.

Certificate course -V

Certificate Course on Food Extrusion Technology

Course Instructor – **Dr. Rituja Upadhyay**, Asso. Professor, DFPT, KITS

Co-Instructor – **Dr. Wasiya Farzana**, Asst. Professor, DFPT, KITS

NEED FOR THE CURRENT COURSE

Food extrusion has evolved into a critical processing operation. Food extruders are now used to make pasta and other cold formed goods, ready-to-eat cereals, snacks, pet food, aquatic feeds, confectionary products, modified starches for soup, infant food and quick meals, beverage bases, and textured vegetable protein. The course is aimed to give students a full understanding of extrusion principles and practice. The single-screw and twin-screw extruders will be discussed in detail. The emphasis will be on defining the fundamental scientific and process engineering principles of extrusion operation in a straightforward, clear, and succinct manner that allows for a thorough comprehension of the extrusion process.

This fundamental approach will directly lead to production and product quality optimization and operation. The chemical nature and alterations of the food components that make up the ingredients usually utilized in extrusion processes will be detailed. The training, when paired with a better grasp of extrusion principles, should result in better understood, controlled, and optimized extrusion operation.

Duration of the course: 30 hr (30 or more than 30 hr. as mandated by NAAC)

Eligibility criteria: M. Tech./ M. Sc students and Ph.D. Scholars of the Department of Food Processing Technology.

Content of the course: Attached below.

Eligibility criteria: Food scientists, technologists, technicians, and engineers who deal with food extruders in research and development. Professionals working in adjacent sectors, equipment makers, and ingredient suppliers involved in food extrusion can also benefit from the training.

Evaluation procedure: **3 quizzes online** (after every 10 h) (10 marks each) + **2 assignments** / **report** to be submitted on topic related to extrusion processing (20 marks each) = Grand total – 30 + 40 = 70 marks

Outcome: Entrepreneurs/Student as entrepreneurs

Course Outline:

Lecture No.	Title
1	Overview and current status of extrusion processing

2	Single Single screw extruder: Applications
3	Introduction to extrusion and single screw extruders including screw design
4-6	Operating characteristics and parameters
7	High shear cooking
8-10	Twin-screw extruder operation (Demonstration)
11	Design criteria for co-rotating twin-screw extruders
12	Barrel and screw design; screw configurations
13	Raw materials for extrusion cooking processes
14	Review of the characteristics, interactions and impact of raw materials utilized in food and feed extrusion
15-16	Components-Including starch, proteins, fats and other minor ingredients
17-19	Texture Analysis for extruded products (Demonstration)
20	Preconditioning
21	Design of operation of effective conditioning prior to extrusion and impact on the extrusion process
22	Cold and hot extrusion of food products
23-25	Noodle/Pasta making (Lab session)
26	Process Engineering: Rheological Properties of Materials during the Extrusion Process
27	Programmable Brookfield Viscometer (Demonstration)
28	Product shaping Process Control
29	Application: Pet Food and Feed Application
30	Application: Food application Review: Extrusion cooking of foods for manufacture of texturized vegetable proteins, meat mimics etc.

Industry participation

- Industry talks to include on each day or one on each day
- 4 experts from Industry will participate

Demonstrations proposed

Practical	Title
1.	Twin screw extruder operation
2.	Texture Analysis for extruded products
3.	Noodle/Pasta making
4.	Brookfield Viscometer

Text Books:

1. Forte, Dennis, and Gordon Young. Food and feed extrusion technology: an applied approach to extrusion theory. Food Industry Engineering, 2021.
2. Maskan, Medeni, and Aylin Altan, eds. Advances in food extrusion technology. CRC press, 2011.

References:

1. N.D. Frame (1994). The Technology of Extrusion Cooking, Springer US, ISBN No. 978-1-4615-2135-8, DOI: 0.1007/978-1-4615-2135-8.
2. Altan, A., & Maskan, M. (Eds.). (2012). Advances in Food Extrusion Technology (1st ed.). CRC Press. https://doi.org/10.1201/b11286.
3. Bouvier, Jean-Marie, and Osvaldo H. Campanella. Extrusion processing technology: Food and non-food biomaterials. John Wiley & Sons, 2014.

Certificate Course -VI

Certificate Course on Spice Processing Technology- Industry Perspective

Course Instructor – Dr. Wasiya Farzana, Asst. Professor, DFPT, KITS

Co-Instructor – Dr. Rituja Upadhyay, Assoc. Professor, DFPT, KITS

Need for the course:

India is known as the spice capital of the world. Spices are abundantly produced and incorporated in food products due to their various medicinal benefits and flavours. With the development of novel products, spices find its way into the food system like 3rd generation snacks, confectionary, beverages, bakery, dairy, RTE meals, enrobing dairy products and plant based formulations. This course aims at fulfilling the requirement of understanding spices from an industrial viewpoint along with an in-depth study on the processing technologies related to spices. The machinery related to spice processing and various extraction techniques will be dealt in depth. The focus will be on understanding the technology with product quality standards maintained. The stability of the spices or derived products into food matrices would be gauged. Hands on trainings on the spice related apparatus will be given for better optimization of process parameters to retain the yield and other quality parameters. .

Duration of the course: 30 h (30 or more than 30 h as mandated by NAAC)

Content of the course: Attached below.

Eligibility criteria: M. Tech./ M. Sc students and Ph.D. Scholars of the Department of Food. Food scientists, technologists, technicians, and students who deal with spice processing technology in research and development. Professionals working in parallel sectors, spice related equipment fabrication, and ingredient suppliers involved in spice will benefit from the training.

Evaluation procedure: 3 quizzes online (after every 10 h) (10 marks each) + 2 assignments /report to be submitted on topic related to spice processing (20 marks each) = Grand total – 30 + 40 = 70 marks

Lecture No.	Course Outline
1	Disinfestation and Sterilization- Natural steam sterilizer (Microbiology) control the Quality of Spices
2	Spices- Pepper processing, Cardamom, Turmeric
3-4	Manufacture of Oleoresins and Essential Oils, Powders
5	Spice flavours
6	Processing issues
7	functional role of spices
8	Oleoresins and Essential oils – General methods of manufacture: SCE, solvent extraction, sonication
9	Major international quality specifications
10	The American Spice Trade Association Standards (ASTA)
11	Spice Board of India
12	The European Spice Association (ESA) Standards
13	Quality Control and assurance of the Spices
14	Extraction technologies and Encapsulation Techniques
15	Natural Food colours- Sources, Extraction.
16	Natural Food colours-production process and manufacturing techniques, storage
17	Medicinal and Functional Food Ingredients-Anti-oxidant property
18	Processing Techniques,
19	Impact on human health.
20	Gourmet products.
21	Processing, microemulsions, mixes
22-25	Standards related to spices-FSSAI, BRIC, ASTA, Test methods of different spices and Oleresins Indian Standards (BIS)
26	Encapsulation of oleoresins and spice oils

Practical Title:

1. Oleoresin content estimation Dr. Wasiya Farzana – 2 h
2. Curcumin content estimation Dr. Wasiya Farzana – 2 h
3. Spice oil extraction with Clevenger apparatus . Dr. Rituja Upadhyay – 4 h
4. Concentration of spice oils with rota evaporator Dr. Rituja Upadhyay – 1 h

Text Books:

1. Perfume and flavor materials of natural origin - arctander
2. Perfumery and flavoring materials - Bedaukian

References:

1. Common fragrance and flavor materials – Bauer
2. Spices by JW Purseglove, EG Brown, CL Green & SRJ Robbins. Longman Group Ltd. Vol. 2 (1981) (pp. 447-813).
3. Handbook of herbs and spices by KV Peter. Woodhead Publishing Limited. 2nd Edition, Vol II (2012).

DEPARTMENT OF FOOD PROCESSING TECHNOLOGY

LIST OF NEW COURSES

S. No.	Course Code	Course Title	Credits			
			L	T	P	C
1.	22FP2047	Smart Sensors for Food Industries Laboratory	0	0	4	2
2.	22FP2048	IoT and Deep Learning for Food Quality	2	0	0	2
3.	22FP2049	Data Analytics for Food Supply Chain	2	0	0	2
4.	22FP2050	Intelligent Food Industries	3	0	0	3
5.	22FT3001	Food Chemistry	4	0	0	4
6.	22FT3002	Food and Industrial Microbiology	4	0	0	4
7.	22FT3003	Principles of Food Preservation	3	0	0	3
8.	22FT3004	Technology of Cereals, Pulses and Oilseeds	3	0	0	3
9.	22FT3005	Technology of Fruits and Vegetable Processing	3	0	0	3
10.	22FT3006	Bakery and Confectionary Technology	3	0	0	3
11.	22FT3007	Technology of Plantation Crops and Spices	3	0	0	3
12.	22FT3008	Technology of Milk and Milk Products	3	0	0	3
13.	22FT3009	Nutrition and Metabolism	3	0	0	3
14.	22FT3010	Food Quality Systems and Management	3	0	0	3
15.	22FT3011	Instrumental Methods of Analysis	3	0	0	3
16.	22FT3012	Analysis of Food Constituents Lab	0	0	4	2.5
17.	22FT3013	Analysis of Food Commodities Lab	0	0	3	2
18.	22FT3014	Food Microbiology Lab	0	0	3	2
19.	22FT3015	Food Product Technology Lab – I	0	0	4	2.5
20.	22FT3016	Food Product Technology Lab – II	0	0	3	2
21.	22FT3017	Technology of Meat, Poultry and Fish Processing	4	0	0	4
22.	22FT3018	Food Packaging Technology	3	0	0	3
23.	22FT3019	Food Additives and Ingredients	3	0	0	3
24.	22FT3020	Nutraceuticals and Health Foods	3	0	0	3
25.	22FT3021	Water and Food Waste Resource Management	3	0	0	3
26.	22FT3022	Food Toxicology	3	0	0	3
27.	22FT3023	Food Biotechnology	3	0	0	3
28.	22FT3024	Enzymes in Food Processing	3	0	0	3
29.	22FT3025	Food Packaging Lab	0	0	3	2
30.	22FT3026	Enzymology Lab	0	0	3	2
31.	22FT3027	Food Additives Lab	0	0	3	2

22FP2047	SMART SENSORS FOR FOOD INDUSTRIES LABORATORY	L	T	P	C
		0	0	4	2

Course Objectives:

1. Understand the principle of operation of different sensors and their applications
2. To elucidate sensors and signal conditioning circuits.
3. To evaluate the process control parameters

Course Outcomes:

1. To select an appropriate sensor for a given application
2. Ability to analyze the suitability of sensor in food industries.
3. Development of a smart sensor using conventional sensors and microcontroller
4. Demonstrate the knowledge of inductance and capacitance transducers.
5. Design appropriate signal conditioning circuits for different types of sensors.
6. Apply appropriate sensors for measuring various physiological parameters of food commodities.

List of experiments

1. Temperature and humidity measurement using smart Sensor

2. Air Flow measurement using anemometer
3. Measuring water flow rate and volume using YFS201 Hall Effect Water Flow Sensor
4. Solid flow measurement
5. Pressure measurement
6. Level control using ultrasonic sensor
7. Gas flow measurement using Gas flow Sensor
8. Humidity measurement using dht11 humidity sensor
9. Experiment on Feedback control system
10. Measurement of speed using Proximity sensor
11. Measurement of color using Photoelectric sensor
12. Measurement of redox reaction using Chemometrics sensor
13. Measurements of volatile organic compounds using gas sensor
14. Detection of metal contaminants in food using smart sensor
15. Detection of enzymatic browning in fruits
16. Measurement of oxygen, nitrogen and carbon dioxide leakage from packaging

22FP2048	IoT AND DEEP LEARNING FOR FOOD QUALITY	L	T	P	C
		2	0	0	2

Course Objectives:

1. To understand the importance of IoT and Deep Learning for Food Industry Environment.
2. To know the principles behind food quality evaluation.
3. To gain knowledge on application of IoT and Deep Learning in food quality evaluation.

Course Outcomes

At the end of the course, the student will be able to

1. Understand the basics of IoT
2. Implement the Feed forward Neural Networks.
3 Write programming for Convolutional Neural Networks
4. Apply IoT and Deep Learning for Quality Evaluation of Meat, Poultry and Seafood
5. Apply IoT and Deep Learning for Quality Evaluation of Fruits and Vegetables
6. Apply IoT and Deep Learning for Quality Evaluation of Grains

Module 1: Fundamentals of IoT (5 hours)

Internet of Things (IoT): Definition, IoT Functional Diagram, Technologies Enabling IoT, Sensors, Networks, Standards, Data Analytics, Intelligence

Module 2: Deep Learning - FNN (5 hours)

Machine Learning and Deep Learning, Feed forward Neural Network- Architecture, Training, Validation and Testing – Prediction and Classification Tasks using Python

Module 3: Deep Learning - CNN (5 hours)

Fundamentals of Computer Vision Technology, Image Acquisition Systems, Object Measurement Methods Object Classification Methods, Introduction to Hyper spectral Imaging Technology Convolutional Neural Network- Architecture, Training, Validation and Testing – Implementation of CNN using Python

Module 4: Quality Evaluation of Meat, Poultry and Seafood (5 hours)

IoT and Deep Learning based quality evaluation of meat cuts, Cooked Meats, Quality Evaluation of Poultry Carcass and Seafood

Module 5: Quality Evaluation of Fruits and Vegetables (5 hours)

IoT and Deep Learning based quality evaluation of apples, citrus fruits and vegetables

Module 6: Quality Evaluation of Grains (5 hours)

IoT and Deep Learning based quality evaluation of wheat, rice, corn and maize

Text Books

1. Sun, D. W. (Ed.). (2016). Computer vision technology for food quality evaluation. Academic Press.
2. McEwen, A., & Cassimally, H. (2013). Designing the internet of things. John Wiley & Sons.
3. Chollet, F. (2021). Deep learning with Python. Simon and Schuster.

Reference

1. Sun, D. W. (Ed.). (2010). Hyperspectral imaging for food quality analysis and control. Elsevier.

22FP2049	DATA ANALYTICS FOR FOOD SUPPLY CHAIN	L	T	P	C
		2	0	0	2

Course Objectives:

1. To understand the importance of food supply chain analytics.
2. To know the key principles of demand planning and inventory planning.
3. To gain the knowledge on the supply chain and logistic network design.

Course Outcomes

At the end of the course, the student will be able to

1. Articulate the philosophy and approach in data-driven Supply Chain Management.
2. Understand the demand planning principle and develop key skills to implement new business solutions and processes.
3 Explain the key principles of Supply Chain Planning, and a typical end-to-end planning process flow
4. Perform inventory optimization by identifying the main inputs that affect the inventory level, perform inventory optimization, and set inventory targets
5. Evaluate a variety of business constraints and inputs in Supply Planning, and develop a realistic constrained model to optimize Master Production Schedule
6. Assess various cost drivers for supply chain network, and develop a realistic model to optimize supply chain network to minimize the total delivered costs

Module 1: Supply Chain Process (5 hours)

Supply Chain Process Overview – SCOR model, An integrated value added supply chain, Organizational and supply chain strategy, Supply chain opportunities and challenges.

Module 2: Demand Planning Principle (5 hours)

Demand planning overview - Forecast Principles, Types of Forecasting, Time series/Associative models, forecasting metrics, Demand forecasting technology and best practices, Case study: Forecast Accuracy Visualization.

Module 3: Inventory planning and control (5 hours)

Inventory Management Introduction- Types of inventory, costs of inventory, Economic order quantity model, ROP model, ABC method of inventory planning and control,

Module 4: Supply Planning -- A Realistic Approach (5 hours)

Supply Planning – Planning and scheduling process overview, Master Production Schedule (MPS) , Material requirements planning, Short-term Scheduling, Case study on Data-Driven Approach for supply planning.

Module 5: Supply chain operation and Transportation systems (5 hours)

Supply chain operation, the procurement process, Follow-up to ensure correct delivery, Transportation systems, and transportation cost structure and modes, transportation economics and key metrics.

Module 6: Supply chain and Logistics Network Design (5 hours)

Supply chain technology, Facility location decision, supply chain network design influencers, types of distribution networks, transportation problem model technology.

Text Books

1. Supply Chain and Logistics Management Made Easy: Methods and Applications for Planning, Operations, Integration, Control and Improvement, and Network Design, by Paul A. Myerson (Author), Pearson FT Press; 1 Edition (May 10, 2015).
2. Truckload Transportation: Economics, Pricing & Analysis by Leo J. Lazarus, Monument Press, 2010.

Reference Books

1. Supply Chain Analytics: Using Data to Optimise Supply Chain Processes (Mastering Business Analytics) By Peter. W.Robertson, Edition: Import, 25 November 2020.
2. Big Data Driven Supply Chain Management: A Framework for Implementing Analytics and Turning Information Into Intelligence (FT Press Analytics) by Nada.R.Sanders, Pearson FT Press, 2014.

3. Operations and Supply Chain Management in the Food Industry, Editors: Rahul S. Mor, Sachin S. Kamble, Kuldip Singh Sangwan, , Lecture Notes in Management and Industrial Engineering, Springer Singapore

Self studies/ Software tools

1. Python for Data Analysis Python (Jupyter Notebook)
2. Tableau Data Visualization

22FP2050	INTELLIGENT FOOD INDUSTRIES	L	T	P	C
		3	0	0	3

Course Objectives:

1. To develop the knowledge of students in the area of emerging or alternative technologies applied to food processing.
2. To understand the advantages and disadvantages over existing technologies
3. To identify the different processing technologies and their application

Course Outcomes:

At the end of this course students will demonstrate the ability to

1. Identify the different key technologies used in the food industries.
2. Apply the robotics and automation in food industries
3. Apply scientific principles in the various food processing sectors.
4. Evaluate communication protocols used in the food industries
5. Designing of smart premises for food industries.
6. Analyze data received through the sensors in IoT.

Module 1: Introduction (7 hours)

Material transfer and Flow properties of liquids, solids and gases – Heat Transfer – Water Activity – Effect of thermal and non-thermal processing methods on nutritional properties – Food safety, GMP and quality assurance

Module 2: Key technologies and Robotics in Food Industry (8 hours)

Automatic process control for the food industry: Introduction - Process control systems structure and Methods - Current manufacturing procedures - Automatic control - Computer-based systems- Types of control systems - Software developments - Automation in the food sector - Future Trends

Module 3: Sensors for Food Industry (7 hours)

Sensors for automated food process control: Principle of operation, construction of different types of sensors, Measurement methods - Applications of Thermo, Bio, Chemometrics, colorimetric and fluorescence sensors in automated food process control - Optical sensing and spectroscopic techniques.

Module 4: SCADA and WSN (8 hours)

Supervisory Control and Data Acquisition (SCADA) and related systems for automated process control in the food industry - SCADA in food processing - Future trends in SCADA - Current and future technologies. WSN: Introduction - Current state of development of WSNs and its application in food production

Module 5: Intelligent quality control systems in food processing (7 hours)

Introduction- Principles of intelligent control systems such as Fuzzy logic and ANN- Current applications in the food industry

Module 6: Recent Intelligent Technologies in food industries (8 hours)

Application of recent intelligent technologies in Fresh produce industry, Dairy industry, Meat-poultry-seafood industry, and confectionery industry

Text Book

1. Darwin G. Caldwell, " Robotics and automation in the food industry Current and future technologies", Woodhead Publishing Limited, 2013.
2. P. Fellows, "Food Processing Technology: Principles and Practice", Woodhead Publishing Limited and CRC Press LLC, Third Edison 2009

Reference Books

1. Da –Wen Sun, "Thermal Food Processing: New Technologies and Quality Issues, 2nd Edition, CRC Press/Taylor & Francis, Boca Raton, Florida,USA, 2012.

2. Leistner L. and Gould G. Hurdle Technologies – Combination treatments for food stability safety and quality, Kluwer Academics / Plenum Publishers, New York (2002).
3. Gustavo V.Barbosa-Canovas, Maria S.Tapia and M.Pilar Cano, " Novel Food Processing Technologies". CRC Press, 2004.
4 Da-Wen Sun,"Emerging Technologies for Food Processing", Academic press/ Elsiever, London, UK,2005.
5 Zeki Berk Professor (Emeritus), " Food Processing Engineering and Technology", Elsevier Pub;ication, 2012 .

Other References

1. Zhang, Z., Lou, Y., Guo, C., Jia, Q., Song, Y., Tian, J. Y., ... & Du, M. (2021). Metal–organic frameworks (MOFs) based chemosensors/biosensors for analysis of food contaminants. Trends in Food Science & Technology, 118, 569-588.

22FT3001	FOOD CHEMISTRY	L	T	P	C
		4	0	0	4

Course Objectives:

1. To understand the chemistry of food constituents.
2. To apply fool molecules interaction in developing technologies/processes.
3. To develop skills for experimenting with food systems and to test various approaches for manipulating the chemical and/or functional properties of foods.

Course Outcomes:

1. The students will be able to
2. Describe the general chemical structures of major components of foods (water, proteins, carbohydrates, and lipids) and selected minor components (vitamins and minerals).
3. Understand, plan, perform and analyze a range of chemical investigations with emphasis on food analysis
4. Demonstrate the ability to relate the chemical composition of foods to their functional properties
5. Examine a molecular rationalization for the observed physical properties and reactivity of major food components.
6. Evaluate and determine the approaches that may be used to control the reactivity of those food components that are likely to impact the overall quality of finished products.
7. Predict how changes in overall composition are likely to change the reactivity of individual food components.

Module 1: Water and simple sugars (9 hours)

Importance of water in foods - Structure of water & ice - the concept of bound & free water. Water activity. Sorption phenomena and their applications. Nomenclature, classification & structure of carbohydrates, chemical reactions of carbohydrates, General properties of monosaccharide.

Module 2: Chemistry of Glycans (10 hours)

Chemistry of Glycans, properties and preparation of pectic substances, gums, starch and its hydrolytic products-native starches, modified starch, resistant starch, starch hydrolysates and its functional role in the food system, cellulose and its products.

Module 3: Chemistry of Lipids (11 hours)

Nomenclature and classification of lipids. Basic Structures and chemistry of fatty acids. physical & chemical characteristics of fats & oils, Phospholipids, and unsaponifiable, auto-oxidation and hydrolysis, antioxidants. Process flow chart for the manufacture of edible oils (refined and hydrogenated), fat interesterification.

Module 4: Chemistry of Proteins (11 hours)

Nomenclature, classification, structure and chemistry of amino acids, peptides & Proteins. Functional properties of Protein. Protein denaturation. Enzymes: Introduction, classification & nomenclature of enzymes, immobilization of enzymes and applications in food systems.

Module 5: Chemistry of Vitamins and minerals (11 hours)

Fat-soluble and water-soluble vitamins – Choline, carnitine. Summary of vitamin stability – Toxicity and sources of vitamins – Bioavailability of vitamins – Reasons for the loss of vitamins in foods. Iron, calcium, sodium, and potassium - Toxicity and sources – Bioavailability. Factors affecting mineral availability.

Module 6: Chemistry of Natural Colourants (8 hours)

Overview of natural colourants/pigments, sources, chemistry and applications of anthocyanin, betalain, carotenoids and chlorophyll.

Text books:

1. Fennema, O. R., Damodaran, S., & Parkin, K. L. (2017). Introduction to food chemistry. In *Fennema's food chemistry* (4th edition). CRC Press.
2. H.D. Belitz, W. Grosch, P. Schieberle (2009). "Food Chemistry". 4th revised and extended edition, Springer-Verlag Berlin Heidelberg, ISBN 978-3-540-69933-0

Reference Books:

3. John M.deMan, John W. Finley, W. Jeffrey Hurst and Chang Yong Lee (2018). "Principles of Food Chemistry", 4th edition, Springer International Publishing. ISBN 978-3-319-63607-8 (eBook).
4. N. Michael Eskin. Biochemistry Of Foods – 2nd Edition Academic Press, USA. (1990) ISBN 13: 9780122423512
5. Pieter Walstra. "Physical Chemistry of Foods". Marcel Dekker Publishing, New York (2003) ISBN 9780824793555
6. Zdzislaw and E.Sikroski. "Chemical and Functional Properties of Food Components", 3rd edition, CRC Press, Taylor & Francis Group USA (2006), ISBN - ISBN 9780849396755.
7. Satyanarayana, U. (2021). *Biochemistry, 6e-E-book*. Elsevier Health Sciences.

22FT3002	FOOD AND INDUSTRIAL MICROBIOLOGY	L	T	P	C
		4	0	0	4

Course Objectives:

1. To understand the microorganisms associated with foods and isolation methods of microorganisms from foods.
2. To impart knowledge of the role of microbes in the industrial production of products.
3. To understand the types and biochemistry of the fermentation process.

Course Outcomes:

The students will be able to

1. Identify the beneficial and spoilage microorganisms associated with foods.
2. Understand the role of microorganisms in water and food commodities.
3. Examine the role of causative agents and pathogenesis of disease-causing food-borne pathogens and their toxins.
4. Illustrate the media formulation, sterilization and culture conditions for the development of suitable strain for industrial fermentation.
5. Evaluate the industrial production of organic acids, amino acids, Vitamins, and Polysaccharides.
6. Comprehend the techniques and underlying principle of downstream processing.

Module 1: History, Screening and Isolation of Microorganisms (10 hours)

History of Microorganisms in Food product Development - Microorganisms associated with foods: Bacteria, Molds, Yeast and their importance –Nutritional requirements of bacteria- Factors affecting the growth of bacteria –Growth curve of bacteria - - General Microbiological Methods of enumeration and isolation of bacteria and fungi, -Identification of bacteria and fungi by staining methods. The growth of Yeast and its application in the food industry. Factors affecting the growth of microorganisms (intrinsic and extrinsic factors).

Module 2: Microbiology of Water and Food Commodities (11 hours)

Microbiology of water and their importance in processing of foods in industries. MPN of coliforms, Membrane filtration Technique. Microbiology of milk –Phosphatase test. Hetero and homo fermentative Lactic acid bacteria – Yogurt and Cheese fermenting organisms - -Microbial spoilage of various food commodities.

Module 3: Food Borne Diseases, Intoxications and Detection of Pathogens (10 hours)

Food Poisoning and intoxication – food-borne diseases – Symptoms of diseases caused by *Bacillus* spp., *Clostridium botulinum*, *Escherichia coli*, *Salmonella* spp, *Staphylococcus aureus*, *Shigella* spp., Hepatitis,

Gastroenteritis viruses, *Entamoeba histolytica* – Mycotoxins, Bacterial toxins and Algal toxins. Rapid methods for detection of microorganisms and toxins- ELISA and PCR and GMP and GHP to overcome food-borne diseases.

Module 4: Industrial Microbiology and Fermentation Media (11 hours)

Brief history and developments in industrial microbiology. Primary and secondary screening, strain development, preservation and maintenance of industrial strains. Crude and synthetic media; molasses, corn-steep liquor, sulphite waste liquor, whey and yeast extract, Media sterilization, Inoculum preparation, Microbial culture conditions - pH, temperature, dissolved oxygen, foaming and aeration.

Module 5: Microbial production of industrial products: Organic acids, Amino acids, Enzymes, Polysaccharides (9 hours)

Organic acids: Citric acid, Acetic acid, Alcoholic products: Beer, Wine. Amino acids: glutamic acid, Lysine, Vitamins: Vitamin B12, riboflavin, Enzymes: amylase, cellulase, Polysaccharides: Xanthan. Production of Single Cell Protein.

Module 6: Downstream processing (9 hours)

Objectives and problems with downstream processing, Product recovery- Filtration, centrifugation, cell disruption, solvent extraction, precipitation and ultrafiltration, lyophilization, spray drying.

Text Books:

Adams M.R and Moss M.O, (2007). "Food Microbiology", Panima Publishing Corporation, New Delhi, 2nd Edition, Third reprint, ISBN-13:9788122410143,978-8122410143.

Patel AH. (2016). *Industrial Microbiology*. 1st edition, Macmillan India Limited. ***ISBN***: 9350590085, 9789350590089

Reference Books:

Sivasankar B, (2009) "Food Processing and Preservation", PHI Learning Private Limited, Eastern Economy Edition, 6th edition, ISBN- 97881203-2086-4.

William C. Frazier and Dennis C. Westoff, (2008). "Food Microbiology", Special Edition, Springer, The McGraw-Hill Companies ISBN-9780070667181.

Stanbury PF, Whitaker A and Hall SJ. (2006). *Principles of Fermentation Technology*. 2nd edition, Elsevier Science Ltd. eBook ISBN:9781483292915

22FT3003	PRINCIPLES OF FOOD PRESERVATION	L	T	P	C
		3	0	0	3

Course Objectives:

1. To impart knowledge on basic aspects of food preservation.
2. To provide technical aspects of food processing.
3. To give orientation towards the process and products developed using different techniques.

Course Outcomes:

The students will be able to

1. Recall the basic principles involved in food preservation.
2. Understand the various processing methods.
3. Comprehend suitable techniques for the preservation of various foods.
4. Apply the modern technologies of food preservation in industry.
5. Analyze the conventional and novel preservation techniques.
6. Evaluate and suggest proper preservation methods and equipment.

Module 1: Principles of Food Preservation (5 hours)

Historical development of food processing and preservation, general principles, and objectives of food preservation. Classification of foods based on water activity, and pH. Mechanism of food spoilage: physical, chemical, and biological.

Module 2: Preservation by Heat (8 hours)

Blanching, pasteurization, sterilization and UHT processing, extrusion cooking, dielectric heating, and Retort processing. Thermal kinetics: D, Z, F value and 12D concept.

Module 3: Preservation by Low Temperature (9 hours)

Chilling**:** Considerations relating to storage of foods at chilling temperature, applications and procedures. Principles of the freezing process, slow and fast freezing of foods and its consequences. Freeze-thaw stability of foods. Cryogenic freezing.

Module 4: Preservation by Drying (9 hours)

Fundamentals of drying and dehydration. Methods of drying and dehydration – sun and solar drying, tray or tunnel drying, spray drying, drum drying, freeze drying, vacuum drying, fluidized bed drying - advantages and disadvantages. Physical and chemical changes during drying.

Module 5: Chemical Preservations (6 hours)

Principles, technological aspects and applications of sugar, acid and salt, antimicrobial agents, and biological agent. Permissible limits for chemical preservatives.

Module 6: Preservation by Non-Thermal Methods (8 hours)

Hurdle technology, High pressure processing, pulsed electric field, ultrasound technology, cold plasma technology, UV and pulsed light technology. Microwave heating, ohmic heating and irradiation.

Hurdle technology, High pressure processing, pulsed electric field, ultrasound technology, cold plasma technology, UV and pulsed light technology.

Text books:

1. Rao, Chandra Gopala, (2009) "Essentials of food process engineering". B.S. Publications. ISBN 9781439803103.
2. Khatkar, Bhupendra Singh, (2007). "Food science and technology", Daya Publishing House. ISBN 13: 9788170354222.
3. Ahlluwalia, Vikas, (2007) "Food processing", Paragon International Publishers, . ISBN-13: 978-8189253523.
4. Sivasankar, B, (2005) "Food processing and preservation", Prentice - Hall of India. *ISBN*-13: 978-8120320864.

Reference Books:

1. Rahman, Shafiur, (2007). "Handbook of food preservation". 2nd Edn., CRC press,. *ISBN*-13: 978-*1*-57444-606-7
2. Fellows. P, (2005).. "Food processing technology", 2nd Edn. Woodhead publishing company, 2005. *ISBN*: 1 85573. 475 3
3. Berk, Zeri, "Food process engineering and technology", CRC Press, 2009. *ISBN* 978-0-470-67223-5

22FT3004	TECHNOLOGY OF CEREALS, PULSES AND OILSEEDS	L	T	P	C
		3	0	0	3

Course Objectives:

1. To equip the students with basic concepts of various unit operations in the processing of food materials.
2. To provide basic knowledge on various processing equipment.
3. To impart skills in product and by-product development.

Course Outcomes:

The students will be able to

1. Recall the basic concept of cereals, pulses and oil seeds processing.
2. Understand the various unit operations involved in milling.
3. Analyze and select suitable equipment for milling.
4. Apply the knowledge to process grains into value-added products.
5. Create new products from pulses and legumes.
6. Gain knowledge on converting the waste into wealth

Module 1: Introduction (5 hours)

General introduction and production and utilization trends; Structure and composition of common cereals, pulses and oilseeds.

Module 2: Wheat milling (8 Hours)

Wheat milling - products and byproducts; physical, chemical and rheological tests on wheat flour; manufacture of whole wheat atta, blended flour and fortified flour. Production of starch and vital wheat gluten and wheat-based products.

Module 3: Paddy milling (9 hours)

Paddy parboiling – methods - quality changes - rice milling technology; by- products of rice milling and their utilization; Rice bran stabilization,– Quick cooking rice – fermented products – puffed, expanded rice. Ageing process of rice, flaking

Module 4: Maize/ corn milling (8 hours)

Dry and wet milling, processing of corn in breakfast cereals, snacks, tortillas, etc., production of glucose syrups, dextrose, high fructose corn syrups, and modified starches.

Module 5: Pulse milling (8 hours)

Anti-nutritional factors and methods of removal. Methods of pulse milling – Byproducts of pulse milling, grading, and development of low-cost protein foods.

Module 6: Oil seed milling (8 hours)

Pre-conditioning of oilseeds - Oil expression and extraction –- mechanical and solvent extraction methods - refining of oil - By-products utilization - protein concentrates and isolates.

Text books:

1. Sahay, K.M. and K.K. Singh, (2006) Unit operations of Agricultural processing. Vikas Publishing House Pvt. Ltd. Noida, New Delhi. ISBN: 9788125911425
2. Chakravarty A. (2000), Post Harvest Technology of cereals, Pulses and oil seeds. Oxford and IBH publishing Co Pvt Ltd, New Delhi. *ISBN*-13: 978-8120409699
3. Amalendu Chakraverty, Arun.S. Mujumdar, Hosahalli. Ramasamy. (2003). Handbook of Postharvest Technology: Cereals, Fruits, Vegetables, Tea, and Spices. CRC Press, *ISBN:* 9780824705145
4. Samuel A. Matz, (2004). The chemistry and Technology of cereals as Food and Feed. CBS Publishers and Distributors, New Delhi. *ISBN* 13: 9788123904764.

Reference Books:

1. Chakravarthy, M.M. (2003). Chemistry and Technology of Oils and Fats. Prentice Hall. *ISBN 1*-84127-331-7
2. Dendy, D.A.V., & Dobraszczyk, B.J. (2001). Cereal and Cereal Products. Aspen. *ISBN* 978-0-8342-1767-6
3. Hamilton, R.J., & Bhati, A. (1980). Fats and Oils - Chemistry and Technology. App. Sci. Publ. I*SBN*, 0853349150
4. Hoseney, R.S. (1994). Principles of Cereal Science and Technology. 2nd Ed. AACC. *ISBN*: 978-1-891127-63-2
5. Kay, D.E. (1979). Food Legumes. Tropical Products Institute. *ISBN*: 0859540855 9780859540858
6. Kent, N.L. (1994). Technology of Cereals. 4th Ed. Pergamon Press. *ISBN*: 9781855733619. eBook *ISBN*: 9781855736603

22FT3005	TECHNOLOGY OF FRUITS AND VEGETABLE PROCESSING	L	T	P	C
		3	0	0	3

Course Objectives:

1. To develop the knowledge of students in the area of fruits and vegetable processing.
2. To know the formulation of various products, their manufacturing process and equipment.
3. To enable the students to appreciate the application of scientific principles in the processing of fruits and vegetables.

Course Outcomes:

The students will be able to

1. Acquire knowledge of different physical, chemical and nutritional properties of fruits and vegetables.
2. Acquire insight into the various chemical and biochemical changes that occur during processing.
3. Learn various ways of designing and monitoring processing chains
4. Gain thorough knowledge about laws, regulations and the monitoring agencies involved in food safety and labeling of fruits and vegetables.
5. Understand the methods of packaging, shelf life and related factors in the processing of fruits and vegetables.
6. Know how fruits and vegetables are processed in industries.

Module 1: Production and post-harvest losses (7 hours)
Current scenario of production and processing of fruits and vegetables. Climacteric and non-climacteric fruits. Scope of fruits and vegetable preservation in India: Postharvest losses and management, marketing facility, precooling – importance and methods.

Module 2: Minimal processing (8 hours)
Minimal processing (Washing, rinsing, trimming, cutting, peeling, cutting, slicing, dicing and disinfection). Modified atmosphere packaging (MAP), Controlled atmospheric packaging, Intelligent packaging, and Aseptic packaging.

Module 3 : Fruit juice processing (7 hours)
Types of juices, process flow diagram for fruit juice production- fruit selection, sorting, washing, juice extraction, machineries for juice extraction, deaeration, straining/filtration, clarification, adding of sugars, fortification, bottling, sealing and storage; methods of juice preservation, causes of juice spoilage.

Module 4 : Aseptic processing (8 hours)
Introduction, canning process - selection of fruits and vegetables, grading, washing, peeling, cutting, blanching, cooling, filling, exhausting, sealing, retorting and storage; types of canning- pressure canning and water bath canning, common causes of spoilage in canning.

Module 5 : Concentration and evaporation (7 hours)
Concentration, evaporation - principle, preparation of fruit powders, pulp and purees, osmotic dehydration.

Module 6: Products and standards (8 hours)
Preparation of products like Jams, Jellies, Marmalades, Pickles, Puree, Ketchup, Sauce, Squashes, nectars, syrups, etc., Fruits and vegetable products standards prescribed by FSSAI,

Text books:

1. R. P. Srivastava & Sanjeev Kumar, (2019). Fruit and Vegetable Preservation: Principles & Practices International book distributing Co. Lucknow (4th print). ISBN 10: 8123924372ISBN 13: 9788123924373
2. Rosenthal, A., Deliza, R., Welti-Chanes, J., & Barbosa-Cánovas, G. V. (Eds.) (2018). Fruit Preservation: Novel and Conventional Technologies. Springer.. *ISBN* 978-1-4939-3311-*2*
3. Giridhari Lal, G.S. Siddappa & G.L. Tondon. (1990). Preservation of Fruits and Vegetables CFTRI, ICAR, New Delhi -12. Y. H. Hui, S. Ghazala, D.M. Graham, K.D. Murrell & W.K. Nip (2003). Handbook of Vegetable Preservation and Processing Marcel Dekker.

Reference books:

1. Lal, G., & Siddappa, G. S. (1959). *Preservation of fruits and vegetables* (No. 664.828 L35).Salunkhe DK, Bolia HR & Reddy NR. Storage, 1991.Processing and Nutritional Quality of Fruits and Vegetables. Vol. I. Fruits and Vegetables. CRC. *ISBN* 9781466566293.
2. Thompson AK. Post-Harvest Technology of Fruits and Vegetables. Blackwell Sci. 1995. ISBN-13: 978-0632040377
3. Siddiqui, M. W., & Rahman, M. S. (Eds.). (2014). Minimally processed foods: Technologies for safety, quality, and convenience. Springer.

22FT3006	BAKERY AND CONFECTIONERY TECHNOLOGY	L	T	P	C
		3	0	0	3

Course objectives:
1. To impart knowledge on the fundamentals involved in various Bakery and confectionery Processes
2. To gain knowledge on the composition and nutritive value of baked products
3. To recognize the factors governing the manufacturing of confectionery products

Course outcomes:
The students will be able to
1. Know the various ingredients used in the baking industry.
2. Study the processes involved in baking technology.
3. Understand the factors affecting the quality of baked and confectionery products
4. Design products with better quality.
5. Learn about the process involved in confectionery products

6. Get exposure to the different parameters involved in the scale-up of bakery products production.

Module 1: Flour for bakery products (9 hours)

Criteria of wheat quality – physical and chemical factors, hard wheat and soft wheat; general principles and operations, grading and classification of flour. quality criteria of flour quality, dough rheology, and its measurement.

Module 2: Additives for bakery and confectionery (6 hours)

Functions of ingredients, Importance of fat, emulsifiers, oxidants, reducing agents, conditioners, CBE and CBS, and leavening agents in bakery products.

Module 3: Bread, Cakes & Biscuits (8 hours)

Bread-making processes, development in bread-making methods, bread faults and remedies. The technology of biscuits, cookies, crackers and cakes, pastries.

Module 4: Snack Foods Technology (7 hours)

The technology of noodles and pasta products (Single and twin screw extrusion), flaked products, composite flour products, and nutri-bars.

Module 5: Candies and Aerated Confectionery (8 hours)

Raw materials used in confectionery and their importance, Sugar crystallization, solubility and sizes of sugars, stages of sugar cooking, caramelization, Technology of Hard boiled candies, Jellies, Jujubes, and Marshmallows.

Module 6: Toffees and Chocolates (7 hours)

The technology of toffees. Types of chocolates and manufacturing process – Quality aspects of toffees and chocolates.

Text books:

1. Center, W. M. (2008). Wheat and flour testing methods: a guide to understanding wheat and flour quality, version 2. *Kansas state university*.Edwards, W. P. (2007). *The science of bakery products*. Royal Society of chemistry. ISBN: 978-0-85404-486-3
2. Hui, Y. H., Corke, H., De Leyn, I., Nip, W. K., & Cross, N. A. (Eds.). (2008). *Bakery products: science and technology*. John Wiley & Sons. ISBN: 978-0-470-27755-3 Sumnu, S. G., & Sahin, S. (2008). *Food engineering aspects of baking sweet goods*. CRC Press.ISBN 9780367387617
3. Mohos, F. Á. (2017). *Confectionery and chocolate engineering: principles and applications*. John Wiley & Sons. ISBN: 978-1-118-93977-2 R. Less and E.B, "Sugar Confectionery and Chocolate Manufacture" Jackson Springer, 2012 ISBN: 9781468414950
4. R. Less and E.B, "Sugar Confectionery and Chocolate Manufacture" Jackson Springer, 2012 ISBN: 9781468414950

Reference books:

1. Stephen T Beckett, "The Science of Chocolate" 2nd Edition Formerly Nestle Product Technology Center, York, UK RSC publication 2008 ISBN: 978-0-85404-970-7
2. Lees, R. (2012). *Sugar confectionery and chocolate manufacture*. Springer Science & Business Media. ISBN: 978-1-4684-1495-0

22FT3007	TECHNOLOGY OF PLANTATION CROPS AND SPICES	L	T	P	C
		3	0	0	3

Course Objectives:

1. To provide the basic concepts of the different unit operations in the processing of plantation and spice crops.
2. To inculcate basic knowledge of various processing equipment
3. To impart skills on quality control measures pertaining to products.

Course Outcomes:

The students will be able to

1. Understand the chemistry of plantation crops and spice processing
2. Recall the various unit operations involved in processing
3. Explore the suitable techniques for coffee and tea processing
4. Develop processes for spice processing
5. Learn the techniques of extraction of oleoresins from spices

6. Develop novel plantation-based products

Module 1: Processing of Coffee (8 hours)

Chemical constituents; fermentation of coffee beans; changes taking place during fermentation; drying; roasting; process flow sheet for the manufacture of coffee powder; instant coffee technology; chicory chemistry; quality grading of coffee.

Module 2: Processing of Tea (8 hours)

Chemistry of constituents; types of tea – green, oolong and CTC; Technology of green and black tea - instant tea manufacture; quality evaluation and grading of tea.

Module 3: Cocoa Processing (7 hours)

Chemistry of the cocoa bean; changes taking place during fermentation of cocoa bean; the processing of cocoa bean; cocoa powder; cocoa liquor manufacture; cocoa butter equivalents and substitutes.

Module 4: Processing of other Plantation crops (8 hours)

Vanilla – processing, and extraction of vanillin – coconut – processing and products – cashew processing and products. Arecanut, Palmyra – processing.

Module 5: Processing of Major Spices (8 hours)

Pepper, cardamom, ginger, chilly, and turmeric–Oleoresins and essential oils - method of manufacture; chemistry of the volatiles; enzymatic synthesis of flavor identicals; quality control; fumigation and irradiation of spices.

Module 6: Processing of other Minor Spices (6 hours)

Cumin – coriander – cinnamon – fenugreek – garlic – clove – Oleoresins and essential oils

Text Books:

1. Panda, H. (2011). *The complete book on cultivation and manufacture of tea*. Asia Pacific Business Press Inc.
2. Minifie Bernard W. Chocolate, Cocoa and Confectionery Technology, 3rd Edition, Aspen Publication, (1999). ISBN: 9780834213012
3. Board, N. (2010). *Handbook On Spices (Reprint Edition-2010)*. National Institute of Industrial Re. . ISBN: 8188330946
4. Chakraverty, A., Mujumdar, A.S., Raghavan, G.S.V., Ramaswamy, H.S. (2010). Handbook of Post Harvest Technology – Cereals, Fruits, Vegetables, Tea and Spices. Marcel Dekker Inc., New York (Special Indian Reprint). ISBN 13: 9780824705145

Reference Books:

1. Peter, K.V, (2004). Hand book of herbs and spices. Volume 2. Wood head publishing Ltd. eBook ISBN: 9780857095688
2. J.S. Pruthi. (1998). Major spices of India – Crop Management and Post Harvest Technology. Indian Council of Agricultural Research, Krishi Anusandhan Bhavan, Pusa, New Delhi. PP. 514.
3. J.S. Pruthi. (1980). Spices and Condiments: Chemistry, Microbiology and Technology. First Edition. Academic Press Inc., New York, USA. ISBN 10:0120164647ISBN 13: 9780120164646

22FT3008	TECHNOLOGY OF MILK AND MILK PRODUCTS	L	T	P	C
		3	0	0	3

Course Objectives:

1. To gain basic knowledge about the constituents and the properties of milk.
2. To provide basic knowledge about the milk processing techniques and equipment.
3. To provide knowledge about the manufacturing of milk products.

Course Outcomes:

The students will be able to:

1. Gain knowledge of the properties and composition of milk.
2. Understand the processing techniques of milk.
3. Learn the different milk products manufacturing.
4. Understand the equipment used in dairy products manufacturing.
5. Learn the packaging and storage of various milk products.
6. Acquire knowledge of Indian dairy products and their manufacturing.

Module 1: Milk Processing (10 hours)
Milk – Constituents and Properties. Market Milk – Milk Collection, Reception, and Chilling. Platform tests and Quality tests. Pasteurization – LTLT, HTST, UHT, ESL Milk. Filling and packaging of milk. Milk Standardization, Filtration – Clarification, Adulteration of milk.

Module 2: Special Milks (6 hours)
Special Milks – Homogenized, Sterilized, Flavored, Standardized, Reconstituted, and Toned Milk. Evaporated Milk and Sweetened Condensed Milk. Lactose free milk.

Module 3: Cream and Butter (9 hours)
Cream – Definition, Composition, Types, Properties, Manufacturing of different types of cream and packaging. Butter - Definition, Composition, Types, Properties, Methods of Manufacture, Defects. Quality of butter and cream. Adulteration in butter. Ghee - Definition, Composition, Properties, Methods of Manufacturing of ghee and packaging.

Module 4: Ice cream and Cheese (8 hours)
Ice cream – Definition, Classification, Composition, Methods of manufacturing -. Cheese – Definition, Classification, Manufacture of Cheddar Cheese and Cottage Cheese. Defects in cheese.

Module 5: Dried Milk (5 hours)
Drying methods - Drum drying and Spray drying. Instantization and agglomeration. Quality aspects.

Module 6: Fermented and Indigenous Milk Products (7 hours)
Cultured Buttermilk, Acidophilous Milk, Kefir. Dahi, Yoghurt, Khoa, Channa, Srikhand, Makkan, Lassi and Paneer. Rasgulla and its method of preparation

Text Books:
1. Sukumar De, "*Outlines of Dairy Technology"*, Oxford University Press, Delhi, 1991, ISBN:9780195611946.
2. Tufail Ahmad, *Dairy Plant Engineering & Management*, Kitab Mahal, Allahabad, India, 2008, ISBN: 9788122501186.
3. Anil Kumar Puniya (2016)**,,** *Fermented Milk and Dairy Products*, CRC Press, ISBN: 9781466577978.

Reference Books:
1. G. Bylund, *Dairy Processing Handbook*, Tetrapack publishers, 2012, ISBN: 9789163134272.
2. Pieter Walstra, Jan T. M. Wouters and Tom J. Geurts, (2012). *Dairy Science and Technology*, 2nd Edition, Taylor and Francis, ISBN: 9781466548916.
3. Ashok Kumar Agarwal, (2011), Processing Technologies for Milk and Milk Products, CRC Press, ISBN: 9781771885485.

22FT3009	NUTRITION AND METABOLISM	L	T	P	C
		3	0	0	3

Course Objectives:
1. To understand metabolic pathways and nutrition.
2. To apply knowledge on the legal aspects of formulating functional foods and dietary supplements.
3. To develop a food product of high nutritive value.

Course Outcomes:
The students will be able to
1. Understand the basics of nutrition and metabolism of the major macromolecules.
2. Describe the biochemistry process, the basic concept of human nutrition, and the relationship of the consumption of foods to nutritional status and health.
3. Apply their knowledge in food biochemistry and nutrition in designing a new range of products with improved nutritional characteristics.
4. Analyze the stages in the catabolism of food molecules and describe what occurs during each stage.
5. Evaluate the biological functions of foods for health in addition to nutritional values.
6. Formulate specialized nutrition for pediatric, geriatric, and sports needs.

Module 1: Concepts of Nutrition (8 hours)

The basic concept of nutrition – Importance of nutrition and dietetics - Assessment of nutritional status – energy value of carbohydrates, proteins, and fats – balanced diet – digestion: assimilation and transportation. Recommended dietary intake – Acceptable dietary intake – Protein efficiency ratio – Net protein utilization and their determinations – Malnutrition and its problems- Deficiency Diseases – Nutrient supplementation & fortification.

Module 2: Nutritional Disorders (8 hours)

Inborn errors of carbohydrate, protein, and fat metabolisms - Nutrition and disorders associated with organs such as liver and kidney - Naturally occurring anti-nutritional factors – Cyanogen, lectins, enzyme inhibitors, phytoalexins, phytates. Defects of micronutrients: osteoporosis.

Module 3: **Metabolism of Carbohydrates (9 hours)**

Interconnection of pathways, glycolysis (EMP), TCA cycle, gluconeogenesis, Pentose phosphate shunt, Metabolic regulation, Electron transport chain & oxidative phosphorylation, and Bioenergetics.

Module 4: **Metabolism of Fatty Acids (6 hours)**

Biosynthesis and degradation of fatty acids- Beta oxidation- Chain elongation – Biosynthesis of cholesterol.

Module 5: **Metabolism of Proteins (6 hours)**

Biosynthesis and degradation of amino acids (one example each for sulfur-containing, aliphatic, aromatic, heterocyclic, basic, and acidic amino acids); Biosynthesis and degradation of purines, pyrimidines and nucleic acids, urea cycle.

Module 6: Specialized Nutrition (8 hours)

Nutrition for specialized purposes – Pediatric nutrition – geriatric nutrition – Sports nutrition – Nutrition during pregnancy. Aging – Theories of aging - Nutrition and aging - Age-related metabolic disorders – Nutrition in the treatment of age-related disorders like hypertension, diabetes, and Alzheimer's disease. Space Foods- Dehydrated- Irradiated- Food for Army in high altitudes

Text Books:

1. Voet, D., Voet, J. G., & Pratt, C. W. (2008). Principles of Biochemistry (Vol. 4). New York: Wiley.
2. Martin Eastwood, (2003). Principles of Human Nutrition. 2nd edition. Wiley - Blackwell Publishing, ISBN: 978-0-632-05811-2.
3. Srilakshmi, B. 2022. Dietetics. 7th edition. New Age International Publishers ltd.-New Delhi. ISBN: 9788122435009.
4. Swaminathan. 2019. Hand Book of Food & Nutrition. BAPPCO ltd.

Reference Books:

1. Ronald Ross Watson, (2003) Functional foods and Nutraceuticals in Cancer Prevention, Ed. Wiley – Blackwell, ISBN-13: 978-0813818542.
2. Nelson D.L., M.M. Cox, Lehninger (2013) Principles of Biochemistry, W.H. Freeman & Company Publications, ISBN-10: 1-4292-3414-8.
3. Tymoczko, J.L., Berg, J.M., Stryer, L. (2009). Biochemistry – A short course", 3rd edition. W.H. Freeman. ISBN-10: 1-4641-2613-5.
4. Sunetra Roday, (2012). Food Science and Nutrition. 2nd edition, Oxford Higher Education/Oxford University Press, ISBN 10: 0198078862

22FT3010	FOOD QUALITY SYSTEMS AND MANAGEMENT	L	T	P	C
		3	0	0	3

Course Objectives:

1. Gain knowledge on the aspects of food quality and quality management systems.
2. Understand food safety and the importance of food regulations.
3. Learn the history of food and concepts of domestic and global food safety standards.

Course Outcomes:

The students will be able to

1. Know the quality attributes of food and their analysis methods.
2. Evaluate the structure and processes of quality management systems.
3. Gain knowledge about HACCP and its implementation.

4. Familiar with food safety, food contamination, and food adulteration.
5. Learn the history, importance, and concepts of food regulations.
6. Understand the global and domestic food safety standards.

Module 1: Food Quality (9 hours)

Concept of quality: Quality attributes- physical, chemical, nutritional, microbial. Quality control and Quality assurance. Pre-requisite programs-Sanitary, and hygienic practices. Quality analysis -Physical, chemical, nutritional, and microbial evaluation and measurement. Sensory evaluation.

Module 2: Food Safety (6 hours)

Food safety - definition, food safety issues, factors affecting food safety. Food Contamination - Types of food contamination, harmful effects, and control. Food adulteration - common adulterants in foods: milk and milk products, edible oils, cereals and pulses, spices, and beverages. Simple screening and control of food adulteration.

Module 3:Quality Management Systems (6 hours)

Quality management systems - structure, record keeping, document control, consumer assurance. Process control and product-related quality aspects. Total Quality Management - tools and techniques. GMP, GHP, GLP, GAP, Hazard analysis critical control point: Definition, principles, development, and application of HACCP plan.

Module 4: Global Food Regulations (9 hours)

World Health Organization – History and mandate – Operations and responsibilities. Codex Alimentarius – History, operations of Codex Alimentarius, Responsibilities – Codex standards – Current Issues under consideration, ISO series of regulations.–. World Trade order – Functioning and responsibilities of the WTO.

Module 5: Food Safety Regulations in India (9 hours)

Food safety and Standards Act, 2006. The operational structure of FSSAI. Enforcement of the act -, Essential Commodities Act, BIS . Role of Food Business Operator. - Licensing and registration of food business. Food safety officer roles and duties. food fraud Offenses and penalties.

Module 6: Global Food Safety Standards (6 hours)

ISO 22000:2018. Implementing ISO 22000:2018 for food industries - plant and animal origin.

Text Books:

1. Early R, (1995). "Guide to Quality Management Systems for Food Industries". Blackie Academic, ISBN: 9781461521273,
2. Kiron Prabhakar, (2017). "A Practical Guide to Food Laws and Regulations", Bloomsbury India, ISBN: 9789386141705.
3. Gould, W.A and Gould, R.W, (2006). "Total Quality Assurance for the Food Industries", CTI Publications Inc. Baltimore, ISBN: 9781845696153,
4. Kees A. van der Heijden and Sanford Miller, (1999). "International Food Safety Handbook: Science, International Regulation, and Control", Published by CRC Press, ISBN: 0824793544, 9780824793548

Reference Books:

1. Patricia A. Curtis, (2005.) "Guide to Food Laws and Regulations", Wiley-Blackwell; 1st Edition, ISBN: 0813819466,
2. Mehta R. and George J., (2005). "Food Safety Regulation Concerns and Trade - The Developing Country Perspective", Published by Macmillan India Ltd., New Delhi. ISBN: 9781403925046

22FT3011	INSTRUMENTAL METHODS OF ANALYSIS	L	T	P	C
		3	0	0	3

Course Objectives:

1. To quantify various components of food using instrumental techniques
2. To know the presence of adulterants in the food sample
3. To interpret the data from instrumental analysis

Course outcomes:

The students will be able to

1. recognize the components of the mixture using chromatographic techniques.
2. identify the functional groups present in the food sample
3. calculate the trace metals present in the food sample

4. analyze the structure of the novel compound isolated from the natural source
5. assess the molecular weight of the given component
6. organize components from a mixture based on electrical property

Module 1: Chromatographic separations (8 hours).
Classification of chromatographic methods: Column, Thin Layer, Paper; Mechanism of separation. Theory of Gas chromatography – Instrumentation. High-performance liquid chromatograph**y:** Basic principles – Mobile phase – Instrumentation – advantages of HPLC over other techniques.

Module 2: FTIR Spectroscopy (7 hours)
Infrared region - Molecular vibrations – Vibrational frequencies and IR absorption Bands- Infrared spectrum - IR spectrophotometer - application. Near Infrared spectroscopy - Far infrared spectroscopy.

Module 3: Atomic Spectrometry (8 hours)
Principle - Atomic Absorption Spectrometer - Working of AAS - Atomic Emission Spectroscopy - Excitation methods - Flame Emission Spectrometry. Inductively coupled Plasma Atomic Emission Spectroscopy ((ICP - AES).

Module 4: NMR and Mass Spectrometry (8 hours)
NMR principle and instrumentation. Relation between spin quantum number and NMR, Chemical shift, shielding, and deshielding effects. ^{1}H and ^{13}C NMR spectrum. Mass spectrometry – Principle, instrumentations.

Module 5: Conductometry and electrophoresis (7 hours)
Conductometry Types, advantages, and disadvantages. Potential measurement - pO_2, pCO_2, $pHCO_3$ determination. Basic Principle of electrophoresis application of paper, starch gel, agarose, and native and denatured SDS PAGE.

Module 6: Other Instrumental methods (7 hours)
Principle and application of SEM, TEM, DLS technique, e-sensors – chemo, biosensors, and water activity meter.

Text books:

1. B. Sivashankar (2012). "Instrumental Methods of Analysis", 1st edition, Oxford University Press, New Delhi . ISBN-13: 978-0198073918.
2. James W Robinson, Eileen M. Skelly Frame George M Frame, (2014) Undergraduate Instrumental Analysis, 7th edition, CRC Press. DOIhttps://doi.org/10.1201/b15921
3. Sham K Anand, Gurdeep R Chatwal (2014) "Instrumentation Methods of Chemical Analysis", 5th edition, Himalaya Publishing House Pvt., Ltd., Bombay, ISBN-13: 978-9351420880.
4. Willard, H.H., Merritt, L.L., Dean, J.A., and Settle, F.A., (2004). "Instrumental Methods of Analysis", 7th edition, CBS Publishers and Distributors, Delhi, ISBN-13: 978-8123909431.
5. Pare J.R.J. and Belanger J.M.R. (1997). "Instrumental Methods of Food Analysis", 1 edition, Elsevier Science, Netherlands. ISBN 9780444818683.

Reference Books:

1. Rouessac F. and Rouessac A., (2007.). "Chemical Analysis: Modern Instrumentation Methods and Techniques", 2nd Edition, John Wiley and Sons. Ltd. England, ISBN: 978-0-470-85903-2.
2. D.L.B. Wetzel G. Charalambous (1998) "Instrumental Methods in Food and Beverage Analysis", Volume 39, 1st edition, Elsevier Science. ISBN: 9780080534756.

22FT3012	ANALYSIS OF FOOD CONSTITUENTS LAB	L	T	P	C
		0	0	4	2.5

Course Objectives:
1. To introduce the nutritional analysis of foods.
2. To provide technical skills on testing of foods.
3. To impart skills on quantification of nutrients in foods

Course Outcomes:
The students will be able to
1. Estimate the quality parameters of different types of food products
2. Classify food products based on their constituents.

3. Estimate the proximate constituents.
4. Analyze the nutritional constituents of food.
5. Interpret results and decide on the type of product.
6. Comment on the quality of food based on proximate constituents.

List of Experiments:

Gravimetric Method

- Determination of moisture content
- Determination of ash content
- Determination of fiber content
- Estimation of protein content
- Estimation of carbohydrate content
- Determination of fat content
- Determination of pectin

Volumetric Method

- Determination of total sugars (Reducing and nonreducing sugars)
- Determination of pH, TSS, and alcohol content
- Determination of acidity
- Determination of total solids
- Estimation of Ascorbic acid
- Determination of sodium chloride

Calorimetric Method

- Determination of Calcium

22FT3013	ANALYSIS OF FOOD COMMODITIES LAB	L	T	P	C
		0	0	3	2

Course Objectives:

1. To introduce analytical and instrumental methods of food commodity testing.
2. To provide technical skills on testing of foods.
3. To impart skills in interpreting the genuineness of the products based on the quality

Course Outcomes:

The students will be able to

1. Estimate the quality parameters of different types of food commodities
2. Demonstrate instrumental techniques of food analysis
3. Estimate bioactive components of food commodities.
4. Analyze the viscosity of liquid food commodities.
5. Compare two brands of the same product and decide the best one based on the quality
6. Interpret results and decide on the quality of the food commodity.

List of Experiments:

1. Determination of maltose equivalent to wheat flour
2. Determination of gluten content of wheat flour
3. Determination of Extract release volume of meat
4. Determination of swelling ratio of meat
5. Determination of TMA in fish
6. Determination of specific gravity and fat content of milk
7. Determination of curcumin content of turmeric
8. Determination of caffeine in coffee
9. Determination of tannins in tea
10. Determination of total sugars in fruit-based products
11. Determination of viscosity using Ostwald Viscometer
12. Demonstration of Brookfield Viscometer
13. Demonstration of Texture Profile Analyzer

22FT3014	FOOD MICROBIOLOGY LAB	L	T	P	C
		0	0	3	2

Course Objectives:

1. To enable the students to understand the basic concepts of isolation of microorganisms from food commodities and proper handling experience of microorganisms.
2. The students will be able to identify the microorganisms using various staining techniques and biochemical tests.
3. To impart skills in comparison of different enzyme activity

Course Outcomes:

The students will be able to

1. Acquire Basic knowledge about Microbiological Laboratory safety
2. Learn media preparation, sterilization, and identify the parts of a compound Microscope
3. Know about aseptic technology's role in the packaging of foods.
4. Study the isolation of pure culture techniques and staining techniques
5. Isolate, cultivate and identify specific bacteria/fungi from different food sources.
6. Evaluate enzymes from different sources and select the right one depending on the type of food/condition

List of Experiments:

1. An introduction to Microbiology, aseptic technique, and safety – Study of Microscopes, Sterilization, and Disinfection, Lab safety guidelines
2. Isolation of pure culture from mixed population- streak plate method.
3. Isolation and enumeration of bacteria and fungi from raw/spoiled fruits and vegetables-Total plate count Method (Pour Plate/Spread Plate method)
4. Isolation and enumeration of fungi/yeast from fruit drinks.
5. Isolation and enumeration of bacteria from canned meat.
6. Staining techniques of bacteria- Gram, Negative, spore staining.
7. Staining Techniques of Fungi- Lacto phenol Cotton Blue Staining
8. Motility testing of Bacteria – Hanging drop method, soft agar
9. Biochemical Characterization of Bacteria.
10. Quality testing of Milk- Methylene Blue Reduction Test.
11. Examination of Potable water – MPN Test
12. Effect of Food Preservatives on the growth of bacteria.
13. Food Production- Yoghurt- Estimation of lactic acid.
14. Determination of Thermal Death Time of Bacteria.
15. Isolation of Specific pathogen from contaminated Foods- *E. coli, Staphylococcus aureus, Salmonella*
16. Determination of kinetics of probiotic microorganisms

22FT3015	FOOD PRODUCT TECHNOLOGY LAB-I	L	T	P	C
		0	0	4	2.5

Course Outcomes:

1. To provide skills to manufacture fruit products and bakery products.
2. To impart knowledge to identify the quality defects in bakery products.
3. To demonstrate the importance of the manufacturing stages to prevent defects in the products.

Course Objectives:

The students will be able to

1. Understand the manufacturing of various fruit-based products
2. Gain knowledge on manufacturing aspects of several bakery products
3. Learn the relevant terminologies in fruit and bakery products manufacturing
4. Develop skills in manufacturing the products through hand-on training
5. Aware of yield and quality aspects of the products
6. Identify defects in products and avoid them during the manufacturing stages

List of Experiments

1. Introduction to food product development, ideation to product launch
2. Concept development (use of survey monkey and market research tools)
3. Preparation of fruit-based RTS / carbonated beverage
4. Preparation of squashes
5. Preparation of Jams Jelly
6. Preparation of fruit spreads
7. Preparation of Gummies
8. Preparation of ketchup/sauce
9. Preparation of white bread by Chorleywood process
10. Preparation of French bread by the sourdough method
11. Preparation of hard/soft dough biscuits
12. Preparation of cakes by all-in-one / three-stage mixing method
13. Preparation of doughnut
14. Preparation of biscuits and cookies

22FT3016	FOOD PRODUCT TECHNOLOGY LAB –II	L	T	P	C
		0	0	3	2

Course Objectives:

1. To impart knowledge on the factors that affect the quality of milk-based products
2. To enable the students to acquire skills on various equipment used in confectionery technology
3. To provide practical knowledge to produce products using commercial ingredients and equipment.

Course Outcomes:

The students will be able to

1. Acquire basic knowledge about various food products
2. Learn resizing of recipes to meet production needs and equipment capacities.
3. Know about the various parameters affecting the structure of extruded products.
4. Study the impact of additives on the texture of products
5. Interpret the FSSAI standards for various food products
6. Acquire knowledge about safe food handling practices using contemporary guidelines.

List of Experiments

1. Experimental design in food product development
2. Preparation of acid-coagulated dairy products – Rosagulla
3. Preparation of thermally coagulated dairy products – Kalakand/ Gulab Jamun
4. Preparation of Peda
5. Preparation of cottage cheese
6. Osmotic Dehydration of Fruits
7. Preparation of Hard-Boiled Candies
8. Preparation of Mysorepak
9. Preparation of Marshmallows
10. Preparation of Extruded Snacks
11. Preparation of premixes – cake/idly/upma
12. Study on the effect of different ingredients on sensory properties of Noodles/Pasta
13. Preparation of cereal/protein bar
14. Preparation of chocolate-based product
15. Preparation of puffed cereal snacks
16. Pilot scale preparation of spray dried milk powder
17. Project report preparation for selected products and Economic feasibility analysis
18. Preparation of ice cream

22FT3017	TECHNOLOGY OF MEAT, POULTRY, AND FISH PROCESSING	L	T	P	C
		4	0	0	4

Course objectives:

1. To understand the composition, and nutritive value of meat, poultry, and fish.
2. To know about the processing technology of meat, poultry, and fish.
3. To learn the technology of meat products and eggs.

Course outcomes:

The students will be able to

1. Understand the composition of flesh foods
2. Learn the types and grades of meat, poultry, and sea foods
3. Explain processing techniques used for the production of commercial meat, poultry, and sea foods.
4. Understand meat plant sanitation, hygiene, and standards.
5. Assess the factors that affect the quality of meat
6. Evaluate the processing techniques and their effect on nutritional value

Module 1: Meat Structure and Composition (9 hours)

Meat composition from different sources - Definitions and measurements, Muscle structure, composition, and its modifiers. Muscle fat and its modifiers. Meat microbiology. Post mortem muscle chemistry.

Module 2: Modern Slaughter House Operations (9 hours)

Modern abattoirs and some features, Antemortem handling, and welfare of animals Stunning methods, meat tenderization. Slaughtering of Beef/ Sheep and Pig. Offal, inedible by-products. Operational factors affecting meat quality.

Module 3: Processing of Meat and Meat Product (10 hours)

Canned meat, frozen meat, dried and preserved meat, cured meats, and intermediate moisture products. Sausages - types and manufacture. . Quality testing and Meat plant hygiene, ISO22000.

Module 4: Poultry processing (10 hours)

Grading of Poultry Species. Composition and nutritional value of poultry meat. Processing operations and equipment – scalding and defeathering, bleeding, evisceration, etc. Frozen poultry meat. Microbiological safety of poultry products.

Module 5: Egg and Egg Products (11 hours)

Structure, composition, and nutritive value of egg, egg proteins, and functional properties of egg white and yolk. Factor affecting egg quality and their measurements. Collection, grading, cleaning, washing, packaging, and transportation of eggs. Preparation of egg products – Liquid whole egg, liquid egg yolk, liquid egg white, and egg powder. Microbial spoilage of egg.

Module 6: Processing of Fish Crustaceans (11 hours)

Nutritional Value of fish and other marine products. Spoilage factors of fish - sea food quality assessment. Processing Operations – fleshy fish and shellfish. Storage and Preservation Techniques - Icing, IQF, RSW, CSW, and glazing of shrimp. By-product Utilization – Fish oil, fish protein concentrate, fish gelatin and chitin, and quality of fish products.

Text books:

1. Hui Y. H., Nip.W. K., Rogers R.W. (2001) " Meat Science and Application". Marcel Dekkar Inc. New York, *ISBN* 10: 0824705483 / *ISBN* 13: 9780824705480.
2. M.D. Ranken "Handbook of Meat product Technology" black well Science Ltd. (2000). *ISBN*-10: 0632053771
3. Balachandran, K. K. (2001). *Post-harvest technology of fish and fish products*. Daya Books.ISBN-13: 978-9351241607
4. Hui, Y. H., & Guerrero-Legarreta, I. (2010). Sanitation requirements. *Handbook of poultry science and technology, Volume 2: secondary processing*, 547-572 . *ISBN*:9780470185537

Reference books:

1. Stadelman WJ and Cotterill OJ. 2002. Egg Science and Technology. Fourth Edition. CBS.
2. Mead G, "Poultry meat processing and quality" Woodhead publishing limited, 2004. *ISBN*: 9781855737273, 9781855739031

22FT3018	FOOD PACKAGING TECHNOLOGY	L	T	P	C
		3	0	0	3

Course Objectives:

1. To study the functions of packaging and the influence of various factors on food quality.
2. To know the different packaging materials and their application in food packaging.
3. To study the various advanced methods of food packaging.

Course Outcomes:

The students will be able to

1. Study the need and functions of packaging to protect and store food.
2. Gain knowledge on the shelf life of food and accelerated shelf-life testing.
3. Know the different packaging materials based on their properties and their application.
4. Learn about the filling and sealing techniques used for different food materials.
5. Interpret labeling methods and legislature.
6. Know about the advanced food packaging techniques.

Module 1: Introduction to Packaging (6 hours)

History of Packaging. Definition, Functions, and types of Packaging. Levels of Packaging. Effect of environmental factors and biological factors on quality of food products.

Module 2: Packaging Materials (8 hours)

Shelf life of food products and accelerated shelf life testing. Properties - Requirements - Packaging strategy for different foods - Test for packaging materials – destructive and non-destructive tests- Advantages and disadvantages.

Module 3: Metals and Glass (7 hours)

Types of metals, Metal Cans - Types of food and beverage cans. Open top sanitary cans and two-piece cans. Can manufacturing operations. Lacquers. Aerosol Cans. Glass Packaging – composition, types of glass. Glass Manufacturing. Advantages and disadvantages

Module 4: Polymers and Paper (8 hours)

Flexible and rigid polymers. Manufacturing of films and containers. Coextruded films, Laminates, and Plastic Containers. Paper and paperboard - Types of Paper and Paperboard. Advantages and disadvantages

Module 5: Filling and Sealing (7 hours)

Types of fillers, seals and sealing equipment. Types of Pouches and Form Fill Seal machines. Labelling - Types of Labels - Nutrition Label - Printing Techniques.

Module 6: Advanced Packaging Technologies (9 hours)

Retort pouch. Vacuum and inert gas packaging. Aseptic Packaging, Biodegradable Packaging, Active Packaging, Smart and Intelligent Packaging, Modified Atmosphere Packaging, Controlled atmosphere storage.

Text Books:

1. Richard Coles, Derek Mc Dowell & Mark J. Kirwan, (2009), *Food Packaging Technology*, Blackwell Publishing Ltd, ISBN:978-1-405-14771-2.
2. Gordon L. Robertson, (2013), *Food Packaging Principles and Practice*, 3rd Edition, CRC Press, ISBN:978-1439862414.

Reference Books:

1. Richard Coles and Mark J. Kirwan, (2011), *Food and Beverage Packaging Technology*, 2nd Edition, Blackwell Publishing Ltd, ISBN: 9781444392180.
2. Gordon L. Robertson, (2009), *Food Packaging and Shelf Life: A Practical Guide*, CRC Press, ISBN:9780429146800.
3. Frank Albert Paine, Heather Y. Paine, (1992) *A Handbook of Food Packaging***,** 2nd edition, Blackie Academic and Professional, London, , ISBN:9781461528104

22FT3019	FOOD ADDITIVES AND INGREDIENTS	L	T	P	C
		3	0	0	3

Course Objectives:

1. To understand the basics of the additives added to food

2. To assess the risk and benefits of using food additives
3. To analyze various applications of food additives in different categories of food.

Course Outcomes:

The students will be able to

1. Recognize the importance of additives in maintaining or improving food quality.
2. Demonstrate and relate the level of addition of food additives to its quality
3. Understand the applications of food additives and methods to study their permissible limits.
4. Categorize and choose the appropriate additive depending on the type of food.
5. Identify and design newer products, with better quality using additives that are economical and safe.
6. Develop a new range of additives that are multifunctional and safe.

Module 1: Introduction and Safety Evaluation of Food Additives (8 hours)

Introduction to Food Additives; Definition and scope of food additives; Functions and uses of Food Additives; Classification-Types of food additives. Classification based on the safety aspects.

Module 2: Preservatives (6 hours)

Introduction; Classification- Natural & chemical preservatives; Mode of action; Acidulants - role in foods and their action. Limits prescribed by FSSAI.

Module 3: Antioxidants (7 hours)

Antioxidants - Role in foods; Types of antioxidants -natural & synthetic; Mode of action of antioxidants in foods; Chelating agents- Natural & synthetic; Mode of action of chelating agents; Applications of antioxidants and chelating agents.

Module 4: Flavourants (9 hours)

Flavoring agents: Introduction; Classification of flavors- natural & synthetic, Role of flavoring agents in food processing. Flavor enhancers: Importance of taste and flavours; Sweeteners: Artificial sweeteners & Non-nutritive sweeteners; Taste modifiers. High Intense Sweeteners.

Module 5: Food colorants (7 hours)

Introduction; Natural & Synthetic food colorants; Nature identical colorants; Classification of Food colorants; Chemical nature; Impact on health. Application of colorants in different food categories.

Module 6: Miscellaneous Food Additives (8 hours)

Emulsifiers and stabilizers: Introduction; Chemical nature; Bleaching & maturing agents, Anti-caking agents and Humectants, Clarifying agents, antifoaming agents, Fat mimetics and replacers.

Text books:

1. Brannen A.L., Davidson P.M., Salminen S. and Thorngate J.H. (2002). “Food additives”. Second Edition, Revised and Expanded. Marcel dekker Inc. USA. ISBN 0-8247–9343-9

Reference Book:

1. Titus A.M. Msagati, (2013) “Chemistry of Food additives and Preservatives”. John Wiley and Sons Ltd. 9781118274149. Online ISBN:9781118274132

22FT3020	NUTRACEUTICALS AND HEALTH FOODS	L	T	P	C
		3	0	0	3

Course Objectives:

1. To provide an overview of the field of nutraceuticals and functional foods.
2. To provide insight on bioactive ingredient-disease relationships and the importance of clinical study support; regulatory aspects of functional foods.
3. To enable the students to understand the functional food concept as related to ingredient efficacy and safety.

Course Outcomes:

The students will be able to

1. Understand the role of nutraceuticals and functional food in health and disease
2. Present ideas and concepts on issues of functional foods and nutraceuticals.
3. Apply the basic concepts of nutraceuticals and functional foods, their chemical nature, and methods of extraction.
4. Acquire knowledge of probiotics and their role in disease prevention.

5. Evaluate the standards of evidence required for efficacy and safety assessment of nutraceutical and functional foods.
6. Know about various phytochemicals, their health promotion, and disease prevention.

Module 1: Nutraceuticals and Functional Foods (7 hours)

Definition, concept; Evolution of nutraceuticals and functional foods market. Classification of nutraceuticals and functional foods. Significance and relevance of nutraceuticals and functional foods in the management of diseases and disorders. Claim substantiation, clinical study introduction.

Module 2: Natural occurring bioactive compounds (9 hours)

Antioxidants and flavonoids: omega – 3 fatty acids, carotenoids, dietary fiber, phytoestrogens, and glucosinolates. Dosage for effective control of disease or health benefit with adequate safety.

Module 3: Bioactive compounds (9 hours)

Bioactive compounds – types and classification, extraction, isolation, purification, bioavailability, delivery mechanism of bioactive compounds.

Module 4: Prebiotics, probiotics and synbiotics (8 hours)

Probiotics: Definition, types, gastrointestinal health, and other health benefits; development of probiotic products; recent advances in probiotics; Prebiotics types of prebiotics and their effects on gut microbes; health benefits recent development in prebiotics. Synbiotics.

Module 5: Functional foods (7 hours)

Development of functional foods, stability of functional ingredients, and safety guidelines.

Module 6: Current Trends in Nutraceuticals and Functional Foods (5 hours)

Research frontiers in functional foods. Nutrigenomics and personalized nutrition. Delivery formats of functional foods, taste, palability (challenges involved in formulation of functional foods).

Text Books:

1. Wildman, Robert, (2016). "Nutraceuticals and Functional Foods", First edition. Taylor and Francis Group. 2016. eBook ISBN9780429195563
2. Gibson GR & William CM., (2001) "Functional Foods - Concept to Product". Woodhead Publishing Limited, London. ISBN 1 855735032

Reference Book:

1. Aluko, Rotimi, (2012). "Functional Foods and Nutraceuticals", Springer-Verlag New York Inc. . e-ISBN 978-1-4614-3480-1.

22FT3021	WATER AND FOOD WASTE RESOURCE MANAGEMENT	L	T	P	C
		3	0	0	3

Course Objectives:

1. To acquire knowledge about the nature of potable water and food waste.
2. To be conversant with suitable treatment methods for water and food industry waste.
3. To assess food waste management methodologies adopted in food industries.

Course Outcomes:

The students will be able to

1. Identify sources of potable water.
2. Identify the origin of waste generated in food industries.
3. Summarize various methods of treating water and food wastes
4. Demonstrate co-product recovery from food waste
5. Decide on suitable food waste resources management strategies.
6. Develop pollution prevention mechanisms.

Module 1: Introduction to food waste (7 hours)

Origin and characterization of food waste - chemical analysis of the waste. legal aspects of handling food waste. Environmental Management Standards and their Application in the Food Industry.

Module 2: Food solid waste treatment methodologies (7 hours)

Composting, anaerobic digestion, aerobic digestion, pyrolysis, incineration.

Module 3: Water treatment (8 hours)

Sources of potable water, physical, chemical, and biological contamination of water. Treatment of water. Disadvantages of chlorination. Treatment of wastewater. Carbon and water footprint.

Module 4: Fruit and Vegetable processing industry waste treatment (7 hours)

Source and characteristics, treatment methods. Valorization of fruit and vegetable waste. Biogas/methane production.

Module 5: Meat and Seafood processing industry waste treatment (8 hours)

Characterization, primary treatment, and secondary treatment. Uses - animal feed, natural pigment, and cosmetics.

Module 6: Dairy industry waste treatment (8 hours)

Characterization, primary, secondary treatment. Uses – hydrogen production. Co-product recovery - whey protein and lactose.

Text Books:

1. Kosseva M and C Webb, (2020) "Food Industry Wastes, Assessment and Recuperation of Commodities", 2nd Edition. Academic Press . ISBN: 9780128171219.
2. Panda H. (2011) "The Complete Book on Managing Food Processing Industry Waste", Asia Pacific Business Press Inc, . ISBN: 9788178331454.
3. Waldron K.W. (2007), "Handbook of waste management and co product recovery in food processing (Volume1)", 1st Edition. Woodhead Publishing Ltd. . ISBN: 9781845690250.
4. Faust, S. D., & Aly, O. M. (2018). *Chemistry of water treatment*. CRC press.
5. Howe, K. J., Hand, D. W., Crittenden, J. C., Trussell, R. R., & Tchobanoglous, G. (2012). *Principles of water treatment*. John Wiley & Sons.

Reference Books:

1. Arvanitoyannis I, (2007) "Waste Management for the Food Industries", 1st Edition. Academic Press, . ISBN: 9780123736543.
2. Wang L.K.,Y.T Hung, H H. Lo and C Yapijakis, (2005), "Waste Treatment in the Food Processing Industry", 1st Edition, CRC Press,. ISBN: 9780429191091
3. Henze, M., van Loosdrecht, M. C., Ekama, G. A., & Brdjanovic, D. (2008). (Eds.). *Biological wastewater treatment*. IWA publishing.

22FT3022	FOOD TOXICOLOGY	L	T	P	C
		3	0	0	3

Course Objectives:

1. To impart knowledge on the toxicology of foods.
2. To introduce the bio-transformations of toxins in foods.
3. To provide an insight into the various contaminants in foods.

Course Outcomes:

The students will be able to

1. Acquire knowledge on the types of toxicants in foods.
2. Identify toxins in food products.
3. Summarize the effect of toxicants on the human system.
4. Examine the methods of destruction of toxicants.
5. Develop methods for the detection of toxicants.
6. Evaluate the safety of food commodities.

Module 1: Absorption and assimilation of toxicants (8 hours)

Toxicants - Dose-response relationship - Potency - biological factors that influence toxicity - Ingestion, Digestion, absorption, and assimilation - Effect on intestinal microflora - Blood-brain barrier - Translocation - Effect on kidney and liver

Module 2: Types of toxicity studies (9 hours)

Qualitative and Quantitative studies - Sample preparation - WHO standard methods for the determination of toxicity - Acute and Chronic toxicity - Teratogenicity, mutagenicity, and carcinogenicity - Genetic toxicity - Concept of LD50.

Module 3: Biotransformations (9 hours)
Phase I and Phase II reactions - Phase I enzymes - Cytochrome P450, Peroxidases, Flavin MonoOxygenases, Epoxide Hydrolases, Esterases - Phase II enzymes - Glucuronide conjugation, glutathione conjugation, sulfate conjugation
Module 4: Naturally occurring phytotoxins (6 hours)
Phytochemicals causing Goitre, Favism, Neuro lathyrism - Cyanogens, Lectins, Vasoactive amines, Strychnine, Phytoalexins - Mechanism of action and methods for destruction
Module 5: Toxins from animals, microbes, and marine organisms (7 hours)
Transmissible Spongiform Encephalopathy (TSE) and Prions, Paralytic shell fish poisoning, Ciguatera poisoning, Scombroid Fish poisoning, Poisonous mushrooms.
Module 6: Food Contaminants from Industrial wastes, Pesticide residues, and Heavy metals (6 hours)
Chlorinated hydrocarbons, Heavy metals, Pesticide residues and their effects on health.
Text books :
1.Shibamoto T & Bjeldanes L. (2009) "Introduction to Food Toxicology", Second Edition, Elsevier Press. . ISBN: 978-0-12-374286-5.
Reference books:
1.Bagchi D. & Swaroop A. (2017) "Food Toxicology", CRC Press. ISBN : 13: 978-1-4987-0874-6 (Hardback)

22FT3023	FOOD BIOTECHNOLOGY	L	T	P	C
		3	0	0	3

Course objectives:
1. To understand the principles and techniques in food biotechnology
2. To impart skills in the production of modified foods
3. To introduce the application of biosensors to foods

Course outcomes:
The students will be able to
1. Understand the application of genetic information of animal and plant species in food.
2. Learn the importance of applications of biotechnology in food.
3. Explain the applications of GMO foods
4. Apply the role of bio preservatives in foods.
5. Evaluate the application of molecular techniques in the characterization food borne pathogens.
6. Apply biosensors in foods.

Module 1: Food biotechnology-Introduction (9 hours)
Overview of biotechnology application in food production - Genetic Engineering Techniques- Recombinant DNA Techniques and Cloning Strategies. transgenic plants. Genetically modified foods – concept, types, and application - Bt brinjal Bt maize and golden rice.
Module 2: Applications of biotechnology in fermented food (8 hours)
Traditional applications of biotechnology in fermented foods - post biotic foods - kombucha, soya sauce, tempeh, miso, and food ingredients - flavor potentiators and enhancers: MSG and 5'nucleotides.
Module 3: GM Foods - Safety and ethics (7 hours)
Regulations concerning Genetically Modified Foods in India and at the i nternational level; Ethical issues concerning GM foods; current guidelines for the production, release, and movement of GMOs; labeling and traceability; trade-related aspects; bio safety; risk assessment and risk management. Public perception of GM foods.
Module 4: Bio Preservatives (7 hours)
Natural antimicrobials for food preservation: bacteriocins: nisin, pediocins, etc; applications of bacteriocins in food systems as bio preservatives.
Module 5: DNA sequencing methods (7 hours)
Nucleic acid hybridization-PCR based typing methods; Polymerase chain amplification - Single-cell analysis; Molecular typing techniques: Ribotyping - Restriction enzyme analysis.

Module 6: Biosensors (7 hours)

Food products as analytical samples, general aspects of biosensors and their potential applications- Biosensors for food component analysis, biosensors for food contaminant analysis, commercially available biosensors for food analysis.

Text Books:

1. Shetty, K., Plaiyath, G., Pometto, A. and Levin, R.E. (2006), Functional Foods & Biotechnology, CRC Press. eBook *ISBN* 9780429129568
2. Shetty, K., Plaiyath, G., Pometto A. and Levin, R.E., (2005). Food Biotechnology, CRC press. ISBN-13: 978-0824753290

Reference Books:

1. Byong H. Lee, (2014)- Fundamentals of Food Biotechnology, 2nd Edition, Wiley- Blackwell. *ISBN*: 978-*1*-118-38495-4
2. Perry Johnson-Green, (2002) - Introduction to Food Biotechnology, CRC Press. *ISBN*, 142005838X, 9781420058383.
3. Sarah Elderidge (2003). "Food Biotechnology; Current issues and perspectives". Nova science pub. Inc. *ISBN*-10: 1590338480; *ISBN*-13: 978-1590338483
4. Brian J. Ford, (2000). "Future of Food". WW Norton and Co. Inc.

22FT3024	ENZYMES IN FOOD PROCESSING	L	T	P	C
		3	0	0	3

Course objectives:

1. To provide an insight into the fundamentals of enzyme structure and function
2. To gain knowledge about the kinetics of enzymes.
3. To impart the current applications and future potential of enzymes.

Course outcomes:

The students will be able to

1. Describe the structure, functions, and mechanisms of action of enzymes.
2. Understand the enzyme activity in foods.
3. Learn kinetics of enzyme-catalyzed reactions and enzyme inhibitory and regulatory processes.
4. Understand immobilization of enzymes.
5. Apply the acquired skills to the applications of enzymes and their future potential
6. Evaluate the application of various enzymes at the industry level.

Module 1: Introduction to Enzymes (7 hours)

General introduction and historical background- General Terminology, Nomenclature, and Classification of Enzymes. Criteria of purity of enzymes- Specific activity. Enzyme units-Katal and IU.

Module 2: Enzyme activity-I (7 hours)

Enzyme activity- chemical nature of enzymes. Protein nature of enzymes and Non-protein enzymes- Ribozymes and DNAzymes.

Module 3: Enzyme activity-II (7 hours)

Metalloenzymes and metal-activated enzymes. Coenzymes and Cofactors- Classification of coenzymes - Isozymes, Abzymes, Synzyme.

Module 4: Enzyme Kinetics (8 hours)

Factors affecting the enzyme activity- Concentration, pH, and temperature. Kinetics of a single-substrate enzyme-catalyzed reaction, Michaelis-Menten Equation - Km, Vmax, L.B Plot, Kcat, Turnover number. Types of Enzyme Inhibition.

Module 5: Enzyme Regulation (8 hours)

Feedback Regulation, Allosteric Regulation. Organization of enzymes in the cell - localization, compartmentation of metabolic pathways, enzymes in membranes, concentrations. Mechanisms of enzyme degradation - lysosomal and non-lysosomal

Module 6: Industrial Enzymes (8 Hours)

Industrial Enzymes- Thermophilic enzymes, amylases, lipases, proteolytic enzymes in food industries, cellulose-degrading enzymes, Metal degrading enzymes.

Text Books:

1. Nicholas Price & Lewis Stevens, (1999) "Fundamentals of Enzymology", Oxford University Press. ISBN: 9780198502296
2. Trevor Palmer, (2007). "Enzymes: Biochemistry, Biotechnology and Clinical Chemistry", Woodhead Publishing. ISBN 10: 1904275273ISBN 13: 9781904275275

22FT3025	FOOD PACKAGING LAB	L	T	P	C
		0	0	3	2

Course objectives:

1. To introduce the concepts of various packaging technologies
2. To provide knowledge of the application of packaging materials based on tests for packaging materials
3. To impart technical skills to analyze the characteristics of packaging materials

Course outcomes:

The students will be able to

1. Learn the terminologies used in food packaging
2. Gain knowledge about practical methods of evaluating the performance of food packages of different levels
3. Acquire knowledge on various packaging techniques
4. Gain experience in testing of packaging materials
5. Comprehend the advanced methods of packaging perishables
6. Evaluate suitable packaging materials for different types of food products

List of Experiments

1. Vacuum packaging of fruits and vegetables
2. Inert gas packaging of snack foods
3. Determination of water vapor transmission rate
4. Determination of migration characteristics of packaging materials
5. Determination of thickness of polymer packaging materials
6. Determination of grammage of paper and paper board
7. Determination of tensile strength of packaging materials
8. Determination of water absorbency by Cobb's test
9. Performance test of Packaging materials - Drop test
10. Determination of burst strength of pouches
11. Modified atmosphere packaging of fresh cut fruit
12. Demonstration of form fill seal machine
13. Evaluation of shelf life of low moisture foods.
14. Evaluation of shelf life of high fat content foods using different packaging materials.
15. Accelerated shelf life study of foods (fruits/vegetables/processed foods/RTS beverages, etc.) at different RH.

22FT3026	ENZYMOLOGY LAB	L	T	P	C
		0	0	3	2

Course Objectives:

1. To provide an overview of enzyme activity and regulation in cells
2. To prepare students to the enzyme systems in the industry.
3. To impart skills in comparison of different enzyme activity

Course outcomes:

The students will be able to

1. Gain knowledge about enzymes
2. Study the importance of each of the factors that affect enzyme activity
3. Apply the same to maximize enzyme action
4. Analyze when a problem arises and give a suitable and logical solution

5. Evaluate enzymes from different sources and select the right one depending on the type of food/condition
6. Analyze and evaluate the characterization of a new source of enzymes

List of Experiments

1. Preparation of buffers
2. Estimation of tyrosine by Folin - Ciocalteau method
3. Effect of pH on PPO activity
4. Investigation of the effect of temperature on the activity of PPO
5. Kinetics of PPO activity
6. Investigation of the effect of varying enzyme concentration on the activity of PPO
7. Investigation of the effect of varying substrate concentration on the activity of PPO
8. Investigation of the effect of activators on the activity of PPO
9. Investigation of the effect of inhibitors on the activity of PPO
10. Estimation of peroxidase (POD) activity in vegetables
11. Effect of pH on POD activity
12. Investigation effect of temperature on the activity of POD
13. Qualitative tests on peroxidase and catalase

22FT3027	FOOD ADDITIVES LAB	L	T	P	C
		0	0	3	2

Course Objectives:

1. To study the chemistry of the additives added to food.
2. To estimate the importance of additives in maintaining or improving food quality
3. To develop newer additives with improved safety standards.

Course Outcomes:

The students will be able to

1. Recognize the importance of additives in maintaining or improving food quality.
2. Acquire knowledge on the chemistry of the additives added to food.
3. Apply their knowledge of the properties of additives to define addition limits in food systems.
4. Analyze the levels of addition and toxicity data of various food additives.
5. Evaluate the levels of additives in food systems.
6. Develop various instant premixes by addition of preservatives within the permissible limits.

List of Experiments

Sweeteners

1. Estimation of protein-based sweeteners.

Anti-oxidants

2. Estimation of Butylated hydroxyl toluene.
3. Estimation of Ascorbic Acid.

Flavor enhancers

4. Estimation of Mono Sodium Glutamate (MSG)

Stabilizers

5. Estimation of Propyl Gallate.

Humectants

6. Estimation of humectants.

Leavening agents

7. Estimation of baking powder.

Colorants

8. Estimation of synthetic colors.
9. Determination of color using RGB color chart.
10. Estimation of curcumin in turmeric.

Preservatives

11. Estimation of sulphur dioxide
12. Estimation of sodium benzoate

DEPARTMENT OF FOOD PROCESSING TECHNOLOGY

LIST OF NEW COURSE

S.No.	Course Code	Course Title	Teaching Hours/week			Credits
1	21FP3001	Paddy and Wheat Processing Technology	3	0	0	3

21FP3001	PADDY AND WHEAT PROCESSING TECHNOLOGY	L	T	P	C
		3	0	0	3

Course Objectives:

1. To equip the students with basic concepts of various unit operations in processing of food materials.
2. To provide basic knowledge about milling techniques of rice and Wheat
3. To impart skills on the product and by-product development.

Course Outcomes:

The student will be able to

1. Recall the basic concept rice and wheat processing
2. Understand the various unit operations involved milling
3. Analyze and select suitable equipment for milling
4. Apply the knowledge to process grains into value added products
5. Create new products from wheat and rice flour
6. Gain knowledge on converting the waste in to wealth

Module 1: Paddy Processing (8 Hours)

Structure and Composition of paddy – Cleaning of paddy -Pre Cleaners, - Paddy Parboiling processes. Physico-chemical changes during parboiling – effect of parboiling on cooking qualities - Parboiling methods - Methods of grain drying- LSU, rotary, columnar, recirculatory dryers

Module 2: Rice Milling (8 Hours)

Rice milling flow chart - Modern Rice Milling equipments– paddy milling - Dehuskingof paddy - Engelberg Huller, Under runner disc shellers, rubber roll sheller and Centrifugaldehusker- Paddy Separators – Satake and Schule Designs – Rice Polishers - Cone polishers and othertypes - Bran and Brokens separators - Rice mill yields and loss due to brokens at different stages of milling – milling efficiency.

Module 3: Wheat Milling (7 Hours)

Structure and composition of wheat – flow chart for wheat milling – milling process - equipments used in wheat milling – parboiling of wheat – bulgur wheat –Physico-chemical and Rheological properties of wheat Flour -by products of wheat.

Module 4: Value added Rice Products and By Products (8 Hours)

Value added products - Rice convenience foods- flattened rice, puffed rice, precooked rice, canned rice, expanded rice, rice based infant food formulas, rice puddings and breads, rice cakes, rice noodles and fermented foods. - Use of Rice Bran in Edible oil Industry - By-products of paddy processing - Paddy husk and its uses as husk ash, activated carbon, furfural and other by products

Module 5: Valueadded Wheat Products (7 Hours)

Baked Products from soft wheat: cookies, crackers: types, ingredients, process, fault causes and remedy Other bakery products: using very hard wheat. Pizza, pastry and its types. Macaroni products: Including spaghetti, noodles, and vermicelli-process. Hard Wheat : Bread and Buns, Soft Wheat : Cakes.

Module 6: Role of Enzymes and other Compounds in Bakery Products (7 Hours)

Functionality of wheat proteins, carbohydrates and lipids in bakery products. Manufacturing techniques, uses and functionality of vital wheat gluten. Enzymes of wheat and their technological significance. Enzymatic degradation of Lignin in paddy. Products of wheat milling industry, flour, atta, etc. flour grades, supplementation, Fortification, Flour additives, flour improvers, Bleaching, Oxidizing agents-Modified starch-physical methods-chemical methods.

Text Books

1. Sahay, K.M. and K.K. Singh, 2006 Unit operations of Agricultural processing. Vikas publishing House Pvt. Ltd. Noida, New Delhi. ISBN: 9788125911425
2. Khatkar, B.S. (2010). Baking Science and Technology. Arihant Prakashan Pvt Ltd., New Delhi. ISBN-13 : 978-9380872308.3. Samuel, A.M. (2014). The Chemistry and Technology of Cereals as Food and Feed: CBS Publication, New Delhi. ISBN 978-0-442-30830-8

Reference Books

1. Khan, K. & Shewry, P. R. (2009). Wheat: Chemistry and Technology: St. Paul, U.S.A. ISBN: 9780128104545
2. Champagne, E.T. (2004). Rice: Chemistry and Technology (3rd ed.): AACC, USA. *ISBN*-13 : 978-1891127410

DEPARTMENT OF FOOD PROCESSING TECHNOLOGY

LIST OF NEW COURSES (2020)

Sl. No.	Course Code	Course Title	L:T:P	Credits
B.Tech.(Food Processing and Engineering)				
1	20FP1001	Basics of Microbiology	2:0:0	2
2	20FP1002	General Microbiology Lab	0:0:3	1.5
3	20FP2001	Food Process Calculations	3:0:0	3
4	20FP2002	Food Chemistry	3:0:0	3
5	20FP2003	Food Analysis Lab –I	0:0:3	1.5
6	20FP2004	Fluid Mechanics for Food Processing	3:0:0	3
7	20FP2005	Fluid Mechanics and Heat Transfer Lab	0:0:3	1.5
8	20FP2006	Applied Food Microbiology	3:0:0	3
9	20FP2007	Applied Food Microbiology Lab	0:0:3	1.5
10	20FP2008	Metabolism and Nutrition	3:0:0	3
11	20FP2009	Food Biochemistry Lab	0:0:3	1.5
12	20FP2010	Process Engineering Thermodynamics	3:0:0	3
13	20FP2011	Dairy Process Engineering	3:0:0	3
14	20FP2012	Unit Operations in Food Processing - I	3:0:0	3
15	20FP2013	Unit Operations in Food Processing Lab	0:0:3	1.5
16	20FP2014	Fruit and Vegetable Processing Technology	3:0:0	3
17	20FP2015	Food Additives	3:0:0	3
18	20FP2016	Food Additives Lab	0:0:3	1.5
19	20FP2017	Material Science for Food Engineers	3:0:0	3
20	20FP2018	Heat and Mass Transfer	3:0:0	3
21	20FP2019	Unit Operations in Food Processing - II	3:0:0	3
22	20FP2020	Milling Technology of Cereals, Pulses and Oil seeds	3:0:0	3
23	20FP2021	Food Standards and Regulations	3:0:0	3
24	20FP2022	Food Enzymology Lab	0:0:3	1.5
25	20FP2023	Food Product Technology Lab – I	0:0:3	1.5
26	20FP2024	Food Analysis Lab – II	0:0:3	1.5
27	20FP2025	Engineering Properties of Biological Materials	3:0:0	3
28	20FP2026	Engineering Properties of Biological Materials Lab	0:0:3	1.5
29	20FP2027	Food Packaging Technology	3:0:0	3
30	20FP2028	Food Engineering and Packaging Lab	0:0:3	1.5
31	20FP2029	Food Product Technology Lab – II	0:0:3	1.5
32	20FP2030	Food Plant Utility Systems	3:0:0	3
33	20FP2031	Refrigeration and Cold Storage Engineering	3:0:0	3
34	20FP2032	Bakery, Beverages and Confectionery Technology	3:0:0	3
35	20FP2033	Plantation and Spices Product Technology	3:0:0	3
36	20FP2034	Meat, Poultry and Fish Processing Technology	3:0:0	3
37	20FP2035	Storage Engineering of Food Materials	3:0:0	3
38	20FP2036	Process Economics and Plant Layout Design	3:0:0	3
39	20FP2037	Fat and Oil Processing Technology	3:0:0	3
40	20FP2038	Drying Technology of Food Materials	3:0:0	3
41	20FP2039	Food Analysis Lab – III	0:0:3	1.5
42	20FP2040	Simulation, Modeling and Statistical Computing Lab	0:0:3	1.5
43	20FP2041	Food Process Equipment Design	3:0:0	3
44	20FP2042	Computer Aided Food Process Equipment Design Lab	0:0:3	1.5
45	20FP2043	Novel Processing Techniques of Food Preservation	3:0:0	3
46	20FP2044	Principles of Food Science and Nutrition	3:0:0	3
47	20FP2045	Processing of Food Commodities	3:0:0	3

48	20FP2046	Technology of Packaging	3:0:0	3
M.Tech.(Food Processing and Engineering)				
49	20FP3001	Mass Transfer and Separation Techniques in Food Processing	3:0:0	3
50	20FP3002	Technology of Food Flavourants and Colourants	3:0:0	3
51	20FP3003	Food Safety Regulations and Control	3:0:0	3
52	20FP3004	Instrumental Techniques for Food Analysis	3:0:0	3
53	20FP3005	Advanced Food Process Equipment Design	3:0:0	3
54	20FP3006	Advances in Food Process Engineering	3:0:0	3
55	20FP3007	Food Analysis Lab	0:0:3	1.5
56	20FP3008	Enzymology Lab	0:0:3	1.5
57	20FP3009	Food Product Technology Lab	0:0:3	1.5
58	20FP3010	Advanced Food Process Engineering Lab	0:0:3	1.5
59	20FP3011	Advances in Dairy, Meat and Fish Processing	3:0:0	3
60	20FP3012	Advances in Processing of Cereals, Pulses and Oil seeds	3:0:0	3
61	20FP3013	Advances in Processing of Horticulture, Spices and Plantation Products	3:0:0	3
62	20FP3014	Advances in Refrigeration and Cold Supply Chain Management	3:0:0	3
63	20FP3015	Advances in Engineering Properties of Food Materials	3:0:0	3
64	20FP3016	Milling, Bakery and Confectionery Technology	3:0:0	3
65	20FP3017	Advances in Food Packaging Technology	3:0:0	3
66	20FP3018	Emerging Trends in Food Process Engineering	3:0:0	3
67	20FP3019	Advanced Storage Engineering of Food Materials	3:0:0	3
68	20FP3020	Food Material Science and Engineering	3:0:0	3
69	20FP3021	Green Technology in Food Processing	3:0:0	3
70	20FP3022	Food Supply Chain Management	3:0:0	3
71	20FP3023	Food Plant Layout and Design	3:0:0	3
M.Sc. (Food Science and Technology)				
72	20FT3001	Food Chemistry	3:0:0	3
73	20FT3002	Food Microbiology	3:0:0	3
74	20FT3003	Principles of Food Processing and Preservation	3:0:0	3
75	20FT3004	Technology of Cereals, Pulses and Oilseeds	3:0:0	3
76	20FT3005	Technology of Fruits and Vegetable Processing	3:0:0	3
77	20FT3006	Bakery and Confectionery Technology	3:0:0	3
78	20FT3007	Technology of Milk and Milk Products	3:0:0	3
79	20FT3008	Technology of Plantation Crops and Spices	3:0:0	3
80	20FT3009	Technology of Meat, Poultry and Fish Processing	3:0:0	3
81	20FT3010	Food Analysis Lab	0:0:4	2
82	20FT3011	Food Microbiology Lab	0:0:3	1.5
83	20FT3012	Food Product Technology Lab - I	0:0:3	1.5
84	20FT3013	Food Product Technology Lab - II	0:0:3	1.5
85	20FT3014	Food Toxicology	3:0:0	3
86	20FT3015	Food Quality Systems and Management	3:0:0	3
87	20FT3016	Instrumental Methods of Analysis	3:0:0	3
88	20FT3017	Food Additives and Ingredients	3:0:0	3
89	20FT3018	Enzymes in Food Processing	3:0:0	3
90	20FT3019	Nutraceuticals and Health Foods	3:0:0	3
91	20FT3020	Food Packaging Technology	3:0:0	3
92	20FT3021	Waste Recycling and Resources Recovery System	2:0:0	2
93	20FT3022	Food Biotechnology	3:0:0	3
94	20FT3023	Industrial Microbiology	3:0:0	3

95	20FT3024	Enzymology Lab	0:0:3	1.5
96	20FT3025	Food Packaging Lab	0:0:3	1.5

20FP1001	BASICS OF MICROBIOLOGY	L	T	P	C
		2	0	0	2

Course Objectives:

1. To facilitate in understanding the classification and taxonomy of microorganisms.
2. To learn the Prokaryotic and eukaryotic structure and replication process.
3. To understand the various methods of enumeration, identification and culturing of bacteria.

Course Outcomes:

The student will be able to

1. Recognize the developments in the discipline of Microbiology and the contributions made by prominent scientists in this field.
2. Understand the classification of microorganisms.
3. Identify key components and their functions in prokaryotic and euckaryotic microorganisms.
4. Point out the bacteriological media and nutritional requirements for growth of bacteria.
5. Recommend the methods used for enumeration, identification and preservation of bacteria.
6. Create sterilization protocol for the control of microorganism.

Module 1: Historical Perspective, Microbial Taxonomy and diversity (4hours)

History and scope of Microbiology- Landmark discoveries in the development of Microbiology-Classification, nomenclature of Microorganisms and Characterization according to Bergey's manual Systematic Bacteriology-Three and Five Kingdom concepts-Broad classification of Prokaryotes and Eukaryotes.

Module 2: Prokaryotic cells and Viruses: Structure, Function and Replication (3hours)

Structure and multiplication of bacteria- Introduction to Viruses and its structure - Animal Virus Replication- Bacterial Virus structure and Replication.

Module 3: Eukaryotic cells: Structure, Function and Replication (5hours)

Introduction to Eukaryotic microorganisms - Algae structure- Replication of algae- Life cycle of Red algae (Gracilaria)- Fungi – mold – structure- Mold replication process- Life cycle of *Rhizopus stolonifer*- Yeast – structure- Replication process of yeast cells – Life cycle of *Saccharomyces cerevisiae*-Protozoan structure-Life cycle of *Entamoeba histolytica.*

Module 4: Microbial Nutrition and growth (6hours)

Nutritional requirements of bacteria- Nutritional types of bacteria-Microbial growth characteristics-growth curve- Kinetics of growth -Batch culture, Continuous culture. Synchronous-Factors affecting the growth of bacteria – Temperature, Oxygen, pH, osmotic pressure, salt concentration etc.- Microbial sporulation and Germination- Bacteriological media: types (complex, synthetic, differential, enrichment and selective media) and their uses, culture characteristics of bacteria on different media.

Module 5: Techniques for enumeration, Identification and culturing of bacteria (8hours)

Techniques for isolation and enumeration of bacteria (streak plate technique, pour plate technique, spread plate technique, membrane filtration, most probable number method, direct microscopic count) -biochemical tests of bacteria- maintenance and preservation of microbial culture - Staining methods: fixation, types of dyes, simple staining, differential staining (Gram and Acid-fast staining), staining of specific structures (capsule, flagella and spore staining)-Microscopy- Light microscopy – Brightfield and Darkfield microscope Fluorescent and phase contrast microscopy Electron microscopy – Transmission and scanning electron Microscope.

Module 6: Concept of sterilization (4hours)

Physical control of microorganisms - dry heat, moist heat, filtration, radiation (mode of action, applications); Chemical control – dye solutions, alcohol, acid, alkali, halogen, heavy metal, phenol, phenol derivatives, formaldehyde, ethylene oxide, detergents (mode of action, applications). Assessment of chemical disinfectant; phenol coefficient-definition and method of determination.

Text Books:

1. M.J Pelczar, E.C.S Chan, N.R Krein "Microbiology", Tata McGraw Hill 5th Edition, New Delhi, India. ISBN 10: 0074623206. 2006.

2. S.C.Parija, "Textbook of Microbiology & Immunology", Second Edition, Elsevier India, ISBN: 788131236246, 2012.

Reference Books:

1. L.M Prescot, J.P Harley, D.A Klein "Microbiology", 7th Edition, McGraw-Hill Education, ISBN: 007299291, 2008.
2. K.P Talaro, B. Chess "Foundations in Microbiology", McGraw-Hill Education, 10th Edition, ISBN-10: 1259705218, 2017.

20FP1002	GENERAL MICROBIOLOGY LAB	L	T	P	C
		0	0	3	1.5

Course Objectives:

1. To understand the working principle of microscopes and sterilization techniques.
2. To know the preparation of media for the cultivation of microorganisms.
3. To identify the isolated strains from food sources using staining techniques

Course Outcomes:

The student will be able to

1. Identify microorganisms using staining techniques.
2. Understand the sterilization and aseptic technique to control the growth of microorganisms to avoid contamination.
3. Apply the knowledge to handle microscopes to observe stained microorganisms.
4. Analyze and isolate pure culture from mixed population found in contaminated foods.
5. Measure the motility of bacteria by hanging drop method
6. Formulate procedures for identification of bacteria and fungi.

List of Experiments

1. Introduction to Microbiology and Laboratory safety
2. Microscopy
3. Sterilization and Disinfection
4. Preparation of culture media.
5. Isolation of bacteria using Streak plate method
6. Staining techniques - Monochrome staining
7. Gram staining
8. Negative staining,
9. Spore staining
10. Lactophenol cotton blue staining for fungi.
11. Hanging drop preparation to observe motility of bacteria
12. Microbial examination of air

20FP2001	FOOD PROCESS CALCULATIONS	L	T	P	C
		3	0	0	3

Course Objectives:

1. To understand the basic principles involved in food process calculations.
2. To apply the principles in food processing.
3. To perform calculations for basic unit operations in food processing.

Course outcomes:

The students will be able to

1. Identify the compositions of mixtures and solutions
2. Compare the properties of ideal and real gases
3. Calculate material balance for various unit operations
4. Analyze energy balance for unit operations
5. Estimate GHV, NHV and composition of fuels
6. Integrate the properties of air water system

Module 1: Units, Dimensions and Basic calculations (7 hours)

Basic and derived units, unit conversions, dimensional homogeneity, concept of mole, methods of expressing composition of mixtures and solutions - weight, volume, atomic and mole percentages.

Module 2: Ideal and real gas (8 hours)

Ideal and real gas laws - gas constant - calculations of pressure, volume and temperature using ideal gas law. Use of partial pressure and pure component volume in gas calculations, application of real gas relationship in gas calculations.

Module 3: Material balance (9 hours)

Law of conservation of mass, material balance without chemical reaction, overall and component mass balance. Continuous and batch operation. Recycle and by-pass operations. Application in unit operations - drying, distillation, evaporation, crystallization, extraction.

Module 4: Energy balance (7 hours)

Heat capacity of solids, liquids, gases and solutions, use of mean heat capacity in heat calculations, problems involving sensible heat and latent heats. Calculation of Standard heat of reaction, heats of formation and combustion. Energy balance for systems without chemical reaction.

Module 5: Combustion calculations (8 hours)

Combustion of solids, liquid and gas, determination of Net Heat Value (NHV) and Gross Heat Value (GHV). Determination of composition by Orsat analysis - Calculation of theoretical oxygen demand and excess air.

Module 6: Psychrometry (6 hours)

Psychrometry - humidity, relative humidity, saturation humidity –wet and dry bulb temperature-dew point – psychrometric chart reading.

Text Books:

1. Gavhane K.A., "Introduction to Process Calculations (Stoichiometry)", 22nd Edition, Nirali Prakashan Publications, Pune, 2009. ISBN : 9788190631668.
2. Venkataramani V. and Anantharaman N., "Process Calculations", 2nd Edition, Prentice Hall of India, New Delhi, 2011. ISBN: 978-81-203-4199-9.
3. Narayanan K.V. and Lakshmikutty B., "Stoichiometry and Process Calculations", 5th Edition, Prentice Hall of India, New Delhi, 2013. ISBN: 9788120329928.

Reference Books:

1. Bhatt B.L. and Vora S.M., "Stoichiometry", 4th Edition, Tata McGraw Hill Publishing Company, New Delhi, 2004. ISBN: 9780070494947.
2. Himmelblau D.M., "Basic Principles and Calculations in Chemical Engineering", 8th Edition, Prentice Hall of India, New Delhi, 2003. ISBN: 9780132885508.

20FP2002	FOOD CHEMISTRY	L	T	P	C
		3	0	0	3

Course Objectives:

1. To understand the chemistry of food constituents.
2. To apply fool molecules interaction in developing technologies / processes.
3. To develop skills for experimenting with food systems and to test various approaches for manipulating the chemical and/or functional properties of foods.

Course Outcomes:

The student will be able to

1. Name and describe the general chemical structures of major components of foods (water, proteins, carbohydrates, and lipids) and selected minor components (vitamins and minerals).
2. Understand, plan, perform and analyse a range of chemical investigations with emphasis on food analysis.
3. Relate the chemical composition of foods to their functional properties.
4. Examine a molecular rationalization for the observed physical properties and reactivity of major food components.
5. Predict how changes in overall composition are likely to change the reactivity of individual food components.
6. Evaluate and determine the approaches that may be used to control the reactivity of those food components that are likely to impact the overall quality of finished products.

Module 1: Chemistry of water (9 hours)
Water in food systems - Structure of water & ice - bound & free water – Water Activity - Sorption isotherms – basic principles, construction and applications – Thermodynamically unstable food systems – Types, factors affecting stability and methods of stabilization.
Module 2: Chemistry of Carbohydrates (8 hours)
Nomenclature, classification & structure of carbohydrates, Reactions of carbohydrates, Chemistry and Technology of homo and heterloglycans , process flowsheet for the production of starch hydrolysis products
Module 3: Chemistry of Lipids (8 hours)
Nomenclature and classification of lipids. Basic Structures and chemistry of fatty acids. physical & chemical characteristics of fats & oils Phospholipids, and unsaponifiables – Oxidative reactions of lipids – types – prevention – Action of antioxidants. Process flow sheet for the manufacture of edible oils (refined and hydrogenated), Modification of fats.
Module 4: Chemistry of Proteins (11 hours)
Chemistry of amino acids – Classification of amino acids - peptides & Proteins. Functional properties of Protein.. Protein denaturation. Enzymes: Introduction, classification &. nomenclature of enzymes and classification. Specificity. Application of enzymes in Foods
Module 5: Chemistry of Vitamins (5 hours)
Overview of Fat-soluble and water soluble vitamins — Toxicity and sources of vitamins – Bioavailability of vitamins – Summary of vitamin stability- Reasons for the loss of vitamins in foods
Module 6: Chemistry of Natural Colourants (4 hours)
Overview of natural colourants- sources, chemistry and applications of anthocyanin, betalain, carotenoids and chlorophyll.
Text Books:

1. Srinivasan Damodaran, Kirk L. Parkin. "Fennema's Food Chemistry". 5th Edition, Taylor & Francis group, ISBN- 9781315372914 (e book), 2017.
2. H.D. Belitz, W. Grosch, P. Schieberle "Food Chemistry". 4th revised and extended edition, Springer-Verlag Berlin Heidelberg, ISBN 978-3-540-69933-0, 2009.

Reference Books:

1. John M. deMan, John W. Finley, W. Jeffrey Hurst and Chang Yong Lee. "Principles of Food Chemistry". 4th edition, Springer International Publishing. ISBN 978-3-319-63607-8 (eBook), 2018.
2. N. Michael Eskin. "Biochemistry of Foods". 2nd Edition Academic Press, USA ISBN 13: 9780122423512, 1990.
3. Pieter Walstra. "Physical Chemistry of Foods". Marcel Dekker Publishing, New York ISBN 9780824793555, 2003.
4. Zdzislaw and E.Sikroski. "Chemical and functional Properties of Food Components". 3rd edition, CRC Press, Taylor & Francis group USA, ISBN - ISBN 9780849396755, 2006.

20FP2003	FOOD ANALYSIS LAB-I	L	T	P	C
		0	0	3	1.5

Course Objectives:
1. To inculcate basics of food analysis and methods.
2. To provide the ability to assess the most appropriate analytical procedure required for a particular food analysis problem.
3. To give practical knowledge of selected food analysis techniques.

Course outcomes:
The student will be able to
1. Gain knowledge on the terminology used in food analysis.
2. Relate to the procedures and equipment required for the analysis of food constituents.
3. Demonstrate the various food analysis conducted in the food industry.
4. Analyze foods for its proximate composition.
5. Evaluate the quality of food materials based on the quality of its constituents.
6. Plan and pick the apt method to be followed for analyzing a food constituent.

List of Experiments

1. Estimation of moisture by hot air and moisture balance method.
2. Estimation of ash content – muffle furnace.
3. Water analysis – TDS by gravimetry and TDS meter, alkalinity, hardness – temporary and permanent.
4. Estimation of Reducing sugars by Willstatter' Iodometric Titration.
5. Estimation of Total sugars by Lane and Eynon's method.
6. Estimation of Free Fatty Acids in Fats and Oils.
7. Estimation of Saponification Value of Fats and Oils.
8. Estimation of Peroxide Value of Fats and oils.
9. Estimation of Anisidine value.
10. Estimation of Iodine Value of Fats and Oils.
11. Estimation of α – Amino Nitrogen by Sorenson's Formol Titration.
12. Estimation of Vitamin C.
13. Estimation of Calcium.
14. Qualitative Analysis of Sugars / Amino acids.
15. Identification of Sugars / amino acids by Paper Chromatography.
16. Estimation of minerals by Flame photometry.
17. Determination of crude fat by soxhlet method.

20FP2004	FLUID MECHANICS FOR FOOD PROCESSING	L	T	P	C
		3	0	0	3

Course Objectives:

1. To impart knowledge on the basics of fluid mechanics.
2. To provide knowledge about the application fluid mechanics in food processing.
3. To give technical knowledge of calculations for fluid flow.

Course Outcomes:

The student will be able to

1. Recognize the various properties of fluids.
2. Identify the various methods of pressure measurement.
3. Calculate the forces acting on bodies submerged in different positions in liquids.
4. Point out the type of flow of fluid and quantify the fluid flow through pipes.
5. Measure the quantity of fluid flow.
6. Create solutions for problems in dimensional analysis.

Module 1: Properties of Fluids (10 hours)

Properties of fluids-Density – Specific weight - Specific Volume- Specific gravity- Viscosity-Thermodynamic properties-Compressibility and Bulk modulus- Surface tension and Capillarity. Dimensional Analysis- Secondary or derived quantities-Dimensional homogeneity-Methods of Dimensional Analysis-Dimensionless Numbers.

Pressure and its Measurement - Fluid pressure at a point- Application of Pascal's law- Pressure variation in a fluid at rest-Absolute, Gauge, Atmospheric and vacuum pressures- Measurement of pressure-Simple manometers-Differential manometers.

Module 2: Application of Forces (8 hours)

Hydro static forces on surfaces- Total pressure and centre of pressure- Vertical plane surface submerged in liquid- Horizontal plane surface submerged in liquid- Inclined plane surface submerged in liquid-curved surface submerged in liquid. Archimedes Principle- Buoyancy- Application in fluid foods.

Kinematics of flow-Types of fluid flow-Rate of flow-continuity equation- continuity equation in three dimensions- velocity and acceleration- velocity potential function and stream function.

Module 3: Flow Measurements- Dynamics of Fluid flow (5 hours)

Dynamics of Fluid flow- Equations of motion- Euler's equation of motion. Bernoulli's equation-Practical applications of Bernoulli's equation – Venturimeter- Orifice meter- Pitot tube. Momentum equation.

Module 4: Viscous Flow and Turbulent flow of fluids (8 hours)

Flow of viscous fluid through a circular pipe-Flow of viscous fluid between two parallel plates-Power absorbed in viscous flow-Loss of head due to friction in viscous flow-Methods of determination of coefficient of viscosity. Turbulent flow- Frictional loss in turbulent flow-expression for loss of head due to friction in pipes-velocity distribution in turbulent flow in pipes- Resistance of smooth and rough pipes.

Module 5: Flow through Pipes (8 hours)

Reynolds Experiment- Laminar and turbulent flow- Loss of energy in pipes- Loss of energy due to friction- Minor energy losses-Hydraulic gradient and Total Energy line- Flow through pipes in series-Equivalent pipe-Flow through parallel pipes- Flow through branched pipes-Power transmission through pipes- Water hammer in pipes- Flow through nozzles- Pipe network.

Module 6: Orifices and Mouth pieces (6 hours)

Classification of orifice-Flow through orifice- Hydraulic coefficients-Coefficient of velocity-coefficient of contraction- coefficient of discharge- Experimental determination of hydraulic coefficients-Flow through large orifice-Discharge through fully submerged orifice- Discharge through partially submerged orifice- Time of emptying a tank through an orifice.

Text Books:

1. Bansal, R.K., "A Textbook of Fluid Mechanics and Hydraulic Machines". 10th edition, Laxmi Publications, New Delhi, ISBN-10: 8131808157, ISBN-13: 978-8131808153, 2018.
2. Modi, P.N. and Seth, S.M., "A Text book of Fluid Mechanics and Hydraulic Machines". 22nd Edition, Standard Book House, New Delhi, ISBN-10: 8189401262, ISBN-13: 978-8189401269, 2017.

Reference Books:

1. S K Som, Gautam Biswas, S Chakraborty, "Introduction to Fluid Mechanics and Fluid Machines". 3rd edition, Tata McGraw Hill, ISBN-10: 0071329196, ISBN-13: 978-0071329194, 2017.
2. Rajput, R.K., "A Text book of Fluid Mechanics and Hydraulic Machines", S Chand & Company, New Delhi, ISBN-10: 9789385401374, ISBN-13: 978-9385401374, 2016.
3. Agarwal, S.K., "Fluid Mechanics and Machinery", Tata Mc Graw Hill Co. New Delhi, 2006.
4. McCabe W.L., Smith J.C., and Harriot P., "Unit Operations of Chemical Engineering", 7th Edition, McGraw Hill, New York, 2017. ISBN: 9789339213237.

20FP2005	FLUID MECHANICS AND HEAT TRANSFER LAB	L	T	P	C
		0	0	3	1.5

Course Objectives:

1. To provide extensive knowledge on various flow measuring equipments involved in food industries.
2. To impart practical skills on measuring the losses in pipe flow.
3. To equip the students to operate and measurement of the heat transfer equipments.

Course Outcomes:

The students will be able to

1. Recognise the importance of fluid flow in industrial applications.
2. Describe the use of flow measuring devices.
3. Demonstrate the loss of energy due to friction in pipes.
4. Calculate the losses of energy due to fittings in pipe flow systems.
5. Evaluate the required length of pipes for fluid flow.
6. Evaluate the performance of heat transfer equipments.

List of Experiments

1. Determination of coefficient of discharge using Venturi meter and Orifice meter.
2. Calibration of Rotameter.
3. Determination of minor losses in pipe due to pipe fittings (sudden expansion and contraction).
4. Determination of minor losses in pipe due to pipe fittings (Bends and Elbows).
5. Determination of friction loss and pressure drop in Helical coil.

6. Determination of Darcy's friction factor in fluid flow.
7. Studies of friction factor in annular pipes.
8. Studies on pressure drop across Fluidized bed columns.
9. Studies on pressure drop across Packed bed columns.
10. Heat transfer studies in a tubular heat exchanger (Parallel and counter flow).
11. Heat transfer studies in a plate heat exchanger (Parallel and counter flow).
12. Heat transfer studies of a shell and tube heat exchanger.
13. Heat transfer through composite walls.

20FP2006	APPLIED FOOD MICROBIOLOGY	L	T	P	C
		3	0	0	3

Course Objectives:

1. To understand the microorganisms associated with foods and isolation methods of microorganisms from foods.
2. To learn the fermentation process and microorganisms involved in the production of fermented foods.
3. To understand the various methods of detection of bacteria and food safety measures.

Course Outcomes:

The students will be able to

1. Identify the characteristics, sources and significance of predominant food microorganisms.
2. Understand food spoilage by microorganisms and the strategies implemented to prevent spoilage.
3. Relate beneficial microorganisms to their role in fermentation of foods.
4. Distinguish thermal and non-thermal mode of preservation of foods.
5. Evaluate the food borne pathogens associated with intoxication and infections
6. Create food safety protocols.

Module 1: Introduction to microbes in foods (6 hours)

History and development of food Microbiology –Characteristics of predominant micro organisms in foods: Molds, Yeast, Protozoan, Viruses and their importance –Sources of microorganisms in foods: Fruits, vegetables, animals, birds, fish, shellfish, water, food ingredients, equipments - Microbiological quality of foods.

Module 2: Beneficial uses of Microorganisms in Foods (6 hours)

Microbiology of fermented foods-starter cultures-General method of production-Fermented Dairy products-Milk composition and quality-Microbiology of cultured buttermilk, cheese-fermented meat products - semidry sausages-fermented vegetable products-Microbiology of Sauerkraut-Alcohol production – wine -Fermentation of oriental food products- Intestinal beneficial bacteria-beneficial effects of probiotics-prebiotics-synbiotics.

Module 3: Microbial spoilage of foods (8 hours)

Important factors in microbial food spoilage-some important spoilage bacteria-spoilage of specific food groups-fresh and ready to eat meat products-egg and –egg products-Fish and fishery products-milk and milk products-vegetables and fruits- fermented foods- canned foods-food spoilage bacteria in refrigerated foods(psychrotrophs)-food spoilage by microbial enzymes

Module 4: Microbial Food borne diseases and intoxication (8 hours)

Food borne intoxication-Staphylococcal, Botulinum, Mycotoxicosis, Biogenic amines, Algal toxins – Food borne infections- Salmonellosis, Listeriosis, Pathogenic *E.coli*, Camphylobacteriosis,*Bacillus cereus*, Vibrio gastroenteritis-Enteric Viruses-Protozoan-*Entamoeba histolytica*.

Module 5: Methods of food preservation (8 hours)

Thermal mode of preservation – Pasteurization, sterilization and Canning – Heat resistance of microorganisms and their spores – spoilage of canned foods and types of spoiled cans – aseptic packaging - Low-temperature storage. Non-thermal methods of preservation: High pressure processing – Pascalisation - Irradiation –Use of chemical preservatives, Natural food preservatives.

Module 6: Microbial detection and food safety (9 hours)

Conventional and biosensor based detection methods for microorganisms in food and food environment- Rapid methods-Immunoassays, Reverse passive Latex agglutination(RPLA) method,

Enzyme Linked Immunosorbent Assay (ELISA),Immunofluorescence assay, Flow cytometry- Nucleic acid based methods-DNA hybridization, Polymerase Chain Reaction (PCR),DNA finger Printing-Biosensor based-Fiber optic biosensor, Surface Plasmon Resonance biosensor, Electrochemical immune biosensor, Impedance based biochip sensor.

Text Books:

1. Ray, B and Bhunia, A., "Fundaments of Food Microbiology" Taylor and Francis group, CRC press, 5th Edition, ISBN-13: 978-0815384311, 2017.
2. Adams M.R and Moss M.O, "Food Microbiology", Panima Publishing corporation, New Delhi, 2nd Edition, Third reprint, ISBN-13:9788122410143,978-8122410143, 2007.

Reference Books:

1. Sivasankar B, "Food Processing and Preservation", PHI Learning Private Limited, Easterrn Economy Edition, 6th edition, ISBN- 97881203-2086-4, 2009.
2. William C Frazier and Dennis C. Westoff, "Food Microbiology", Special Edition, Springer, The Mc Graw-Hill Companies, ISBN-9780070667181, 2008.

20FP2007	APPLIED FOOD MICROBIOLOGY LAB	L	T	P	C
		0	0	3	1.5

Course Objectives:

1. To understand the working principle of microscopes and sterilization techniques.
2. To know the preparation of media for the cultivation of microorganisms.
3. To identify the isolated strains using staining techniques and biochemical tests.

Course Outcomes:

The student will be able to

1. Identify the specific pathogens found in foods by selective media.
2. Understand about the characteristics of microorganisms.
3. Apply aseptic technique to properly handle microorganisms to avoid contamination.
4. Analyze the quality of raw milk by methylene blue reduction test.
5. Evaluate the quality characteristics of food by TPC.
6. Create pure culture and staining techniques for specific microorganisms.

List of Experiments

1. Introduction to food Microbiology and Laboratory safety.
2. Enumeration of microorganisms (bacteria, fungi) from water/milk/fruit drinks/contaminated food by spread and pour plate method.
3. Evaluation of petrifilm plate count method for coliforms *(Escherichia coli)* isolated from organic fruit juices.
4. Isolation of foodborne pathogens on selective, differential, enriched medium by streak plating.
5. Enumeration and identification of *Staphylococcus aureus* from food sample.
6. Isolation and identification of Salmonella from broiler carcasses.
7. Enumeration of molds from bread/pickle.
8. MPN Test for coliforms.
9. Methylene blue reduction test for assessing the quality of raw milk.
10. Biochemical characterization of bacteria.
11. Microbial examination of canned products for yeasts and molds.
12. Enumeration of important groups of microorganisms in foods ie., Proteolytic, lipolytic,
13. acid producers.
14. Enumeration of important groups of microorganisms in foods i.e., Psychrotrophic, thermoduric, thermophilic bacteria.

20FP2008	METABOLISM AND NUTRITION	L	T	P	C
		3	0	0	3

Course Objectives:

1. To understand about metabolic pathways and nutrition.
2. To apply knowledge on the legal aspects of formulating and labelling functional foods and dietary supplements.

3. To develop a food product of high nutritive value.

Course Outcomes:

The student will be able to

1. Identify the structure of ATP and the major class of macromolecules to which ATP belongs.
2. Describe the biochemistry process, basic concept of human nutrition and the relationship of the consumption of foods to nutritional status and health
3. Apply their knowledge in food biochemistry and nutrition in designing new range of products with improved nutritional characteristics (Nutraceuticals and functional foods).
4. Analyze the stages in catabolism of food molecules and describe what occurs during each stage.
5. Evaluate the biological functions of foods for health in addition to nutritional values
6. Formulate specialized nutrition for pediatric, geriatric and sport's needs.

Module 1: Metabolism of Carbohydrates (9 hours)

Interconnection of pathways, glycolysis (EMP), TCA cycle, gluconeogenesis, Pentose phosphate shunt, Metabolic regulation, Electron transport chain & oxidative phosphorylation Bioenergetics: energy rich compounds.

Module 2: Metabolism of Fatty Acids (6 hours)

Biosynthesis and degradation of fatty acids- Beta oxidation- Chain elongation – Biosynthesis of cholesterol.

Module 3: Metabolism of Proteins (6 hours)

Biosyntheses and degradation of amino acids (one example each for sulphur containing, aliphatic, aromatic, heterocyclic, basic and acidic amino acids); Biosynthesis and degradation of purines, pyrimidines and nucleic acids, urea cycle.

Module 4: Concepts of Nutrition (8 hours)

Basic concept of nutrition – Importance of nutrition and dietetics - Assessment of nutritional status – energy value of carbohydrates, proteins and fats – determination of energy value – balanced diet – Recommended dietary intake – Acceptable dietary intake – Protein efficiency ratio – Net protein utilisation and their determinations – Malnutrition and its problems- Deficiency Diseases – Nutrient supplementation & fortification - Nutritional labeling and its importance.

Module 5: Nutritional Disorders (8 hours)

Inborn errors of carbohydrate, protein and fat metabolisms - Nutrition and disorders associated with organs such as liver and kidney - Naturally occurring anti-nutritional factors – Cyanogens, lectins, enzyme inhibitors, phytoallexins, phytates.

Module 6: Specialized Nutrition (8 hours)

Nutrition for specialized purposes – Pediatric nutrition – geriatric nutrition – Sports nutrition – Nutrition during pregnancy. Ageing –Theories of ageing – Nutrition and ageing - Age-related metabolic disorders – Nutrition in the treatment of age-related disorders like hypertension, diabetes, alzheimer's disease. Space Foods- Dehydrated- Irradiated- Food for Army in high altitudes.

Text Books:

1. Voet D, Voet G, "Principles of Biochemistry", 3rd edition, John Wiley and Sons, ISBN-13: 9780470233962, 978-0470233962, 2008.
2. Martin Eastwood, "Principles of Human nutrition", 2nd edition. Wiley - Blackwell Publishing, ISBN: 978-0-632-05811-2 , 2003.

Reference Books :

1. Ronald Ross Watson, "Functional foods and Nutraceuticals in Cancer Prevention", Ed. Wiley – Blackwell, ISBN-13: 978-0813818542, 2003.
2. Nelson D.L., M.M. Cox, Lehninger "Principles of Biochemistry", W.H. Freeman & Company Publications, ISBN-10: 1-4292-3414-8, 2013.
3. Tymoczko, J.L., Berg, J.M., Stryer, L. "Biochemistry – A short course", 3rd edition. W.H. Freeman. ISBN-10: 1-4641-2613-5, 2009.
4. Sunetra Roday, "Food Science and Nutrition", 2nd edition, Oxford Higher Education/Oxford University Press, ISBN 10: 0198078862, 2012.

20FP2009	FOOD BIOCHEMISTRY LAB	L	T	P	C
		0	0	3	1.5

Course Objectives:

1. To gain knowledge of practices for proper literature reviews and evaluation of appropriate methods for analysis.
2. To understand proper use of methods of analysis
3. To interpret various methodologies for analysis of components in foods.

Course Outcomes:

The students will be able to

1. Demonstrate the presence of protein, lipid, carbohydrate and water in food using chemical methods
2. Describe various separation and quantification techniques frequently used for food analysis.
3. Evaluate proper selection and application of appropriate methods of analysis.
4. Aware of how analytical techniques may be used determine food composition and quality
5. Work with other students to successfully complete lab experiment
6. Apply their knowledge in food biochemistry and nutrition in designing new range of products with improved nutritional characteristics

List of Experiments

1. Laboratory safety rules, requirements and regulations.
2. Estimation of sugars by DNS method.
3. Estimation of proteins by the Biuret method.
4. Estimation of total free amino acid.
5. Estimation of proteins by Lowry's method.
6. Estimation of proteins by dye-binding method.
7. Determination of total protein by Bradford's method.
8. Estimation of thiamine.
9. Estimation of riboflavin.
10. Estimation of cholesterol.
11. Estimation of total carbohydrate by anthrone/ phenol sulphuric method.
12. Estimation of total phenols.
13. Estimation of total antioxidant activity by FRAP method.
14. Determination of phosphorus by colorimetric method.
15. Estimation of tyrosine by UV spectrophotometer.

20FP2010	PROCESS ENGINEERING THERMODYNAMICS	L	T	P	C
		3	0	0	3

Course Objectives:

1. To acquire knowledge about thermodynamic principles.
2. To apply the principle in the food processing system.
3. To develop an energy efficient system for food processing.

Course outcomes:

The students will be able to

1. Examine thermodynamic quantities for various systems.
2. Explain various laws of thermodynamics related to food processing
3. Calculate the properties of pure fluids
4. Differentiate the properties of a component in a mixture
5. Choose the properties of steam generated for food application
6. Integrate the properties of air and water vapour system for food processing

Module 1: Fundamental Concepts (9 hours)

Thermodynamic terms, variables, processes and states. First and zeroth law of thermodynamics. State and path function. C_p and C_v. Joule Thomson porous plug experiment. Calculation of thermodynamic quantities - Isothermal expansion, free expansion and adiabatic reversible process - problems.

Module 2: First and Second Law of Thermodynamics and its Application (9 hours)

Steady flow energy equation and its application to steam generator, condenser, nozzles and air compressors. Second law of thermodynamics and its application to refrigerator, heat engine and heat pump.

Module 3: Properties of Pure Fluids (7 hours)

PVT Behavior of Pure Fluids: PVT surfaces: P-V, P-T, T-S and H-S Diagrams. Helmholtz and Gibbs free energy, Maxwell's equations and various equations of states.

Module 4: Partial molar properties (5 hours)

Partial molar properties, concept of chemical potential, concept of fugacity -Lewis Randall rule, Raoult's law, Henry's law. Gibbs- Duhem equations.

Module 5: Properties of steam (7 hours)

Formation of steam at a constant pressure - Temperature Vs total heat during steam formation. Wet, dry saturated and superheated steam - Dryness fraction of wet steam - Enthalpy and specific volume of steam - uses of steam tables - Classification of steam boilers, Vertical and Cross tube Cradley boiler, Cochran, Lancashire, Locomotive and Babcock-Wilcox boilers.

Module 6: Psychrometric process in Thermodynamics (8 hours)

Psychrometric properties of air. Psychrometric process – sensible heat exchange process, latent heat exchange process, adiabatic mixing, evaporative cooling – problems

Text Books:

1. Narayanan K.V., "A Textbook of chemical engineering thermodynamics", 2nd Edition, PHI Learning Private Limited, Delhi, 2013. ISBN: 9788120347472
2. Rastogi R.P. and Misra R.R., "An Introduction to chemical thermodynamics", Vikas Publishing House Pvt Ltd.,2008. ISBN: 9780706999358.
3. Kothandaraman C.P., Khajuria P.R., Arora S.C. and Domkundwar S.A., "Course in Thermodynamics and Heat Engines", 3rd Edition, Dhanpat Rai & Sons, New Delhi, 1993. ISBN: 123757280.

Reference Books:

1. Nag P.K., "Engineering Thermodynamics", 3rd Edition, McGraw Hill Education (India) Private Limited, New Delhi, 2006. ISBN: 0070591148.
2. Roy Choudhury T., "Basic Engineering Thermodynamics", Tata McGraw Hill, 1973. ISBN: 9780070965881.
3. Vanwylen and Sontag, "Fundamentals of Classical thermodynamics", 4th Edition, Wiley Eastern, 1994. ISBN: 9780471593959.
4. Paul Singh, R and Dennis R. Heldman. "Introduction to Food Engineering", 4th Edition, Academic Press, ISBN-10: 0123709008, ISBN-13: 978-0123709004, 2008.

20FP2011	DAIRY PROCESS ENGINEERING	L	T	P	C
		3	0	0	3

Course Objectives:

1. To impart knowledge on basic engineering principles and concepts used in various unit operations in dairy manufacturing processes.
2. To provide the students the knowledge on properties and processing of milk, manufacture of dairy products, and selection of process and equipment for the product manufacture.
3. To understand the working principles, process controls, operation and maintenance of the dairy processing and product manufacturing equipments and to develop confidence in handling the equipment.

Course Outcomes:

The student will be able to

1. Gain knowledge on the physio-chemical properties of milk and milk constituents.
2. Understand the various milk processing methods and technologies.
3. Apply the knowledge of engineering principles involved in different unit operations in the formulation and processing of milk and milk products.
4. Analyze the engineering and technological problems in dairy processing lines reaching substantiated solution or conclusion

5. Evaluate the working of dairy equipments used in the dairy plant.
6. Design operations and equipments for dairy processing.

Module 1: Properties and handling of milk (8 hours)

Milk – composition -Physical and chemical properties of milk—milk constituents - milk reception – cooling - principles and methods – transportation of milk - sanitary pipes and fittings – installation and maintenance - storage tanks –silos –tankers - construction details – can washers – types – construction, working principle and maintenance.

Module 2: Pasteurization and filling of milk (8 hours)

Pasteurization – principles and objectives – methods – batch / LTLT method -- equipments – HTST method – process and equipments – plate heat exchanger – pasteurizer controls – flow diversion valve -functions and working principles - regeneration efficiency – milk flow diagram - UHT pasteurization – principles and methods – vacreation - cleaning and sanitization - CIP cleaning - filling – principle and working of bottle fillers and cappers — form fill seal machines— aseptic filling and handling system.

Module 3: Homogenization and cream separation (8 hours)

Homogenization – theory - effect on milk - working principle of homogenizers — valves -- pumps – single and two stage homogenization -homogenization efficiency – power requirement cream separation – principles – gravity and centrifugal separation – types of Centrifuges - clarifiers and separators – centrifugal separator – parts – construction and working principle – separation efficiency - fat loss in skim milk—self desludging centrifuge -bactofugation.

Module 4: Butter and cheese processing (7 hours)

Butter – method of manufacture – churning of cream - theory of churning – Steel and wooden butter churns - operation of butter churn – churning efficiency- over run—batch and continuous methods of butter making - cheese – classification – cheddar and cottage cheese – method of manufacture - equipments – cheese vats - double O' vat – cheese mills -- cheese press—horizontal and vertical press.

Module 5: Ice cream and dried milk (7 hours)

Ice cream - ingredients – preparation of ice cream mix –properties of ice cream mix - Mix calculation-freezing – Changes during freezing – soft and hardened ice cream - ice cream freezers –batch and continuous freezers - drying of milk - Milk drying systems - equipments – drum drier – principle – Heat transfer through drums- operating points- spray drier –principle- atomization –type of spray nozzles- Drying chambers- construction and working principles- Powder Recovery-cyclones – filter bags - Instantization.

Module 6: Membrane processing (7 hours)

Membrane separation of milk – principles- ultra filtration - reverse osmosis—membrane material and structures -Membrane materials-- cellulose, synthetic polymers – membrane structure – plate, tubular, and hollow fibre – applications in Dairy Industry.

Text books:

1. Tufail Ahmad. "Dairy Plant Engineering and Management". 9th Edition, Kitab Mahal, Allahabad. ISBN-10: 8122501184, ISBN-13: 978-8122501186, 2003.
2. De Sukumar, "Outlines of Dairy Technology", Oxford University Press, New Delhi ISBN-10: 9780195611946, ISBN-13: 978-0195611946, 2001.
3. Da-Wen Sun, "Engineering Aspects of Milk and Dairy Products", CRC Press, Taylor & Francis Group, ISBN 978-1-4200-9022-2, 2010.

Reference books:

1. Trevor J. Britz and Richard K. Robinson, "Advanced Dairy Science and Technology", Blackwell Publishing Ltd, ISBN: 978-1-4051-3618-1, 2008.
2. The Codex Alimentarius Commission, "Milk and Milk Products", 1st edition, ISBN 978-92-5-105837-4, 2007.
3. Adnan Y. Tamime, "Milk Processing and Quality Management", Blackwell Publishing Ltd. ISBN 978-1-4051-4530-5, 2009.

20FP2012	UNIT OPERATIONS IN FOOD PROCESSING-I	L	T	P	C
		3	0	0	3

Course Objectives:

1. To impart knowledge on different unit operations and its significance in food industry.
2. To learn the operation and utilization of equipments involved.
3. To choose suitable techniques for the food processing operation.

Course Outcomes:

The student will be able to

1. Recognize the applications of mechanical separation in food materials.
2. Understand the various unit operations performed in food processing
3. Analyze the principle and operation of different types of dryers and understanding the drying of principles.
4. Apply knowledge of unit operations into choice of equipments for processing.
5. Evaluate the efficiency of equipments used in unit operations of foods.
6. Design equipments for screening, grading, drying, size reduction, mechanical separation and mixing of foods.

Module 1: Screening & Grading (9 hours)

Screening: Definition-screen motions-screen fractions-screen specifications-Types of screens-Revolving screen-Rotary screen-Shaking screen-Vibratory screen-Horizontal screen-Perforated metal screens- Wire mesh screens- Ideal and actual screens- Effectiveness of screens-Problems. Equipment for cleaning, grading and separation: Separation based on size- screen cleaner/grader-Air screen cleaner -Specific gravity separator-Pneumatic and aspirator separator-Separation based on fluidization technique-Cyclone separator- Colour separator.

Module 2: Drying (10 hours)

Moisture content and its measurement methods - direct and indirect methods – Equilibrium moisture – methods of determination – Hysteresis- EMC Models – Henderson, Kelvin, PET and GAB models – importance of EMC- water activity. Drying and Dehydration- Definition-Drying theory – Drying rate – Types of drying-Mechanical Drying – hot air dryers – Types- fixed -fluidized bed – LSU drier-Spray drier- vacuum shelf dryer – freeze dryer.

Module 3: Size Reduction (6 hours)

Definition-Benefits, Theory of size reduction-Types of size reduction-– characteristics of comminuted products – particle size distribution in comminuted products- Principles and laws of size reduction-Energy requirement- Problems- Size reduction equipments- crushers – hammer mill – Disc mill-Ball mill-Colloidal mill-

Module 4 : Mechanical Separation-I (6 hours)

Filtration: Definition- Theory of Filtration - filter media types and requirement –-constant rate filtration – constant pressure filtration – filter cake resistance – filtration equipments – filter press – rotary drum filters- Selection of filter press- Applications of filtration.

Sedimentation: Definition-Principle of sedimentation- Terminal velocity and Stoke's law derivation-Batch sedimentation- Problems- Sedimentation equipment- Sedimentation thickener.

Module 5: Mechanical Separation-II (7 hours)

Centrifugal separation: Principles of centrifugation-Centrifuge effect- sigma factor-separation of liquids in a centrifuge- radius of neutral zone- residence time of particle- derivation and problems-Centrifugation equipment- Tubular bowl centrifuge-Disc bowl centrifuge-Basket centrifuge-Applications of centrifugation.

Module 6: Mixing (7 hours)

Definitions and principles- Mixing of solids and pastes: Mixing index for granular solids- rate of mixing- problems-Mixing equipment for solids and pastes-Planetary mixer- Kneader-Ribbon mixer-Double cone mixer- Applications of mixing of solids in food processing.

Mixing of Fluids: agitation and mixing – purpose of agitation – agitated vessels – impellers – propellers – turbine –high effect impellers – impellers for high viscosity liquids-Power required for mixing.

Text Books:

1. DG Rao, "Fundamentals of Food Engineering", PHI Learning Private Limited, New Delhi. *ISBN*-10: 8120338715; *ISBN*-13: 978-8120338715, 2009.
2. Geankoplis CJ, "Transport Processes and Separation Processes Principles", Prentice Hall India, New Delhi, ISBN-978-81-203-2614-9, 2008.

Reference Books :

1. R.L. Earle, "Unit Operations in Food Processing", 2nd Revised Edition, Butterworth-Heinemann Ltd; Pergamon Press, *ISBN* 1483293106, *9781483293103*, 2013.
2. Zeki Berk, "Food Process Engineering and Technology", 2nd Edition, Academic Press International Series, Oxford, ISBN: 978-0-12-415923-5, 2013.
3. P.G. Smith, "Introduction to Food Process Engineering", Springer second edition, New York, ISBN 978-1-4419-7661-1, 2010.
4. K. M. Sahay and K.K. Singh, "Unit Operation of Agricultural Processing", Vikas Publishing House Pvt. Ltd., New Delhi, *ISBN 9788125911425*, 2004.
5. Albert Ibarz, Gustavo V. Barbosa-Canovas, "Unit Operations in Food Engineering", Food Preservation Technology Series, CRC Press, London, ISBN: 1420012622, 9781420012620, 2003.

20FP2013	UNIT OPERATIONS IN FOOD PROCESSING LAB	L	T	P	C
		0	0	3	1.5

Course Objectives:

1. To know the various types of equipments used in the food industry.
2. To learn the operation and utilization of equipments involved.
3. To choose suitable techniques for the food processing operation.

Course Outcomes:

The students will be able to

1. Recognize the various unit operations in food processing.
2. Compute the drying characteristics of food materials.
3. Describe and demonstrate the equipments for various unit operations.
4. Estimate the energy requirement for the grain milling operations.
5. Estimate the mixing properties of flours and grains.
6. Evaluate the performance of grain separators and rice mill.

List of Experiments

1. Experiment on concentration of liquid foods.
2. Studies on drying characteristics of vegetables using Cross flow dryer.
3. Studies on drying characteristics of vegetables using Through flow dryer.
4. Studies on size reduction of grains using multi mill.
5. Studies on size reduction of grains using Disc/Pin mill.
6. Determination of milling efficiency of Dhall mill.
7. Studies on mixing properties using Ribbon mixer.
8. Studies on mixing properties using Sigma mixer.
9. Experiment on Dewatering Centrifuge.
10. Studies on cleaning efficiency of specific gravity separator for grains.
11. Performance evaluation of Engleberg huller and Rubber Roll Sheller.
12. Studies on performance evaluation of LSU dryer.
13. Determination of extraction efficiency of sugarcane crusher.
14. Experiment on oil extraction using oil expeller.

20FP2014	FRUIT AND VEGETABLE PROCESSING TECHNOLOGY	L	T	P	C
		3	0	0	3

Course Objectives:

1. To enable the students to understand the processing of fruits and vegetables.
2. To impart technical knowledge on preservation and how to develop new products.
3. To understand the methods of dehydration.

Course Outcomes:

The students will be able to

1. Observe the production status and post-harvest handling methods of fruits and vegetables.
2. Understand the methods of processing and preservation of freshly harvested and cut fruits and vegetables.
3. Apply their knowledge of unit operations to pick specific heat treatment for processing and preservation of fruits and vegetables.
4. Analyze the various production and preservation methods of fruit juices.
5. Evaluate the dehydration methods and aseptic technologies used in fruit and vegetable processing.
6. Design of driers used for drying fruit and vegetables.

Module 1: Introduction to fruits and vegetables (6 hours)

Importance and current status of production and processing of fruits and vegetables, scope of fruits and vegetables preservation in India, biochemical composition, ripening and softening, senescence, reparation rate, ethylene production, climacteric and non-climacteric fruits, micronutrients in fruits and vegetables, post-harvest losses, reasons for losses, strategies for loss reduction, physiological storage disorders, chilling and freezing injury.

Module 2: Post-harvest handling operations and drying (7 hours)

Cleaning and washing of fruits and vegetables, types of cleaners, machinery for cleaning of fruits and vegetables - air cleaners, washers, Sorting and grading: Sorting, grading, methods of grading; Grading- Size grading, colour grading, screening, equipment for grading of fruits and vegetables, grading efficiency.

Module 3: Juice extraction and canning (8 hours)

History of juicing, types of juices extraction methods, juice extraction process, methods of juice preservation, causes of juice spoilage. Canning: Introduction, can manufacture, canning process - selection of fruits and vegetables, grading, washing, peeling, cutting, blanching, cooling, filling, exhausting, sealing, processing, cooling and storage; types of canning- pressure canning and water bath canning, common causes of spoilage in canning of foods. Retort processing, Aseptic packaging.

Module 4: Processing fruits and vegetable products (8 hours)

Jam, Jelly & Marmalades; candied fruits, dried fruits and fruit products (eg. Aam papads, bars); soup mixes; sauces & ketchups; puree & pastes; chutneys & pickles, Specialty fruit and vegetable products, FSSAI specifications, waste management in fruits & vegetable industry. Drying: principles, merits and demerits of drying, working principles of various dryers – drum, cabinet, tunnel, freeze, spray, etc., preparation of fruit powders and dried slices, intermediate moisture foods, osmotic dehydration.

Module 5: Minimally processed fruits and vegetables (9 hours)

Modified atmosphere packaging (MAP): Introduction, gases used in MAP, role of N2, O2 & Co2, Principles of MAP, Types of MAP - active packaging & passive packaging, factors affecting MAP, application of MAP, effect of MAP on shelf-life, future research needed, advantages and disadvantages; and controlled atmosphere packaging (CAP): Introduction, gases used in CAP, factors affecting CAP- Temperature control, humidity control and gas control, advantages and disadvantages, Hurdle technology, Emerging technologies – PEF, HPP, ultra-sonication, pulsed light, etc.

Module 6: Statutory Provisions for Quality Control (7 hours)

HACCP, ISO 22000, GMP, AGMARK, Food Standardization and regulatory agencies in India: Central Committee for Food Standards - FSSAI, Central and state food departments, State Food Laboratories / Food and Drug Administration, Bureau of Indian Standards, Food Corporation of India, Army Supply Corps and Central Insecticide Board

Text Books:

1. Paliyath, Gopinadhan, Dennis P. Murr, Avtar K. Handa, and Susan Lurie. “Postharvest biology and technology of fruits, vegetables, and flowers”. Wiley-Blackwell, ISBN-10: 0813804086, ISBN-13: 978-0813804088, 2008.
2. Hui Y.H, “Hand Book of Vegetable Preservation and Processing”, CRC Press, New York. ISBN-10: 1482212285, ISBN-13: 978-1482212280, 2015.

3. Wills, Lee, Graham, McGlasson & Hall. "Post-Harvest Physiology & Handling of Fruits & Vegetables". 6th edition, CABI Publishing, ISBN-10: 9781786391483, ISBN-13: 978-1786391483, 2016.

Reference Books:

1. Chakraverty, A., Mujumdar A.S., Raghavan G.S.V and Ramaswamy H.S. "Handbook of Post-harvest Technology", CRC Press, USA. ISBN-10: 0824705149, ISBN-13: 978-0824705145, 2003.
2. L.R. Verma and V.K. Joshi. "Post-Harvest Technology of fruits and vegetables". Indus Publishing Co, New Delhi. 2000.
3. P. Fellows, "Food processing Technology: Principles and Practice", 3rd Edition. Wood Head Publishing Limited, Cambridge, England. ISBN-10: 1845692160, ISBN-13: 978-1845692162, 2009.
4. James G. Brennan. "Food Processing Hand book". Wiley VCH, Weinheim, Germany. ISBN-10: 3527307192, ISBN-13: 978-3527307197, 2005.

20FP2015	FOOD ADDITIVES	L	T	P	C
		3	0	0	3

Course Objectives:

1. To understand the Chemistry of the additives added to food.
2. To know the limits of addition as prescribed by FAO/WHO and PFA.
3. To develop newer additives with improved safety standards.

Course Outcomes:

The students will be able to

1. Recognize the importance of additives in maintaining or improving food quality.
2. Understand the applications of food additives
3. Interpret the toxicity of food additives through NOAEl, ADI and LD 50 values.
4. Distinguish the characteristics of additives and their specific use in foods.
5. Evaluate the dietary intake of individuals consuming foods with food additives.
6. Development of various instant premixes by addition of preservatives within the permissible limits.

Module 1: Classification and Regulations (6 hours)

Food additives - definition and classification (INS), food safety levels as per the Specifications, Safety Evaluation of Additives – Determination Of Acute And Chronic Toxicity Test Methods - NOAEL, ADI, LD50 value, FSSAI regulations, GRAS status & Regulations.

Module 2: Acidulants, Preservatives, Emulsifiers, Thickeners and Antioxidants (9 hours)

Types, chemical properties, levels of additions in individual products, toxicity data of Acidulants – Preservatives – Emulsifiers and gums - Antioxidants – Limits of addition to food products.

Module 3: Humectants (7 hours)

Types, chemical properties, levels of additions in individual products, toxicity data of Dough conditioners - flour improvers – Humectants – Limits of addition to food products.

Module 4: Colorants, Flavourants and Fat Substitutes (6 hours)

Types, chemical properties, levels of additions in individual products, toxicity data of Colourants – Natural and artificial, Flavourants, Flavour enhancers.

Module 5: Fat replacers / substitutes and Sweeteners (9 hours)

Fat substitutes and replacers – Cocoa butter substitutes and equivalents - Types, chemical properties, levels of additions in individual products, toxicity data of Sweeteners – Taste modifiers.

Module 6: Chelating and Antibrowning agents (8 hours)

Natural and synthetic, Chelating agents, antibrowning agents, Nutritional additives – Levels of addition to Food products.

Food adulteration: definition, reasons for food adulteration, methods of adulteration, and methods of detection. Consumer's responsibilities, consumer organizations. The prevention of food adulteration Act, 1954. The consumer protection Act 1986, normal food adulterants in coffee, tea leaves, edible oil, milk, cereals, spice powders.

Text book:

1. Branen A.L., Davidson P.M., Salminen S. and Thorngate J.H. , "Food additives", 2nd Edition, Revised and Expanded. Marcel Dekker Inc. USA, 2002. ISBN: 0-8247-9343-9.

Reference Books:

1. Newton, D.E. "Food Chemistry", Facts on File Inc., New York, ISBN-10: 0816052778, ISBN-13: 978-08160527762007.
2. Gerorge, A.B. 2004. Fenaroli's Handbook of Flavor Ingredients. 5th Ed. CRC Press.
3. Madhavi,D.L., Deshpande,S.S & Salunkhe,D.K. 1996. Food Antioxidants: Technological, toxicological and Health Perspective. Marcel Dekker

20FP2016	FOOD ADDITIVES LAB	L	T	P	C
		0	0	3	1.5

Course Objectives:

1. To understand the chemistry of the additives added to food.
2. To understand the importance of additives in maintaining or improving food quality
3. To develop newer additives with improved safety standards.

Course Outcomes:

The students will be able to

1. Recognize the importance of additives in maintaining or improving food quality.
2. Understand the chemistry of the additives added to a food.
3. Apply their knowledge of properties of additives to define addition limits in food systems.
4. Analyze the levels of addition and toxicity data of various food additives.
5. Evaluate the levels of additives in food systems.
6. Develop various instant premixes by addition of preservatives within the permissible limits.

List of Experiments

1. Estimation of Sulphur-Di-Oxide.
2. Estimation of Sodium Benzoate.
3. Estimation of Sorbic Acid.
4. Estimation of Butylated hydroxyl toluene.
5. Estimation of Propyl Gallate.
6. Estimation of Ascorbic Acid.
7. Estimation of Iron.
8. Estimation of Copper.
9. Estimation of preservatives like benzoic and sorbic.
10. Estimation of synthetic colours.
11. Estimation of protein based sweeteners.
12. Estimation of carotenoids.
13. Determination of colour using RGB colour chart.
14. Estimation of humectants.
15. Estimation of curcumin in turmeric.
16. Estimation of capsaicin.
17. Estimation of iodine in Iodised salt
18. Estimation of salt in pickled products.
19. Estimation of baking powder.

20FP2017	MATERIAL SCIENCE FOR FOOD ENGINEERS	L	T	P	C
		3	0	0	3

Course objectives:

1. To understand the fundamentals of material science.
2. To impart basic knowledge on the methods of analysis of materials.
3. To know the biocompatible material for food industry.

Course outcomes:

The student will be able to

1. Enumerate the fundamentals of various bonds in materials.
2. Understand the importance of strength of material in choice of material of construction.
3. Apply knowledge of alloying and developing alloyed material for food systems.
4. Analyze materials to check for imperfections of metals
5. Evaluate and characterize metals.
6. Design material manufacture techniques to develop materials for specific purposes.

Module 1: Introduction to Materials (9 hours)

Introduction to materials, bonding between atoms: metallic bonding, ionic bonding, covalent bonding, Van der Waals bond, thermal expansion, elastic modulus and melting point of materials, Role of materials selection in design, structure-property-processing-performance relationships ; Imperfections in solids: vacancies, equilibrium concentration of vacancies, interstitial and substitutional impurities in solids, dislocations, types and characteristics of dislocations, interfacial defects, stacking faults.

Module 2: Strength of Materials (8 hours)

Structure of materials and Strength of Materials: Yield strength, tensile strength, Hardness and ductility of materials: stress strain behaviour of metals, ceramics and polymers,

Module 3: Fast fracture, Toughness and Fatigue (5 hours)

Micromechanism of fast fracture – Mechanism of crack propogation – Fatigue failure – Fatigue of uncracked and cracked components. ASTM

Module 4: Creep and Corrosion (6 hours)

Creep deformation and creep fracture – Mechanism of creep deformation in metals and designing to lower creep – wet corrosion in materials – Prevention of corrosion

Coating Materials

Module 5: Carbon steels and Alloys (10 hours)

Microstructures produced by cooling – Mechanical Properties of normalized carbon steel- Quenched and tempered carbon steels – TTT diagram – Need for alloying – Hardenability and methods – Corrosion resistance – Passivation - Stainless steel and types

Module 6: Experimental Techniques (7 hours)

Introduction to experimental techniques: XRD, NMR, PSA, for material characterization highlighting links between molecular structure and macroscopic properties.

Text Books:

1. Michael F. Ashby and David R. H. Jones. “Engineering Materials -1. An Introduction to their Properties and Applications”, 2nd Edition. Butterworth-Heinemann, ISBN 0 7506 3081 7, 2002.
2. Michael F. Ashby and David R. H. Jones. “Engineering Materials -2. An Introduction to Microstructures, Processing and Design”. 2nd Edition. Butterworth-Heinemann. ISBN 0 7506 4019 7, 1999.

Reference Books:

1. V. Raghavan. “Materials Science and Engineering: A First Course”, 5th Edition Prentice Hall India, ISBN-10: 9788120350922, ISBN-13: 978-8120350922, ASIN: 8120350928, 2015.
2. S. Upadhyaya and A. Upadhyaya, “Material Science and Engineering”, Viva Books, ISBN-10: 8130902648, ISBN-13: 978-8130902647, 2007.
3. B. S. Mitchell. “An Introduction to Materials Engineering and Science for Chemical and Materials Engineers”, John Wiley & Sons, 2004.

20FP2018	HEAT AND MASS TRANSFER	L	T	P	C
		3	0	0	3

Course Objectives:

1. To understand and apply the principles in heat transfer phenomena in food processing.
2. To understand and apply the principles in mass transfer phenomena in food processing.
3. To design heat transfer equipment.

Course outcomes:

The student will be able to

1. Calculate heat transfer rate by conduction through given geometry.
2. Evaluate the convective heat transfer coefficient for various flow.

3. Understand the role of radiation in heat transfer.
4. Asses the overall heat transfer rate in a heat exchanger.
5. Apply the principle of evaporation in food processing.
6. Relate to the concept of mass transfer in food processing.

Module 1: Conduction (8 hours)

Fourier's law of heat conduction - One dimensional steady state heat conduction equation for flat plate, hollow cylinder - Heat conduction through resistances in series and parallel. Theory of insulation, critical radius of insulation. Thermal conductivity - effect of temperature on thermal conductivity.

Module 2: Convection principle (8 hours)

Natural and forced convection. Hydrodynamic/ velocity boundary layer, boundary layer formation in straight pipes, laminar boundary layer over a flat plate, thermal boundary layer, turbulent boundary layer calculations. Heat transfer in laminar flow over a flat plate.

Module 3: Convection calculation (7 hours)

Application of dimensional analysis for convection - Equations for forced and natural convection under laminar, transition and turbulent conditions. Film Coefficients: Individual and overall heat transfer coefficients and its relationship between them.

Module 4: Radiation and heat transfer with phase change (7 hours)

Radiation - definition and properties. Black body concept - Stefan Boltzman's law, emissivity and absorptivity. Wien's Displacement law. Concept of grey body. Radiation between surfaces and radiation shields. Condensation and boiling heat transfer

Module 5: Heat Exchangers (8 hours)

Classification - Double pipe heat exchanger - parallel and counter flow. Shell and Tube heat exchanger - 1-1, 1-2, 2-4 passes. Plate type heat exchanger - cross flow. Scraped surface heat exchanger. Overall Heat Transfer Coefficient, log mean temperature difference (LMTD), LMTD correction factor, fouling factor and effectiveness of heat exchangers.

Module 6: Mass transfer by diffusion (7 hours)

Molecular diffusion, steady state molecular diffusion in fluids at rest and in laminar flow, molecular diffusion in gases-steady state diffusion of A through non-diffusing B, equimolar counter diffusion. Effect of temperature and pressure on diffusivity.

Text Books:

1. Dutta. Binay K., "Heat Transfer: Principles and Applications", 1st Edition, Prentice Hall of India, New Delhi, 2000. ISBN: 9788120316256.
2. Gavhane K.A., “Heat Transfer SI Units”, 21st Edition, Nirali Prakashan Publications, Pune, 2019. ISBN: 9788190639613.
3. Anantharaman N., Begum K. M. and Meera Sheriffa, “Mass Transfer: Theory and Practice”, Prentice Hall of India, 2017. ISBN: 9788120341692.
4. McCabe W.L., Smith J.C., and Harriot P., “Unit Operations of Chemical Engineering”, 7th Edition, McGraw Hill, New York, 2017. ISBN: 9789339213237.

Reference Books:

1. Kern D.Q., “Process Heat Transfer”, 1st Edition, McGraw Hill, New York, 1950. ISBN: 9780070341906.
2. Cengel Yunus A., "Heat Transfer: A Practical Approach", 2nd Edition, WCB / McGraw Hill, New Delhi, 2002. ISBN: 9780072458930.

20FP2019	UNIT OPERATIONS IN FOOD PROCESSING - II	L	T	P	C
		3	0	0	3

Course Objectives:

1. Understanding the unit operations and their importance in food processing.
2. Learn the operation and utilization of equipments involved in food technology.
3. Select and develop suitable techniques for the food processing operation.

Course Outcomes:

The student will be able to

1. Recognize the properties of liquids and the unit operations related to them.
2. Understand the principles of various unit operations used in food industries.

3. Apply the knowledge of unit operations in mechanization of equipments for food industries.
4. Analyze the requirements for successful operation of evaporators, extractors, extrusion, crystallization and distillatory units.
5. Evaluate the efficiency of evaporators, extractors, extrusion, absorption, crystallization and distillatory units.
6. Design and analyze evaporators, extractors, extrusion, absorption, crystallization and distillatory units for the food industries.

Module 1: Evaporation (9 hours)

Definition –-liquid characteristics – Types of evaporators- Principles of evaporation- Mass balance and Heat balance in single and multiple effect evaporators- heat transfer coefficient - evaporator capacity – boiling point elevation and Duhring's rule- Evaporator economy- Problems-Types of feeding methods in multiple effect evaporators. Vapour compression evaporation systems. Evaporation equipments: Short tube vertical evaporator- Horizontal tube evaporator-Long tube rising film evaporator- Long tube falling film evaporator-Forced circulation evaporator- Applications of evaporation in food processing.

Module 2: Distillation (9 hours)

Definition -Distillation methods– Flash Distillation, Steam distillation, Vacuum distillation– continuous distillation with reflux – combined rectification and stripping- McCabe and Thiele method of determination of no of plates. – Advantages and limitations – distillation equipments – construction and operation – factors influencing the operation. Vacuum Distillation.

Module 3: Leaching and Extraction (8 hours)

Principles of extraction – Solvent selection criteria for extraction – principles of countercurrent and cross current mode of contact - Classification of extraction - extraction equipment Applications; extraction of Fatty acids, oleoresins and essential oils; Relative advantages, limitations and economics - Special extraction techniques– supercritical fluid extraction. Leaching – Leaching equipments – principles of continuous and countercurrent leaching. Mechanical extraction – Expellers, screw press, filter press.

Module 4: Absorption, Adsorption & Ion Exchange (7 hours)

Absorption: Definition & principle -- rate – mass balance– packing and packed tower for absorption – pressure drop and limiting flow rates – **Adsorption**: – equipment – fixed bed adsorber - pressure swing adsorption – Adsorption from liquids**. Ion exchange:** Basic principles-applications-properties.

Module 5: Crystallization (6 hours)

Crystallization equilibrium -rate of crystal growth – stage of crystallization – magma- nucleation crystallization equipment. Variations in crystallizers – vacuum crystallizers. Draft tube, baffle crystallizers.

Module 6: Extrusion Process (6 hours)

Principles of extrusion-Extrusion systems- cold extrusion-extrusion cooking- Extrusion equipments-Single screw extruder- Twin screw extruder-Comparison of single screw and twin screw extruders-Effects of extrusion on the properties of foods-extrusion of starch based products-Nutritional changes-Flavour formation and retention during extrusion- Food application of extrusion.

Text Books:

1. DG Rao, "Fundamentals of Food Engineering" Prentice Hall India Learning Private Limited, New Delhi. ISBN-10: 8120338715, ISBN-13: 978-8120338715, 2009.
2. Earle, R.L. "Unit Operations in Food Processing". Butterworth-Heinemann Ltd; 2nd Revised edition, Pergamon Press, ISBN-10: 0080255361, ISBN-13: 978-0080255361, 1983.
3. Geankoplis, CJ, "Transport Processes and Separation Processes Principles", Prentice Hall India, New Delhi, ISBN-978-81-203-2614-9, 2008.

Reference Books:

1. Zeki Berk, "Food Process Engineering and Technology", 2nd Edition, Academic Press International Series, Oxford, ISBN: 978-0-12-415923-5, 2013.
2. Warren, L McCabe, J.C. Smith and Peter Harriot. "Unit Operations of Chemical Engineering", 7thEdition, McGraw Hill International, Singapore, ISBN-007-424740-6, 2005.
3. G. Brennan, "Food Processing Handbook", WILEY-VCH Verlag GmbH & Co, KGaA, Weinheim, ISBN: 3-527-30719-2, 2006.
4. Dennis R. Heldman and Daryl B. Lund, "Handbook of Food Engineering", 2nd Ed., Taylor &

Francis, ISBN:13:978-0-8247-5331-3, 2007.
5. Zeki Berk, "Food Process Engineering and Technology", Elsevier, Academic Press, ISBN: 978-0-12-373660-4, 2009.

20FP2020	MILLING TECHNOLOGY OF CEREALS, PULSES AND OILSEEDS	L	T	P	C
		3	0	0	3

Course Objectives:

1. To create awareness about the various unit operations involved in milling of cereals, pulses and oil seeds.
2. To study the techniques and equipment used for milling.
3. To make the students to know about the byproducts obtained during processing along with their uses.

Course Outcomes:

The students will be able to

1. Gain knowledge about the structure, composition and pre milling operations in processing of cereals, pulses and oil seeds.
2. Understand about paddy processing and rice milling equipment which will help them for developing entrepreneurial skills.
3. Apply the knowledge to process food grains into value added products.
4. Analyze the suitable technique for milling of various millets.
5. Evaluate the types of mills used for milling of cereals, pulses and oilseeds.
6. Design layout for milling plants.

Module 1: Rice Milling (9 hours)

Important cereals, pulse and oilseed crops - nutritive value - their importance as food, Rice processing – parboiling, drying, dehusking, polishing, modern rice mill machineries – construction and operation- layout of modern rice mills. Products and by products of rice milling.

Module 2: Wheat milling (8 hours)

Wheat – parboiling – drying -flour milling - cleaning – conditioning, hydrothermal treatment - grinding - different components of wheat mill, modern flour milling - different unit operations and material flow through flow diagram and specification for wheat products.

Module 3: Milling of Pulse and soy bean (8 hours)

Pulse milling – pre-treatments- wet and dry method – pulse milling equipments –construction and operation- soya bean processing - nutritive importance of soy bean - Soy bean dehuller – drying –drying of soy products (splits and flakes) – utilization of soy kernel - products

Module 4: Corn Milling (5 hours)

Structure and composition of corn - Corn milling methods – degerming and non-degerming methods - dry milling - wet milling - products and by products obtained from corn milling – Extraction of corn oil.

Module 5: Milling of Oil seeds (9 hours)

oil seeds – types of extraction – pre milling – presses used – screw press and expellers – oil extraction - ghanies – rotary – filters used – solvent extraction method – equipments used – layout of oil milling plant. Processing of soya bean oil, sunflower seed oil, coconut oil, mustard seed oil, palm oil, sesame oil, ground nut oil and cotton seed oil.

Module 6: Millet milling (6 hours)

Major millets and minor millets - nutritive value, methods of processing pearl millet, little millet, finger millet, fox tail millet and banyard millet - methods of processing for making traditional foods. Millets for value addition.

Text Books:

1. Chakraverty, A. "PostHarvest Technology of cereals, pulses and oil seeds", 3rd Edition, Oxford & IBH publishing & Co. Pvt. Ltd., New Delhi. ISBN13: 9788120409699, 2019.
2. Sahay, K.M. and K.K. Singh, "Unit operations of Agricultural Processing". Vikas Publishing House Pvt. Ltd., New Delhi. ISBN No. 81-259-1142-1/9788125911425, 2009.

Reference Books:

1. Gavin Owens, "Cereals processing technology", Bio-Green Elsevier (Exc), New York, ISBN-10: 9351073297, ISBN-13: 978-9351073291, 2015.
2. EIRI Board, "Technology of Oilseeds Processing, Oils & Fats and Refining", Engineers India Research Institute, ISBN-10: 9789380772073, ISBN-13: 978-9380772073, 2011.
3. Riley. K.W, S.C. Gupta, A. Seetharam and J.N. Muhonga. "Advances in small millets", Oxford & IBH Publishing Co. (P) Ltd. New Delhi, 1993.

20FP2021	FOOD STANDARDS AND REGULATIONS	L	T	P	C
		3	0	0	3

Course Objectives:

1. To study importance of food safety in food manufacture.
2. To understand the regulating authorities for food safety world over.
3. To apply safety principles in food production lines.

Course Outcomes:

The students will be able to

1. Recognize the various national and international regulatory bodies working to ensure food safety in the food industries.
2. Understand the safety aspects in food industries with special emphasis on GMO and irradiated foods, water, meat and dairy products.
3. Apply their knowledge of regulations to develop manuals and protocols for food systems based on existing standards both national & international.
4. Analyze and point out the various offences of Food Business Operators based on their knowledge of food regulations.
5. Evaluate the various food hazards in a food system based on HACCP and ISO 22000:2018 standards.
6. Create new food safety management systems or innovative norms for safety of foods.

Module 1 : Introduction to Food Safety (8 hours)

Definition of food safety and concept of safe food; characterization of food hazards- physical, chemical and biological; Hygienic design of food plants and equipments, Food Contaminants (Microbial, Chemical, Physical), Food Adulteration (Common adulterants), Food Additives (functional role, safety issues), Food Packaging & labelling. Sanitation in warehousing, storage, shipping, receiving, containers and packaging materials. Control of rats, rodents, mice, birds, insects and microbes. Cleaning and Disinfection.

Module 2 : Food Safety Regulation Act, 2006 (8 hours)

Food safety and Standards Act – organizational chart – role of individual authority - Provisions as to articles of food –imported items – Responsibilities of the food business operator – Liability of manufacturers, packers, wholesalers, distributors and sellers –Enforcement of the act – Licensing and registration of food business – Analysis of food – regulations regarding labs involved in food analysis – Offences and penalties – Adjudication and food safety appellate tribunal – Recent FSSAI court cases.

Module 3 : Food Quality (5hours)

Key issues in food labelling – Perspective of labelling w.r.t consumer, manufacturers' and Legislators' Food quality Various Quality attributes of food, Instrumental, chemical and microbial Quality control. Sensory evaluation of food and statistical analysis. Water quality and other utilities.

Module 4 : Hazards and Quality Control (8 hours)

Concept of HACCP – Prerequisites for HACCP Programme – Principle based application of HACCP on food systems. Food Quality and Quality control including the HACCP system. Food inspection and Food Law, Risk assessment – microbial risk assessment, dose response and exposure response modelling, risk management, implementation of food surveillance system to monitor food safety, risk communication. ISO 22000 – Importance and Implementation. Kaizen and 5S Process Principles.

Module 5 : Regulations (9hours)

Indian and global regulations FAO in India, Technical Cooperation programmes, Bio-security in Food and Agriculture, World Health Organization (WHO) History and mandate – Operational Structure. Mandate and Functions of the WTO – Agreements, SPS (Sanitary and phytosanitary measures)

agreement, TBT Agreements, World Animal Health Organization(OIE), International Plant Protection Convention (IPPC)

Module 6 : CODEX Commission (7hours)

Codex Alimentarius Commission - Codex India – Role of Codex Contact point, National Codex contact point (NCCP), National Codex Committee of India – ToR, Functions, Shadow Committees etc.

Text Books

1. S. S. Deshpande, "Handbook of Food Toxicology", CRC Press; 1 edition, ISBN-10: 0824707605, ISBN-13: 978-0824707606, 2002.
2. Cynthia A. Robert, "The Food Safety Information handbook", Publisher: Oryx Press Inc, ISBN-10: 1573563056, ISBN-13: 978-1573563055, 2001.
3. Kelley Lee, "The World Health Organization (WHO) (Global Institutions)", Routledge; 1st Edition, ISBN-10: 0415370132, ISBN-13: 978-0415370134, 2008.
4. Editorial Group, FAO Information Division "Understanding Codex, Food and Agriculture Organization of the United Nations and World Health Organization", ISBN 978-92-5-109236-1, 2016.
5. Kiron Prabhakar, "A Practical Guide to Food Laws and Regulations", Bloomsbury India, ISBN-10: 9386141701, ISBN-13: 978-9386141705, 2016.
6. Sara E. Mortimore and Carol A. Wallace, "HACCP - Food Industry Briefing, Book 9", John Wiley & Sons, ISBN – 9780470999561, 2008.
7. Patricia A. Curtis, "Guide to Food Laws and Regulations", Wiley-Blackwell; 1st Edition, ISBN-10: 0813819466, 2005.

Reference Books

1. Marianna B. Karttunen, "Transparency in the WTO SPS and TBT Agreements: The Real Jewel in the Crown (Cambridge International Trade and Economic Law)", Cambridge University Press; ISBN-10: 1108486452, ISBN-13: 978-1108486453, 2020.
2. J. Ralph Blanchfield, "Food Labelling", Woodhead Publishing Limited and CRC Press LLC; CRC Press ISBN 0 8493 0852 6, 2000.
3. Vindika Lokunarangodage, "ISO 22000: 2018 Generic Model: ISO 22000:2018 Food Safety Management System", ISBN-10: 9553584004, ISBN-13: 978-9553584007, 2018.
4. IS 10500:2012 "Indian Standard for Drinking Water – Specification", Publication unit of BIS, (Second Revision), 2012.

20FP2022	FOOD ENZYMOLOGY LAB	L	T	P	C
		0	0	3	1.5

Course Objective:

1. To study the characteristics of various enzymes applicable in food industries.
2. To study the factors affecting enzyme activity in food systems.
3. To apply knowledge of enzymes in food systems.

Course Outcomes:

The students will be able to

1. Gain knowledge about enzymes.
2. Understand the importance of each of the factors that affect enzyme activity.
3. Apply the same to maximize enzyme action.
4. Analyze when a problem arises and give a suitable and logical solution.
5. Evaluate enzymes from different sources and select the right one depending on the type of food / condition.
6. Make appropriate decision of evaluation and characterization when it comes to newer source of enzymes.

List of experiments

1. Estimation of amylase activity
2. Effect of pH on amylase activity
3. Effect of temperature on amylase activity
4. Effect of substrate concentration on amylase activity

5. Effect of enzyme concentration on amylase activity
6. Determination of total and specific activity of amylase
7. Estimation of protease activity
8. Effect of pH on protease activity
9. Effect of temperature on protease activity
10. Effect of substrate concentration on protease activity
11. Effect of enzyme concentration on protease activity
12. Determination of total and specific activity of protease
13. Effect of activators/inhibitors on protease activity.
14. Studies on enzyme immobilization.
15. Comparison of graphical methods for the determination of K_m and V_{max}.
16. Determination of total dietary fiber by enzymatic method – GOD POD method.
17. Determination of Lipases and /or lipoxygenase experiment.
18. Determination of urease inhibitor activity in horse gram.
19. Determination of trypsin inhibitor activity in soya flour
20. Demonstration of allergen testing using ELISA

20FP2023	FOOD PRODUCT TECHNOLOGY LAB-I	L	T	P	C
		0	0	3	1.5

Course Objectives:

1. To learn the various factors affecting the quality of fruit and bakery products.
2. To develop an understanding of the different processes involved in commercial production of fruit and bakery-based products.
3. To demonstrate the ability to develop new products using commercial available ingredients and equipment.

Course Outcomes:

The students will be able to

1. Outline the processing steps for the production of various fruit and bakery-based products.
2. Understand the role of various ingredients in the production of fruit and bakery-based products.
3. Choose appropriate levels of additives for the production of various fruit and bakery-based products.
4. Analyze the flaws in the manufacture of products based upon quality parameters and indexes.
5. Assess the manufactured products and suggest corrective actions in manufacture process.
6. Create standards and protocols for manufacture of new products for fruit and bakery-based products.

List of Experiments

Fruit Based Products

1. Pilot scale manufacture of fruit based RTS beverage.
2. Pilot scale manufacture of squashes.
3. Pilot scale manufacture of carbonated beverages.
4. Pilot scale manufacture of Jams and marmalade.
5. Preparation of fruit preserves.
6. Preparation of fruit spreads.
7. Pilot scale manufacture of Gummies.
8. Pilot scale manufacture of ketchups/sauce.

Bakery Products

9. Pilot scale manufacture of white breads by chorleywood process.
10. Pilot scale manufacture of French breads by sourdough method.
11. Pilot scale manufacture of hard dough biscuits.
12. Pilot scale manufacture of soft dough biscuits.
13. Pilot scale manufacture of cakes by all-in-one method.
14. Pilot scale manufacture of cakes by three stage mixing method.
15. Preparation of doughnut.

20FP2024	FOOD ANALYSIS LAB – II	L	T	P	C
		0	0	3	1.5

Course Objectives:

1. To inculcate basics of food analysis and methods
2. To provide the ability to assess the most appropriate analytical procedure required for a particular food analysis problem.
3. To give practical knowledge of selected food analysis techniques.

Course outcomes:

The student will be able to

1. Gain knowledge on the terminology used in food analysis.
2. Relate to the procedures and equipment required for the analysis of food constituents.
3. Demonstrate the various food analysis conducted in the food industry.
4. Analyze foods for its proximate composition.
5. Evaluate the quality of food materials based on the quality of its constituents.
6. Plan and pick the apt method to be followed for analyzing a food constituent.

List of Experiments:

Sugar rich products like Jams, Squashes, Marmalades, Sugar and confectionery products

1. Analysis of total sugars
2. Different sugars by HPLC method – RI detector
3. Determination of pectin
4. Determination of acidity
5. Determination of fruit solids
6. Determination of Calcium
7. Estimation of Ascorbic acid
8. Estimation of iron
9. Determination of Carbonation volume in carbonated beverages

Milk and Milk products

10. Qualitative tests for checking of milk including a. Clot on boiling test. b. Test for the presence of urea c. Alkaline phosphatase test for checking of pasteurised milk. d. Gerber's method
11. Determination of RM, P and K value of ghee, butter

Wheat and Bakery Products

12. Determination of gluten content
13. Determination of alcoholic acidity
14. Determination of maltose equivalent
15. Estimation of total nitrogen content of food commodities by Kjeldahl method

20FP2025	ENGINEERING PROPERTIES OF BIOLOGICAL MATERIALS	L	T	P	C
		3	0	0	3

Course Objectives:

1. To study about the different methods of determining the quality and properties of different foods.
2. To gain knowledge of engineering properties during processing, packing, storage and transport.
3. To impart knowledge about electrical properties of food and its applications in food engineering.

Course Outcomes:

The student will be able to

1. Identify the structure and chemical composition of foods.
2. Understand Engineering properties of food materials.
3. Apply the rheological physical properties of food materials to design equipments.
4. Analyze food material for its water activity, food stability sorption and desorption isotherm.
5. Discriminate between Newtonian and non-Newtonian fluids.
6. Develop food equipments based on thermal, electrical and magnetic properties of food.

Module 1: Physical Properties of Food Materials (9 hours)
Definitions and measurements- shape, size, density, porosity and surface area-Shrinkage-determination of moisture content. Frictional properties - types, coefficient of friction, angle of repose - types and its determination.

Module 2: Rheological Properties of Foods (9 hours)
Rheology-Types of fluids- Rheological Classification and models, Static tests for solid foods, Creep, relaxation, Dynamic testing of solid foods, stress and strain in solid foods, stress-strain diagram, visco-elastic fluids, measurement methods, Viscometers and Rheometers of different design and their applications, texture measuring instruments, Hardness and brittleness of food materials.

Module 3 : Thermal Properties (7 hours)
Thermal properties, Definition of specific heat, enthalpy, conductivity and diffusivity, surface heat transfer coefficient. Measurement of specific heat, thermal conductivity, thermal diffusivity. Cryogenics, Calorific value of food, Bomb calorimeter. Applications of thermal properties.

Module 4: Hydro and Aerodynamic Properties (7 hours)
Hydrodynamic properties - Properties of fluids, surface tension, diffusion, osmosis, osmotic pressure, Reverse osmosis, separation techniques using membranes and applications. Aerodynamics-Drag Coefficient, terminal velocity, Reynolds number. Application of aerodynamics properties to agricultural products.

Module 5: Textural & Electromagnetic Properties (7 hours)
Types of food textures, Texture measuring instruments- Texture measuring methods- Texture Profile Analysis (TPA), Properties of food powders. Electrical properties, dielectric heating, electrical conductivity, dielectric measurements, microwave heating and other Applications.

Module 6: Optical Properties (6 hours)
Refractive index of food items, Abbe's refractometer, Sorting of food material using optical properties , Optical activity, Polarimeter, Spectrophotometer, Gloss, color, translucency – Definitions, measurement and applications.

Text Books:

1. Serpil Sahin and Servet Gulum Sumnu "Physical Properties of Foods", Special Indian Edition, Re-print, Springer Nature (SIE), ISBN-10: 107160094X, ISBN-13: 978-1071600948, 2020.
2. Mohesnin N.N., "Physical Properties of Plant and Animal Materials, Volume I", Gordon and Breach Science Publishers, New York, ISBN-13: 978-0677213705, ISBN-10: 0677213700, 1970.

Reference Books:

1. Rao, M.A and S.S.H. Rizvi, "Engineering Properties of Foods", 4th edition, CRC Press; New York, ISBN-10: 1466556420, ISBN-13: 978-1466556423, 2014.
2. Lewis M.J, "Physical properties of foods and food processing systems", Woodhead publishing Cambridge, UK, ISBN-10: 9789351072645, ISBN-13: 978-9351072645, ASIN: 935107264, 1990.
3. Shafiur Rehman, "Food Properties Hand book", 2nd Edition, Special-Indian Edition, CRC Press, New York, ISBN-10: 1138627593, ISBN-13: 978-1138627598, 2016.
4. Micha Peleg and Edward B. Bagley, "Physical Properties of Foods" AVI publishing company INC., Westport USA, ISBN-10: 0870554182, ISBN-13: 978-0870554186, 1983.
5. Kachru R.P. and R.K. Gupta, "Physico – Chemical Constituents and Engineering Properties of Food crops", Scientific Publishers Journals Dept., ISBN-10: 8172330839, ISBN-13: 978-8172330835, 1994.

20FP2026	ENGINEERING PROPERTIES OF BIOLOGICAL MATERIALS LAB	L	T	P	C
		0	0	3	1.5

Course Objectives:

1. To study about the different methods of determining the quality and properties of different food materials.
2. To gain knowledge of engineering properties during processing, packing, storage and transport.
3. To impart knowledge about various properties of food and its applications in food engineering.

Course Outcomes:

The students will be able to

1. Understand Engineering properties of food materials.
2. Identify the structure and chemical composition of foods.
3. Determine the physical properties of food materials.
4. Calculate the sorption and desorption isotherm of food materials.
5. Study the rheological behavior of Newtonian and non-Newtonian fluids.
6. Evaluate the properties and quality of food materials.

List of Experiments

1. Determination of viscosity of liquid food using Brookfield viscometer.
2. Determination of surface area of fruits and vegetables by graphical method.
3. Determination of porosity of food grains.
4. Estimation of volume and density of food materials by solid displacement method.
5. Determination of coefficient of friction of grains.
6. Determination of sphericity, roundness and roundness ratio of food materials.
7. Measurement of terminal velocity of food particles.
8. Measurement of angle of repose of food materials.
9. Determination of viscosity of batter by marsh funnel method.
10. Determination of hardness of fruits by penetrometer.
11. Estimation of moisture content of food grains using moisture analyser.
12. Calculation of specific heat of food materials.
13. Calculation of thermal conductivity of food materials.
14. Determination of sorption isotherms for food materials.

20FP2027	FOOD PACKAGING TECHNOLOGY	L	T	P	C
		3	0	0	3

Course Objectives:

1. To study about the functions of packaging along with the influence of various factors on food.
2. To know about the different packaging materials, their manufacturing process and equipment.
3. To study about the various methods of packaging to improve the shelf life of the products.

Course Outcomes:

The students will be able to

1. Recognize the need and functions of packaging in food systems.
2. Understand about shelf life of food and various methods of estimating it.
3. Apply their knowledge of different packaging materials, their manufacturing process and equipment involved.
4. Analyze various closures and sealing mechanisms for use in different packaging solutions.
5. Evaluate and select different printing and labelling methods based on legislative requirements.
6. Devise innovations in food packaging and their applications.

Module 1: Introduction to Food Packaging (7 hours)

Need for Packaging and Functions of packaging. Levels of packaging. Factors affecting quality of good materials– product environment and spoilage factors, Shelf life–estimation and accelerated shelf life studies. Food Packaging design and strategies. Properties of packaging materials. Packaging legislation. Environmental sustainability – packaging waste, reuse and recovery.

Module 2: Metal and Glass Packaging (8 hours)

Common formats for metal cans and metals used. Metal cans – three-piece and two-piece manufacturing, end manufacturing, double seaming, lacquering and decoration. Aerosol can. Aluminum foil, laminate and metallized films. Glass – composition, types, nomenclature and manufacturing. Glass container manufacturing, annealing, surface treatments and inspection.

Module 3: Paper and Paperboard Packaging (6 hours)

Paper – definition and types. Paperboard – definition and types. Manufacturing process. Corrugated board and cartons. Applications in food packaging – paper sack, paper bags, spiral and convolute containers, laminate liquid cartons, folding cartons, multipacks and trays.

Module 4: Flexible, Semi-rigid and Rigid Plastic Packaging (9 hours)
Polymers and Copolymers, Common Plastics in food packaging. Film manufacturing – Extrusion and Calendaring. Cast and blow film processes, Orientation, annealing. Coextrusion, Lamination and Coating. Rigid and semi rigid plastic manufacture – thermoforming, compression molding, injection molding and blow molding.

Module 5: Filling, Sealing, Printing and Labelling of Food Packages (7 hours)
Closing and sealing of containers. Filling equipment, Seal types - Bead seals, Lap Seals and Fin. Hot wire sealing, hot bar sealing and impulse sealing, Types of Pouches. Form Fill Seal equipment – vertical, horizontal and thermoform fill sealing. Printing on food packages. Labels – Types and Nutrition labeling.

Module 6: Advanced Food Packaging methods and Tests on packaging materials (8 hours)
Retort Pouch, Aseptic Packaging, Modified atmosphere packaging, Active packaging – moisture, CO_2 and O_2 control. Intelligent Packaging – Self-heating and Cooling cans, Indicators, Barcode and RFID, Sensors. Smart packaging, Antimicrobial packaging, Nano-packaging, Edible packaging and biodegradable packaging. Tests on packaging materials – mechanical tests, permeation tests – GTR, WVTR, and migration tests.

Text Books:

1. Gordon L. Robertson. "Food Packaging Principles & Practice", CRC Press, ISBN: 9781439862414, 2013.
2. Anne Emblem and Henry Emblem, "Packaging technology Fundamentals, materials and processes", Woodhead Publishing Ltd., ISBN: 9781845696658, 2012.
3. Coles, R., Dowell, D.M., Kirwan, J, "Food Packaging Technology", Blackwell Publishing Ltd., ISBN: 9781405147712, 2009.

Reference Books:

1. Preeti Singh, Ali Abas Wani and Horst-Christian Langowski, "Food Packaging Materials: Testing & Quality Assurance", CRC Press, ISBN:9781315374390, 2017.
2. Kit L Yam and Dong Sun Lee, "Emerging Food Packaging Technologies: Principles and Practice", Woodhead Publishing Ltd, ISBN:9781845698096, 2012.
3. Jung H. Han, "Innovations in Food Packaging", Academic Press, ISBN: 0123116325, 2014.
4. Scott A. Morris, "Food and Package Engineering", Wiley-Blackwell Publishing, ISBN:9781119949794, 2011.
5. Takashi Kadoya, "Food Packaging", Academic Press, ISBN:9780080923956, 1990.

20FP2028	FOOD ENGINEERING AND PACKAGING LAB	L	T	P	C
		0	0	3	1.5

Course Objectives:

1. To gain knowledge on characterization of dehydrated food products.
2. To understand the heat and mass transfer in food materials.
3. To acquire the skills on quality of packaging materials.

Course Outcomes:

The student will be able to

1. Gain knowledge about the characteristics of dehydrated and extruded food products.
2. Understand the importance of particle size of food products.
3. Determine the heat transfer in heat exchangers.
4. Identify suitable processes for the extraction of anthocyanin.
5. Evaluate the migration characteristics of packaging materials.
6. Develop suitable packaging methods for food products.

List of Experiments

1. Characterization of dehydrated Products/extruded Products/flaked Products.
2. Determination of Particle Size-Sieve Analysis
3. Experiment on Plate type pasteurizer.
4. Experiment on plate type contact freezer.
5. Determination of Kinetics of Anthocyanin extraction.
6. Determination of viscosity by viscometer.

7. Determination of thickness and grammage of the given packaging material.
8. Determination of moisture and oil absorption by packaging material using COBB tester.
9. Determination of strength of packaging material using pouch burster.
10. Experiment on vacuum packaging of fruits and vegetables.
11. Experiment on MAP of fruits and vegetables.
12. Determination of thermal process time in retort packaging of food products.
13. Determination of filling efficiency of form fill sealing machine.
14. Experiment on WVTR.
15. Studies on vacuum packaging of fruits and vegetables.
16. Experiment MAP of fruits and vegetables.
17. Retort packaging of food products.
18. Demonstration experiment on form fill sealing machine.

20FP2029	FOOD PRODUCT TECHNOLOGY LAB - II	L	T	P	C
		0	0	3	1.5

Course Objectives:

1. To learn the various factors affecting the quality of milk and confectionery products.
2. To develop an understanding of the different processes involved in commercial production of milk and confectionery based products.
3. To demonstrate the ability to develop new products using commercial ingredients and equipment.

Course Outcomes:

The student will be able to

1. Outline the processing steps for the production of various milk and confectionery based products.
2. Understand the role of various ingredients in the production of milk and confectionery based products.
3. Choose appropriate levels of additives for the production of various milk and confectionery based products.
4. Analyze the flaws in the manufacture of products based upon quality parameters and indexes.
5. Assess the manufactured products and suggest corrective actions in manufacture process.
6. Create standards and protocols for manufacture of new products for milk and confectionery industries.

List of Experiments:

Milk Products

1. Preparation of acid coagulated dairy products – *Rosagulla*
2. Preparation of Butter.
3. Preparation of thermally concentrated dairy products – *Kalakhand.*
4. Preparation of thermally concentrated dairy products *Gulab Jamun.*
5. Preparation of Bread and Butter Pickle/ Hot and Sour Tomato Pickle
6. Osmotic Dehydration of Fruits
7. Preparation of peanut butter
8. Preparation of mayonnaise
9. Experiments on curing of meat/fish using salt

Snack Foods

10. Preparation of extruded snacks
11. Preparation of fried snacks

Gram/legumes Confectionery based

12. Preparation of chikki
13. Preparation of sohanpapdi
14. Preparation of Mysorepak

Sugar based Confectionery

15. Preparation of Hard Boiled Candies
16. Preparation of Marshmallows

20FP2030	FOOD PLANT UTILITY SYSTEMS	L	T	P	C
		3	0	0	3

Course Objectives:

1. To provide knowledge about various types of plant utilities.
2. To impart understanding about industrial water, steam generation and water/air transport mechanism.
3. To gain knowledge on the principles of power transmission and material handling systems.

Course outcomes:

The students will be able to

1. Classify industrial water and water treatment processes.
2. Understand the working principle of pumps and their applications.
3. Apply their knowledge on working principle of steam generators and measurement of performance.
4. Analyze the various power transmission elements and their design.
5. Evaluate food effluent treatment plants.
6. Design and construct various material handling systems.

Module 1: Industrial Water (8 hours)

Water quality. Potable water, Hard water, Substances in Water, Treatment of Water Supplies – Aeration, Filters, Softening - TDS, demineralization, turbidity treatment, disinfection. Treatment for boiler water and refrigerant water.

Module 2: Steam Generation and Fuels (8 hours)

Types of Water tube and fire tube boilers – Boiler mountings and Boiler accessories. Boiler specification- IBR, Performance of steam generators (Simple problems). Boiler maintenance - descaling. Peak load calculation. Boiler Fuels – Types, calorific value and flue gases – problems.

Module 3: Food Plant Pumps and Piping (9 hours)

Pump – theory and heads. Types of pumps - centrifugal pumps – Velocity triangle, efficiency, reciprocating pump - problems – piston pump, rotary gear pump, vane pump, diaphragm pump and peristaltic pump – working and construction. Compressors – Types of compressors. Plant piping and materials

Module 4: Mechanical Power Transmission Systems (8 hours)

Types of shafts - design of solid and hollow shafts – Problems. Rigid and flexible couplings. Belt drives, gear drives, chain drives and rope drives - types and materials. Torque, power and speed – Velocity ratio (Simple problems)

Module 5: Food Effluent Treatment (7 hours)

Food Plant Effluents - Characteristics -Effluents from various food industries – Fruits, vegetables, dairy, distillery, meat, poultry and sea food. Treatment systems and Equipment –Physical, chemical and biological treatments. Sludge and waste water disposal. Solid waste - Incineration and Landfill

Module 6: Material Handling in Food Plants (5 hours)

Material handling in various food industries. Chutes, Belt Conveyor, Roller Conveyor, Vibratory Conveyor, Screw Conveyor, Slat Conveyor, Pneumatic Conveyor, Bucket elevators. Trucks, Pallets and Bulk handling.

Text Books:

1. T.C. Robberts, “Food Plant Engineering Systems”, 2nd edition, CRC Press, Taylor & Francis Group, ISBN: 9781138199392, 2013.

Reference Books:

1. P.G. Smith, “Introduction to Food Process Engineering”, Springer international Edition, ISBN: 9780123709004, 2005.
2. James G. Brennan and Alistair S. Grandison, “Food Processing Handbook - Volume 1”, 2nd edition, Wiley-VCH, ISBN: 9783527324682, 2012.
3. Maria R. Kosseva and Colin Webb, “Food Industry Wastes: Assessment and Recuperation of Commodities”, Academic Press, ISBN: 9780123919281, 2013.

4. R.K Rajput, “Thermal Engineering”, Laxmi Publications, ISBN: 9788131808047, 2008.
5. R.K. Bansal, “Fluid Mechanics and Hydraulic Machines”, Laxmi publications (P) Ltd, ISBN: 9789351382867, 2004.
6. R.S. Khurmi and J.K. Gupta, "A Text Book of Machine Design", Eurasia Publishing House, ISBN: 9788121925372, 2005.

20FP2031	REFRIGERATION AND COLD STORAGE ENGINEERING	L	T	P	C
		3	0	0	3

Course Objectives:

1. To understand the importance of low temperature storage of foods.
2. To design cold storage for food commodities.
3. To know the importance of cold supply chain management.

Course outcomes:

The student will be able to

1. Recognize the principle of refrigeration and various refrigeration cycles.
2. Understand factors affecting cold storage of food commodities.
3. Calculate the thermal load for the air conditioning system.
4. Analyze freezing and its effect on the texture of food.
5. Predict the problems encountered in chilling of foods
6. Design cold supply chain management systems for food sector.

Module 1 : Refrigeration (9 hours)

Refrigeration cycle - Vapour Compression and Vapour Absorption cycles. P-V and T - s and p - h diagram. Ton of refrigeration, coefficient of performance. Components of a Refrigeration system - compressor, condenser, evaporator and piping system. Refrigerants - primary and secondary refrigerants, characteristics of different refrigerants and net refrigerating effect.

Module 2: Air conditioning system (8 hours)

Simple Air Conditioning System. Winter and All Year Air Conditioning Systems. Design Conditions. Load Calculation, Transmission and Distribution of Air.

Module 3: Cold Storage (9 hours)

Cold storage - Design and Construction. Cold load estimation. Properties of insulating materials, air diffusion equipment, Doors and other openings. Prefabricated systems, walk-in-coolers, and refrigerated container trucks. Cold Storage practice - Stacking and handling of material. Optimum temperatures of storage for different food materials.

Module 4: Chilling of foods (7 hours)

Evaporative cooling and direct expansion techniques in chilling. Chilling equipment for liquid foods. Secondary refrigerants. Chilled foods transport and retail cabinets - Basics of Chilled foods microbiology, Packaging of Chilled foods.

Module 5: Freezing of foods (7 hours) Freezing Curve, Freezing rates, crystal size and its effect on texture and quality of foods, Freezer types, Individual quick freezing and Cryogenic Freezing. Freezing practice as applied to different food sectors.

Module 6 : Cold supply chain management (5 hours)

Cold Chain - Introduction, Components of cold chain. Refrigerated distribution and transport systems, Cold chain in retail, Traceability and barcode - Application of RFID in cold chain. Product Temperature and Moisture monitoring.

Text Books:

1. R.K. Rajput, “Thermal Engineering”, 10th edition, Laxmi Publications, 2018, ISBN-13: 978-8131808047.
2. Clive.V.J Dellino, “Cold and Chilled Storage Technology”, Chapman Hall India , 1990. ISBN: 9780442206734.
3. C.P. Arora, “Refrigeration and Air conditioning”, 3rd Edition, Tata McGraw Hill, 2013. ISBN: 9780074630105
4. Da-Wen Sun, “Handbook of Frozen Food Processing and Packaging”, 2nd Edtion, CRC Press, 2011. ISBN: 9781439836040.

Reference Books:

1. Florkowski W.J, Shewfelt R.L, Brueckner B and Prussia S.E, "Post Harvest Handling and Systems Approach", 2nd edition, Academic Press, 2009. ISBN: 9780123741127.
2. Colin Dennis and Michael Stringer: "Chilled Foods – A Comprehensive Guide", 2nd Edition.CRC Press, 2000. ISBN: 9780849308567

20FP2032	BAKERY, BEVERAGES AND CONFECTIONERY TECHNOLOGY	L	T	P	C
		3	0	0	3

Course Objectives:

1. To learn the process involved in the bakery, beverage and confectionery products.
2. To develop an understanding of the different quality parameters required in bakery beverage and confectionery products
3. To demonstrate the ability to develop products in pilot plant scale for bakery beverage and confectionery products.

Course Outcomes:

The student will be able to

1. Gain knowledge on the ingredients, process and machinery involved in bakery, confectionery and beverage technology.
2. Understand the factors affecting the quality of baked and confectionery products.
3. Apply gained knowledge in manufacturing of new products
4. Analyze the process for maintaining and improving the quality of the final product
5. Evaluate the steps involved in the process and improve existing technologies or develop newer technologies
6. Design and create newer process and products that are better economically, nutritionally or technologically.

Module 1: Overview of wheat quality and Equipments used for baking (7 hours)

Wheat Quality Tests-Moisture Test Grain hardness testing. Viscograph, Amylograph, Farinograph. Dough rheology. Baking Equipments Dough mixers, Dividers, rounders, Proofing, moulding, Ovens, Slicers, Packaging materials and equipment, Sanitation and safety.

Module2: Technology of Baking (8 hours)

Bread manufacturing process – Straight dough fermentation, Sponge and dough, Bread faults and staling , Biscuit-Types of biscuit dough – Developed dough, short dough, semi-sweet, enzyme modified dough and batters- importance of the consistency of the dough- Difference between Cookies crackers and biscuits Technology of Wafers manufacturing, Cake – Flour specification – ingredients – manufacturing process – types of chemically aerated goods. Technology of other baked products – Quality Flour Improvers.

Module 3: Sugar Manufacture (8 hours)

Types of sugars- Energy and material balance of cane sugar process. Technology of sugar manufacture – Unit operations involved in sugar manufacture -Grades of sugar - Sugar plant sanitation – Technology of jaggery manufacture – Molasses – Recent trends in sugar cane technology.

Module 4: Beverage Technology – Alcoholic beverages (7 hours)

Manufacture of beer, wine and champagne - Quality characteristics, Manufacture of distilled beverages including whisky, rum and gin – Quality aspects.

Module 5: Beverage Technology – Non-alcoholic beverages (7 hours)

Carbonated beverages – Additives used - Sugar-free, sugarless, carbonated beverages- quality aspects and standards – Water polishing and its importance Probiotic beverages, Hydrodynamic Cavitation-Assisted Vegetable beverages.

Module 6: Confectionery Technology (8 hours)

Types of Confectionery, Principle of characterization, Structural formulae of confectionery products, - Processing of toffee, chocolates, fruit drops, hard boiled candies – Correlation of string consistency and total solids Quality aspects of confectionery products - Technology of aerated confectionery - Additives for Confectioneries. Equipments used in non-conventional / traditional methods of baking.

Text Books:

1. Y. H. Hui "Bakery Products Science and Technology" Editor John Wiley & Sons Ltd UK, ISBN978-1-119-96715-6, 2014.
2. Stanley P. Cauvain, Linda S Young "Baked Products: Science, Technology and Practice" BakeTran, High Wycombe, Bucks, UK, ISBN1405171529, 2008.
3. Emmanuel Ohene Afoakwa "Chocolate Science and Technology" John Wiley & Sons Ltd UK, ISBN978-1-1189-13789-9, 2016.
4. Alexandru Mihai & Alina Maria Holban "Production and management of beverages" Elsevier Publications, ISBN978-0-12-815700-8, 2019.

Reference Books:

1. Sumnu SG and Sahin S. "Food Engineering aspects of Baking sweet goods" CRC Press, ISBN 9781420052749, 2008.
2. Varnam A.H. & Sutherland J.P. "BEVERAGES - Technology, Chemistry and Microbiology", Springer-Science Business Media, B.V., ISBN 978-1-4615-2508-0, 1994.
3. Edwards, W.P. "The Science of Sugar Confectionery" RSC Publishing, UK., ISBN 0-8 5404-593-7, 2000.

20FP2033	PLANTATION AND SPICES PRODUCT TECHNOLOGY	L	T	P	C
		3	0	0	3

Course Objectives:

1. To study about the various methods of processing tea products.
2. To demonstrate a basic knowledge on process of coffee and cocoa products.
3. To develop an awareness of various processing procedure for major spices & minor spices.

Course Outcomes:

The students will be able to

1. Recognize the different unit operations and equipments involved in coffee, tea, cocoa and spices processing.
2. Understand the quality standards in coffee, tea, cocoa and spices processing industries.
3. Apply their knowledge on processing and quality aspects in reducing quality losses and optimization of processing parameters in coffee, tea, cocoa and spices processing industries.
4. Analyze the quality of plantation and spices products based on industrial standards.
5. Evaluate and point out the appropriate technique for the extraction of spice oil and oleoresin from specific spices.
6. Develop functional products based on the functional properties of plantation and spices crops.

Module 1: Coffee Processing Technology (8 hours)

Coffee – Occurrence – chemical constituents – harvesting – Processing of Green Coffee – Cherry Coffee – Parchment Coffee - Manufacture of Roasted and Ground Coffee – Grading of Coffee Beans - Cup Tasting of Coffee - Soluble Coffee - Decaffeinated Coffee - Other Convenience Products.

Module 2: Tea Processing Technology (8 hours)

Occurrence – chemistry of constituents – harvesting – types of tea – Conventional Tea manufacture - Black Tea, Green Tea, Yellow Tea, Red Tea, Dark Tea, White Tea and Green Brick Tea. Nonconventional Tea Products - Flavored Teas - Decaffeinated Teas - Instant Teas - Quality standards and specifications.

Module 3: Cocoa Processing Technology (8 hours)

Occurrence – Harvesting – Curing, Fermentation, Drying - Sorting and Quality Determination - Chemistry of the cocoa bean – Processing of cocoa bean – cocoa powder – cocoa liquor manufacture Chocolates – Types – Chemistry and technology of chocolate manufacture – Quality control of chocolates.

Module 4: Manufacture of Oleoresins and Essential Oils (7 hours)

Spice flavours - Processing issues - functional role of spices - Oleoresins and Essential oils – General methods of manufacture – Major international quality specifications - The American Spice Trade Association (ASTA) - The European Spice Association (ESA) - Quality assurance systems. Encapsulation of oleoresins and spice oils.

Module 5: Chemistry and Technology of Major Spices (7 hours)
Description, Quality issues, Handling after harvest, Chemical structure, Industrial processing, Products - Functional properties - Black Pepper, Cardamom, Ginger, Chilli, Mint, and Turmeric.
Module 6: Chemistry and Technology of Minor Spices (8 hours)
Description, Quality issues, Handling after harvest, Chemical structure, Industrial processing, Products - Functional properties - Cumin, Coriander, Cinnamon, Fenugreek, Garlic, Clove and Vanilla.

Text Books:

1. Chakraverty, A., Mujumdar, A.S., Raghavan, G.S.V., Ramaswamy, H.S. "Handbook of Post-Harvest Technology – cereals, fruits, vegetables, tea and spices", Marcel Dekker Inc., New York (Special Indian Reprint). ISBN 13: 9780824705145, 2010.
2. H. Panda, "Handbook on Spices and Condiments (Cultivation, Processing and Extraction)", National Institute of Industrial Research (NIIR) Board, Asia Pacific Business Press Inc., ISBN-10: 8178331322, ISBN-13: 978-8178331324, 2010.
3. Peter, K.V. "Hand book of herbs and spices", Volume 2, Wood head publishing Ltd.; eBook ISBN: 9780857095688. 2004.
4. N. Kumar, "Introduction to Spices, Plantation Crops, Medicinal and Aromatic Plants", Oxford & IBH Publishing Co Pvt. Ltd; 2nd Revised edition, ISBN-10: 8120417763, ISBN-13: 978-8120417762, 2018.

Reference Book:

1. Minifie Bernard W., "Chocolate, Cocoa and Confectionery Technology", 3rd Edition, Aspen Publication, 1999. ISBN: 9780834213012.

20FP2034	MEAT, POULTRY AND FISH PROCESSING TECHNOLOGY	L	T	P	C
		3	0	0	3

Course Objectives:
1. To understand about the composition and nutritive value of meat, poultry and fish
2. To know about processing technology of meat, poultry and fish
3. To understand the HACCP and GMP of meat, poultry and fish plant.

Course Outcomes:
The students will be able to
1. Describe the muscle structure related to physical and chemical properties.
2. Explain the slaughtering methods and carcass processing of different types of meats.
3. Demonstrate effective preservation methods for ensuring consumer safety.
4. Analyze meat quality with respect to HACCP and GMP of meat, poultry and fish processing.
5. Evaluate the quality of processed and preserved poultry and egg products.
6. Design layout for slaughter houses and meat processing units.

Module 1: Introduction to Meat Science, Meat Microbiology and Safety (6 hours)
Meat composition from different sources-Muscle structure and compositions and its modifiers- White and Red Meat -description of animal fat and its modifiers- description of bone and its modifiers-Post mortem muscle chemistry, Meat colour and Flavor- meat microbiology and safety. Sensory characteristics and evaluation of meat
Module 2: Slaughtering and Carcass Processing (8 hours)
Modern abattoirs and some features, Ante mortem handling and welfare of animals, design of handling facilities, Hoisting rail and traveling pulley system, and stunning methods, stunning pen, slaughtering equipment, Washing area, Sticking, bleeding, dressing, Beef/Sheep and Pig Dressing operations, Offal handling and inspection, Inedible by products: Carcass processing equipment, Operational factors affecting meat quality, effects of processing on meat tenderization; meat processing equipment. Meat plant hygiene, GMP and HACCP.
Module 3: Meat Products and Processing Methods (8 hours)
Processing methods of meat and meat products- Chilling and Freezing of Meat, Irradiation of Meat. Secondary methods: Mechanical Deboning, Breading, Marination-Drying: Principles and Applications, Canned meat, Meat- Cured Meat, Smoked meat, Fermented Meat- Processing of meat and meat products like Cooked Ham, Cooked Sausages, Bacon, Dry-Cured Ham, Mold-Ripened Sausages,

Semidry and Dry Fermented Sausages -Intermediate moisture meat products

Module 4: Processing of Poultry and Poultry Meat Products (7 hours)

Poultry industry in India, measuring the yields and quality characteristics of poultry products, microbiology of poultry meat, spoilage factors; Plant sanitation; Poultry meat processing operations in detail along with equipment used- Unloading, Stunning, Bleeding, Scalding, De-feathering, Electrical Stimulation, Evisceration etc. Chilling, Weighing and Grading. Packaging of poultry products, refrigerated storage of poultry meat, HACCP in poultry processing.

Module 5: Processing of Egg and Egg Products (7 hours)

Structure, composition and nutritive value of egg, egg proteins and functional properties of egg white and yolk. Factor affecting egg quality and their measurements. Industrial uses of eggs. Collection, grading, cleaning, washing, packaging and transportation of eggs, preparation of egg products. Microbial spoilage of egg and egg; products-by products – eggs, egg products, Whole egg powder, Egg yolk products, their manufacture, packaging and storage.

Module 6: Processing of Fish and Fishery Products (9 hours)

Commercially important marine products from India, spoilage factors of fish, fish handling, cleaning and sanitization, field refrigeration and icing practice, merits and demerits, Use of dry ice and liquid nitrogen as preservation elements, use of Refrigerated Sea Water (RSW) for preservation, Changes during storage in RSW and CSW; Freeze preservation; freezing of prawn and shrimp, weighing, filling and glazing, Individual quick freezing - relative merits and demerits, Canning operations, Salting and drying of fish, pickling and preparation of fish protein concentrate and fish oil. Packaging of fish and fishery products, Seafood quality assessment- Physical, chemical, sensory, HACCP in fish processing.

Text Books:

1. Hui, Y. H., “Handbook of Meat and Meat Processing”, CRC Press, Taylor & Francis Group, Boca Raton, FL, ISBN-13: 978-1-4398-3684-2, 2012.
2. Kerry, J. P., and Kerry, J. F., “Processed Meats: Improving Safety, Nutrition and Quality”, Woodhead Publishing, Cambridge, UK, ISBN - 978-1-84569-466-1, ISBN - 978-0-85709-294-6, 2011.

Reference Books:

1. Toldra, F., “Handbook of Meat Processing”, Blackwell Publishing, Ames, Iowa, ISBN- 978-0-8138-2182-5, 2011.
2. Barbut, S., “The Science of Poultry and Meat Processing”, Library and Archives Canada Cataloguing in Publication, Guelph, Ontario, Canada, ISBN- 978-0-88955-625-6 (bound), 978-0-88955-626-3, 2015.
3. Boziaris, I. S., “Seafood Processing: Technology, Quality and Safety”, John Wiley & Sons, Ltd, West Sussex, UK, ISBN- 978-1-118-34621-1, 2014.
4. Granata, L. A., Flick, G. J., Martin, R. E., “The Seafood Industry: Species, Products, Processing, and Safety”, John Wiley & Sons, Ltd, West Sussex, UK, ISBN- 978-0-8138-0258-9, 2012.

20FP2035	STORAGE ENGINEERING OF FOOD MATERIALS	L	T	P	C
		3	0	0	3

Course Objectives:

1. Acquiring knowledge and improve skill-sets in the area of food storage.
2. Understanding the specific aspects of storage techniques and requirements.
3. Designing storage structures for any food material.

Course Outcomes:

The student will be able to

1. Identify the specific storage requirements for various food materials.
2. Understand the pre-requisites for the safe handling and storage of food materials.
3. Solve problems related to identification of time-temperature combinations, cooling load and other operational parameters for food materials storage.
4. Analyze the shelf-life testing of various food materials during storage.
5. Evaluate the pest control strategies in the storage space used for food storage.

6. Design structures for storage of grains and other major crops.

Module 1: Physico - Chemical and thermal properties of grains (7 hours)

Grain dimensions, bulk density, true density, porosity, coefficient of friction, angle of repose, thermal conductivity and aerodynamic properties. Psychrometry: humidity, relative humidity, humid heat, deterioration index, wet bulb temperature, use of psychrometric charts.

Module 2: Cold storage (7 hours)

Cold storage- Moist air and applied psychrometry, Estimation of cooling load, Air conditioning systems, Evaporators, Compressors, Condensers, Expansion devices, Cooling towers, Different types of refrigerants, Transmission and distribution system of cool air, Thermal and vapor insulation materials, Design of small capacity cold storage, Instrumentation and climate.

Module 3: Frozen storage (8 hours)

Quality loses in frozen foods- Physical changes, Chemical changes in food components, Nutritional aspects of freezing, Microbiology of frozen products, Glass transitions temperature and stability of frozen foods, Temperature requirements during frozen storage, Shelf-life of frozen foods- shelf-life testing, Modelling loss of quality in frozen foods, Time-Temperature integrators, Packaging of frozen foods, Different types of freezers.

Module 4: Modified atmospheric storage (7 hours)

Overview of Modified atmospheric storage, Gases and Vapor applied to modified atmosphere processing operations, MAP modelling- Kinetics of food deteriorative reactions, Shelf-life testing, Enzyme kinetics applied to MAP, MAP design with oxygen modelling.

Module 5: Controlled atmospheric storage (7 hours)

Biochemical considerations of CAS, Gas exchange mechanisms, Mass balance principles, Gas generators, Equipment's for producing and regulating controlled atmosphere, Design of controlled atmosphere storage chambers.

Module 6: Grain storage structures (9 hours)

Storage of grains–physicochemical and biochemical changes, storage factors affecting losses, integrated pest management- Chemical and nonchemical - Fumigation; Damage caused by rodents; Storage pests, Traditional storage structures – merits and demerits, improved storage structures, modern storage structures; Farm silos: Horizontal silos, tower silos, pit silos, trench silos, bag and bulk storage–pressure distribution theories, design of silos – design consideration - size and capacity of silos, storage requirements. Central Warehouse – Regulations.

Text Books:

1. Rao, Chandra Gopala. "Engineering for storage of fruits and vegetables: cold storage, controlled atmosphere storage, modified atmosphere storage",1st edition. BS Publications, ISBN-10: 8178003260, ISBN-13: 978-8178003269, 2014.
2. Burg, Stanley. "Hypobaric storage in food industry: advances in application and theory", Academic Press, ISBN-10: 0124199623, ISBN-13: 978-0124199620, 2014.
3. Evans, Judith A., "Frozen food science and technology". 1st edition, Wiley-Blackwell, ISBN-10: 1405154780, ISBN-13: 978-1405154789, 2008.

Reference Books:

1. Ahvenainen, Raija, "Novel food packaging techniques", 1st edition, Woodhead Publishing, ISBN-10: 1855736756, ISBN-13: 978-1855736757, 2003.
2. Morris S.A., "Food and Package Engineering", Wiley – Blackwell, ISBN No. 1119949777, 2011.
3. Robertson G.L., "Food packaging: Principles and practice", Taylor & Francis/CRC Press, ISBN No. 0849337755, 2006.
4. Kirwan M.J., Derek McDowell D., and Coles R., "Food Packaging Technology", Blackwell Publication, ISBN No. 084939788X, 2003.

20FP2036	PROCESS ECONOMICS AND PLANT LAYOUT DESIGN	L	T	P	C
		3	0	0	3

Course Objectives :

1. To enable the students understand various concepts of economics of food plant.
2. To understand the processes involved in layout design.

3. To understand the development and design consideration and cost estimation in food industry.

Course Outcomes :

The students will be able to

1. Gain knowledge on the various factors involved in setting up a Food Processing Industry.
2. Understand the process of food plant layout design.
3. Apply their knowledge to design projects for setting up a Food Processing Industry.
4. Analyse the problems involved in deciding the level of manufacture of a food product
5. Evaluate the options involved and decide on the right choice based on the economics of the system
6. Develop own industry or plan turn-key projects based on the request from customers

Module 1: Food Process Design Development (7 hours)

Feasibility studies and its importance. Technical feasibility survey of Food Industry, process development, Food Process flow sheets Product and Process flow diagram- Representative examples–– Computed-aided process design – Principles of spread-sheet aided process design (Basic concepts only).

Module 2: Plant Layout (7 hours)

Criteria for selection of site, process and product Government regulations and other legal restrictions, community factors and other factors affecting investment and production costs. Plant Layout based on process and product. Richard Muther's Simple Systematic Plant Layout. Layout design for representative product industries – Hazard and its prevention- OSHA guidelines

Module 3: Overview of Sanitary and Hygienic Design and Layout (6 hours)

Hygienic food process design – Principles of Sanitary design - equipment design and specifications-Basic outline on FSMS.

Module 4: Project Evaluation and Cost Estimation (9 hours)

Capital investments – fixed capital investments including land, building, equipments and utilities, installation costs (including equipments, instrumentation, piping, electrical installation and other utilities), working capital investments. Methods of cost estimation – Cost Indices.

Module 5: Product Cost and Plant Overheads (9 hours)

Manufacturing costs – Direct production costs(including raw materials, human resources, maintenance and repair, operating supplies, power and other utilities, royalties, etc.). – Process Profitability - Application to a Food Processing plant. Depreciation, Amortization and methods of determining the same. – Energy audit concept.

Module 6: Profitability Analysis (7 hours)

Methods to determine profitability - Cash flow diagram and its importance - Optimization techniques – Linear and Dynamics programming, Optimization strategies. Overview of the concepts of Total quality management.

Text Book:

1. Max S. Peters, Klaus D. Timmerhaus, Ronald E. West. "Plant design and Economics for Chemical Engineers, 5th Edition, McGraw Hill, ISBN -125900211X, 9781259002113, 2011.

Reference Books:

1. Rudd D F and Watson C C, "Strategy of Process Engineering", John Wiley & Sons Inc, ISBN-978-0471844559, 2013.
2. Maroulis Z.B. and Saravacos G.D. "Food Process Design", Marcel Dekker Inc. ISBN-0824743113, 2003.
3. Towler G and Sinnott R.K. "Chemical Engineering design principles, practice and Economics of Plant and Process", 2nd Edition. Elsevier, ISBN-9780080966595, 2012.
4. Baasel W.D, "Preliminary chemical engineering plant design", 2nd Edition, ISBN-10: 0442234406, ISBN-13: 978-0442234409, 1990.
5. Heldman D.R. and Lund D B. "Hand Book of Food Engineering", 2nd edition, CRC Press, Taylor and Francis Group, ISBN-10: 1466563125, ISBN-13: 978-1466563124, 2019.

20FP2037	FAT AND OIL PROCESSING TECHNOLOGY	L	T	P	C
		3	0	0	3

Course Objectives:

1. To understand the physical and chemical properties of fats and oils.
2. To study the extraction and refining processes of various oils and fats.
3. To learn the packaging, quality standards of fats and oils.

Course Outcomes:

The students will be able to

1. Recognize the importance of fats and oils in human diet.
2. Describe the manufacturing process of oils and fats.
3. Apply knowledge on manufacture to design alternate fats.
4. Analyze the quality attributes of oils and fats.
5. Defend the use of specialty fats to meet human dietary requirement.
6. Design suitable packaging materials for fats and oils.

Module 1: Raw material and Properties (8 hours)

Overview of fats and oil, sources of fats and oils- vegetables, animal fat; properties of fats and oils- nomenclature ad structure; chemical properties and reactions – hydrolysis and free fatty acids, esterification, inter-esterification, saponification and iodine value, oxidative stability, peroxide value, conjugated dienes, anisidine value; physical properties – colour, crystal structure of fat, thermal properties, density, optical and spectroscopical properties.

Module 2: Extraction Methods (8 hours)

Oil extraction methods –mechanical expression Cold Press Extraction–Advantages ghani , power ghani, rotary, hydraulic press, screw press, expellers, filter press - principle of operation and maintenance-solvent extraction process – steps involved, batch and continuous-continuous solvent extraction process for rice bran, soy bean and sunflower-oil extraction process for groundnut and cotton seed-production of special oils – palm oil, virgin coconut oil – extraction process.

Module 3: Refining of Oils (7 hours)

Refining of oils – objectives – characterization - degumming – Zeneath process – deacidification process – continuous acid refining-bleaching of oil –decolourising agents-deodorization and winterization processes- Hydrogenation of Fats – Vanaspati and Margarine – Ghee and butter-Physical Refining

Module 4: Quality of oils (8 hours)

Flavour quality of fats and oils – formation of flavours and off-flavours, hydrolytic rancidity, oxidative rancidity, flavour impact of oxidation compound, factors affecting flavour quality – intrinsic and extrinsic, methods to measure flavour quality - chemical, sensory analysis, oil quality improvement through processing

Module 5: Packaging of Edible Oils and storage (8 hours)

Packaging of edible oils – requirements – types – tinplate, semi rigid, glass, Polyethylene Terephthalate, Poly Vinyl Chloride, flexible pouches – packaging for Vanaspati and ghee. Changes during storage of oil –rancidity – causes – atmospheric oxidation and enzyme action – free fatty acid – colour.

Module 6: Oils and fat applications (6 hours)

Utilization of fats and oils: shortening technology, margarine types and preparation technology, liquid oil technology, speciality fats and oils, by product utilization.

Text books:

1. Harry W. Lawson, “Food oils and Fats - Technology, Utilization and Nutrition”, Springer; Softcover reprint of the original 1st ed., ISBN-10: 144194737X, ISBN-13: 978-1441947376, 2011.
2. Gunstone F.D., “Oils and Fats in Food Industry”, Blackwell Publishing, United Kingdom, ISBN – 13: 9781405181212, 2008.

Reference book:

1. Gunstone F.D., “Vegetable Oils in Food Technology: Composition, Properties and Uses”, 2nd Edition, Wiley - Blackwell Publishing Ltd., ISBN 9781444332681, 2011.

20FP2038	DRYING TECHNOLOGY OF FOOD MATERIALS	L	T	P	C
		3	0	0	3

Course Objectives:

1. To understand the basic theory of drying and its significance in food systems
2. To understand the importance of drying as a method of food processing
3. To learn about the working of different types of dryers.

Course Outcomes:

The students will be able to

1. Gain knowledge on drying principles.
2. Understand different types of dryers for different food materials.
3. Apply the principles to solve problem on drying.
4. Analyze the efficiency of industrial dryers.
5. Evaluate the dryer performance.
6. Design dryers for different types of foods

Module 1: Theory of Drying (6 hours)

Principles of drying – Fundamentals of air-water mixtures – Psychrometric chart – Problems based on psychrometry – Drying curves – constant and falling rate period - Heat and mass transfer in dryers – moisture content in foods – determination of moisture content and its measurement - methods of determination. Water Activity and measurement methods-Models.

Module 2: Principles of Drying Methods (6 hours)

Selection of dryers – Conventional drying. Conduction drying – convection drying – Pneumatic or fluidized bed drying – natural air drying – heated air drying – recirculatory dryer (non mixing type) – Radiation drying – Sun drying and infrared drying – Dielectric drying -Thin layer and deep bed drying - dryer performance. Chemical drying

Module 3: Design of Dryers (8 hours)

Drying - pre-conditioning and suitability of crops for drying - Heat requirements - estimation of heat required and design of heating system - estimation of thermal efficiency of drying system.– selection of driers. Drier types - design considerations - design criteria – calculation. Operation and their control.

Module 4: Drying Technology of Crops (7 hours)

Drying characteristics of cereals and, pulses - factors affecting drying process - initial moisture content, temperature of hot air, airflow rate and humidity. Drying characteristics of oilseeds - factors affecting drying process - initial moisture content, temperature of hot air, airflow rate and humidity. Drying characteristics of fruits, nuts , herbal plants & spices - factors affecting drying process - initial moisture content, temperature of hot air, airflow rate and humidity.

Module 5: Drying Techniques (9 hours)

Drying of liquid foods – principles and requirements – methods. Spray drying – suitability of material – construction and operation – types of nozzles. Adjustments in spray drying – quality of the spray dried products. Drum drying – drum driers – construction and operation – adjustments, suitability of materials – quality of drum dried products. Freeze drying – principles and suitability – construction of freezers and operation – packaging requirements of freeze dried products. Foam mat drying – principles and applications – advantages – foaming and stabilizing agents. Agitators and foaming devices - drying methods of foams Vacuum drying – principles and construction of dryer. Source of heat and stability of the walls. Solid gain and water loss in osmosis - drying methods for osmotic dehydration of foods – tray drying and vacuum drying.

Module 6: Advanced Drying Methods (9 hours)

Heat pump drying – concept and apparatus – construction and operation. Adjustments and operation of heat pump driers – suitability of materials and quality of heat pump dried products.

Tray and vacuum drying of osmosis products and quality of products. Selection of dryers for various food materials – factors to be considered - requirement of the product. Heat utilization factor and thermal efficiency of drying systems – performance testing - factors to be considered to increase the efficiency of the dryer. Installation, operation and maintenance of industrial dryers – concept and practice.

Osmo-Vac dehydration – principles and methods – different osmotic agents- suitability and selection of osmotic agents. Microwave drying, radio frequency drying and tunnel drying - principles and equipment.

Text Books:

1. Arun S. Mujumdar, "Handbook of Industrial Drying", CHIPS, 3rd Edition, *ISBN* 9781466596658, 2006.
2. Chakraverty. A. " Post-Harvest Technology of Cereals, Pulses and Oil seeds", Oxford and IBH Publishing Co. Pvt. Ltd. New Delhi, *ISBN*: 9788120409699, 9788120409699, 2014.

Reference Books:

1. Paul Singh, R and Dennis R. Heldman. "Introduction to Food Engineering", 4th Edition, Academic Press, ISBN-10: 0123709008, ISBN-13: 978-0123709004, 2008.
2. Arun S Mujumdar, Hong-Wei Xiao, "Advanced Drying Technologies for Foods", CRC Press, ISBN-10: 1138584908, ISBN-13: 978-1138584907, 2019.
3. Harry W. Von Loesecke, "Drying and Dehydration of Foods", Read Books, ISBN-10: 1447449630, ISBN-13: 978-1447449638, 2012.

20FP2039	FOOD ANALYSIS LAB-III	L	T	P	C
		0	0	3	1.5

Course Objectives:

1. To determine the quality of Food commodities.
2. To interpret the genuineness of the products based on the quality.
3. To learn advanced techniques of food analysis for food commodities.

Course Outcomes:

The student will be able to

1. Understand the quality parameters of different types of food products.
2. Classify food products based on their quality.
3. Interpret results and decide on the quality.
4. Compare two brands of the same product and decide the best one based on the quality.
5. Evaluate newer products based on quality.
6. Design and develop newer and better methods of analysis for improving the quality of a food product.

List of Experiments

Meat, Fish and egg

1. Determination of Extract release volume.
2. Determination of swelling ratio.
3. Determination of TMA.
4. Qualitative tests for eggs.

Plantation Products including Tea, Coffee and Cocoa, spices

5. Determination of Total extractives.
6. Determination of Tannin content.
7. Determination of Caffeine.
8. Moisture content of spices by karl Fisher method or Xylene distillation method.
9. Estimation of volatiles – steam distillation method.
10. Determination of capsaicin content of chilli.
11. Determination of pipperine content of pepper.
12. Tests for checking quality of condiments.

High Fat Products

13. Peroxide value and free fatty acid in chips and traditional fried items.
14. Trans fat – GC method.

Vitamins, Minerals and Colourants

15. Estimation of anthocyanins.
16. Estimation of Chlorophyll.
17. Kinetics of extraction / degradation of colourants.
18. Sensory evaluation of foods.

20FP2040	SIMULATION, MODELING AND STATISTICAL COMPUTING LAB	L	T	P	C
		0	0	3	1.5

Course objectives:

1. To understand the fundamentals of simulation.
2. To impart basic knowledge on simulation and modeling.
3. To know the importance of dynamics and control.

Course outcomes:

The student will be able to

1. Recognize the role of simulation in the design of equipments.
2. Understand the various methods of calculating the properties.
3. Calculate the various properties of fluids used for/in distillation.
4. Analyze the transient behavior of fluids.
5. Predict the role of modeling and simulation of equipment design.
6. Design equipments for unit operations involved in food industry through simulation, modeling and statistical computing.

List of Experiments

1. Simulation of a Flash drum.
2. Computation of bubble point temperature.
3. Computation of dew point temperature.
4. T-x-y and P-x-y diagram of a binary mixture.
5. Simulation of Continuous Stirred Tank Reactor.
6. Simulation of Plug Flow Reactor.
7. Simulation of the binary distillation column.
8. Simulation of the multi component distillation column.
9. Simulation of the reactive distillation column.
10. Dynamics and control of Continuous Stirred Tank Reactor.
11. Dynamics and control of Plug Flow Reactor.
12. Dynamics and control of a reactive distillation column.

20FP2041	FOOD PROCESS EQUIPMENT DESIGN	L	T	P	C
		3	0	0	3

Course Objectives:

1. To be conversant with the materials of construction for food processing equipment.
2. To know the criteria for design of equipments
3. To integrate process equipment design and Safety

Course Outcomes:

The students will be able to

1. Identify the factors that will affect the design of equipment
2. Classify the variables based on various properties
3. Interpret the relation between various process variables
4. Select the critical variables for the design of equipments
5. Develop a conceptual design model
6. Assess the validity of the conceptual model

Module 1: Materials of Construction and Process Flow Diagram (7 hours)

Basic considerations in process equipment design. Materials of construction – mechanical properties. Metals and non-metals for construction. Design considerations - stresses created due to static and dynamic loads. Process flow diagrams (PFD) – symbols used in PFD.

Module 2: Design of Pressure Vessels (10 hours)

Design conditions and stresses – design stress, design criteria, corrosion allowance. Design of a shell and its components – cylindrical and spherical shells, head, nozzles and flange thickness. Vessels subjected to internal pressure and combined loading – cylindrical shell and spherical shell, stresses induced in the vessel. Vessels subjected to external pressure. Optimum proportions of a vessel and optimum vessel size.

Module 3: Design of Storage Vessels (6 hours)

Storage of fluids – storage of volatile, non-volatile liquids and storage of gases. Design of rectangular tanks – with and without stiffeners. Design of tanks – bottom and shell design and self-supporting roof design.

Module 4: Design of reaction vessels (6 hours)

Classification of reaction vessels, heating system. Design considerations – jacket design, coil and channel design.

Module 5: Design of Heat Exchangers and Evaporators (8 hours)

Classification of heat exchangers – double pipe heat exchangers, shell and tube heat exchangers, plate and frame heat exchanger. Design of shell and tube heat exchanger. Design of calendria type evaporators.

Module 6: Design of Mixers and Dryers (8 hours)

Types of agitators. Power requirements for agitation. Design of agitation system components – shaft design and agitator design. Design of tray dryers.

Text Books:

1. B.C. Bhattacharya, "Introduction to Chemical Equipment Design: Mechanical Aspects" 1st edition, CBS Publishers and Distributors Pvt Ltd, New Delhi, 2018. ISBN-13: 978-8123909455.
2. Shrikant D Dawande, "Process design of equipment". Volume I, 6th edition, Central Techno Publications, Nagpur, 2012. ISBN-13: 978-8189904425.
3. Mahajani V.V and Umarji S.B, "Joshi's process equipment design", 5th edition, Laxmi Publications Pvt Ltd, New Delhi, 2017, ISBN-13: 978-9351380191.

Reference Books:

1. Singh & Heldman."Introduction to Food Engineering", 5th edition, Academic Press – Elsevier India Private Ltd. New Delhi, 2014, ISBN: 978-0-12-398530-9.
2. Jasim Ahmed, Mohammad Shafuir Rahman "Handbook of Food Process Design, 2 volume Set" Wiley-Blackwell, 2012, ISBN: 978-1-444-33011-3.
3. Miguel A. Galan, Eva Martin del Valle. "Chemical Engineering: Trends and Developments" , 1st edition, Wiley-Blackwell, 2005, ISBN-13: 978-0470024980.
4. Zacharias B. Maroulis, George D. Saravacos "Food Process Design", 1st edition, CRC Press, 2003, ISBN: 9780367270087.

20FP2042	COMPUTER AIDED FOOD PROCESS EQUIPMENT DESIGN LAB	L	T	P	C
		0	0	3	1.5

Course Objectives:

1. To provide basic knowledge to design food plant equipment using computing software.
2. To impart skills on simulating process environment virtually.
3. To understand relational database and design specific unit operations.

Course Outcomes:

The students will be able to

1. Recognize the need for automation of design process for food industries.
2. Understanding the elements of computer aided design principles.
3. Solve design problems using computer aided simulation tools.
4. Analyze unit operations in heat transfer process through computer aided simulation.
5. Predict heat transfer and flow rates using computer aided software.
6. Design a chemical plant using ANSYS FLUENT.

List of Experiments:

1. Basic concept of simulation and CFD.
2. Introduction to GAMBIT
3. Introduction to FLUENT
4. Heat transfer through laminar flow
5. Heat transfer through Turbulent flow.
6. Simulation of flow past sphere.
7. 2-Dimensional heat flow analysis.

8. 3-Dimensional heat flow analysis.
9. Conjugate heat transfer study.
10. Heat transfer through fluid.

20FP2043	NOVEL PROCESSING TECHNIQUES OF FOOD PRESERVATION	L	T	P	C
		3	0	0	3

Course objectives:

1. To understand the fundamentals of novel processing of foods.
2. To impart basic knowledge on the methods of food preservation.
3. To know the application of advanced preservation in food industry.

Course outcomes:

The student will be able to

1. Enumerate the fundamentals of various food preservation techniques.
2. Understand the importance of preservation techniques.
3. Apply knowledge of choosing appropriate methods food systems.
4. Analyze methods of various preservation techniques.
5. Evaluate and characterize the quality of products.
6. Design new manufacture techniques to develop process for specific purposes.

Module 1: High Pressure Processing (8 hours)

Principles of high pressure processing, use of high pressure to improve food safety and stability. Effects of high pressure on food quality: Pressure effects on microorganisms, enzyme, texture and nutrients of food. Modelling HP processes. Other applications of high pressure processing.

Module 2: Pulsed electric field processing (8 hours)

Pulsed electric fields processing: Historical background, PEF treatment systems, main processing parameters. Mechanisms of action: mechanisms of microbial and enzyme inactivation. PEF for processing of liquid foods and beverages, PEF Processing for solid foods. Food safety aspects of pulsed electric fields. Pulsed electric field and high pressure processing.

Module 3: Osmotic dehydration and membrane concentration: (7 hours)

Osmotic dehydration: mechanism of osmotic dehydration, effect of process parameters on mass transfer, determination of moisture and solid diffusion coefficient, application of osmotic dehydration. Athermal membrane concentration of liquid foods and colours: osmotic membrane distillation, direct osmosis, membrane modules, Applications of membrane concentration.

Module 4: Ultrasound processing (7 hours)

Ultrasound processing: fundamentals of ultrasound, ultrasound as a food preservation and processing aid, effects of ultrasound on food properties.

Module 5: Microwave heating (7 hours)

Microwave heating: dielectric properties of foods, heat and mass transfer in microwave processing, application of microwave processing for foods

Module 6: Hybrid drying technologies (8 hours)

Hybrid drying technologies: combined microwave vacuum drying, combining microwave vacuum drying with other processes, equipment for microwave vacuum drying, product quality degradation during dehydration.

Text Books:

1. Sun, D. *Emerging Technologies for Food Processing,* (Academic Press, 2005)
2. Barbosa-Canovas, G. V., Tapia, M. S. and Cano, M. P. *Novel Food Processing Technologies,*(CRC Press, 2004)

Reference Books:

1. Ohlsson, T. and Bengtsson, N. *Minimal Processing technologies in the food industry,* (Woodhead Publishing Limited, 2002)

20FP2044	PRINCIPLES OF FOOD SCIENCE AND NUTRITION	L	T	P	C
		3	0	0	3

Course objectives:

1. To understand the fundamentals of bio molecules
2. To impart basic knowledge on the methods of analysis of fats and oils
3. To know the food additives and microbes associated with food

Course outcomes:

The students will be able to

1. Recognize the fundamentals of food constituents and quality analysis.
2. Understand the types of food additives and their importance in food.
3. Use their understanding of microorganisms associated with food to develop safe foods.
4. Analyze the factors responsible for spoilage of various foods.
5. Evaluate the methods of preservation of foods.
6. Predict the role of food borne diseases and intoxication.

Module 1: Fundamentals of Food Constituents - Carbohydrates (5 hours)

Introduction to Proximate constituents of food -Carbohydrates – Classification – Simple & complex, mono-, di-, oligo- and polysaccharides; Important reaction of carbohydrates –Caramelisation, Maillard.

Module 2: Fundamentals of Food Constituents – Fats and Vitamins (6 hours)

Fats – classification – Analysis of Fats and oils – Saponification value, Iodine value, Acid value, Acetyl value, Peroxide value – Principles and Importance of the analytical methods, Vitamins – Fat and water-soluble – nutritional significance.

Module 3: Food Additives (9 hours)

Introduction to food additives - Classification, intentional and non-intentional additives, functional role in food processing and preservation; food colourants – natural and artificial; food flavours; enzymes as food processing aids.

Module 4: Microorganisms associated with Food (9 hours)

Bacteria, yeasts and molds – sources, types and species of importance in food processing and preservation; Oriental fermented foods and, Production of Sauerkraut, Wine, Lactic acid and single cell protein.-examples and their applications.

Module 5: Food Borne Diseases and Intoxication (8 hours)

Food intoxications and poisonings – *Bacillus* spp., *Clostridium botulinum*,*Staphylococcus aureus*,Hepatitis, Gastroenteritis viruses, *Entamoeba histolytica*.Food spoilage – factors responsible for spoilage, spoilage of vegetable, fruit, meat, poultry, beverage and other food products.

Module 6: Food Preservation (8 hours)

Principles involved in the use of sterilization, pasteurization and blanching, thermal death point - methods of determination of thermal death time (Graphical, mathematical) – D, Z and F values – Importance of 12 D concept, Time – Temperature indicators - Canning; frozen storage-freezing methods, factors affecting quality of frozen foods; irradiation preservation of foods.

Text Books:

1. Coultate, T.P, "Food – The Chemistry of its Components", 4th Edition. Royal Society, London, ISBN-10: 0854046151, ISBN-13: 978-0854046157, 2001.
2. Sivasanker, B, "Food Processing and Preservation", Prentice-Hall of India Pvt. Ltd. New Delhi, ISBN-9788120320864, 2002.

Reference Books:

1. Frazier W.C. and D.C. Westhoff, "Food Microbiology", 4th Ed., McGraw-Hill Book Co., New York, ISBN_9780070667181,2008.
2. Adams M.R and Moss M.O, "Food Microbiology", Panima Publishing corporation, New Delhi, 2nd Edition, Third reprint, ISBN-13:9788122410143,978-8122410143, 2007.

20FP2045	PROCESSING OF FOOD COMMODITIES	L	T	P	C
		3	0	0	3

Course Objectives:

1. To study various processing methods for various food commodities like fruits & vegetables, dairy products, cereals, meat, poultry, fish and bakery products.
2. To study various innovative food processing techniques in food processing industries.
3. To apply safety and regulations involved in food production lines.

Course Outcomes:

The students will be able to

1. Recognize the characteristics of various food commodities produced from fruits and vegetables, dairy, cereals, meat, fish, egg and plantation products.
2. Understand the processing technologies involved in food processing industries.
3. Apply their knowledge of processing techniques in production of fruits and vegetables, dairy, cereals, meat, fish, egg and plantation products.
4. Analyze various methods of preservation involved in food production and categories them.
5. Evaluate and choose the best fit processing technique for a specific food commodity.
6. Design layouts for processing units involved in fruit and vegetable, cereals and pulses, dairy and meat and marine product manufacture.

Module 1: Cereal and Pulses Processing Technology (8 hours)

Rice milling, Pulse milling, Wheat milling - Major Bread making Processes - Straight Dough, Sponge and Dough, Rapid Processing, Chorleywood Bread Process (CBP), Frozen Dough Process - Manufacture process of Biscuits, Cakes and Cookies - Method of manufacture – Tortilla, Pasta.

Module 2: Fruits and Vegetable Processing (8 hours)

Production of Fruits and vegetables in India, Cause for heavy losses, Methods of Preservation and Processing - Basics of Canning, Hurdle technology in Fruit and Vegetable Processing, Methods of manufacture and FSSAI standard of Jams, Jellies, Squash, Cordial, Tomato Sauce.

Module 3: Dairy Processing (8 hours)

Composition of Milk, Microorganisms in Milk, Platform Tests, MMPO standards and manufacture of dairy products such as Standardised, Toned and Double toned milk, Icecream, Cheese, Yoghurt Skimmed milk powder – Dairy Equipments - Pasteurizers, Homogenizers, Spray Dryers, Centrifuges and Cream Separators.

Module 4: Meat, Poultry and Fish Processing (8 hours)

Meat composition from different sources, Carcass Processing unit outline, Sausage and Bacon manufacture - Processing of Poultry Meat - Fish Processing outline and Microbiological safety of Fish based products.

Module 5: Processing of Plantation Products (7 hours)

Manufacturing process of Black Tea, Green Tea and Instant Tea - Manufacturing process of Cherry Coffee, Parchment Coffee and Instant Coffee - Cocoa - Outline Cocoa Processing and Chocolate Processing. General defects in Chocolates.

Module 6: Technology of Spices Processing (6 hours)

Outline of the methods of processing of Pepper, cardamom, ginger, vanilla and turmeric.
Encapsulation method for spice oil production. Functional properties of major spices.

Text Books:

1. R.P. Srivastava and Sanjeev Kumar, “Fruit and Vegetable Preservation Principles and Practices”, CBS; 3rd Revised edition, ISBN-10: 8123924372, ISBN-13: 978-8123924373, 2019.
2. Amalendu Chakraverty, Arun S. Mujumdar, Hosahalli S. Ramaswamy, “Handbook of Postharvest Technology: Cereals, Fruits, Vegetables, Tea, and Spices”, CRC Press; 1st Edition, ISBN-10: 0824705149, ISBN-13: 978-0824705145, 2003.
3. NIIR Board, “Modern Technology of Milk Processing & Dairy Products”, NIIR Project Consultancy Services; 4th Edition, ISBN-10: 8190568574, ISBN-13: 978-8190568579, 2013.
4. NPCS Board of Consultants & Engineer, “The Complete Technology Book on Meat, Poultry and Fish Processing”, NIIR Project Consultancy Services; 2nd Revised Edition, ISBN-10: 819056854X, ISBN-13: 978-8190568548, 2013.

5. N. Kumar, "Introduction to Spices, Plantation Crops, Medicinal and Aromatic Plants", Oxford & IBH Publishing Co Pvt. Ltd; 2nd Revised edition, ISBN-10: 8120417763, ISBN-13: 978-8120417762, 2018.

Reference Books:

1. Karel Kulp and Joseph G Ponte Jr, "Handbook of Cereal Science and Technology", CRC Press; 2 edition, ISBN-10: 0824782941, ISBN-13: 978-0824782948, 2000.

20FP2046	TECHNOLOGY OF PACKAGING	L	T	P	C
		3	0	0	3

Course Objectives:

1. To provide knowledge on packaging and packaging materials.
2. To understand the working of various packaging methods.
3. To enable the students to understand applications of various packaging materials in food industry.

Course Outcomes:

The students will be able to

1. Identify the need for food quality and packaging.
2. Understand sealing and filling operations for various food packaging materials.
3. Apply the knowledge on advance food packaging methods on industrial problems.
4. Analyze the manufacturing process of various packaging materials.
5. Evaluate the food packaging levels, design strategies and framework.
6. Design packages for food systems by testing of packaging materials.

Module 1: Introduction to Food Packaging (7 hours)

Packaging developments–historical perspective. Food supply and the protective role of packaging. Definition of basic functions of packaging. Packaging strategy – Packaging design and development framework. Levels of Packaging. Food Package Environments. Factors affecting product quality - Shelf Life Testing.

Module 2: Metal and Glass as Food Packaging Materials (9 hours)

Metal cans – Types of metals used. Container Making process – Three-piece cans and Two-piece cans – End-making processes. Aerosol cans. Protective and Decorative Coatings. Glass as Food Packaging Material – Types of Glasses and Composition – Glass Container Manufacturing Processes - annealing and surface treatments.

Module 3: Plastic as Food Packaging Materials (9 hours)

Plastics used in Food Packaging – Polymers and Copolymers. Plastic Manufacturing - Extrusion and Calendaring. Extrusion – Cast and Blow film processes - Orientation and Annealing. Coextrusion. Coating and Lamination of Plastic Films. Rigid and semi rigid plastic manufacture – Blow molding, injection molding, compression molding and thermoforming.

Module 4: Paper as Food Packaging Materials (4 hours)

Paper Manufacturing Process. Types of Paper and applications. Paper board – Types. Laminated Paper board – Types. Corrugated Fibre Board and Fibre Drum packaging.

Module 5: Filling and Sealing of various types of Packages (9 hours)

Closures for Glass and Plastic Containers. Sealing of Plastic Films. Heat Sealing and Types of Seal. Conductance, Impulse, Induction, Dielectric, and Ultrasonic sealing. Types of Pouch. Form fill Seal Equipment – Vertical and Horizontal. Types of filling equipment.

Module 6: Advanced Packaging Methods and Testing of Materials (7 hours)

Vacuum and Inert Gas Packaging. Retort pouch packaging. Active packaging and Modified atmosphere packaging – principles and applications. Aseptic Packaging, Intelligent packaging, Biodegradable packaging, Edible packaging. Tests on packaging materials – Physical, chemical and mechanical tests. Gas and water vapour transmission rates.

Text Book:

1. Coles, R., Dowell, D.M., Kirwan, J, "Food Packaging Technology", Blackwell Publishing Ltd., ISBN-10: 084939788X, ISBN-13: 978-0849397882, 2003.

Reference Books:

1. Gordon L. Robertson. "Food Packaging Principles & Practice", 3rd Edition, CRC Press, ISBN-10: 9781138628052, ISBN-13: 978-1138628052, ASIN: 1138628050, 2013.
2. Scott A. Morris, "Food and package engineering", Wiley-Blackwell Publishing, ISBN-10: 9788126566747, ISBN-13: 978-8126566747, ASIN: 8126566744, 2011.
3. Takashi Kadoya, Food Packaging, Elsevier India, ISBN-10: 9351072401, ISBN-13: 978-9351072409, 2014.

20FP3001	MASS TRANSFER AND SEPARATION TECHNIQUES IN FOOD PROCESSING	L	T	P	C
		3	0	0	3

Course Objectives:

1. To provide knowledge on the basic principles involved in mass transfer and separation processes.
2. To impart knowledge on the functioning of mass transfer and separation in food processing.
3. To equip the students with sufficient technical skills to perform the operations.

Course Outcomes:

The students will be able to

1. understand the principles of various mass transfer and separation processes.
2. express the various mass transfer and separation processes.
3. describe the types of separation processes in food engineering.
4. calculate the material balance in food processing units.
5. appraise the performance of processing unit operations
6. provide solutions to the issues in food processing operations.

Module 1: Mass Transfer Operations in Food Processing (7 hours)

Mass Transfer Laws: Fick's law for molecular diffusion, molecular diffusion in biological solutions and gels, molecular diffusion in solids, mass transfer coefficients, interphase mass transfer, diffusion of gases in porous solids and capillaries. Conservation of mass and materials balances, energy and heat units, conservation of energy and heat balance. Dimensional analysis.

Module 2: Evaporation and Distillation (9 hours)

Evaporation: Basic principles, single and multiple effect evaporation, Heat economy, Vapour recompression, evaporation equipments.

Distillation: Vapour liquid equilibria, boiling point diagram, relative volatility, enthalpy concentration diagram, flash vapourization, differential distillation, steam distillation, azeotropic distillation and extractive distillation for binary system. Continuous rectification, McCabe Thiele method.

Module 3: Extraction and Leaching (7 hours)

Mechanical extraction – Expellers, screw press, filter press. Liquid-liquid extraction, liquid-liquid extraction equipment, single and multistage extraction. Super critical Fluid extraction

Liquid-liquid extraction: Ternary liquid–liquid equilibrium and tie line data, choice of solvents, extraction equipments. Leaching principle and equipments.

Module 4: Gas Absorption (7 hours)

Equilibrium solubility of gases in liquids, ideal and non ideal solutions. Equipments: Gas dispersed-bubble columns, tray towers, liquid dispersed-venturi scrubbers, wetted wall towers, spray tower, packed towers. Concept of NTU, HTU and HEPT. Ideal stage and stage efficiency.

Module 5: Mechanical Separations (8 hours)

Screening/sieving: Types of screens- screen capacity – screen effectiveness. **Filtration:** Filtration process- constant volume filtration, Constant pressure filtration, Filtration equipment-Rotary filter-Leaf filter-Plate and frame filter. **Sedimentation:** gravity sedimentation, Sedimentation thickening-stokes law. **Centrifugal Separation:** Principles of centrifugation- -separation of liquids in a centrifuge - Centrifugation equipment and applications.

Module 6: Separation by Membranes (7 hours)

Membrane types and their characteristics, Membrane Concentration-Polarization Configuration of membranes, membrane materials, Design of membranes, membrane fouling and control measures Cross flow filtration, solvent transport in membrane systems, membrane separation processes: Reverse

Osmosis (RO), Nano filtration (NF), Diafiltration, Ultra filtration (UF), Micro filtration (MF), Perevaporation.

Text books:

1. Geankoplis C.J., "Transport process and separation process principles", PHI learning private limited, New Delhi, 4th edition, ISBN-978-81-203-2614-9, 2008.
2. McCabe, W.L., Smith, J.C., and Harriott, P., "Unit operations of chemical engineering". McGrawhill Intl. Edition, Singapore, 7th edn. ISBN-007-424740-6, 2005.

Reference books:

1. Coulson J.M., Richardson J.F., Bachurst J.R., and J.H. Harker – "Coulson & Richardson's Chemical Engineering – Vol. 2 Particle Technology and Separation Processes", Butterworth & Heinemann - Elsevier science Ltd., Fifth Edition, ISBN 0750644451, 2002.
2. Ramaswamy H.S. and Markotte M., "Food Processing Principles and Applications", CRC Press Ltd. ISBN-1-58716-008-0, 2006.
3. Introduction to Food Engineering- Singh R. Paul & Heldmann Dennis R, Academic Press, London, UK. *ISBN*: 9780123985309.

20FP3002	TECHNOLOGY OF FOOD FLAVOURANTS AND COLOURANTS	L	T	P	C
		3	0	0	3

Course Objectives:

1. To enable the student to understand the basics of food flavourants and colourants.
2. Basics of foods flavors and colours.
3. Chemistry & technology of natural flavours, pigments.

Course Outcomes:

The student will be able to

1. recognize the basics of flavours and colours and their safety aspects
2. understand the correlation between appearance and taste
3. develop methods for stabilization of flavourants and colourants
4. assess the quality of a food based on flavaourants and colourants
5. develop a new range of flavorants and colorants
6. design new techniques for analysis of colorants and aroma chemicals

Module 1: Basics of Flavours and Colours (8 hours)

Olfactory perception of flavour and taste – Theories of olfaction - Molecular structure and activity relationships of taste – Sweet, bitter, acid and salt, Chemicals causing pungency, astringency, cooling effect – properties. Classification of flavours – Natural, Nature identical and synthetic – Flavor potentiators. Basics of colour – Hue, chroma, brightness. Regulations regarding additions – Toxicology and safety aspects

Module 2: Technology of Natural Flavours (7 hours)

Classification – Alliaceous flavours – Bittering agents, Coffee and Cocoa, Fruit flavours.Evolution of flavours during processing – enzymatic development, effect of roasting, cooking frying on flavour developments- Essential oils and oleoresins –Extraction – Super critical fluid extraction - Continuous and semi-continuous methods- Effect of types of solvents used. -Staling of flavours. Microbial and cell suspensions in the synthesis of flavours and colours - Microwave assisted extraction of colours.

Module 3: Technology of Natural colorants (9 hours)

Chlorophyll and chlorophyll derivatives, Haems and bilins, Carotenoids, annatto, saffron, turmeric-Anthocyanins and betalains, Less common colourants – Acylated β-ring substituted anthocyanins, Monascus, cochineal and related pigments. Stability to pH, temperature and other processing conditions - Technology for the production of dried colourants.

Module 4: Techniques of Flavour Isolation and Analysis (7 hours)

Total component analysis– Basics and methods – Recent developments. Head space analysis – static and dynamic methods – basic principles – method and developments - Solid phase micro extraction of aroma components - E nose technology. Tristimulus colorimetry – Basics and application to foods.

Module 5: Techniques of Flavour Stabilisation (7 hours)
Methods for the stabilisation of flavorants and colorants - Liquid suspensions and emulsions - Techniques of micro and nano encapsulation - Technology for the production of dried colourants. Encapsulation technology - Micro and nano encapsulation

Module 6: Sensory Attributes of Food (7 hours)
Principles of Good Practice – Protocols to be followed – Design considerations – Discrimination testing – Types of discriminatory tests – Descriptive analysis.

Text Books:

1. Reineccius G. and Heath H.B., "Flavor Chemistry and Technology" , Taylor and Francis group, CRC Press, II Edition, 2006. ISBN 10: 1-56676-933-7 (Hardcover)
2. Socaciu C., "Food Colorants - Chemical and Functional Properties", CRC Press, Taylor and Francis group, LLC, ISBN No. 9780849393570, 2008.

Reference Books:

1. Goodner K. and Rouseff R. "Practical Analysis of Flavor and Fragrance Materials"Blackwell Publishing Limited. 2011. Print ISBN: 978-1-405-13916-8; ePDF ISBN: 978-1-444-34314-4
2. Rowe D.J., **"**Chemistry and Technology of Flavors and Fragrances", Blackwell Publishing Ltd., U.K., ISBN No. 1405114509, 2005.
3. Francisco D-V and Octavio P-L., "Natural Colorants for Food and Nutraceutical Uses", CRC Press LLC, 2003. ISBN: 1-58716-076-5
4. Henry G.A.F and Houghton J.D. "Natural Food Colorants". Second Edition. Springer SciencetBusiness Media Dordrecht. 1997. ISBN 978-1-4615-2155-6 (eBook)

20FP3003	FOOD SAFETY REGULATIONS AND CONTROL	L	T	P	C
		3	0	0	3

Course Objectives:
1. To enable the students to understand the need for regulations and safety in Food Industries.
2. To enable the students to understand the basics of food safety and regulations governing the same, the world over.
3. To make the students to understand the role of individual personnel of the regulatory authority.

Course Outcomes:
The students will be able to
1. recognize the various national and international regulatory bodies working to ensure food safety in the food industries.
2. understand the safety aspects in food industries with special emphasis on GMO and irradiated foods, water, meat and dairy products.
3. apply their knowledge of regulations to develop manuals and protocols for food systems based on existing standards both national & international.
4. analyze and point out the various offences of Food Business Operators based on their knowledge of food regulations.
5. evaluate the various food hazards in a food system based on HACCP and ISO 22000:2018 standards.
6. create new food safety management systems or innovative norms for safety of foods.

Module 1 : Introduction to Food Safety (8 hours)
Definition of food safety and concept of safe food; characterization of food hazards- physical, chemical and biological; Hygienic design of food plants and equipments, Food Contaminants (Microbial, Chemical, Physical), Food Adulteration (Common adulterants), Food Additives (functional role, safety issues), Food Packaging & labelling. Sanitation in warehousing, storage, shipping, receiving, containers and packaging materials. Control of rats, rodents, mice, birds, insects and microbes. Cleaning and Disinfection.

Module 2 : Food Safety Regulation Act, 2006 (8 hours)

Food safety and Standards Act – organizational chart – role of individual authority - Provisions as to articles of food –imported items – Responsibilities of the food business operator – Liability of manufacturers, packers, wholesalers, distributors and sellers –Enforcement of the act – Licensing and registration of food business – Analysis of food – regulations regarding labs involved in food analysis – Offences and penalties – Adjudication and food safety appellate tribunal – Recent FSSAI court cases.

Module 3 : Food Quality (5hours)

Key issues in food labelling – Perspective of labelling w.r.t consumer, manufacturers' and Legislators' Food quality Various Quality attributes of food, Instrumental, chemical and microbial Quality control. Sensory evaluation of food and statistical analysis. Water quality and other utilities.

Module 4 : Hazards and Quality Control (8 hours)

Concept of HACCP – Prerequisites for HACCP Programme – Principle based application of HACCP on food systems. Food Quality and Quality control including the HACCP system. Food inspection and Food Law, Risk assessment – microbial risk assessment, dose response and exposure response modelling, risk management, implementation of food surveillance system to monitor food safety, risk communication. ISO 22000 – Importance and Implementation. Kaizen and 5S Process Principles.

Module 5 : Regulations (9hours)

Indian and global regulations FAO in India, Technical Cooperation programmes, Bio-security in Food and Agriculture, World Health Organization (WHO) History and mandate – Operational Structure. Mandate and Functions of the WTO – Agreements, SPS (Sanitary and phytosanitary measures) agreement, TBT Agreements, World Animal Health Organization(OIE), International Plant Protection Convention (IPPC)

Module 6 : CODEX Commission (7hours)

Codex Alimentarius Commission - Codex India – Role of Codex Contact point, National Codex contact point (NCCP), National Codex Committee of India – ToR, Functions, Shadow Committees etc.

Text Books:

1. S. S. Deshpande, "Handbook of Food Toxicology", CRC Press; 1 edition, ISBN-10: 0824707605, ISBN-13: 978-0824707606, 2002.
2. Cynthia A. Robert, "The Food Safety Information handbook", Publisher: Oryx Press Inc, ISBN-10: 1573563056, ISBN-13: 978-1573563055, 2001.
3. Kelley Lee, "The World Health Organization (WHO) (Global Institutions)", Routledge; 1st Edition, ISBN-10: 0415370132, ISBN-13: 978-0415370134, 2008.
4. Editorial Group, FAO Information Division "Understanding Codex, Food and Agriculture Organization of the United Nations and World Health Organization", ISBN 978-92-5-109236-1, 2016.
5. Kiron Prabhakar, "A Practical Guide to Food Laws and Regulations", Bloomsbury India, ISBN-10: 9386141701, ISBN-13: 978-9386141705, 2016.
6. Sara E. Mortimore and Carol A. Wallace, "HACCP - Food Industry Briefing, Book 9", John Wiley & Sons, ISBN – 9780470999561, 2008.
7. Patricia A. Curtis, "Guide to Food Laws and Regulations", Wiley-Blackwell; 1st Edition, ISBN-10: 0813819466, 2005.

Reference Books:

1. Marianna B. Karttunen, "Transparency in the WTO SPS and TBT Agreements: The Real Jewel in the Crown (Cambridge International Trade and Economic Law)", Cambridge University Press; ISBN-10: 1108486452, ISBN-13: 978-1108486453, 2020.
2. J. Ralph Blanchfield, "Food Labelling", Woodhead Publishing Limited and CRC Press LLC; CRC Press ISBN 0 8493 0852 6, 2000.
3. Vindika Lokunarangodage, "ISO 22000: 2018 Generic Model: ISO 22000:2018 Food Safety Management System", ISBN-10: 9553584004, ISBN-13: 978-9553584007, 2018.
4. IS 10500:2012 "Indian Standard for Drinking Water – Specification", Publication unit of BIS, (Second Revision), 2012.

20FP3004	INSTRUMENTAL TECHNIQUES FOR FOOD ANALYSIS	L	T	P	C
		3	0	0	3

Course Objectives:

1. To quantify various components of food using instrumental techniques
2. To know the presence of adulterants in the food sample
3. To interpret the data from various instrumental techniques

Course outcomes:

The students will be able to

1. recognize the components of the mixture using chromatographic techniques.
2. identify the functional groups present in the food sample
3. calculate the trace metals present in the food sample
4. analyze the structure of the novel compound isolated from natural source
5. assess the molecular weight of the given component
6. organize components from mixture based on electrical property

Module 1: Chromatographic Techniques (9 hours)

Classification of chromatographic methods: Column, Thin Layer, Paper; Mechanism of separation. Theory of Gas chromatography – Instrumentation – types of detectors – FID, TCD, ECD - Chromatographic parameter. HPLC: Basic principles – Mobile phase – Instrumentation – Types of detector - solvent property detectors and solute property detectors – advantages of HPLC over other techniques.

Module 2: FTIR Spectroscopy (8 hours)

Infrared region - Molecular vibrations – Vibrational frequencies and IR absorption Bands- Infrared spectrum - IR spectrophotometer - Sample preparation - application. - Diffuse reflectance Infrared Fourier Transform Spectrometry - Attenuated total reflectance Spectroscopy - Near Infrared spectroscopy - Far infrared spectroscopy.

Module 3: Atomic Absorption Spectrometry (8 hours)

Principle - Atomic Absorption Spectrometer - Working of AAS - Atomic Emission Spectroscopy - Excitation methods - Flame Emission Spectrometry - Plasma Emission Spectrometry - Inductively coupled Plasma Atomic Emission Spectroscopy ((ICP - AES) - Direct Current Plasma Atomic Emission Spectroscopy (DCP - AES) - General features of plasma source spectrometers - Atomic fluorescence spectroscopy - principle.

Module 4: NMR Spectroscopy and Mass Spectrometry (7 hours)

NMR principle and instrumentation. Relation between spin quantum number and NMR, Chemical shift, shielding and deshielding effects. ^{1}H and ^{13}C NMR spectrum. Mass spectrometry – Principle, instrumentations – Ionization Methods - applications.

Module 5: Conductometry (7 hours)

Conductometry titrations Types, advantages and disadvantages. Potential measurement - pH, pO_2, pCO_2, $pHCO_3$ determination. Basic Principle of electrophoresis, application of paper, starch gel, agarose, and native and denatured PAGE. Isoelectric focusing, capillary, microchip and 2D electrophoresis.

Module 6: Other Analytical Instruments (6 hours)

Principle and application of SEM, TEM, XRF, Differential Scanning Calorimeter, XRD, e-sensors and biosensors. Instrumentation and Application of water activity meter, Texture analyzer.

Text books:

1. B. Sivashankar "Instrumental Methods of Analysis", 1st edition, Oxford University Press, New Delhi, 2012. ISBN-13: 978-0198073918.
2. Sham K Anand , Gurdeep R Chatwal "Instrumentation Methods of Chemical Analysis", 5th edition, Himalaya Publishing House Pvt., Ltd., Bombay, 2014. ISBN-13: 978-9351420880.
3. Willard, H.H., Merritt, L.L., Dean, J.A., and Settle, F.A., "Instrumental Methods of Analysis", 7th edition, CBS Publishers and Distributors, Delhi, 2004. ISBN-13: 978-8123909431.
4. Pare J.R.J. and Belanger J.M.R. "Instrumental Methods of Food Analysis", 1 edition, Elsevier Science, Netherlands, 1997. ISBN 9780444818683.

Reference Books:

1. Rouessac F. and Rouessac A., "Chemical Analysis: Modern Instrumentation Methods and Techniques", 2nd Edition, John Wiley and Sons. Ltd. England, 2007. ISBN: 978-0-470-85903-2.
2. D.L.B. Wetzel G. Charalambous "Instrumental Methods in Food and Beverage Analysis", volume 39, 1st edition, Elsevier Science, 1998. ISBN: 9780080534756.

20FP3005	ADVANCED FOOD PROCESS EQUIPMENT DESIGN	L	T	P	C
		3	0	0	3

Course Objectives

1. To design and develop equipment used in food processing operations.
2. To be conversant with type of the equipment and the materials of construction
3. To acquire knowledge about process design and safety

Course Outcomes

The students will be able to

1. Identify the factors that affects the design of equipments
2. Classify the design variables based on various properties
3. Relate various process variables
4. Prioritize the critical variables for the design of equipments
5. Recommend a conceptual design model
6. Assess the validity of the conceptual model

Module 1: Basic Design Considerations (7 hours)

Basic considerations in process equipment design. Materials of construction – mechanical properties and materials. Design considerations - stresses created due to static and dynamic loads. Process flow diagrams (PFD) – symbols used in PFD.

Module 2: Design of Pressure Vessels, Storage Tanks and Pulper (8 hours)

Introduction to design - principles and selection of food processing equipment - design of pressure vessels - design aspects of storage tanks, design of sterilizers and process vats - design of pulper - design considerations.

Module 3: Design of Cold Storage and Freezers (8 hours)

Design of cold storage - estimation of cooling load - construction, operation and maintenance of cold storage -design consideration for controlled atmospheric storage and modified atmospheric storage of perishables - design of freezers - types of freezers - design considerations - construction and operation-design of frozen storage.

Module 4: Process and mechanical design of reactors (6 hours)

Batch and continuous reactors. Design equation for batch, continuous stirred tank and plug flow reactor- Classification and accessories. Mechanical design of – jacket, coil and channel.

Module 5: Design of Heat Exchangers and Evaporators (8 hours)

Classification of heat exchangers. Design consideration for double pipe heat exchangers, shell and tube heat exchangers. Design of plate and frame heat exchangers. Process and mechanical design of calendria type evaporators.

Module 6: Design of Dryers and Mixers (8 hours)

Types of agitators. Power requirements for agitation. Design of agitation system components – shaft design and agitator design. Design of tray dryers.

Text Books:

1. B.C. Bhattacharya, "Introduction to Chemical Equipment Design: Mechanical Aspects" 1st edition, CBS Publishers and Distributors Pvt Ltd, New Delhi, 2018. ISBN-13: 978-8123909455.
2. Shrikant D Dawande, "Process design of equipment". Volume I, 6th edition, Central Techno Publications, Nagpur, 2012. ISBN-13: 978-8189904425.
3. Mahajani V.V and Umarji S.B, "Joshi's process equipment design", 5th edition, Laxmi Publications Pvt Ltd, New Delhi, 2017, ISBN-13: 978-9351380191.

Reference Books:

1. Singh & Heldman."Introduction to Food Engineering", 5th edition, Academic Press – Elsevier India Private Ltd. New Delhi, 2014, ISBN: 978-0-12-398530-9.
2. Jasim Ahmed, Mohammad Shafuir Rahman "Handbook of Food Process Design, 2 volume Set" Wiley-Blackwell, 2012, ISBN: 978-1-444-33011-3.
3. Miguel A. Galan, Eva Martin del Valle. "Chemical Engineering: Trends and Developments" , 1st edition, Wiley-Blackwell, 2005, ISBN-13: 978-0470024980.
4. Zacharias B. Maroulis, George D. Saravacos "Food Process Design", 1st edition, CRC Press, 2003, ISBN: 9780367270087.

20FP3006	ADVANCES IN FOOD PROCESS ENGINEERING	L	T	P	C
		3	0	0	3

Course Objectives:

1. To provide knowledge on the significance of thermal processing of foods.
2. To make them understand the advanced technologies in processing of foods.
3. To impart skill on applications of advanced instrumentation in food industries.

Course Outcomes:

The students will be able to

1. understand the role of time – temperature combination of food processing.
2. explain the low temperature food preservation.
3. identify the suitable drying methods for specific food.
4. describe the technology that useful for targeted food delivery.
5. analyze the importance of food nanostructures.
6. evaluate the efficiency of biosensors in food applications.

Module 1: Thermal Preservation of foods (7 hours)

Thermal processing of foods – principles – methods –- Pasteurization – sterilization- commercial sterility - thermo bacteriology – thermal process time calculations – Ball formula method – problems on thermal process calculation.

Module 2: Low temperature preservation of foods (8 hours)

Low temperature preservation - Freezing of foods - Theory of freezing- freezing curves - changes occur during freezing – heat and mass transfer during freezing – Freeze drying -working and construction of freeze dryer– types of freeze dryers - Freeze concentration of foods – IQF process – problems based on freezing.

Module 3: Advanced drying technologies (8 hours)

Spray drying principle – Equipment construction and working – design aspects of spray drier — recent advancement in spray drying – construction and working of heat pump dryer – suitability of heat pump dryer – advantages and disadvantages –Superheated steam drying – Microwave and Radio frequency drying – Infrared drying – hybrid drying techniques.

Module 4: Application of Nanotechnology in food processing (8 hours)

Present status of nanotechnology- Natural and synthetic nanostructures in foods - Designing food nano structures - Nutraceuticals and functional food components – Delivery of bioactive lipids – carbohydrates and proteins - Food architecture – structural design principles – delivery systems - Nano materials for food application - Nano sized food ingredients and additives - Potential health risk and regulations pertaining to nano foods.

Module 5: Encapsulation Technology (7 hours)

Encapsulation of food products – Theory and principles - Encapsulation of functional food products - Methods of encapsulation - Micro and nano encapsulation - Materials used to make encapsulated products – list of encapsulated products – release pattern of encapsulated materials – Encapsulation efficiency

Module 6: Biosensors and biocatalyst (7 hours)

Biocatalysts- Sources-Types- Processes in Food Industry- Enzymatic – Biocatalysis using enzymes- flavors and fragrance – Biosensors types- application of biosensors to food industry requirements- Development of Biosensors – Automated methods of sensory evaluation - e- nose and e- tongue and their applications.

Text Books:

1. PJ. Fellows, "Food Processing Technology, Principles and Practice, Third edition. Wood Head Publishing Ltd. England. 2009. ISBN: 9781845692162
2. ZeKi Berk. "Food Process Engineering and Technology". Second edition. Academic Press, New York. 2013. ISBN: 9780124159235
3. Biosensors for food analysis, A O Scott, The Tetley Group Limited, UK, Woodhead Publishing
4. Limited, Abington Hall, Abington, Cambridge, CB21 6AH, England, 2008.
5. Nanotechnologies in food , Qasim Chaudry, Laurence Castle and Richard Watkins.2010. ISBN: 978 0 85404 169 5

Reference Books:

1. Sun D-W, "Emerging Technologies for Food Processing". Second edition. Published by Academic Press. 2014. ISBN: 9780124114791
2. Nano technology in agri food sector - LJ . Frewer, W. Norde, A. fishetrs and F. Kampers. 2011
3. Gould G.W., "New Methods of Food Preservation", Aspen Publishers, Great Britain, ISBN No. 0834213419, 1999.

20FP3007	FOOD ANALYSIS LAB	L	T	P	C
		0	0	3	1.5

Course Objectives:

1. To inculcate basics of food analysis and methods.
2. To provide the ability to assess the most appropriate analytical procedure required for a particular food analysis problem.
3. To give practical knowledge of selected food analysis techniques.

Course outcomes:

The student will be able to

1. Gain knowledge on the terminology used in food analysis.
2. Relate to the procedures and equipment required for the analysis of food constituents.
3. Demonstrate the various food analysis conducted in the food industry.
4. Analyze foods for its proximate composition.
5. Evaluate the quality of food materials based on the quality of its constituents.
6. Plan and pick the appropriate method to be followed for analyzing a food constituent.

List of Experiments:

Sugar rich products

1. Analysis of total sugars
2. Determination of pectin
3. Determination of acidity
4. Determination of total fruit solids
5. Determination of Calcium
6. Estimation of Ascorbic acid

Bakery Products including wheat

7. Determination of gluten content
8. Determination of alcoholic acidity
9. Determination of maltose equivalent
10. Estimation of total nitrogen content by Kjeldahl method

Meat and meat products

11. Determination of Extract release volume
12. Determination of swelling ratio
13. Determination of TMA

Milk and Milk products

14. Determination of Fat content by Gerber method
15. Determination of lactose content by Lactometer

Plantation Products including Tea, Coffee and Cocoa

16. Determination of Total extractives
17. Determination of Tannin content
18. Determination of Caffeine by HPLC

Vitamins, Minerals and Colourants

19. Estimation of anthocyanins
20. Estimation of Chlorophyll
21. Determination of Iron
22. Determination of encapsulation efficiency
23. Kinetics of extraction/degradation
24. Determination of Arrhenius constant
25. Sensory evaluation of foods
26. Determination of observed colour by RGB colour chart

20FP3008	ENZYMOLOGY LAB	L	T	P	C
		0	0	3	1.5

Course Objective:

1. To study the characteristics of various enzymes applicable in food industries.
2. To study the factors affecting enzyme activity in food systems.
3. To apply knowledge of enzymes in food systems.

Course Outcomes:

The students will be able to

1. gain knowledge about enzymes.
2. understand the importance of each of the factors that affect enzyme activity.
3. apply the same to maximize enzyme action.
4. analyze when a problem arises and give a suitable and logical solution.
5. evaluate enzymes from different sources and select the right one depending on the type of food / condition.
6. make appropriate decision of evaluation and characterization when it comes to newer source of enzymes.

List of experiments

1. Estimation of amylase activity
2. Effect of pH on amylase activity
3. Effect of temperature on amylase activity
4. Effect of substrate concentration on amylase activity
5. Effect of enzyme concentration on amylase activity
6. Determination of total and specific activity of amylase
7. Estimation of protease activity
8. Effect of pH on protease activity
9. Effect of temperature on protease activity
10. Effect of substrate concentration on protease activity
11. Effect of enzyme concentration on protease activity
12. Determination of total and specific activity of protease
13. Studies on enzyme immobilization
14. Effect of activators/inhibitors on enzyme activity
15. Study of Trysin/ Urease inhibitor
16. Determination of PPO Activity

20FP3009	FOOD PRODUCT TECHNOLOGY LAB	L	T	P	C
		0	0	2	1.5

Course Objectives:

1. To gain knowledge of various products from milk, fruits, vegetables and cereals.
2. To prepare the constituents required for making food products.
3. To acquire the skill of manufacturing various food products.

Course Outcomes:

The students will be able to

1. gain knowledge about the manufacturing technology of food products.
2. understand the importance of various ingredients required for preparation of milk based food products.
3. understand the importance of various ingredients required for preparation of cereal, fruit and vegetable based food products.
4. calculate the quantity requirement of each constituent.
5. prepare food product of desired specification.
6. evaluate the sensory quality of the prepared food product.

List of Experiments

Fruit based products

1. Pilot scale manufacture of fruit
2. Pilot scale manufacture of squashes & cordial
3. Pilot scale manufacture of Jam and marmalades
4. Pilot scale manufacture of ketchups/sauce
5. Preparation of fruit preserves.

Bakery products

6. Pilot scale manufacture of white breads by chorleywood process
7. Pilot scale manufacture of cakes by all-in-one method

Milk products

8. Preparation of thermally coagulated dairy products – *Kalakhand and Gulab Jamun*
9. Preparation of acid coagulated dairy products – *Rosagulla*
10. Preparation of Butter

Gram/legumes Confectionery based

11. Preparation of Mysorepak
12. Preparation of Chikki

Sugar based Confectionery

13. Preparation of Hard Boiled Candies
14. Preparation of Marshmallows

Extruded products

15. Preparation of Extruded Snacks

20FP3010	ADVANCED FOOD PROCESS ENGINEERING LAB	L	T	P	C
		0	0	3	1.5

Course Objectives:

1. To provide knowledge on the operation of various processing equipment.
2. To estimate flow characteristics of various fluids.
3. To operate and assess the efficiency of the heat transfer equipment.

Course Outcomes:

The students will be able to

1. Recall the importance of fluid flow in industrial applications.
2. Demonstrate the drying characteristics of food materials.
3. Experiment various unit operations involved in food processing.
4. Classify various mass transfer operations.
5. Assess the efficiency of unit operations.
6. Integrate different unit operations.

List of Experiments

1. Determination of energy losses in pipes due to sudden enlargement and contraction.
2. Determination of pressure drop using fluidized bed column.
3. Determination of pressure drop using a packed bed column.
4. Drying studies using through flow dryer – drying rate, drying curve and modeling.
5. Determination of heat transfer through composite walls.
6. Determination of overall heat-transfer coefficient of a tubular pasteurizer.

7. Determination of overall heat transfer coefficient in shell and tube heat exchanger.
8. Determination of enthalpy balances in single effect evaporator.
9. Performance evaluation of scraped surface evaporator
10. Determination of mixing index of a mixer – sigma, ribbon, planetary mixers.
11. Determination of mass transfer coefficient using Fick's law.
12. Performance evaluation of twin screw extruder using Design of Experiments
13. Determination of mass transfer rate in leaching / extraction
14. Filtration efficiency of membrane filtration
15. Filtration efficiency of Plate and Frame filtration
16. Microwave processing of food materials.
17. Study on adsorption isotherm

20FP3011	ADVANCES IN DAIRY, MEAT AND FISH PROCESSING	L	T	P	C
		3	0	0	3

Course Objectives:

1. To understand about the composition, nutritive value of meat, poultry and fish.
2. To know about processing technology of meat, poultry and fish.
3. To learn the value addition and packaging of meat, fish and poultry products.

Course Outcomes :

The student will be able to

1. understand the precautions that need to be taken while handling products from this segment.
2. decall the different types of meat, poultry and fish and the processes involved in their processing.
3. analyze the challenges in developing new value-added products from this segment.
4. evaluate the hygienic and safe handling of Meat, Fish and Dairy Products.
5. design the machinery involved in the Meat, Fish and Dairy Products processing segment.
6. Create solutions for quality checks involved in Meat, Fish and Dairy Products processing segment.

Module 1: Dairy Chemistry and Microbiology (8 hours)

Introduction - Basic dairy terminology - milk as raw material – composition - nutritive value - physico-chemical constituents of milk and its constituents – contaminants - microbiology of milk- milk collection - cooling and milk transport - milk reception -Quality control tests - applications of enzymes in dairy industry

Module 2: Dairy Processing and Equipments (9 hours)

Milk processing equipment – filtration/clarification – Pasteurization – HTST – LTLT – UHT methods - storage tanks - Cream separating Centrifuges - Homogenization – theory – working principle of homogenizers – homogenization efficiency - cream separation – principles – gravity and centrifugal separation – centrifugal separator – parts – construction and working principle – separation efficiency

Module 3: Chemistry and Microbiology of Meat (5 hours)

Meat composition from different sources; Definitions and measurements, Explanation of muscle structure and compositions and its modifiers, White and Red Meat, Description of animal fat and its modifiers, description of bone and its modifiers; Post mortem muscle chemistry, Meat colour, flavors of meat products, meat microbiology and safety.

Module 4: Slaughtering and Processing of Meat Products (8 hours)

Modern abattoirs and some features, Ante mortem handling and welfare of animals, design of handling facilities, Carcass processing equipment, Operational factors affecting meat quality, effects of processing on meat tenderization; meat processing equipment. Canned meat, Frozen meat, Cooked and Refrigerated meat, Dried and preserved meat, Cured meat.

Module 5: Meat Products and Safety (6 hours)

Production methods for Intermediate moisture and dried meat products, Different kinds of sausages – Equipment used for all the process operations; Meat plant hygiene, Good manufacturing practice and HACCP.

Module 6: Fish and other Marine Products Processing (9 hours)

Commercially important marine products from India, Basic biochemistry, spoilage factors of fish, field refrigeration and icing practice, merits and demerits, Use of dry ice and liquid nitrogen as preservation elements, use of Refrigerated Sea Water (RSW) for preservation, Changes during storage in RSW and CSW; Freeze preservation; freezing of prawn and shrimp, weighing, filling and glazing, Individual quick freezing - relative merits and demerits, Canning operations, Salting and drying of fish, pickling and preparation of fish protein concentrate and fish oil.

Text Books:

1. Hui, Y.H., Nip, W.K., Rogers, R.W, "Meat Science and Applications". Marcel Dekkar Inc. New York,2001.

Reference Books :

1. Leo M. L. Nollet, "Handbook of Meat, Poultry and Seafood Quality", Blackwell Publishing, 2007.
2. Garret Smit. G., Dairy Processing. Woodhead Publishing Limited, England. 2005.
3. Mead G, "Poultry meat processing and quality", Woodhead Publishing Limited, 2004.
4. National Institute of Industrial Research, Modern Technology of Milk processing and Dairy products, II Edition, NIIR Publications, India, 2004
5. Joseph Kerry, John Kerry and David Ledwood, "Meat Processing", Woodhead Publishing Limited, CRC Press, 2002.
6. Sukumar De. Outlines of Dairy Technology, Oxford University Press. 2001. ISBN: 9780195611946
7. Balachandran, K.K, "Post Harvest Technology of Fish and Fish Products", Daya Publishing House, New Delhi, 2001.

20FP3012	ADVANCES IN PROCESSING OF CEREALS, PULSES AND OIL SEEDS	L	T	P	C
		3	0	0	3

Course Objectives:

1. To create awareness about the processing of major cereals like paddy, maize etc.
2. To impart knowledge on milling techniques of cereals and pulses
3. To provide insight into the byproducts obtained during processing along with their uses.

Course Outcomes:

The student will be able to:

1. gain knowledge on the structure, composition and pre milling operations of food grains, pulses and oil seeds
2. understand the Paddy Processing and Rice milling equipment which will help them for developing entrepreneurial skills.
3. develop skills needed in milling of pulses and oil seeds which will promote employment.
4. analyze the suitable method for corn/maize milling
5. predict a better equipment for processing the raw materials
6. apply the knowledge to process food grains into value added products

Module 1: Paddy Processing (8 hours)

Structure and Composition of paddy – Cleaning of paddy -Pre Cleaners, - Paddy Parboiling processes - Parboiling methods - Methods of grain drying- LSU, rotary, columnar, recirculatory dryers – dehusking of paddy – Whitening of brown rice – rice polishing and glazing – grading of rice – milling efficiency of rice milling equipments – utilization of products and by products.

Module 2: Wheat Processing (7 hours)

Structure and composition of wheat – flow chart for wheat milling – milling process - equipments used in wheat milling – parboiling of wheat – bulgur wheat – wheat flour milling - products and by products of wheat.

Module 3: Processing of Maize/Corn (8 hours)

Structure and composition of maize – milling methods – degerming and non degerming methods- Dry milling of maize – wet milling – Products and by products of milling – value added products – Acid Hydrolysis - Enzyme Hydrolysis - Isomerization processes - Processing for Dextrose - Malto dextrin and other products - Extraction and refining of Corn oil in brief – corn nixtamalization.

Module 4: Pulses and Soybean Processing (9 hours)

Structure and composition – Unit operations of pulse milling – domestic and commercial scale pulse milling methods – CFTRI, CIAE, Jadavpur methods - Pulse milling machineries - working principle – pulse milling efficiency - pulse flour products - soya bean processing - nutritive importance of soy bean - Soy bean dehuller – drying –drying of soy products (splits and flakes) – utilization of soy kernel – products.

Module 5: Processing of Oil Seeds (7 hours)

Structure and composition of oil seeds – Oil expression and extraction - Traditional milling equipments – Ghani – Improvement over conventional method of expression – Mechanical expression devices – hydraulic press – screw press – Solvent extraction method – Cold pressed oil - Virgin coconut oil - Extraction of oil from soybean– sunflower – palm and coconut kernel – Utilization of by products from oil milling industries.

Module 6: Millet Processing (6 hours)

Major millets - nutritive value – drying methods - methods of processing of millets – equipments used in millet milling – Value addition of millets – development of functional and nutraceutical based foods.

Text Books:

1. KM. Sahay and KK. Singh. Unit operations of Agricultural Processing, Second edition. Vikash Publishing house PVT Ltd. Delhi, 2014. ISBN No.10: 9788125911425
2. Chakraverty, A.: Post Harvest Technology of Cereals, Pulses and Oilseeds. Oxford and IBH Publishing Co, Calcutta, 2014. ISBN No. 10: 9788120409699
3. Chakraverty, A., Mujumdar, A.S., Raghavan, G.S.V., Ramaswamy, H.S. Handbook of post harvest technology – cereals, fruits, vegetables, tea and spices. Marcel Dekker Inc., New York (Special Indian Reprint). 2010. ISBN 13: 9780824705145

Reference Books:

1. Samuel A .Matz: "The Chemistry and Technology of Cereals as Food and Feed", Chapman and Hall, 1992.
2. Bernard Godon and Claude Willm, "Primary Processing of Cereals" Berns and Noble Publishers, 1994.
3. Karel Kulp and Joseph P Pante, "Handbook of Cereal Science and Technology", MercelDekkar, USA, 2000.
4. Seetharam.A, K.W.Riley and H.Harinarayana.1989. Small millets in global agriculture. Oxford & IBH Publishing Co. (P) Ltd. New Delhi.
5. Riley.K.W, S.C.Gupta,A.Seetharam and J.N.Muhonga.1993.Advances in small millets. Oxford & IBH Publishing Co. (P) Ltd. New Delhi.

20FP3013	ADVANCES IN PROCESSING OF HORTICULTURE, SPICES AND PLANTATION PRODUCTS	L	T	P	C
		3	0	0	3

Course Objectives:

1. To impart the various methods of processing tea products.
2. To demonstrate a basic knowledge on process of coffee, and cocoa.
3. To develop an awareness of various processing procedure for major spices & minor spices.

Course Outcomes:

The students will be able to

1. define the different unit operations and its equipments involved in coffee, tea and cocoa processing.
2. gain knowledge in processing of plantation crops and spices and also its value added products.
3. outline ways in which quality loss can be minimised during preparation and processing.
4. develop value added products from plantation products and spices.
5. demonstrate appropriate technique for the extraction of spice oil and oleoresin with quality standards.
6. acquire a confident to get placement in any kind of cereals and spices industry with minimum post harvest losses and maximum benefit to the industry.

Module 1: Primary Processing of Fruits and Vegetables (7 hours)

Importance of post harvest technology of fruits and vegetables. Structure, cellular components,

composition and nutritive value of fruits and vegetables, fruit ripening, spoilage of fruits and vegetables. Harvesting and washing, pre-cooling, preservation of fruits and vegetables, blanching, commercial canning of fruits and vegetables, minimal processing of fruits and vegetables.

Module 2: Drying and Dehydration of fruits and vegetables (8 hours)

Radiation preservation of fruits and vegetables, preservation by irradiation sources. High pressure processing of fruits and vegetables and its applications. Cold storage of fruits and vegetables, controlled atmosphere packaging of fruits and vegetables, gas composition, quality of storage. Osmotic dehydration, foam mat drying, freeze drying. Intermediate moisture foods, Sensory evaluation of fruit and vegetable products, packaging technology for fruits and vegetables, general principles of quality standards and control, FPO, quality attributes.

Module 3: Production and processing of Tea (8 hours)

Production status of tea, Types of tea, Black tea, Green tea and Oolong tea. chemistry of tea manufacturing and tea quality; tea aroma precursors; tea flavour; tea grades; storing of tea. Instant tea, tea concentrates, decaffeinated tea, flavoured tea; herbal tea.

Module 4: Production and processing of coffee (7 hours)

Production status of coffee, processing of coffee cherries- wet and dry methods.Coffee beans, grinding, storage and preparation of brew, Soluble /Instant coffee, Use of chicory in coffee, decaffeinated coffee.

Module 5: Production and processing of cocoa beans (8 hours)

Production, processing and chemical composition of cocoa beans. Cocoa Processes: Cleaning, roasting, alkalization, cracking and fanning, Nib grinding for cocoa liquor, cocoa butter and cocoa powder. Manufacturing process for chocolate: Ingredients, Mixing, Refining, Conching, Tempering, Moulding. Enrobed and other confectionary products.

Module 6: Processing of Spices (7 hours)

Classification of spices- Major, minor- production, pre-harvest and post-harvest problems in processing, properties, drying, storage and packaging, health benefits; flavouring components; spice powder and paste: processing, quality, storage; spice based food additives; volatiles, essential oils and oleoresins: characteristics, extraction procedure and utilization.

Text Books:

1. Srivastava RP & Sanjeev Kumar. 1994. Fruit and Vegetable Preservation. Principles and Practices. International Book Distr. ISBN 13: 9788123924373
2. Verma LR & Joshi VK. 2000. Post Harvest Technology of Fruits and Vegetables. Vols. I-II. Indus Publ. ISBN : 8173871086
3. Banerjee, B. Tea Production and Processing, (Oxford & IBH Pub. Co., 1993). *ISBN* : 8120408020, 9788120408029
4. Sivetz, M. Coffee Technology, (AVI publishing Co., 1979). ISBN-13: 978-0870552694
5. Purthi, J. S. Major Spices of India: Crop Management and Post Harvest Technology, (ICAR publication, 2003)
6. Purthi, J. S. Minor Spices and Condiments: Crop Management and Post Harvest Technology, (ICAR publication, 2001)

Reference Books:

1. Salunkhe, D. K. and Kadam, S. S. Handbook of Fruit Science and Technology: Production, Composition, Storage, and Processing, (CRC Press, 1995). ISBN-13: 978-0824796433
2. Sumanbhatti & Uma Varma. 1995. Fruit and Vegetable Processing. CBS. ISBN 10: 8123904045 ISBN 13: 9788123904047
3. Thompson AK. 1996. Post Harvest Technology of Fruits and Vegetables. Blackwell. ISBN-13: 978-0632040377
4. Jain, N. K. Global Advances in Tea Science, (Aravali Books International, 1999). *ISBN*-10: 8186880127
5. Clifford, M. N. and Willson, K. C. Coffee: Botany, Biochemistry and Production of Beans and Beverage, (AVI publishing Co., 1985). *ISBN* 978-1-4615-6657-1

20FP3014	ADVANCES IN REFRIGERATION AND COLD SUPPLY CHAIN MANAGEMENT	L	T	P	C
		3	0	0	3

Course Objectives:

1. To apply the principle of refrigeration for processing perishable foods.
2. To be conversant with suitable equipment for food processing.
3. To recognize the importance of cold storage supply chain management

Course Outcomes:

The students will be able to

1. Recall refrigeration of food and its operational components.
2. Classify various forms of food refrigeration in plants, stores and logistics.
3. Apply advanced food freezing concepts and techniques.
4. Point out food safety aspects of chilled foods and frozen foods.
5. Assess cold chain management in the food distribution sector.
6. Develop cold storage and packaging of frozen perishable products.

Module 1: Principles of Refrigeration (9 hours)

Refrigeration – Ton of refrigeration, refrigeration cycles – Vapor Compression and Vapor Absorption cycles. Refrigerants - characteristics of different refrigerants, net refrigerating effect, Ozone depletion potential. Components of a Refrigeration system - compressor, condenser, evaporator, expansion valves piping and different controls.

Module 2: Air-Conditioning systems (8 hours)

Psychrometry and Psychrometric Processes. Air conditioning systems - Comfort and Industrial air conditioning system. Classification - winter, summer and year- round air conditioning system. Unitary and central air conditioning system. Equipment used. Design conditions and load calculations. Application of air conditioning in the food industry.

Module 3: Cold Storage Construction (8 hours)

Low Temperature Storage Systems and pre-cooling systems. Controlled atmosphere and Modified atmosphere storages - principles, insulation and operation. Design of cold storage unit. Calculation of refrigeration load. Prefabricated systems, walk-in-coolers, refrigerated container trucks. Cold Storage practice - Stacking and handling of material in and around cold rooms. Optimum temperatures of storage for meat and poultry products, marine products, fruits and vegetables, spices and food grains

Module 4: Chilling of foods (7 hours)

Chilling equipment for liquid foods, Secondary refrigerants and direct expansion techniques in chilling, chilled foods transport and display cabinets. Chilled foods microbiology and packaging. Hygienic design considerations for chillers and chilled Storages. Optimum temperatures of storage for different chilled foods.

Module 5: Freezing of Foods (6 hours)

Freezing of foods - freezing time, freezing rate, freezing curve, growth rate of ice crystals, crystal size and its effect on texture and quality of foods. Freezing types - Individual quick freezing and cryogenic freezing. Freezing load and freezing time calculation. Freezing equipment. Freezing practice as applied to marine foods, meat and poultry, fruits and vegetables. Innovations in the freezing process.

Module 6: Cold Supply Chain Management (7 hours)

Cold Chain - Introduction, Components of cold chain. Important Factors to consider. Logistic - Protocols for Domestic, Sea and Airfreight- Traceability, barcode and RFID in cold chain. Product Temperature and Moisture monitoring. Refrigerated transport and distribution systems and Cold chain in retail. Role of cold chain management in beverage, meat, poultry, marine, fruit /vegetables and dairy products.

Text Books:

1. R.K. Rajput, “Thermal Engineering”, 10th edition, Laxmi Publications, 2018, ISBN-13: 978-8131808047.
2. C.P. Arora, “Refrigeration and Air conditioning”, 3rd edition, McGraw Hill Education, 2008, ISBN -13: 978-0070083905.
3. Clive.V.J Dellino, “Cold and Chilled Storage Technology”, 1st edition, Van Nostrand Reinhold, 1990, ISBN-13: 978-0442206734.

4. Da-Wen Sun, "Handbook of Frozen Food Processing and Packaging", 2nd edition, CRC Press, 2011, ISBN-13: 978-1439836040.

Reference Books:

1. Florkowski W.J, Shewfelt R.L, Brueckner B and Prussia S.E, "Postharvest Handling. A Systems Approach", 2nd edition, Academic Press, 2009, ISBN: 9780123741127.
2. Colin Dennis and Michael Stringer: "Chilled Foods – A Comprehensive Guide", 2nd edition, Woodhead Publishing Ltd, 2000, ISBN-13: 978-1855734999.

20FP3015	ADVANCES IN ENGINEERING PROPERTIES OF FOOD MATERIALS	L	T	P	C
		3	0	0	3

Course Objectives:

1. Determining the quality and properties of different foods.
2. Application of engineering properties during processing, packing, storage and transport.
3. Evaluating electrical and optical properties of food

Course Outcomes:

The student will be able to

1. Interpret physical properties of food materials.
2. Elaborate Rheological properties of foods and their applications.
3. Recognize the thermal properties of food materials.
4. Outline the Hydro and Aerodynamic properties of food materials.
5. Infer Textural and EM properties of foods.
6. Examine the optical properties of food.

Module 1: Physical Characteristics of Food Materials (9 hours)

Importance of the engineering properties of the biological materials, Physical characteristics of different food grains, fruits and vegetables; Shape and size, description of shape and size, volume and density, porosity, surface area and their methods of determinations.

Module 2: Rheological Properties of Foods (9 hours)

Concept of Rheology and ASTM standard definitions of terms related to mechanical properties, physical states of a material, classification of Rheology, classical ideal materials, rheological models and rheological equations, visco-elasticity, creep-stress relaxation, Non-Newtonian fluid and viscometry, rheological properties of solid and liquid food, force, deformation, stress, strain, elastic, plastic behaviour. Viscometers- Capillary, Orifice, Falling ball and Rotational viscometers. Rheological modeling of foods.

Module 3: Thermal & Electromagnetic Properties (7 hours)

Thermal properties: Specific heat, thermal conductivity, thermal diffusivity, methods of determination, steady state and transient heat flow. Calorific value of food, Bomb calorimeter. Applications of thermal properties. **Electromagnetic Properties:** Electrical properties, dielectric heating, electrical conductivity, dielectric measurements, microwave heating and other Applications.

Module 4: Aerodynamic, Hydrodynamic and Frictional Properties (7 hours)

Drag coefficient, terminal velocity, Relation between Drag coefficient and Reynolds number, terminal velocity from time distance relation, Friction in agricultural materials, rolling resistance, angle of internal friction, angle of repose, Contact stresses between bodies, Hertz problems, firmness and hardness, mechanical damage, dead load and impact damage, vibration damage, friction, effect of load, sliding velocity, temperature, water film and surface roughness. Application of engineering properties in design and operation of agricultural equipment and structures.

Module 5: Textural Properties (6 hours)

Types of food textures, Methods of texture measurement-Texture measuring instruments- Texture Profile Analysis, Properties of food powders. **Colour:** Interaction of object with light, Colorimeter-Colour order systems- Munsel colour system-CIE colour system, Hunter color lab, Lovibond system.

Module 6: Optical Properties (7 hours)

Refractive index of food items, Abbe's refractometer, Sorting of food material using optical properties, Optical activity, Polarimeter, Spectrophotometer, Gloss, color, translucency – Definitions, measurement and applications.

Text books:

1. Serpil Sahin and Servet Gulum Sumnu "Physical Properties of Foods", Springer,USA, 2006. *ISBN*-13: 978-0387-30780-0
2. Mohesnin N.N. Physical Properties of Plant and Animal Materials‖, Volume I, Gordon and Breach Science Publishers, New York, 1970. ISBN-13: 978-0677023007

Reference Books:

1. Rao, M.A and S.S.H. Rizvi:"Engineering Properties of Foods", Mercel Dekker inc. New York, 1998. ISBN 0824775260
2. Lewis M.J, "Physical properties of foods and food processing systems" Woodhead publishing Cambridge, UK, 1990. *ISBN* 9781855732728, 9781845698423
3. Shafiur Rehman: Food Properties Hand book CRC press inc. New York, 1995. ISBN 9781138627598
4. Micha Peleg and Edward B. Bagley, "Physical Properties of Foods" AVI publishing company inc, Westport USA, 1983. *ISBN* 13: 9780870554186

20FP3016	MILLING, BAKERY AND CONFECTIONERY TECHNOLOGY	L	T	P	C
		3	0	0	3

Course Objectives:

1. To provide know how on the machinery and process involved in the baking and confectionery process.
2. To understand the various types of sugar and its grades.
3. To know the process and machinery involved in the manufacture of beverages.

Course Outcomes:

The student will be able to

1. Gain knowledge on the ingredients, process and machinery involved in bakery and confectionery and beverage technology.
2. Understand the importance and effect of quality of raw materials on the final products\
3. Apply the knowledge gained in formulating new types of products
4. Analyze the process for maintaining and improving the quality of the final product
5. Evaluate the steps involved in the process and improve existing technologies or develop newer technologies
6. Design and create newer process and products that are better economically, nutritionally or technologically.

Module 1: Overview of wheat quality and Equipments used for baking (9 hours)

Moisture tests, Grain hardness testing. Visco graph, Amylograph, Farinograph. Dough mixers, Dividers, rounders, Proofing, moulding, Ovens, Slicers, Packaging materials and equipment, Sanitation and safety

Module 2: Technology of Baking (8 hours)

Bread manufacturing process – Straight dough fermentation, Sponge and dough, Biscuit-Types of biscuit dough – Developed dough, short dough, semi-sweet, enzyme modified dough and batters-importance of the consistency of the dough - Cake – Flour specification – ingredients – manufacturing process – types of chemically aerated goods.

Module 3: Snack Food Technology (9 hours)

Snack Food Preparations and Dedicated equipments – Corn - based products – Potato - based product – Extruders in snack food processing – Popcorn products – Snacks of animal origin – Rice – based snack foods – Snack Foods of India.

Module 4: Beverage Technology – Alcoholic beverages (7 hours)

Manufacture of beer, wine and champagne - Quality characteristics, Manufacture of distilled beverages including whisky, brandy, rum and gin – Quality aspects

Module 5: Beverage Technology – Non-Alcoholic beverages (4 hours)

Manufacture of sugar-free, sugarless, carbonated beverages – Fruit based beverages- quality aspects and standards

Module 6: Confectionery Technology (8 hours)
Types of Confectionery, raw materials and processing of toffee, chocolates, fruit drops, hard boiled candies. Additives for Confectioneries. Equipments used in Confectionery manufacture.

Text Books:

1. Samuel A. Matz, "Bakery Technology and Engineering", Chapman & Hall, 3rd Edition, 1992. ISBN 978-0-442-30855-1
2. Lusas E.W. and Rooney L.W. "Snack Food Processing", CRC Press, First Reprint, 2002. ISBN 1-56676 – 932-9.

Reference Books:

1. Bakery Products – Science and Technology, Ed., Y.H. Hui, Blackwell Publishing, 2006. ISBN-13: 978-0-8138-0187-2
2. Sumnu SG and Sahin S. Food Engineering aspects of Baking sweet goods. CRC Press,2008. ISBN 9781420052749
3. Hunsigi G. Production of Sugarcane Theory and Practice, Springer Verlag, 1993. e-ISBN-13: 978-3-642-78133-9
4. Varnam A.H. & Sutherland J.P. BEVERAGES - T*echnology, Chemistry and Microbiology*, Springer-Science+Business Media, B.V., 1994. ISBN 978-1-4615-2508-0 (eBook)
5. Lees R and Jackson EB. Sugar Confectionery and Chocolate Manufacture, Chapman and Hall Pub.,1992. e-ISBN-13: 978-1-4684-1495-0
6. Edwards, W .P. The Science of Sugar Confectionery, RSC Publishing, UK., 2000. ISBN 0-8 5404-593-7

20FP3017	ADVANCES IN FOOD PACKAGING TECHNOLOGY	L	T	P	C
		3	0	0	3

Course Objectives:
1. To study about the functions of packaging along with the influence of various factors on food.
2. To know about the different packaging materials, their manufacturing process and equipment.
3. To study about the various methods of packaging to improve the shelf life of the products.

Course Outcomes:
The student will be able to
1. Gain knowledge on shelf life of food and various methods of estimating it.
2. Understand the need and functions of packaging as a solution to various factors affecting food.
3. Apply their knowledge of packaging materials to pick the right material for packaging of foods.
4. Analyze the packages for their life cycle.
5. Evaluate selection of test methods for packaging materials.
6. Devise innovations in eco-packaging designs for food systems.

Module 1: Introduction to Food Packaging (7 hours)
Functions of packaging, Effect of environmental factors - light, Oxygen, Moisture, Temperature, mechanical forces and biological factors on quality of food. Estimation of shelf life. General Approach, analysis of storage requirement, accelerated storage studies: Vacuum and Inert Gas Packaging: Tests on packaging materials, Mechanical strength (Tension, notch and tearing strengths), Gas and water vapour transmission rates.

Module 2: Packaging Materials for Food Systems (9 hours)
Metallic can - Tin cans and Aluminum cans. Open top sanitary cans, Glass jars and Bottles in food packaging, Formation of Films and pouches, Plastics used and their Specific applications, Copolymers their applications. Co-extruded films and Laminates. Laminated Paper board Cartons and their applications.

Module 3: Development in Active Packaging (6 hours)
Controlled release, Flavor release, Active microbiological, Active nanocomposites – Free radical and Oxygen scavenging. Anti-microbial nanocomposites for food and beverage packaging. Edible coatings for minimally processed foods.

Module 4: Life Cycle Assessment and Eco-Packaging Solutions (9 hours)
Life Cycle Assessment (LCA) and sustainability, LCA in food and beverage packaging, Improvement of packaging through LCA. Packaging and food waste, Scale of food waste problem, food-saving packaging. Environmental impact of conventional food packaging. Biodegradable Packages. Eco-design of food packages.

Module 5: Innovations in Food Packaging (7 hours)
Modified atmosphere packaging – principles, applications. Permeability of gases in packs. Edible packaging films. Intelligent Packaging (IP)– Application of IP to enhance food safety and biosecurity. Principles and applications of RFID tags. Concept of Tamper evidence, Application of tamper evidence to food and beverage packs. Freshness and safety indicators in food and beverage packaging.

Module 6: Safety and Regulatory Aspects of plastics as Food Packaging (7 hours)
Indirect food additives, Nanotechnology in food contact materials, migration of additives. Overall migration – Indian standards, US code of federal regulations, EU Directives on plastic containers. Specific migration curve of toxic additives. Problems in specific migration.

Text Books:

1. Gordon L. Robertson. "Food Packaging: Principles and Practice", 3rd Edition, CRC Press; ISBN-10: 9781138628052, ISBN-13: 978-1138628052, 2016.
2. Kit L & Dong Sun Lee eds Yam, "Emerging Food Packaging Technologies: Principles and Practices", Woodhead Publishing Ltd, ISBN-10: 9789351073246, ISBN-13: 978-9351073246, 2015.

Reference Books:

1. Coles, R., Dowell, D.M., Kirwan, J, "Food Packaging Technology" (Sheffield Packaging Technology), Black Well Publishing Ltd., ISBN-10: 084939788X, ISBN-13: 978-084939788, 2003.
2. Jung H. Han, "Innovations in Food Packaging" 2nd edition, Bio-Green Elsevier, ISBN-10: 9789351073482, ISBN-13: 978-9351073482, 2016.
3. Scott A. Morris, "Food and Package Engineering", Wiley-Blackwell Publishing, ISBN-10: 9788126566747, ISBN-13: 978-8126566747, ASIN: 8126566744, 2017.

20FP3018	EMERGING TECHNIQUES IN FOOD PROCESS ENGINEERING	L	T	P	C
		3	0	0	3

Course Objectives:

1. To provide basic concepts on food preservation techniques.
2. To impart knowledge on Pulse light techniques, ohmic heating and microwave processing.
3. To create awareness on novel techniques like Food irradiation, high pressure processing and cold plasma technology.

Course Outcomes:
The student will be able to

1. Remember the principles of preservation.
2. Interpret the various emerging techniques available for food processing.
3. Apply the techniques for preservation of foods.
4. Analyze the most suitable method for processing foods.
5. Explain a novel food preservation technique.
6. Evaluate the suitability of the techniques for specific foods.

Module 1 : Hurdle Technology (6 hours)
Hurdle technology - principles and applications - hurdle effect in fermented food - shelf stable products - intermediate moisture foods - minimally processed foods - total quality of foods - optimal range of hurdles and potential safety -application of hurdle technology - fruit preservation, dairy products and meat.

Module 2: Pulse light, pulsed electric field and UV Technique (8 hours)
High-intensity pulse technique - principle and microbial inactivation mechanism - Processing systems-design of static and continuous chambers - generation of different voltage waveforms -– UV treatment – principle involved – mechanism of inactivation – Role of UV light in food preservation - Pulsed

electric field – principles of microbial inactivation – Generation of PEF – impact on microorganisms, enzymes and food constituents - application in food processing.

Module 3: Microwave and Ohmic Heating (7 hours)

Microwave properties – principle – design aspects of microwave equipment - interaction with food materials, material properties - application of microwave in food processing – merits and demerits – recent advancement in microwave processing - inactivation of microorganisms and enzymes – electrical resistance heating of food - ohmic heating - treatment of products - Elsteril process - influence on microorganisms - food ingredients.

Module 4: Ultrasound & High Pressure Processing (8 hours)

Ultrasound – introduction – types of pressure waves – generation of ultrasound – mechanism of microbial inactivation – application in food processing – High pressure processing – Principles – concepts – basic laws related to HPP - design of equipment - processing of food using HPP - effect of HPP on biological cells – effect on enzymes – effect on food constituents - process structure function interaction - design of packaging materials - commercial applications of HPP.

Module 5: Food irradiation (8 hours)

Food irradiation – principle of irradiation – radioactive substances – types of irradiation – construction and working of equipment – effect of irradiation on the nutritional and biochemical changes – application in food sectors – social and ethical issues - electron beam radiation - application in food processing.

Module 6: Cold plasma technology (8 hours)

Plasma definition -Types- cold plasma techniques – principles involved in microbial decontamination – Mode of application of plasma – Methods of generation of cold plasma – application of cold plasma in food packaging – Applications in Food industries.

Text Books:

1. Nonthermal Preservation of Foods. Gustavo V. Barbosa-Canovas, Usha R. Pothakamury, *ISBN* 0-8247-9979-8
2. Enrique Palou and Barry G. Swanson. Published by Marcel Dekker, Inc., 270, Madison Avenue, New Yorkm 10016, 1998. ISBN: 9780824799793
3. Advances in Food Process Engineering Research and Applications. Stavros Yanniotis, Petros Taoukis, Nikolaos G. Stoforos, Vaios T. Karathanos. Published by Springer, 2013. ISBN 978-1-4614-7905-5.

Reference Books:

1. Trends in Food Engineering, Jorge E. Lozano, Cristina Anon, Efren Parada-Arias, Gustavo V. Barbosa-Canovas, Contributor Jorge E. Lozano, Published by CRC Press, 2000. ISBN-13: 978-1566769914
2. Gould G.W., "New Methods of Food Preservation", Aspen Publishers, Great Britain, ISBN No. 0834213419, 1999.
3. Da Wun Sun "Emerging trends in Food Engineering"

20FP3019	ADVANCED STORAGE ENGINEERING OF FOOD MATERIALS	L	T	P	C
		3	0	0	3

Course Objectives:

1. Acquiring knowledge and improve skill-sets in the area of food storage.
2. Understanding the specific aspects of storage techniques and requirements.
3. Designing storage structures for any food material.

Course Outcomes:

The students will be able to

1. Identify the specific storage requirements of variety of food materials.
2. Ascertain the pre-requisites for the safe handling and storage of food materials.
3. Identify the best time-temperature combinations for food materials during storage.
4. Identify the shelf-life testing of various food materials during storage.
5. Design structures for storage of grains and other major crops.
6. Identify the pest control strategies in the storage space.

Module 1: Cold storage (7 hours)

Cold storage- Moist air and applied psychrometry, Estimation of cooling load, Air conditioning systems, Evaporators, Compressors, Condensers, Expansion devices, Cooling towers, Different types of refrigerants, Transmission and distribution system of cool air, Thermal and vapor insulation materials, Design of small capacity cold storage, Instrumentation and climate.

Module 2: Frozen storage (8 hours)

Quality loses in frozen foods- Physical changes, Chemical changes in food components, Nutritional aspects of freezing, Microbiology of frozen products, Glass transitions temperature and stability of frozen foods, Temperature requirements during frozen storage, Shelf-life of frozen foods- shelf-life testing, Modelling loss of quality in frozen foods, Time-Temperature integrators, Packaging of frozen foods, Different types of freezers.

Module 3: Modified atmospheric storage (7 hours)

Overview of Modified atmospheric storage, Gases and Vapor applied to modified atmosphere processing operations, MAP modelling- Kinetics of food deteriorative reactions, Shelf-life testing, Enzyme kinetics applied to MAP, MAP design with oxygen modelling

Module 4: Controlled atmospheric storage (7 hours)

Biochemical considerations of CAS, Gas exchange mechanisms, Mass balance principles, Gas generators, Equipment's for producing and regulating controlled atmosphere, Design of controlled atmosphere storage chambers.

Module 5: Hypobaric storage (8 hours)

History of Hypobaric storage, Experimental errors in hypobaric storage research, Gas and vapor mass transfer at low pressure, Requirements for installation- measurement devices (Relative humidity, Pressure, Air-change rate, Oxygen, Carbon dioxide, Ethyl alcohol, Acetaldehyde, hypobaric acid vapor), Flow control, Humidity control, Effects on food, Effects on microbes.

Module 6: Grain storage structures (8 hours)

Storage of grains–physicochemical and biochemical changes, storage factors affecting losses, integrated pest management; Damage caused by rodents; Storage pests, Traditional storage structures – merits and demertis, improved storage structures, modern storage structures; Farm silos: Horizontal silos, tower silos, pit silos, trench silos, bag and bulk storage– pressure distribution theories, design of silos – design consideration - size and capacity of silos, storage requirements.

Text Books:

1. Rao, Chandra Gopala. Engineering for storage of fruits and vegetables: cold storage, controlled atmosphere storage, modified atmosphere storage. Academic Press, 2015. ISBN-13: 978-0128033654
2. Burg, Stanley. Hypobaric storage in food industry: advances in application and theory. Elsevier, 2014. *ISBN* 9780124199620, 9780124199781.
3. Evans, Judith A., ed. Frozen food science and technology. John Wiley & Sons, 2009. *ISBN*: 978-1-4051-5478-9

Reference Books:

1. Ahvenainen, Raija, ed. Novel food packaging techniques. Elsevier, 2003. *ISBN*: 9781855736757
2. Morris S.A., Food and Package Engineering, Wiley – Blackwell, ISBN No. 1119949777, 2011.
3. Robertson G.L., Food packaging: Principles and practice, Taylor & Francis/CRC Press, ISBN No. 0849337755, 2006.
4. Kirwan M.J., Derek McDowell D., and Coles R., Food Packaging Technology, Blackwell Publication, ISBN No. 084939788X, 2003.
5. Karel, Marcus, Owen R. Fennema, and Daryl B. Lund. Principles of food science. Part II. Physical principles of food preservation. Marcel Dekker, Inc., 1975. *ISBN*, 082476322X, 9780824763220.

20FP3020	FOOD MATERIAL SCIENCE AND ENGINEERING	L	T	P	C
		3	0	0	3

Course Objectives:

1. To enable students understand the physical chemistry of foods
2. To introduce the kinetics of food systems
3. To make the students understand the interaction of food constituents in maintaining the texture and structure of a food

Course Outcomes:

The students will be able to

1. understand the importance of glass transitions and its relation to stability
2. understand the theory of gelling and its effect on texture of foods
3. develop new products which are nutritional and cost effective
4. understand the relationship between structure and properties of foods
5. predict their behavior during storage
6. develop cheaper sources of raw materials for a product

Module 1: Food Polymers (7 hours)

Interactions of Food Biopolymers in Molecular and Colloidal Dispersions – Interbiopolymer complexes – Functional properties of electrostatic complexes – Incompatibility of biopolymers – The Space occupancy concept – Phase diagram – Biopolymers in Food systems – Molecular mimicry and symbiosis – Functional properties of Food systems

Module 2: Material Science approach towards Food design (8 hours)

Basics of theory of glass transitions – Difference between crystalline and amorphous polymers - Key elements of the food polymer science approach –Consumer-driven food design - Food design based on the supplemented state diagram- Design of foods and encapsulation systems in the glassy state - Retro-design for the delivery of bioactive ingredients in foods

Module 3: Structuring of Food Products (8 hours)

Structuring Dairy products by means of processing and Matrix design – Structured cereal products – structured meat products – Structured chocolate products - Edible Moisture Barriers for Food Product Stabilization

Module 4: Characterisation Techniques in Food Material Science (8 hours)

Principles and applications of NMR, FTIR, SANS and SAXS, XRD, Confocal Microscopy Atomic Force microscopy, Chemical Force microscopy in Food system.

Module 5: Food Powders and their characteristics (8 hours)

Processing of food powders-powder properties and functionality –production of food powders-spray drying- comminution- processing food powders-coating-principles and mechanism-micro encapsulation-fluidized bed coating-granulation of food powders-segregation-process and mechanism-caking-particle breakage-degradation of ingredients and functionality. Solubility of powders-dispersibility- instantization

Module 6: Nanotechnology in Food materials research (6 hours)

Food Nanotechnology – Food Protein based nanotubes – Nano composites – Nano scale properties of Food biopolymers – Protein – polysaccharide interactions – Interfacial properties of proteins and polysaccharides – Nanotechnology in Functional food research

Text Books:

1. Aguilera JM and Lillford P.J., “Food Materials Science - Principles And Practice”, Springer, USA. 2008. e- ISBN No. 978-0-387-71947-4.
2. Bhandari B. and Roos Y.J. “Food Materials Science And Engineering”, Wiley Blackwell Publishing Ltd., UK. 2012. ISBN 978-1-4051-9922-3.

Reference Books:

1. Schwartzberg H.G., and Hartel R.W., “Physical Chemistry of Foods”, Marcel Dekker Inc., New York, ISBN No. 0824786939, 1992.
2. Friberg S., Larsson K. and Sjoblom S. “Food Emulsions” Marcel Dekker Inc., Fourth Edition, ISBN No. 0824746961, 2004.

3. Damodaran S., Parkin K. and Fennema O.R.,"Fennema's Food Chemistry", CRC Press, ISBN No. 0849392721, 9780849392726, 2008.
4. Belitz H-D., Grosch W.and Schieberle P., "Food Chemistry"- Springer Verlag, Berlin Heidelberg, Germany, III Revised Edition, ISBN No. 3540408177, 2004.

20FP3021	GREEN TECHNOLOGY IN FOOD PROCESSING	L	T	P	C
		3	0	0	3

Course Objectives:

1. To provide basic knowledge of Green chemistry.
2. To provide the importance of eco-friendly methods of manufacture of various products.
3. To introduce the process intensification for Green chemistry.

Course Outcomes:

The student will be able to

1. Understand the basics of Green Technology
2. Predict the efficiency of a system and relate it with Green Technology
3. Examine suitable processes towards Green processing of Foods
4. Choose an eco-friendly and cost-effective method of manufacture of products
5. To Improve existing methods for improved efficiency and economics
6. Develop novel methods for improved efficiency and economics

Module 1: Introduction to Global Agri Food System (7 hours)

Introduction – Characteristics of Global agri-food system – Types of food systems – Structures and layers - Agri-food supply chain – Key drivers of the Food chain – Industrialization of agriculture – Green revolution - Globalisation and agriculture – Environmental and sustainable agriculture certification

Module 2: Sustainability and Life Cycle Assessment (LCA) (8 hours)

Concept of Sustainability – Green Chemistry and Sustainability parameters – LCA methodology – Methodological Framework – Applications of LCA – Product Oriented LCA – Process Oriented LCA

Module 3: Green Technology in Food Processing – Supercritical and near-supercritical CO_2 processing and Sub-critical water extractions (7 hours)

Properties of CO_2 – Environmental and safety advantages of using CO_2 in process- Operating a process economically with CO_2 - principles and practice of supercritical fluid extraction – process systems and industrial applications - Sub critical water extraction – Industrial applications

Module 4: Electrodialysis in Food Processing (6 hours)

Basic principles of conventional Electrodialysis – Membranes – operating variables – Bipolar membranes and principle of Bipolar membranes - Green technologies applications of conventional and bipolar ED in food processing

Module 5: Enzyme assisted Food Processing (9 hours)

Sources of Food Enzymes – Major Food enzyme groups – Oxidoreductease, Proteases, Transferases, Carbohydrases, lipases, Isomerases and their application in Food Processing – Controlling enzymatic activity in Foods

Module 6: Emerging Technologies in Green Processing (8 hours)

Microbial control in Foods using biopreservatives – Novel Thermal Technologies – Microwave Technology – Green technology in Food dehydrations – "Green drying" scheme - Energy efficient dryers – Green Packaging

Text Book:

1. Joyce I. Boye and Yves Arcand. "Green Technologies in Food Production and Processing", Springer Publications, 2012. e-ISBN 978-1-4614-1587-9

Reference books:

1. James Clark and Duncan Macquarrie, "Handbook of Green Chemistry and Technology", Blackwell Publishing, First Edition, ISBN – 0632057157, 2002.
2. Stanley E. Manahan. "Green Chemistry and the Ten commandments of Sustainability", ChemChar Res. Inc., 2006. ISBN 0-9749522-4-9

20FP3022	FOOD SUPPLY CHAIN MANAGEMENT	L	T	P	C
		3	0	0	3

Course Objectives:

1. The key aspects of food supply chains from a management and social perspective.
2. To take up the logistics and supply chain activities in food industries.
3. To measure and improve the performance of supply chain systems.

Course Outcomes:

The students will be able to

1. Learn the methods of logistics.
2. Understand the concepts of supply chain management.
3. Identify challenges of food retailing as well as international food supply chains.
4. Empower the students in the field of logistics and supply chain management.
5. Design logistics and supply chain management for food industries.
6. Apply Methods and Tools for creating sustainable supply chains

Module 1: Elements of Supply Chain Management (9 hours)

Logistics and supply chain management-Players of supply chain , elements of logistics – inbound outbound Logistics, Four utilities – Operations, Performance Scope, Significance and Drivers; Basic Model – Primary and Secondary Activities; Role and Challenges of Logistics and supply chain management in food industry,. Performance metrics in Supply Chain.

Module 2: Procurement and Warehousing (8 hours)

Demand and supply management, Forecasting techniques, Planning -Strategic planning for material sourcing, Outsourcing –strategies, Merits and demerits , Warehouse strategies, Inventory , management models and control techniques

Module 3: Distribution and Transportation (8 hours)

Various sources of distribution channels, Distribution models, 3PL and 4PL Advantages and disadvantages of 3PL. Framework for development of 3PL, Distribution network planning, Modes of transportation, Design of trans shipment .

Module 4: Packaging and Information Technology (7 hours)

Types of packaging and packaging materials, Export & import packaging and labelling details, Containerization, IOT in Supply Chain Management – ERP, Bar-coding, RFID, GPS, E-Procurement.

Module 5:- Global SCM (7 hours)

Global Supply chain management, lean , agile, sixsigma Factors , challenges ,Protocols of import and export –SOP, book driving Global supply chain management Managing challenges in international food supply chains Export and import procedure and Documentation, Risk management in global logistics, Customer relationship management in SCM.

Module 6: Food Logistics (6 hours)

Agriculture Logistics Entities in the agriculture supply chain , Temperature-controlled supply chains Cold supply Chain, Trends in supply chain relationships, Current relationship models within the food sector, Risk management in Food supply chain Indian agencies- EIC, EIA, APEDA, MEPEDA. Rapid alert system. Retail food supply logistics. ,E food management.

Text Books:

1. D K Agarwal, “Logistics and supply chain management”, Macmillan Publishers India Ltd., Eighth Impressions, 2010. ISBN13:978-1403-909954
2. Samir Dani “Food supply chain Management and logistics” CPI Group (UK) Ltd, Croydon CR0 4YY 2015 ISBN 978-0-7494-7364-8
3. Rezapour; Reza Farahani; Laleh Kardar “Logistics Operations and Management Shabnam” Published by Elsevier, 2011. ISBN:978-0-12-385202-1

Reference Books:

1. Sunil Chopra and Peter Meindi, “Supply chain management” Pearson Education publishers, 2013. *ISBN: 978-0-13-274395-2*.
2. David Taylor and David Brunt “Manufacturing Operations and Supply chain Management”, Vikas Thomson Learning publishers, 2009.1-86152-604-0

20FP3023	FOOD PLANT LAYOUT AND DESIGN	L	T	P	C
		3	0	0	3

Course Objectives:

1. To enable the students understand various concepts of economics of food plant.
2. To understand the processes involved in layout design.
3. To understand the development and design consideration and cost estimation in food industry.

Course Outcomes :

The student will be able to

1. Gain knowledge on the various factors involved in setting up a Food Processing Industry.
2. Understand the process of food plant layout design.
3. Apply their knowledge to design projects for setting up a Food Processing Industry.
4. Analyse the problems involved in deciding the level of manufacture of a food product
5. Evaluate the options involved and decide on the right choice based on the economics of the system
6. Develop own industry or plan turn-key projects based on the request from customers

Module 1: Food Process Design Development (7 hours)

Technical feasibility survey of Food Industry, process development, Food Process flow sheets — Computed-aided process design – Principles of spread-sheet aided process design (Basic concepts only)

Module 2: Plant Layout (7 hours)

Marketability of the product, availability of technology, raw materials, equipments, human resources, land and utilities, site characteristics, waste disposal, Government regulations and other legal restrictions, community factors and other factors affecting investment and production costs. Plant Layout based on process and product. Richard Muther's Simple Systematic Plant Layout.

Module 3: Overview of Sanitary and Hygeinic Design and Layout (7 hours)

Hygienic food process design – Principles of Sanitary design - equipment design and specifications-Basic outline on FSMS.

CIP Sanitary Process design:CIP system components – CIP program control - Criteria for CIP'able Process Equipment Design –Application of CIP for Liquid and Solid Food Processes – Typical Cleaning Protocols and Procedures.

Module 4: Project Evaluation and Cost Estimation (9 hours)

Capital investments – fixed capital investments including land, building, equipments and utilities, installation costs (including equipments, instrumentation, piping, electrical installation and other utilities), working capital investments. Methods of Cost estimation – Cost Indices.

Module 5: Product Cost and Plant Overheads (8 hours)

Manufacturing costs – Direct production costs(including raw materials, human resources, maintenance and repair, operating supplies, power and other utilities, royalties, etc.). – Process Profitability - Application to a Food Processing plant e.g. Tomato processing - Administration, safety and other auxiliary services, payroll overheads, warehouse and storage facilities etc. Depreciation, Amortization and methods of determining the same.

Module 6: Profitability Analysis (7 hours)

Return on original investment, interest rate of return, accounting for uncertainty and variations and future developments. Cash flow diagram and its importance - Optimization techniques – Linear and Dynamics programming, Optimization strategies.

Text Book:

1. Peters and Timmerhaus, Plant design and Economics for Chemical Engineers, McGraw Hill 5th Edition, ISBN-007-124044-6, 2004 .

Reference Books:

1. Rudd D F and Watson C C, Strategy of Process Engineering, John Wiley & Sons Inc, ISBN-978-0471844559, 2013
2. Maroulis Z.B. and Saravacos G.D. Food Process Design, Marcel Dekker Inc. ISBN-0824743113, 2003.
3. Towler G and Sinnott R.K. Chemical Engineering design principles, practice and Economics of Plant and Process. 2nd Edition. Elsevier, ISBN-9780080966595, 2012

4. Rudd and Watson, Strategy of Process Engineering, Wiley and Sons, 1987
5. Baasel W.D. Preliminary chemical engineering plant design, van Nostrand Reinhold, 2nd Edition, 1990
6. Heldman D.R. and Lund D B. Hand Book of Food Engineering, 2nd edition, CRC Press, Taylor and Francis Group, 2007

20FT3001	FOOD CHEMISTRY	L	T	P	C
		3	0	0	3

Course Objectives:

1. To understand the chemistry of food constituents.
2. To apply fool molecules interaction in developing technologies / processes.
3. To develop skills for experimenting with food systems and to test various approaches for manipulating the chemical and/or functional properties of foods.

Course Outcomes:

The student will be able to

1. describe the general chemical structures of major components of foods (water, proteins, carbohydrates, and lipids) and selected minor components (vitamins and minerals).
2. understand, plan, perform and analyse a range of chemical investigations with emphasis on food analysis
3. demonstrate the ability to relate the chemical composition of foods to their functional properties
4. examine a molecular rationalization for the observed physical properties and reactivity of major food components.
5. evaluate and determine the approaches that may be used to control the reactivity of those food components that are likely to impact the overall quality of finished products.
6. predict how changes in overall composition are likely to change the reactivity of individual food components.

Module 1: Water and Ice (9 hours)

Importance of water in foods - Structure of water & ice - concept of bound & free water. Sorption phenomena and sorption isotherms with example. Dispersed systems – Properties and factors affecting stability.

Module 2: Chemistry of Carbohydrates (8 hours)

Nomenclature, classification & structure of carbohydrates, chemical reactions of carbohydrates, General properties of monosaccharide, chemistry of polysaccharides, properties and preparation of pectic substances, gums, starch and its hydrolytic products, cellulose, process flowsheet for the production of cyclodextrins, maltodextrins, HFCS.

Module 3: Chemistry of Lipids (8 hours)

Nomenclature and classification of lipids. Basic Structures and chemistry of fatty acids. physical & chemical characteristics of fats & oils Phospolipids, and unsaponifiables, auto oxidation and hydrolysis, antioxidants. Process flow sheet for the manufacture of edible oils (refined and hydrogenated), fat interesterification.

Module 4: Chemistry of Proteins (11 hours)

Nomenclature, classification, structure and chemistry of amino acids, peptides & Proteins. Functional properties of Protein.. Protein denaturation. Enzymes: Introduction, classification & nomenclature of enzymes. Specificity. amylases, pectic enzymes, proteases; glucose oxidases, catalases, peroxidases, lipoxygenases, xanthine oxidases. Immobilized enzyme - One example of working of each enzyme.

Module 5: Chemistry of Vitamins (5 hours)

Fat-soluble and water soluble vitamins – Choline, carnitine. Summary of vitamin stability – Toxicity and sources of vitamins – Bioavailability of vitamins – Reasons for the loss of vitamins in foods

Module 6: Chemistry of Natural Colourants (4 hours)

Overview of natural colourants, sources, chemistry and applications of anthocyanin, betalain, carotenoids and chlorophyll.

Text books:

1. Srinivasan Damodaran, Kirk L. Parkin. “Fennema’s Food Chemistry”. 5th Edition, Taylor & Francis group, (2017). ISBN- 9781315372914 (e book)

2. H.D. Belitz, W. Grosch, P. Schieberle. "Food Chemistry". 4th revised and extended edition, Springer-Verlag Berlin Heidelberg, (2009). ISBN 978-3-540-69933-0

Reference Books:

1. John M.deMan, John W. Finley, W.Jeffrey Hurst and Chang Yong Lee . "Principles of Food Chemistry", 4th edition, Springer International Publishing.(2018). ISBN 978-3-319-63607-8 (eBook).
2. N. Michael Eskin. Biochemistry Of Foods – 2nd Edition Academic Press, USA. (1990) ISBN 13: 9780122423512
3. Pieter Walstra. "Physical Chemistry of Foods". Marcel Dekker Publishing, New York (2003)ISBN 9780824793555
4. Zdzislaw and E.Sikroski. "Chemical and functional Properties of Food Components", 3rd edition, CRC Press, Taylor & Francis group USA (2006), ISBN - ISBN 9780849396755.

20FT3002	FOOD MICROBIOLOGY	L	T	P	C
		3	0	0	3

Course Objectives:

1. To understand the microorganisms associated with foods and isolation methods of microorganisms from foods.
2. To know the methods of preservation of foods.
3. To learn the food safety standards and methods of detection of pathogens.

Course Outcomes:

The student will be able to

1. identify the beneficial and spoilage microorganisms associated with foods and the conditions under which they will grow.
2. understand the growth and methods of isolation of microorganisms from food.
3. understand the principles that makes a food product safe for consumption.
4. know the spoilage and deterioration mechanisms in foods and methods for detection of pathogens.
5. evaluate the role of microorganisms in various foods and water.
6. predict the causative agent and pathogenesis of disease causing food borne pathogens and their toxins.

Module 1: History, Screening and Isolation of Microorganisms (8 hours)

History of Microorganisms in Food Development - Micro organisms associated with foods: Bacteria, Molds, Yeast and their importance –Nutritional requirements of bacteria- Factors affecting the growth of bacteria –Growth curve of bacteria - antimicrobial barriers and constituent - General Microbiological Methods of enumeration and isolation of bacteria and fungi,-Identification of bacteria and fungi by staining methods.

Module 2: Microbiology of Water and Food Commodities (8 hours)

Microbiology of water and their importance in processing of foods in industries. MPN of coliforms, Membrane filtration Technique. Microbiology of milk –Phosphatase test. Hetero and homo fermentative Lactic acid bacteria – Yogurt and Cheese fermenting organisms- Importance of Biofilm and their role in transmission of pathogens in dairy products and preventive strategies-Microbial spoilage of various food commodities

Module 3: Food Borne Diseases and Intoxications (7 hours)

Food Poisoning and intoxication – food borne diseases – Symptoms of diseases caused by *Bacillus* spp., *Clostridium botulinum*, *Escherichia coli*, *Salmonella* spp, *Staphylococcus aureus*, *Shigella* spp., Hepatatis, Gastroenteritis viruses, *Entamoeba histolytica* – Mycotoxins, Bacterial toxins and Algal toxins.

Module 4: Methods for Detection of Pathogens and Food Safety Standards (8 hours)

Rapid methods for detection of microorganisms and toxins- Immunological methods, Rapid methods for detection of microorganisms and toxins- DNA/RNA methodology, Hazard analysis Critical Control Point(HACCP), Food Safety Standards Authority of India(FSSAI), Food and Drug Administration, Food and Agriculture Organization, International Commission on Microbiological specification for Foods (ICMSF).

Module 5: Conventional Methods of Preservation (7 hours)
Thermal mode of preservation – Pasteurisation , sterilization and Canning – Heat resistance of microorganisms and their spores – spoilage of canned foods and types of spoiled cans – aseptic packaging - Low-temperature storage.
Module 6: Non-thermal Methods of Preservation (7 hours)
High pressure processing – Pascalisation - Irradiation – Brief account of microwave, UV and ionizing radiation - Use of chemical preservatives, Natural food preservatives- Application of Probiotics and Prebiotics.

Text Books:

1. Adams M.R and Moss M.O, "Food Microbiology", Panima Publishing corporation, New Delhi, 2nd Edition, Third reprint, ISBN-13:9788122410143,978-8122410143, 2007.

Reference Books:

1. Sivasankar B, "Food Processing and Preservation", PHI Learning Private Limited, Easterrn Economy Edition, 6th edition, ISBN- 97881203-2086-4, 2009.
2. William C Frazier and Dennis C. Westoff, "Food Microbiology", Special Edition, Springer, The Mc Graw-Hill Companies2008. ISBN-9780070667181.

20FT3003	PRINCIPLES OF FOOD PROCESSING AND PRESERVATION	L	T	P	C
		3	0	0	3

Course Objectives:
1. To impart knowledge on basic aspects of food preservation.
2. To provide technical aspects of food processing.
3. To give orientation towards the process and products developed using different techniques.

Course Outcomes:
The student will be able to
1. recall the basic principles involved in food preservation.
2. understand the various processing methods.
3. comprehend suitable techniques for preservation of various foods.
4. apply the modern technologies o food preservation in industry.
5. evaluate and suggest proper preservation methods and equipments.
6. create new processes for product development.

Module 1: Principles of Fresh Food Storage and Preservation (5 hours)
Definition and scope of Food Science and Technology- Nature of harvested crop, plant, animal; product storage; effect of cold storage and quality – storage of grains, historical development of food processing and preservation, general principles of food preservation.
Module 2: Preservation by Heat (8 hours)
Blanching, pasteurization, sterilization and UHT processing, canning, extrusion cooking, dielectric heating, microwave heating, baking, roasting and frying. Retort processing of Ready to eat (RTE) products. Newer methods of thermal processing – batch and continuous.
Module 3: Preservation by Low Temperature (9 hours)
Chilling**:** Considerations relating to storage of foods at chilling temperature, applications and procedures, controlled and modified atmosphere storage of foods. Freezing temperature**:** Freezing process, slow and fast freezing of foods and its consequences, other occurrences associated with freezing of foods. Technological aspects of pre-freezing, Actual freezing, frozen storage and thawing of foods.
Module 4: Preservation by Drying (9 hours)
Drying – water activity, microbial spoilage due to moisture. Dehydration of fruits, vegetables, milk, animal products. Various methods employed in production of dehydrated commercial products, selection of methods based on characteristics of foods to be produced, advantages and disadvantages of different methods, sundrying, tray or tunnel drying, spray drying, drum drying, freeze drying, fluidized bed drying. Physical and chemical changes during drying, control of chemical changes, desirable and undesirable changes.

Module 5: Chemical Preservations (6 hours)
Principles, technological aspects and applications of sugar and salt, antimicrobial agents, biological agent, Hurdle technology. Effects of various food processing operations on the nutritive value of foods.

Module 6: Preservation by Non-Thermal Methods (8 hours)
High pressure, pulsed electric field, ultrasound technology, cold plasma technology, UV and pulsed light technology, hurdle technology. Permissible limits for chemical preservatives. Use and application of enzymes in processing and preservation of foods.

Text books:

1. Rao, Chandra Gopala, "Essentials of food process engineering". B.S. Publications, 2009. *ISBN* 9781439803103.
2. Khatkar, Bhupendra Singh, "Food science and technology", Daya Publishing House, 2007. *ISBN* 13: 9788170354222
3. Ahlluwalia, Vikas, "Food processing", Paragon International Publishers, 2007. *ISBN*-13: 978-8189253523
4. Sivasankar,B, "Food processing and preservation", Prentice - Hall of India, 2005. *ISBN*-13: 978-8120320864

Reference Books:

1. Rahman, Shafiur, "Handbook of food preservation". 2nd Edn., CRC press, 2007. *ISBN*-13: 978-*1*-57444-606-7
2. Fellows.P, "Food processing technology", 2nd Edn. Woodhead publishing company, 2005. *ISBN*: 1 85573. 475 3
3. Berk, Zeri, "Food process engineering and technology", CRC Press, 2009. *ISBN* 978-0-470-67223-5

20FT3004	TECHNOLOGY OF CEREALS, PULSES AND OILSEEDS	L	T	P	C
		3	0	0	3

Course Objectives:
1. To equip the students with basic concepts of various unit operations in processing of food materials.
2. To provide basic knowledge on various processing equipment.
3. To impart skills on the product and by-product development.

Course Outcomes:
The students will be able to
1. recall the basic concept on cereals, pulses and oil seeds processing
2. understand the various unit operations involved milling
3. analyze and select suitable equipment for milling
4. apply the knowledge to process grains into value added products
5. create new products from pulses and legumes
6. gain knowledge on converting the waste in to wealth

Module 1: Introduction (3 hours)
General introduction and production and utilization trends; Structure and composition of common cereals, pulses and oilseeds.

Module 2: Wheat milling (9 Hours)
Types and physicochemical characteristics; wheat milling -products and byproducts; factors affecting quality parameters; physical, chemical and rheological tests on wheat flour; additives used in bakery products; flour improvers and bleaching agents; manufacture of bakery products, pasta products and various processed cereal-based foods; manufacture of whole wheat atta, blended flour and fortified flour. Production of starch and vital wheat gluten.

Module 3: Paddy milling (9 hours)
Classification, physicochemical characteristics; Paddy parboiling – methods - quality changes - cooking quality - rice milling technology; by- products of rice milling and their utilization; Rice bran

stabilization, oil extraction and refining – Quick cooking rice – fermented products – puffed, expanded rice.

Module 4: Maize/ corn milling (8 hours)

Types and nutritive value; dry and wet milling, processing of corn in breakfast cereals, snacks, tortilla etc., production of glucose syrups, dextrose, high fructose corn syrups, modified starches.

Module 5: Pulse milling (8 hours)

Anti-nutritional factors – pulse milling – unit operations – traditional and commercial milling - processing for production of flour, protein concentrates and isolates - extrusion cooking technology - snack foods - development of low cost protein foods.

Module 6: Oil milling (8 hours)

Types of oil seeds - Pre-conditioning of oilseeds - Oil expression and extraction – Traditional ghani - Mechanical expression, screw press, hydraulic press - solvent extraction methods - refining of oil - By-products utilization.

Text books:

1. Sahay, K.M. and K.K. Singh, 2006 Unit operations of Agricultural processing. Vikas publishing House Pvt. Ltd. Noida, New Delhi. ISBN: 9788125911425
2. Chakraverty A. 2000, Post Harvest Technology of cereals, Pulses and oil seeds. Oxford and IBH publishing Co Pvt Ltd, New Delhi. *ISBN*-13: 978-8120409699
3. Amalendu Chakraverty, Arun.S.Mujumdar, Hosahalli.Ramasamy. Handbook of Postharvest Technology: Cereals, Fruits, Vegetables, Tea, and Spices. CRC Press, 2003, *ISBN:* 9780824705145
4. Samuel A. Matz, 2004. The chemistry and Technology of cereals as Food and Feed. CBS Publishers and Distributors, New Delhi. *ISBN* 13: 9788123904764.

Reference Books:

1. Chakrabarthy, M.M. (2003). Chemistry and Technology of Oils and Fats.Prentice Hall. *ISBN 1*-84127-331-7
2. Dendy, D.A.V., & Dobraszczyk, B.J. (2001). Cereal and Cereal Products. Aspen. *ISBN* 978-0-8342-1767-6
3. Hamilton, R.J., & Bhati, A. (1980). Fats and Oils - Chemistry and Technology.App. Sci. Publ. I*SBN*, 0853349150
4. Hoseney, R.S. (1994). Principles of Cereal Science and Technology. 2nd Ed.AACC. *ISBN*: 978-1-891127-63-2
5. Kay, D.E. (1979). Food Legumes. Tropical Products Institute. *ISBN*: 0859540855 9780859540858
6. Kent, N.L. (1994). Technology of Cereals. 4th Ed. Pergamon Press. *ISBN*: 9781855733619. eBook *ISBN*: 9781855736603

20FT3005	TECHNOLOGY OF FRUITS AND VEGETABLE PROCESSING	L	T	P	C
		3	0	0	3

Course Objectives:

1. To develop the knowledge of students in the area of fruits and vegetable processing.
2. To know formulation of various products, their manufacturing process and equipment.
3. To enable the students to appreciate the application of scientific principles in the processing of fruits and vegetables.

Course Outcomes:

The students will be able to

1. acquire knowledge on different physical, chemical and nutritional properties of fruits and vegetables.
2. acquire insight in the various chemical and biochemical changes occur during processing.
3. learn various ways of designing and monitoring processing chains
4. know about laws, regulations and the monitoring agencies involved in food safety and labelling of fruits and vegetables.
5. understand the methods of packaging, shelf life and related factors in the processing of fruits and vegetables.

6. know how fruits and vegetables are processed in industries.

Module 1: Introduction (8 hours)

Current status of production and processing of fruits and vegetables. Scope of fruits and vegetables preservation in India: Postharvest losses and management, marketing facility, Logistics and supply chain management.

Module 2: Juice extraction (7 hours)

Types of juices, process flow diagram for fruit juice production, juice extraction process- fruit selection, sorting, washing, juice extraction, deaeration, straining/filtration, clarification, adding of sugars, fortification, bottling, sealing and storage; methods of juice preservation, causes of juice spoilage.

Module 3: Canning (7 hours)

Introduction, can manufacture, canning process - selection of fruits and vegetables, grading, washing, peeling, cutting, blanching, cooling, filling, exhausting, sealing, retort processing and storage; types of canning- pressure canning and water bath canning, common causes of spoilage in canning of foods.

Module 4: Drying (7 hours)

Drying: principles, merits and demerits of drying, working principles of various dryers – drum, cabinet, tunnel, freeze, spray, etc., preparation of fruit powders and dried slices, intermediate moisture foods, osmotic dehydration.

Module 5: Minimal processing (8 hours)

Physico chemical aspects affecting the postharvest life, technologies used in preservation – chemicals and non-chemical, methods to extend the shelf life, food packaging -Modified atmosphere packaging (MAP), Controlled atmospheric packaging, Intelligent packaging, Temperature control, humidity control and gas control, advantages and disadvantages. Hurdle technology – basic aspects, commonly used hurdle combinations, future trends.

Module 6: Products and standards (8 hours)

Preparation of products like Jams, Jellies, Marmalades, Pickles, Puree, Ketchup, Sauce, and Squashes etc. Common machinery for operations like Peeling, Slicing/Dicing and Pulping, quality standards: AGMARK act, FSSAI, Food and Drug Administration, Bureau of Indian Standards, International standards.

Text books :

1. R. P. Srivastava & Sanjeev Kumar. Fruit and Vegetable Preservation: Principles & Practices International book distributing Co. Lucknow (2019 4th print). ISBN 10: 8123924372ISBN 13: 9788123924373
2. Rosenthal, A., Deliza, R., Welti-Chanes, J., & Barbosa-Cánovas, G. V. (Eds.). Fruit Preservation: Novel and Conventional Technologies. Springer. 2018. *ISBN* 978-1-4939-3311-*2*
3. Giridhari Lal, G.S. Siddappa & G.L. Tondon. Preservation of Fruits and Vegetables CFTRI, ICAR, New Delhi -12. 1990
4. Y. H. Hui, S. Ghazala, D.M. Graham, K.D. Murrell & W.K. Nip Handbook of Vegetable Preservation and Processing Marcel Dekker. 2003.

Reference books:

1. Lal G, Siddapa GS & Tandon GL. Preservation of Fruits and Vegetables. ICAR. 1986.
2. Salunkhe DK, Bolia HR & Reddy NR. Storage, Processing and Nutritional Quality of Fruits and Vegetables. Vol. I. Fruits and Vegetables. CRC. 1991. *ISBN* 9781466566293.
3. Thompson AK. Post-Harvest Technology of Fruits and Vegetables. Blackwell Sci. 1995. ISBN-13: 978-0632040377

20FT3006	BAKERY AND CONFECTIONERY TECHNOLOGY	L	T	P	C
		3	0	0	3

Course objectives:

1. To impart knowledge on the fundamentals involved in various Bakery and confectionery Processes
2. To gain knowledge on the composition and nutritive value of baked products
3. To recognize the factors governing the manufacturing of confectionery products

Course outcomes:

The student will be able to

1. know the various ingredients used in the baking industry.
2. study about the processes involved in baking technology.
3. understand the factors affecting the quality of baked and confectionery products
4. design products with better quality.
5. learn about the process involved in confectionery products
6. get an exposure to the different parameters involved in scale up of bakery products production.

Module 1: Flour for Bakery Goods (9 hours)

Structure and composition of wheat grain; criteria of wheat quality – physical and chemical factors; Wheat milling – general principles and operations various flour grades and types; criteria of flour quality, dough rheology and its measurement.

Module 2: Additives for bakery and confectionery (6 hours)

Functions of ingredients, Importance of fat, emulsifiers, oxidants, reducing agents, conditioners, CBE and CBS and leavening agents in bakery products.

Module 3: Breads, Cakes & Biscuits (8 hours)

Bread making processes, development in bread making methods, bread faults and staling. Technology of biscuit, cookies, crackers and cakes manufacturing.

Module 4: Snack Foods Technology (7 hours)

Technology of noodles and pasta products, flaked products, semonilla, composite flour products, nutri-bars, musli.

Module 5: Candies and Aerated Confectionery (8 hours)

Raw materials used in confectionery and their importance, Sugar crystallization., solubility and sizes of sugars, stages of sugar cooking, caramelization, Technology & of Hard boiled candies. Gellies, Jujubes, Marshmellows.

Module 6: Toffees and Chocolates (7 hours)

Technology of toffees Types of chocolates and manufacturing process – Quality aspects, Formulation of candies, toffees.

Text books:

1. Wheat and Flour Testing Methods1 - A Guide to Understanding Wheat and Flour Quality: Version 2, Kansas State University Publication, 2008
2. Edwards W.P , "The Science of Bakery Products", RSC Publishing, 2007. ISBN: 978-0-85404-486-3
3. Y.H. Hui, "Bakery Products – Science and Technology", Ed., Blackwell Publishing, 2006. ISBN-13: 978-0-8138-0187-2
4. Sumnu SG and Sahin S, "Food Engineering aspects of Baking sweet goods", CRC Press, 2008. ISBN 978-1-4200-5274-9
5. Ferenc Á. Mohos, "Confectionery and Chocolate Engineering Principles and Applications" © 2010 Ferenc Á. Mohos. ISBN: 978-1-405-19470-9
6. R. Less and E.B, "Sugar Confectionery and Chocolate Manufacture" Jackson Springer, 2012 ISBN: 9781468414950

Reference books:

1. Stephen T Beckett, "The Science of Chocolate" 2nd Edition Formerly Nestle Product Technology Center, York, UK RSC publication 2008 ISBN: 978-0-85404-970-7
2. Sugar Confectionery and Chocolate Manufacture R LEES E B JACKSON BLACKIE ACADEMIC & PROFESSIONAL An Imprint of Chapman & Hall London . Glasgow· New York . Tokyo . Melbourne· Madras ISBN-13: 978-1-4684-1497-4 e-ISBN-13: 978-1-4684-1495-0 001: 10.1007/978-1-4684-1495-0

20FT3007	TECHNOLOGY OF MILK AND MILK PRODUCTS	L	T	P	C
		3	0	0	3

Course Objectives:

1. To gain basic knowledge about constituents and properties of milk.

2. To provide basic knowledge about the milk processing techniques and equipment.
3. To provide knowledge about the manufacturing of milk products.

Course Outcomes:

The student will be able to:

1. gain knowledge on properties and composition of milk.
2. understand the processing techniques of milk.
3. learn the different milk products manufacturing.
4. understand the equipment used in dairy products manufacturing.
5. learn the packaging and storage of various milk products.
6. acquire knowledge on the Indian dairy products and their manufacturing.

Module 1: Milk Processing (10 hours)

Milk – Constituents and Properties. Market Milk – Milk Collection, Reception and Chilling. Platform tests and Quality tests. Pasteurization – LTLT, HTST, UHT, ESL Milk. Filling and packaging of milk. Milk Standardization, Filtration – Clarification, Cream Separation, Homogenization. Adulteration of milk.

Module 2: Special Milks (6 hours)

Special Milks – Homogenized, Sterilized, Flavored, Standardized, Reconstituted and Toned Milks. Evaporated Milk and Sweetened Condensed Milk.

Module 3: Cream and Butter (9 hours)

Cream – Definition, Composition, Types, Properties, Production, Manufacturing of different types of cream and packaging. Butter - Definition, Composition, Types, Properties, Methods of Manufacturing, Defects. Quality of butter and cream. Adulteration in butter. Ghee - Definition, Composition, Types, Properties, Methods of Manufacturing of different types of ghee and packaging.

Module 4: Ice cream and Cheese (9 hours)

Ice cream – Definition, Classification, Composition, Methods of manufacturing - Ice cream freezers. Cheese – Definition, Classification, Manufacture of Cheddar Cheese and Cottage Cheese. Storage, ageing, and defects in cheese.

Module 5: Dried Milk (5 hours)

Drying methods - Drum drying and Spray drying. Instantization and agglomeration. Quality aspects.

Module 6: Fermented and Indigenous Milk Products (6 hours)

Cultured Buttermilk, Acidophilous Milk, Kefir. Dahi, Yoghurt, Khoa, Channa, Srikhand, Makkan, Lassi and Paneer.

Text Books:

1. Sukumar De, "*Outlines of Dairy Technology"*, Oxford University Press, Delhi, 1991, ISBN:9780195611946.
2. Tufail Ahmad, *Dairy Plant Engineering & Management*, Kitab Mahal, Allahabad, India, 2008, ISBN: 9788122501186.
3. Anil Kumar Puniya**,** *Fermented Milk and Dairy Products*, CRC Press, 2016, ISBN: 9781466577978.

Reference Books:

1. G. Bylund, *Dairy Processing Handbook*, Tetrapack publishers, 2012, ISBN: 9789163134272.
2. Pieter Walstra, Jan T. M. Wouters and Tom J. Geurts, *Dairy Science and Technology*, 2nd Edition, Taylor and Francis, 2012, ISBN: 9781466548916.
3. Ashok Kumar Agarwal, *Processing Technologies for Milk and Milk Products*, CRC Press, 2011, ISBN: 9781771885485.

20FT3008	TECHNOLOGY OF PLANTATION CROPS AND SPICES	L	T	P	C
		3	0	0	3

Course Objectives:

1. To provide the basic concepts of different unit operation in processing of plantation and spice crops.
2. To inculcate basic knowledge on various processing equipment
3. To impart skills on quality control measures pertaining to products.

Course Outcomes:

The students will be able to

1. understand the chemistry of plantation crops and spice crop processing
2. recall the various unit operations involved in processing
3. explore the suitable techniques for coffee and tea processing
4. develop processes for spice crops processing
5. learn the techniques of extraction of oleoresins from spices
6. create new plantation based products

Module 1: Processing of Coffee (8 hours)

Production and cultivation - chemical constituents; harvesting, fermentation of coffee beans; changes taking place during fermentation; drying; roasting; process flow sheet for the manufacture of coffee powder; instant coffee technology; chicory chemistry; quality grading of coffee.

Module 2: Processing of Tea (8 hours)

Production and cultivation - chemistry of constituents; harvesting; types of tea – green, oolong and CTC; chemistry and technology of CTC tea; manufacturing process for green and black tea - instant tea manufacture; quality evaluation and grading of tea.

Module 3: Cocoa Processing (7 hours)

Production and cultivation - chemistry of the cocoa bean; changes taking place during fermentation of cocoa bean; processing of cocoa bean; cocoa powder; cocoa liquor manufacture; chocolates–types, chemistry and technology of chocolate manufacture; quality control of chocolates.

Module 4: Processing of Major Spices (7 hours)

Pepper, cardamom, ginger, chili and turmeric–Oleoresins and essential oils; method of manufacture; chemistry of the volatiles; enzymatic synthesis of flavour identicals; quality control; fumigation and irradiation of spices.

Module 5: Processing of Minor Spices (7 hours)

Cumin – coriander – cinnamon – fenugreek – garlic – clove – Processing and extraction of essential oils

Module 6: Processing of other Plantation crops (8 hours)

Vanilla – processing and extraction of vanillin – coconut – processing and products – cashew processing and products - Oil palm. Arecanut, Palmyra – processing

Text Books:

1. Banerjee B. 2002. Tea Production and Processing – 3rd edition, Oxford & IBH Publishing Co.Pvt.Ltd., New Delhi.
2. Minifie Bernard W. Chocolate, Cocoa and Confectionery Technology, 3rd Edition, Aspen Publication, 1999. ISBN: 9780834213012
3. Handbook on Spices, National Institute of Industrial Research (NIIR) Board, Asia Pacific Business Press Inc., New Delhi 2004. ISBN: 8188330946
4. Chakraverty, A., Mujumdar, A.S., Raghavan, G.S.V., Ramaswamy, H.S. Handbook of post harvest technology – cereals, fruits, vegetables, tea and spices. Marcel Dekker Inc., New York (Special Indian Reprint). 2010. ISBN 13: 9780824705145

Reference Books:

1. Peter, K.V. Hand book of herbs and spices. Volume 2. Wood head publishing Ltd., 2004. eBook ISBN: 9780857095688
2. J.S.Pruthi. 1998. Major spices of India – Crop Management and Post Harvest Technology. Indian Council of Agricultural Research, KrishiAnusandhanBhavan, Pusa, New Delhi. PP. 514.
3. J.S. Pruthi. 1980. Spices and Condiments: Chemistry, Microbiology and Technology. First Edition. Academic PressInc., New York, USA. ISBN 10: 0120164647ISBN 13: 9780120164646

20FT3009	TECHNOLOGY OF MEAT, POULTRY AND FISH PROCESSING	L	T	P	C
		3	0	0	3

Course objectives:

1. To understand about the composition, nutritive value of meat, poultry and fish.
2. To know about processing technology of meat, poultry and fish.
3. To learn the technology of meat products and eggs.

Course outcomes:

The student will be able to

1. understand of the composition of flesh foods
2. learn the types and grades of meat, poultry, and sea foods
3. explain processing techniques used for the production of commercial meat, poultry, and sea foods.
4. understand about meat plant sanitation, hygiene and standards.
5. assess the factors that affect the quality of meat
6. evaluate the processing techniques and their effect on nutritional value

Module 1: Meat Structure and Composition (7 hours)

Meat composition from different sources - Definitions and measurements, Muscle structure, composition and its modifiers. Muscle fat and its modifiers, Meat colour and flavor. Meat microbiology. Post mortem muscle chemistry.

Module 2: Modern Slaughter House Operations (7 hours)

Modern abattoirs and some features, Ante mortem handling and welfare of animals Stunning methods, stunning pen, slaughtering equipment, meat tenderisation, washing area, sticking bleeding and dressing. Beef/ Sheep and Pig Dressing operations. Offal handling and inspection, inedible by-products. Carcass processing equipment. Operational factors affecting meat quality.

Module 3: Processing of Meat and Meat Products (8 hours)

Canned meat, frozen meat, dried and preserved meat, cured meats and intermediate moisture products. Different kinds of sausages. Equipment used for sausage manufacture. Meat plant hygiene, GMP and HACCP.

Module 4: Poultry processing (7 hours)

Grading of Poultry Species. Composition and nutritional value of poultry meat. Processing operations – scalding and defeathering, bleeding, evisceration etc.. Equipments for processing operations. Frozen poultry meat. Microbiological safety of poultry products.

Module 5: Egg and Egg Products (7 hours)

Structure, composition and nutritive value of egg, egg proteins and functional properties of egg white and yolk. Factor affecting egg quality and their measurements. Collection, grading, cleaning, washing, packaging and transportation of eggs. Preparation of egg products – Liquid whole egg, liquid egg yolk, liquid egg white and egg powder. Microbial spoilage of egg and egg; products.

Module 6: Processing of Fish and Crustaceans (9 hours)

Grading of Marine Foods, nutritional Value of fish and other marine products. Spoilage factors of fish - sea food quality assessment. Processing Operations – fleshy fish and shell fish. Storage and Preservation Techniques - Icing, IQF, RSW, CSW and glazing of shrimp. By-product Utilization – Fish oil, fish protein concentrate, fish gelatin and chitin.

Text books:

1. Hui Y. H., Nip,.W.K., Rogers R.W " Meat Science and Application". Marcel Dekkar Inc.New York,2001. *ISBN* 10: 0824705483 / *ISBN* 13: 9780824705480.
2. M.D.Ranken "Handbook of Meat product Technology"black well Science Ltd.2000. *ISBN*-10: 0632053771
3. Balachandran,K.K "Post Harvest Technology of Fish and Fish Product"Daya publishing limited,CRC Press,2002. ISBN-13: 978-9351241607
4. Hui Y.H "Handbook of poultry Science and Technology" A JOHN WILEY & SONS, INC., PUBLICATION 2010. *ISBN*:9780470185537

Reference books:

1. Stadelman WJ and Cotterill OJ. 2002. Egg Science and Technology. Fourth Edition. CBS.

2. Mead G, "Poultry meat processing and quality"woodhead publishing limited,2004. *ISBN*: 9781855737273, 9781855739031

20FT3010	FOOD ANALYSIS LAB	L	T	P	C
		0	0	4	2

Course Objectives:

1. To introduce the analysis methods of food commodities.
2. To provide technical skills on testing of foods.
3. To impart skills on interpreting the genuineness of the products based on the quality

Course Outcomes:

The students will be able to

1. understand the quality parameters of different types of food products
2. classify food products based on their quality
3. interpret results and decide on the quality
4. compare two brands of the same product and decide the best one based on the quality
5. evaluate newer products based on quality
6. design and develop newer and better methods of analysis for improving the quality of a Food Product

List of Experiments:

Sugar rich products like Jams, Squashes, Marmalades, Sugar and Jaggery

1. Analysis of total sugars
2. Determination of pectin
3. Determination of acidity
4. Determination of total fruit solids
5. Determination of Calcium
6. Estimation of Ascorbic acid

Bakery Products including wheat

7. Determination of gluten content
8. Determination of alcoholic acidity
9. Determination of maltose equivalent
10. Estimation of total nitrogen content by Kjeldahl method

Meat and meat products

11. Determination of Extract release volume
12. Determination of swelling ratio
13. Determination of TMA

Milk and Milk products

14. Determination of Fat content by Gerber method
15. Determination of lactose content by Lactometer

Plantation Products including Tea, Coffee and Cocoa

16. Determination of Total extractives
17. Determination of Tannin content
18. Determination of Caffeine

Vitamins, Minerals and Colourants

19. Estimation of anthocyanins
20. Estimation of Chlorophyll
21. Determination of Iron

20FT3011	FOOD MICROBIOLOGY LAB	L	T	P	C
		0	0	3	1.5

Course Objectives:

1. To enable the students to understand the basic concepts of isolation of microorganisms from food commodities and proper handling experience of microorganisms
2. To enable the students to learn the parts of microscopes and the functions

3. The students will be able to identify the microorganisms using various staining techniques and biochemical tests.

Course Outcomes:

The students will be able to

1. acquire Basic knowledge about Microbiological Laboratory safety
2. learn media preparation, sterilization and identify the parts of a compound Microscope
3. know about aseptic technology role in packaging of foods.
4. study the isolation of pure culture techniques and staining techniques
5. isolate, cultivate and identify specific bacteria/fungi from different food sources.
6. know the effect of food preservatives on spoilage microorganisms.

List of Experiments:

1. An introduction to Microbiology, aseptic technique and safety – Study of Microscopes, Sterilization and Disinfection, Lab safety guidelines
2. Isolation of pure culture from mixed population- streak plate method.
3. Isolation and enumeration of bacteria and fungi from raw/spoiled fruits and vegetables-Total plate count Method (Pour Plate/Spread Plate method)
4. Isolation and enumeration of fungi/yeast from fruit drinks.
5. Isolation and enumeration of bacteria from canned meat.
6. Staining techniques of bacteria- Gram, Negative, spore staining.
7. Staining Techniques of Fungi- Lacto phenol Cotton Blue Staining
8. Motility testing of Bacteria – Hanging drop method, Soft agar
9. Biochemical Characterization of Bacteria.
10. Quality testing of Milk- Methylene Blue ReductionTest.
11. Examination of Potable water – MPN Test
12. Effect of Food Preservatives on growth of bacteria.
13. Food Production- Yoghurt- Estimation of lactic acid.
14. Determination of Thermal Death Time of Bacteria.
15. Isolation of Specific pathogen from contaminated Foods- *E.coli, Staphylococcus aureus, Salmonella, Bacillus*

20FT3012	FOOD PRODUCT TECHNOLOGY LAB-1	L	T	P	C
		0	0	3	1.5

Course Outcomes:

1. To provide skills to manufacture fruit products and bakery products.
2. To impart knowledge to identify the quality defects in the and bakery products.
3. To understand the importance of the manufacturing stages to prevent defects in the products.

Course Objectives:

The students will be able to

1. understand the manufacturing of various fruit-based products
2. gain knowledge on manufacturing aspects of several bakery products
3. learn the relevant terminologies in fruit and bakery products manufacturing
4. develop skills in manufacturing the products through hand-on training
5. aware of yield and quality aspects of the products
6. identify defects in products and avoid them during manufacturing stages

List of Experiments

1. Pilot scale manufacture of fruit based RTS beverage
2. Pilot scale manufacture of squashes
3. Pilot scale manufacture of carbonated beverages
4. Pilot scale manufacture of Jams and marmalade
5. Preparation of fruit preserves.
6. Preparation of fruit spreads
7. Pilot scale manufacture of Gummies
8. Pilot scale manufacture of ketchups/sauce
9. Pilot scale manufacture of white breads by chorleywood process

10. Pilot scale manufacture of French breads by sourdough method
11. Pilot scale manufacture of hard dough biscuits
12. Pilot scale manufacture of soft dough biscuits
13. Pilot scale manufacture of cakes by all-in-one method
14. Pilot scale manufacture of cakes by three stage mixing method
15. Manufacture of doughnut

20FT3013	FOOD PRODUCT TECHNOLOGY LAB –II	L	T	P	C
		0	0	3	1.5

Course Objectives:

1. To impart knowledge on the factors that affect the quality of milk based products
2. To enable the students to acquire skills on various equipments used in confectionery technology
3. To provide practical knowledge to produce products using commercial ingredients and equipment.

Course Outcomes:

The student will be able to

1. acquire basic knowledge about various food products
2. learn resizing of recipes to meet production needs and equipment capacities.
3. know about the various parameters affecting the structure of extruded products.
4. study the impact of additives on the texture of products
5. interpret the FSSAI standards for various food products
6. acquire knowledge about safe food handling practices using contemporary guidelines.

List of Experiments

1. Preparation of acid coagulated dairy products – Rosagulla
2. Preparation of thermally coagulated dairy products – Kalakhand
3. Preparation of Peda
4. Preparation of thermally coagulated dairy products Gulab Jamun
5. Preparation of Bread and Butter Pickle
6. Osmotic Dehydration of Fruits
7. Preparation of Hard Boiled Candies
8. Preparation of Mysorepak
9. Preparation of Marshmallows
10. Preparation of Extruded Snacks
11. Preparation of premixes
12. Preparation of Noodles and Pasta

20FT3014	FOOD TOXICOLOGY	L	T	P	C
		3	0	0	3

Course Objectives:

1. To impart knowledge on toxicology of foods.
2. To introduce the bio-transformations of toxin in foods.
3. To provide an insight about the various contaminants in foods.

Course Outcomes:

The student will be able to

1. acquire knowledge on the types on toxicants in foods.
2. identify toxins in food products.
3. summarize the effect of toxicants on the human system.
4. examine the methods of destruction of toxicants.
5. develop methods for detection of toxicants.
6. evaluate the safety of food commodities.

Module 1: Absorption and assimilation of toxicants (8 hours)

Toxicants - Dose - response relationship - Potency - biological factors that influence toxicity - Ingestion, Disgestion, absorption and assimilation - Effect on intestinal microflora - Blood - brain barrier - Translocation - Effect on kidney and liver

Module 2: Types of toxicity studies (9 hours)
Qualitative and Quantitative studies - Sample preparation - WHO standard methods for the determination of toxicity - Acute and Chronic toxicity - Teratogenecity, mutagenicity and carcinogenicity - Genetic toxicity - Concept of LD50

Module 3: Biotransformations (9 hours)
Phase I and Phase II reactions - Phase I enzymes - Cytochrome P450, Peroxidases, Flavin Mono Oxygenases, Epoxide Hydrolases, Esterases - Phase II enzymes - Glucuronide conjugation, glutathione conjugation, sulphate conjugation

Module 4: Naturally occurring phytotoxins (6 hours)
Phytochemicals causing Goitre, Favism, Neuro lathyrism - Cyanogens, Lectins, Vasoactive amines, Strychnine, Phytoalexins - Mechanism of action and methods for destruction

Module 5: Toxins from animals, microbes and marine organisms (7 hours)
Transmissible Spongiform Encephalopathy (TSE) and Prions, Paralytic shell fish poisoning, Ciguatera poisoning, Scombroid Fish poisoning , Mycotoxins and Poisonous mushrooms.

Module 6: Food Contaminants from Industrial wastes, Pesticide residues and Heavy metals (6 hours)
Chlorinated hydrocarbons, Heavy metals, Pesticide residues and their effects on health. Methods of analysis of pesticide residues.

Text books :

1. Shibamoto T & Bjeldanes L. “Introduction to Food Toxicology”, Second Edition, Elsevier Press. 2009. ISBN: 978-0-12-374286-5.

Reference books:

1. Bagchi D. & Swaroop A. “Food Toxicology”, CRC Press. 2017. ISBN : 13: 978-1-4987-0874-6 (Hardback)

20FT3015	FOOD QUALITY SYSTEMS AND MANAGEMENT	L	T	P	C
		3	0	0	3

Course Objectives:
1. Gain knowledge on the aspects of food quality and quality management systems.
2. Understand food safety and the importance of food regulations.
3. Learn the history of food and concepts of domestic and global food safety standards.

Course Outcomes:
The students will be able to
1. know the quality attributes of food and their analysis methods.
2. evaluate the structure and processes of quality management systems.
3. gain knowledge about HACCP and its implementation.
4. familiar with food safety, food contamination and food adulteration.
5. learn the history, importance and concepts of food regulations.
6. understand the global and domestic food safety standards.

Module 1: Food Quality (9 hours)
Concept of quality: Quality attributes- physical, chemical, nutritional, microbial. Quality control and Quality assurance- Objectives, importance and functions. Pre-requisite programmes- GMP, GHP, GLP, GAP, Sanitary and hygienic practices. Quality analysis -Physical, chemical, nutritional and microbial evaluation and measurement. Sensory evaluation - Sensory characteristics of food, sensory requirements. Types of sensory evaluation.

Module 2: Quality Management systems (6 hours)
Quality management systems - structure, record keeping, document control, consumer assurance. Process control and product related quality aspects. Total Quality Management - tools and techniques. Hazard analysis critical control point: Definition, principles, development and application of HACCP plan.

Module 3: Food Safety (6 hours)
Food safety - definition, food safety issues, factors affecting food safety. Safe food and importance of safe food. Food Contamination - Types of food contamination, harmful effects and control. Food

adulteration - common adulterants in foods: milk and milk products, edible oils, cereals and pulses, prepared foods, spices and beverages. Simple screening and control of food adulteration.

Module 4: Food Regulations (9 hours)

World Trade order – Functioning and responsibilities of the WTO - Codex Alimentarius –History, operations of Codex alimentarius, Responsibilities – Codex standards and Maximum residue limits – Current Issues under consideration – SPS (Sanitary and phytosanitary measures) agreement. World Health Organisation – History and mandate – Operations and responsibilities. Concept of Six Sigma.

Module 5: Food Safety Regulations in India (9 hours)

Regulation predating FSSAI - FPO, MMPO, PFA, AGMARK, Essential Commodities Act, BIS. Flaws in the regulations predating FSSA, 2006. Food safety and Standards Act. Operational structure of FSSAI. Role of Food Business Operator. Enforcement of the act - Licensing and registration of food business. Food safety officer and analysis of food. Offences and penalties.

Module 6: Global Food Safety Standards (6 hours)

ISO 22000:2005-Food safety management system. ISO 9001:2000-Quality management system. Principles of ISO 22000:2018. Revisions from ISO 22000:2005. Implementing ISO 22000:2018 for foods of Animal origin – Dairy Foods, Meat & Meat Products and Poultry.

Text Books:

1. Early R, "Guide to Quality Management Systems for Food Industries". Blackie Academic, ISBN: 9781461521273, 1995.
2. Kiron Prabhakar, "A Practical Guide to Food Laws and Regulations", Bloomsbury India, ISBN: 9789386141705, 2016.
3. Gould, W.A and Gould, R.W, "Total Quality Assurance for the Food Industries", CTI Publications Inc. Baltimore, ISBN: 9781845696153, 2006.
4. Kees A. van der Heijden and Sanford Miller, "International Food Safety Handbook: Science, International Regulation, and Control", Published by CRC Press, ISBN: 0824793544, 9780824793548, 1999.

Reference Books:

1. Patricia A. Curtis, "Guide to Food Laws and Regulations", Wiley-Blackwell; 1st Edition, ISBN: 0813819466, 2005.
2. Mehta R. and George J., "Food Safety Regulation Concerns and Trade - The Developing Country Perspective", Published by Macmillan India Ltd., New Delhi. ISBN: 9781403925046, 2005.

20FT3016	INSTRUMENTAL METHODS OF ANALYSIS	L	T	P	C
		3	0	0	3

Course Objectives:

1. To quantify various components of food using instrumental techniques
2. To know the presence of adulterants in the food sample
3. To interpret the data from instrumental analysis

Course outcomes:

The students will be able to

1. recognize the components of the mixture using chromatographic techniques.
2. identify the functional groups present in the food sample
3. calculate the trace metals present in the food sample
4. analyze the structure of the novel compound isolated from natural source
5. assess the molecular weight of the given component
6. organize components from mixture based on electrical property

Module 1: Chromatographic separations (8 hours)

Classification of chromatographic methods: Column, Thin Layer, Paper; Mechanism of separation. Theory of Gas chromatography – Instrumentation. High performance liquid chromatograph**y:** Basic principles – Mobile phase – Instrumentation – advantages of HPLC over other techniques.

Module 2: FTIR Spectroscopy (7 hours)

Infrared region - Molecular vibrations – Vibrational frequencies and IR absorption Bands- Infrared spectrum - IR spectrophotometer - application. Near Infrared spectroscopy - Far infrared spectroscopy.

Module 3: Atomic Spectrometry (8 hours)

Principle - Atomic Absorption Spectrometer - Working of AAS - Atomic Emission Spectroscopy - Excitation methods - Flame Emission Spectrometry. Inductively coupled Plasma Atomic Emission Spectroscopy ((ICP - AES).

Module 4: NMR and Mass Spectrometry (8 hours)

NMR principle and instrumentation. Relation between spin quantum number and NMR, Chemical shift, shielding and deshielding effects. ^{1}H and ^{13}C NMR spectrum. Mass spectrometry – Principle, instrumentations.

Module 5: Conductometry and electrophoresis (7 hours)

Conductometry titrations Types, advantages and disadvantages. Potential measurement - pO_2, pCO_2, $pHCO_3$ determination. Basic Principle of electrophoresis, application of paper, starch gel, agarose, and native and denatured PAGE.

Module 6: Other Instrumental methods (7 hours)

Principle and application of SEM, TEM, e-sensors and biosensors. Instrumentation and Application of water activity meter, Texture analyzer.

Text books:

1. B. Sivashankar "Instrumental Methods of Analysis", 1st edition, Oxford University Press, New Delhi, 2012. ISBN-13: 978-0198073918.
2. Sham K Anand, Gurdeep R Chatwal "Instrumentation Methods of Chemical Analysis", 5th edition, Himalaya Publishing House Pvt., Ltd., Bombay, 2014. ISBN-13: 978-9351420880.
3. Willard, H.H., Merritt, L.L., Dean, J.A., and Settle, F.A., "Instrumental Methods of Analysis", 7th edition, CBS Publishers and Distributors, Delhi, 2004. ISBN-13: 978-8123909431.
4. Pare J.R.J. and Belanger J.M.R. "Instrumental Methods of Food Analysis", 1 edition, Elsevier Science, Netherlands, 1997. ISBN 9780444818683.

Reference Books:

1. Rouessac F. and Rouessac A., "Chemical Analysis: Modern Instrumentation Methods and Techniques", 2nd Edition, John Wiley and Sons. Ltd. England, 2007. ISBN: 978-0-470-85903-2.
2. D.L.B. Wetzel G. Charalambous "Instrumental Methods in Food and Beverage Analysis", volume 39, 1st edition, Elsevier Science, 1998. ISBN: 9780080534756.

20FT3017	FOOD ADDITIVES AND INGREDIENTS	L	T	P	C
		3	0	0	3

Course Objectives:

1. To understand the basics of the additives added to food
2. To assess the risk and benefits of using food additives
3. To analyse various applications of food additives in different categories of food.

Course Outcomes:

The student will be able to

1. recognize the importance of additives in maintaining or improving food quality.
2. demonstrate and relate the level of addition of food additives to its quality
3. understand the applications of food additives and methods to study their permissible limits.
4. categorize and choose the appropriate additive depending on the type of food.
5. identify and design newer products, with better quality using additives which are economical and safe.
6. develop a new range of additives which are multifunctional and safe.

Module 1: Introduction and Safety Evaluation of Food Additives (8 hours)

Introduction to Food Additives; Scope of food additives; Functions and uses of Food Additives; Classification-Types of food additives . Classification based on safety aspects. FAO , JECFA, Toxicological testing of Food additives - Concept of NOAEL and ADI

Module 2: Antimicrobial Preservatives (6 hours)

Introduction; Classification- Natural & chemical preservatives; Mode of action; Acidulants - role in foods and their action. Limists of addition to foods.

Module 3: Antioxidants (7 hours)

Antioxidants & Sequesterants - Role in foods; Types of antioxidants -natural & synthetic; Mode of action of antioxidants in foods; Chelating agents- Natural & synthetic; Mode of action of chelating agents; Applications of antioxidants and chelating agents

Module 4: Flavourants (9 hours)

Flavoring agents: Introduction; Classification of flavors- natural & synthetic, Role of flavoring agents in food processing. Flavor enhancers: Importance of taste and flavours; Sweeteners: Artificial sweeteners & Non-nutritive sweeteners; Health implications. Taste modifiers. Leavening agents

Module 5: Food colorants (7 hours)

Introduction; Natural & Synthetic food colorants; Nature identical colorants; Classification of Food colorants; Chemical nature; Impact on health. Application of colorants in different food categories. Pigments: Importance; Classification: Utilization as food colour

Module 6: Food Processing aids (8 hours)

Emulsifiers and stabilisers: Introduction; Chemical nature; Concept of HLB value - Role in food processing. Bleaching & maturing agents**,** Anti-caking agents and Humectants, Clarifying agents, antifoaming agents, Fat mimetics and replacers. Enzymes in Food Processing

Text books:

1. Brannen A.L., Davidson P.M., Salminen S. and Thorngate J.H. "Food additives". Second Edition, Revised and Expanded. Marcel dekker Inc. USA, 2002. ISBN 0-8247–9343-9

Reference Book:

1. Titus A.M. Msagati. "Chemistry of Food additives and Preservatives". John Wilery and Sons Ltd. 2013. 9781118274149. Online ISBN:9781118274132

20FT3018	ENZYMES IN FOOD PROCESSING	L	T	P	C
		3	0	0	3

Course objectives:

1. To provide an insight into the fundamentals of enzyme structure and function
2. To gain knowledge about the kinetics of enzymes.
3. To impart the current applications and future potential of enzymes.

Course outcomes:

The student will be able to

1. describe structure, functions and the mechanisms of action of enzymes.
2. understand the enzyme activity in foods.
3. learn kinetics of enzyme catalyzed reactions and enzyme inhibitory and regulatory process.
4. understand immobilization of enzymes.
5. apply the acquired skills on the applications of enzymes and their future potential
6. evaluate the application of various enzymes at industry level.

Module 1 : Introduction to Enzymes (7 hours)

General introduction and historic background- General Terminology, Nomenclature and Classification of Enzymes. Criteria of purity of enzymes- Specific activity. Enzyme units-Katal and IU.

Module 2 : Enzyme activity-I (7 hours)

Enzyme activity- chemical nature of enzymes. Protein nature of enzymes and Non protein enzymes- Ribozymes and DNAzymes.

Module 3 : Enzyme activity-II (7 hours)

Metalloenzymes and metal activated enzymes. Coenzymes and Cofactors- Prosthetic group, coenzymes involved in different metabolic pathways. Classification of coenzymes. Isozymes, Abzymes, Synzyme Enzymes in food, effect, analysis, modification of food using enzymes.

Module 4 : Enzyme Kinetics (8 hours)

Factors affecting the enzyme activity- Concentration, pH and temperature. Kinetics of a single-substrate enzyme catalysed reaction, Michealis-Menten Equation, Km, Vmax, L.B Plot, Turnover number, Kcat. Kinetics of Enzyme Inhibition. Kinetics Allosteric enzymes.

Module 5 : Enzyme Regulation (8 hours)

Feedback Regulation, Allosteric Regulation, Reversible Covalent Modification and Proteolytic Activation. Organisation of enzymes in the cell. Enzymes in the cell, localization, compartmentation of

metabolic pathways, enzymes in membranes, concentrations. Mechanisms of enzyme degradation, lysosomal and nonlysosomal pathways, examples.

Module 6 : Industrial Enzymes (8 hours)

Industrial Enzymes- Thermophilic enzymes, amylases, lipases, proteolytic enzymes in food industries, enzymes used in various fermentation processes, cellulose degrading enzymes, Metal degrading enzymes.

Text Books:

1. Nicholas Price & Lewis Stevens, "Fundamentals of Enzymology",Oxford University Press, 1999. ISBN: 9780198502296
2. Trevor Palmer, "Enzymes : Biochemistry, Biotechnology and Clinical Chemistry", Woodhead Publishing, 2007. ISBN 10: 1904275273ISBN 13: 9781904275275
3. Stryer, Voet and Lehninger, " Biochemistry"

20FT3019	NUTRACEUTICALS AND HEALTH FOODS	L	T	P	C
		3	0	0	3

Course Objectives:

1. To provide an overview of the field of nutraceuticals and functional foods.
2. To provide an insight on bioactive ingredient-disease relationships and the importance of clinical study support; regulatory aspects of functional foods.
3. To enable the students to understand the functional food concept as related to ingredient efficacy and safety.

Course Outcomes:

The students will be able to

1. understand the role of nutraceuticals and functional food in health and disease
2. present ideas and concepts on issues of functional foods and nutraceuticals.
3. apply the basic concepts of nutraceuticals and functional foods, their chemical nature and methods of extraction.
4. acquire knowledge on probiotics and its role in disease prevention.
5. evaluate the standards of evidence required for efficacy and safety assessment of nutraceutical and functional foods.
6. know about various phytochemicals their health promotion and disease prevention.

Module 1: Nutraceuticals and functional Foods (7 hours)

Definition, concept, history and market; Evolution of nutraceuticals and functional foods market. Classification of nutraceuticals and functional foods. Significance and relevance of nutraceuticals and functional foods in the management of diseases and disorders. Regulatory standards in progressive nutraceuticals and functional food markets.

Module 2: Natural occurring bioactive compounds (9 hours)

Antioxidants and flavonoids: omega – 3 fatty acids, carotenoids, dietary fiber, phytoestrogens, glucosinates and organosulphur compounds. Dosage for effective control of disease or health benefit with adequate safety.

Module 3: Technology of bioactive compounds (9 hours)

Care in handling and storage of raw materials with minimal damage to sensitive bioactive compounds. Extraction, isolation, purification, bioavailability, nutraceutical formulation and delivery mechanism of phytochemicals.

Module 4: Prebiotics, probiotics and synbiotics (8 hours)

Probiotics: Definition, types and relevance; Usefulness in gastro intestinal health and other health benefits; development of probiotic products; recent advances in probiotics; Challenges and regulatory issues related to probiotic products. Prebiotics: Prebiotic ingredients in foods; types of prebiotics and their effects on gut microbes; health benefits of prebiotics; recent development in prebiotics. Synbiotics.

Module 5: Functional foods (7 hours)

Definition, development of functional foods, effect of environmental condition on food matrix. Delivery of immune modulators /vaccines through functional foods.

Module 6: Current Trends in Nutraceuticals and Functional Foods (5 hours)
Development of biomarkers to indicate efficacy of functional ingredients. Research frontiers in functional foods. Nutrigenomics and personalised medicine.

Text Books:

1. Wildman, Robert. "Nutraceuticals and Functional Foods", First edition. Taylor and Francis Group. 2016. eBook ISBN9780429195563
2. Gibson GR & William CM. "Functional Foods - Concept to Product". Woodhead Publishing Limited, London. 2001. ISBN 1 85573 503 2

Reference Book:

1. Aluko, Rotimi. "Functional Foods and Nutraceuticals", Springer-Verlag New York Inc. 2012. e-ISBN 978-1-4614-3480-1.

20FT3020	FOOD PACKAGING TECHNOLOGY	L	T	P	C
		3	0	0	3

Course Objectives:

1. To study about the functions of packaging and the influence of various factors on food quality.
2. To know about the different packaging materials and their application in food packaging.
3. To study about the various advance methods of food packaging.

Course Outcomes:

The student will be able to

1. understand the need and functions of packaging to protect and store food.
2. gain knowledge on shelf life of food and accelerated shelf life testing.
3. know the different packaging materials based on their properties and their application.
4. learn about the filling and sealing techniques used for different food materials.
5. understand labeling methods and legislature.
6. know about the advanced food packaging techniques.

Module 1: Introduction to Packaging (8 hours)
History of Packaging. Functions of Packaging. Levels of Packaging in food distribution. Effect of environmental factors and biological factors on quality of food products. Shelf life of food products and accelerated shelf life testing.

Module 2: Packaging Materials (6 hours)
Types – Metals, Glass, Papers and Polymers. Properties - Requirements - Packaging strategy for different foods - Total product concept.

Module 3: Metals and Glass (7 hours)
Metal Cans - Types of metals, Types of food and beverage cans. Open top sanitary cans and two-piece cans. Can manufacturing operations. Lacquers. Aerosol Cans. Glass Packaging – Properties, composition, types of glass. Glass Manufacturing. Bottle sterilization.

Module 4: Polymers and Paper (9 hours)
Types and applications. Flexible and rigid polymers. Manufacturing of films and containers. Coextruded films, Laminates and Plastic Containers. Paper and paperboard - Types of Paper and Paperboard. Test for packaging materials.

Module 5: Filling and Sealing (7 hours)
Types of fillers, seals and sealing equipment. Types of Pouches and Form Fill Seal machines. Labelling - Types of Labels - Nutrition Label - Printing Techniques.

Module 6: Advanced Packaging Technologies (8 hours)
Vacuum and inert gas packaging. Retort packaging. Aseptic Packaging, Biodegradable Packaging, Active Packaging, Smart and Intelligent Packaging, Modified Atmosphere Packaging, Controlled atmosphere storage and Diffusion channels.

Text Books:

1. Richard Coles, Derek Mc Dowell & Mark J. Kirwan, *Food Packaging Technology*, Blackwell Publishing Ltd, 2009, ISBN:978-1-405-14771-2.
2. Gordon L. Robertson, *Food Packaging Principles and Practice*, 3rd Edition, CRC Press, 2013, ISBN:978-1439862414.

Reference Books:

1. Richard Coles and Mark J. Kirwan, *Food and Beverage Packaging Technology*, 2nd Edition, Blackwell Publishing Ltd, 2011, ISBN: 9781444392180.
2. Gordon L. Robertson, *Food Packaging and Shelf Life: A Practical Guide*, CRC Press, 2009, ISBN:9780429146800.
3. Frank Albert Paine, Heather Y. Paine, *A Handbook of Food Packaging*, 2nd edition, Blackie Academic and Professional, London, 1992, ISBN:9781461528104.

20FT3021	WASTE RECYCLING AND RESOURCES RECOVERY SYSTEM	L	T	P	C
		2	0	0	2

Course Objectives:

1. To acquire knowledge about the nature of food waste and its environmental effects.
2. To be conversant with suitable treatment methods for food industry waste.
3. To assess pollution prevention methodologies adopted in food industries.

Course Outcomes:

The student will be able to

1. identify origin of waste generated in food industries.
2. summarize various treatment methods for food wastes
3. demonstrate co product recovery from food wastes
4. prioritize by product recovery for food industries
5. decide suitable waste handling strategies.
6. develop pollution prevention mechanisms.

Module 1: Introduction (5 hours)

Origin and characterization of food waste - Biochemical and chemical analysis of the waste. Various legal aspects of food waste. Environmental Management Standards and their Application in the Food Industry.

Module 2: Food waste treatment methodologies (6 hours)

Composting, anaerobic digestion, aerobic digestion, thermophilic anaerobic digestion, sequencing batch reactor, electro dialysis, wet oxidation, pyrolysis, incineration, solid state fermentation and Ozonation.

Module 3: Fruit and Vegetable processing industry waste (5 hours)

Source and characteristics, treatment methods, comparison of various waste treatment methods. Various uses of fruit wastes and fruit processing by products.

Module 4: Meat and Seafood processing industry waste (5 hours)

Characterization, primary treatment and secondary treatment. Uses – livestock feed and protein recovery, energy recovery, heavy metal adsorption. Uses of fish waste - animal feed, natural pigment and cosmetics.

Module 5: Dairy and beverage industry waste (5 hours)

Characterization, primary, secondary treatment. Uses – biogas/methane/ hydrogen production. Co product recovery.

Module 6: Pollution prevention (4 hours)

Pollution Prevention case studies – waste generated from plant based and animal based food processing industries. Carbon and water footprint.

Text Books:

1. Kosseva M and C Webb, “Food Industry Wastes, Assessment and Recuperation of Commodities”, 2nd Edition. Academic Press, 2020. ISBN: 9780128171219.
2. Panda H. “The Complete Book on Managing Food Processing Industry Waste”, Asia Pacific Business Press Inc, 2011. ISBN: 9788178331454.
3. Waldron K.W., “Handbook of waste management and co product recovery in food processing (Volume1)”, 1st Edition. Woodhead Publishing Ltd., 2007. ISBN: 9781845690250.

Reference Books:

1. Arvanitoyannis I, “Waste Management for the Food Industries”, 1st Edition. Academic Press, 2007. ISBN: 9780123736543.

2. Wang L.K.,Y.T Hung, H H. Lo and C Yapijakis, 1st Edition, "Waste Treatment in the Food Processing Industry", CRC Press, 2005. ISBN: 9780429191091

20FT3022	FOOD BIOTECHNOLOGY	L	T	P	C
		3	0	0	3

Course objectives:

1. To understand the principles and techniques in food biotechnology
2. To impart skills on the production of modified foods
3. To introduce the application of biosensors for foods

Course outcomes:

The student will be able to

1. understand the application of genetic information of animal and plant species in food.
2. learn the Importance of applications of biotechnology in food.
3. explain the applications of GMO foods
4. apply the role of bio preservatives in foods.
5. evaluate the application of molecular techniques in characterization food borne pathogens.
6. apply biosensors in foods.

Module 1: Food biotechnology-Introduction (8 hours)

Biotechnology relating to the food industry - application of genetics to food production - Genetic Engineering Techniques- Recombinant DNA Techniques and Cloning Strategies - role of bio process engineering in biotechnology industry. Regulatory and Social aspects of biotechnology of foods. Biotechnological approaches to improve nutritional qualities and shelf life of fruits and vegetables live stock, poultry and fish products

Module 2: Applications of biotechnology in food (8 hours)

Traditional applications of biotechnology in food - Fermented foods: Dairy products, oriental fermentations, alcoholic beverages, and food ingredients. Health benefits of fermented foods. Types of fermented foods and importance of food fermentation in food preservation and nutritional enhancement. Batch/Continous – Vats.

Module 3: GMO Foods (8 hours)

Plant and animal culture, transgenic plants, application of genetic engineering in food science and technology. Genetically modified foods – concept, types and application. Regulations concerning Genetically Modified Foods in India and at the International level; Ethical issues concerning GM foods; testing for GMOs; current guidelines for the production, release and movement of GMOs; labeling and traceability; trade related aspects; bio safety; risk assessment and risk management. Public perception of GM foods. IPR. Bt brinjal Bt maize and golden rice.

Module 4: Bio Preservatives (7 hours)

Natural antimicrobials for food preservation: phytoalexins, essential oils and their components; bacteriocins: nisin, pediocins etc; applications of bacetriocins in food systems as biopreservatives

Module 5: Detection and Characterization of Food-Borne Pathogens (7 hours)

Detection and identification of food borne pathogens: Nucleic acid hybridization-Polymerase chain amplification-Single cell analysis; Molecular typing techniques: Ribotyping-Restriction enzyme analysis-PCR based typing methods; Selection of method; Sample preparation.

Module 6: Biosensors (7 hours)

Food products as analytical samples, general aspects of biosensors and their potential applications-Biosensors for food component analysis, biosensors for food contaminant analysis, commercially available biosensors for food analysis.

Text books:

1. Shetty, K., Plaiyath, G., Pometto, A. and Levin, R.E., Functional Foods & Biotechnology, CRC Press (2006). eBook *ISBN* 9780429129568
2. Shetty, K., Plaiyath, G., Pometto A. and Levin, R.E., Food Biotechnology, CRC press, (2005). ISBN-13: 978-0824753290

Reference Books:

1. Byong H. Lee, (2014)- Fundamentals of Food Biotechnology, 2nd Edition, Wiley- Blackwell. *ISBN*: 978-*1*-118-38495-4

2. Perry Johnson-Green, (2002) - Introduction to Food Biotechnology, CRC Press. *ISBN*, 142005838X, 9781420058383.
3. Sarah Elderidge. "Food Biotechnology; Current issues and perspectives". Nova science pub. Inc. 2003. *ISBN*-10: 1590338480; *ISBN*-13: 978-1590338483
4. Brian J. Ford. "Future of Food". WW Norton and Co. Inc. 2000.

20FT3023	INDUSTRIAL MICROBIOLOGY	L	T	P	C
		3	0	0	3

Course Objectives:

1. To impart the knowledge of role of microbes in industrial production of products.
2. To understand the types and biochemistry of fermentation process.
3. To know about the design of a bioreactor.

Course Outcomes:

The student will be able to

1. acquire knowledge about screening, strain development and maintenance of industrial strains.
2. know about media formulation, sterilization and culture conditions for the development of suitable strain for industrial fermentation.
3. learn the different fermentation techniques and bioreactor design for industrial fermentation.
4. understand the industrial production of organic acids, amino acids, Vitamins, Polysaccharides.
5. comprehend the techniques and underlying principle of downstream processing.
6. study the industry-market based value of fermented products.

Module 1: History and Scope of Industrial Microbiology (7 hours)

Brief history and developments in industrial microbiology. Primary and secondary screening, strain development, preservation and maintenance of industrial strains.

Module 2: Fermentation Media and sterilization (8 hours)

Crude and synthetic media; molasses, corn-steep liquor, sulphite waste liquor, whey and yeast extract, Media sterilization, Inoculum preparation, Microbial culture conditions - pH, temperature, dissolved oxygen, foaming and aeration.

Module 3: Overview on industrial fermentation and Fermentors (8 hours)

Types of Fermentation-Solid-state and liquid-state (stationary and submerged) fermentations; Batch, fedbatch and continuous fermentations. Components of a typical bioreactor, types of bioreactors- Laboratory, pilot- scale and production fermenters; constantly stirred tank fermenter, tower fermenter, fixed bed and fluidized bed bioreactors and air-lift fermenter.

Module 4: Microbial production of industrial products: Organic acids, Amino acids (8 hours)

Organic acids: Citric acid, Lactic acid, Acetic acid, Alcoholic products: Ethanol, Beer, Wine.
Aminoacids: glutamic acid, Lysine, Vitamins: Vitamin B12, riboflavin,

Module 5: Microbial production of industrial products: Enzymes, Polysaccharides (7 hours)

Enzymes: isomerase, glucose oxidase, amylase, cellulase, protease, lipase, Polysaccharides: Dextran and Xanthan.Production of single Cell Protein,Production of Mushrooms.

Module 6: Downstream processing (7 hours)

Objectives and problems with downstream processing, Product recovery- Filtration, centrifugation, cell disruption, solvent extraction, precipitation and ultrafiltration, lyophilization, spray drying.

Text Books:

1. Adams MR and Moss MO. (2007). *Food Microbiology*. 4th edition, New Age International (P) Limited Publishers, New Delhi, India. ISBN-13: 978-1849739603
2. Patel AH. (2016). *Industrial Microbiology*. 1st edition, Macmillan India Limited. ***ISBN*** : 9350590085, 9789350590089

Reference Books:

1. Frazier WC and Westhoff DC. (2008). *Food Microbiology*. 3rd edition. Tata McGraw-Hill Publishing Company Ltd, New Delhi, India. ISBN-13: 978-0070219212
2. Stanbury PF, Whitaker A and Hall SJ. (2006). *Principles of Fermentation Technology*. 2nd edition, Elsevier Science Ltd. eBook ISBN:9781483292915

20FT3024	ENZYMOLOGY LAB	L	T	P	C
		0	0	3	1.5

Course Objectives:

1. To provide an overview of enzyme activity and regulation in cells
2. To prepare students to the enzyme systems in industry.
3. To impart skills on comparison of different enzyme activity

Course outcomes:

The students will be able to

1. gain knowledge about enzymes
2. understand the importance of each of the factors that affect enzyme activity
3. apply the same to maximize enzyme action
4. analyze when a problem arises and give a suitable and logical solution
5. evaluate enzymes from different sources and select the right one depending on the type of food / condition
6. analyze and evaluate the characterization of new source of enzymes

List of Experiments

1. Extraction of enzyme extract using buffer system
2. Estimation of polyphenol oxidase (PPO) activity in fruit juice samples
3. Effect of pH on PPO activity
4. Investigation effect of temperature on the activity of PPO
5. Estimation of peroxidase (POD) activity in vegetables
6. Effect of pH on POD activity
7. Investigation effect of temperature on the activity of POD
8. Indirect estimation of lactate dehydrogenase
9. To study effect of substrate concentration on enzyme activity for determination K_m and V_{max}
10. Comparison of enzyme activity in thermally processed and minimally processed food samples

20FT3025	FOOD PACKAGING LAB	L	T	P	C
		0	0	3	1.5

Course objectives:

1. To introduce the concepts of various packaging technologies
2. To provide the knowledge of application of packaging materials based on tests for packaging materials
3. To impart technical skills to analyze the characteristics of packaging materials

Course outcomes:

The students will be able to

1. learn the terminologies used in food packaging
2. gain knowledge about practical methods of evaluating the performance of food packages of different levels
3. understand the need for various packaging techniques
4. gain experience in testing of packaging materials
5. comprehend the advanced methods of packaging of perishables
6. suggest suitable packaging materials for different types of food products

List of Experiments

1. Vacuum packaging of fruits and vegetables
2. Inert gas packaging of snack foods
3. Determination of water vapour transmission rate
4. Determination of migration characteristics of packaging materials
5. Determination of thickness of packaging materials
6. Determination of grammage of paper and paper board
7. Determination of tensile strength of packaging materials
8. Determination of water absorbency by Cobb's test
9. Performance test of Packaging materials - Drop test
10. Determination of burst strength of pouches
11. Modified atmosphere packaging of fresh cut fruit

FOOD PROCESSING TECHNOLOGY

LIST OF COURSES

Sl. No.	Course Code	Name of the Course	Credits
1.	18FP1001	Basics of Biology for Food Engineers	2:0:0
2.	18FP2001	Principles of Food Process Engineering	3:0:0
3.	18FP2002	Food Chemistry	3:0:0
4.	18FP2003	Fluid Mechanics for Food Engineers	3:0:0
5.	18FP2004	Food Microbiology	3:0:0
6.	18FP2005	Food Analysis Lab –I	0:0:1.5
7.	18FP2006	Fluid Mechanics and Heat Transfer Lab	0:0:1.5
8.	18FP2007	Food Microbiology Lab	0:0:1.5
9.	18FP2008	Metabolism and Nutrition	3:0:0
10.	18FP2009	Applied Thermodynamics for Food Engineers	3:0:0
11.	18FP2010	Heat and Mass Transfer	3:0:0
12.	18FP2011	Dairy Engineering and Technology	3:0:0
13.	18FP2012	Unit Operations in Food Process Engineering - I	3:0:0
14.	18FP2013	Fruit and Vegetable Processing Technology	3:0:0
15.	18FP2014	Unit Operations in Food Process Engineering Lab	0:0:1.5
16.	18FP2015	Food Biochemistry Lab	0:0:1.5
17.	18FP2016	Unit Operations in Food Process Engineering - II	3:0:0
18.	18FP2017	Refrigeration, Air conditioning and Cold Storage Construction	3:0:0
19.	18FP2018	Mechanical Systems for Food Processing	3:0:0
20.	18FP2019	Cereals and Pulses Processing Technology	3:0:0
21.	18FP2020	Bakery, Beverages and Confectionery Technology	3:0:0
22.	18FP2021	Food Safety Regulations	3:0:0
23.	18FP2022	Food Enzymology Lab	0:0:1.5
24.	18FP2023	Food Product Technology Lab - I	0:0:1.5
25.	18FP2024	Engineering Properties of Food Materials	3:0:0
26.	18FP2025	Engineering Properties of Food Materials Lab	0:0:1.5
27.	18FP2026	Food Engineering and Packaging Lab	0:0:1.5
28.	18FP2027	Food Process Equipment Design	3:0:0
29.	18FP2028	Food Analysis Lab – II	0:0:1.5
30.	18FP2029	Computer Aided Food Process Equipment Design Lab	0:0:1.5
31.	18FP2030	Food Additives	3:0:0
32.	18FP2031	Plantation and Spices Product Technology	3:0:0
33.	18FP2032	Fat and Oil Processing Technology	3:0:0
34.	18FP2033	Technology of Meat, Poultry and Fish	3:0:0
35.	18FP2034	Drying Technology	3:0:0
36.	18FP2035	Food Packaging Technology	3:0:0
37.	18FP2036	Storage Engineering	3:0:0
38.	18FP2037	Process Economics and Plant Layout Design	3:0:0
39.	18FP2038	Food Additives Lab	0:0:1.5
40.	18FP2039	Food Product Technology Lab - II	0:0:1.5
41.	18FP2040	Material Science for Food Engineers	3:0:0
42.	18FP2041	Simulation, Modeling and Statistical Computing Lab	0:0:1.5
43.	18FP2042	Principles of Food Science and Nutrition	3:0:0
44.	18FP2043	Processing of Food Commodities	3:0:0
45.	18FP2044	Technology of Packaging	3:0:0

Sl. No	Course Code	Course Name	Credits			
			L	T	P	C
1	18FP3001	Mass Transfer and Separation Processes in Food Engineering	3	0	0	3
2	18FP3002	Technology of Food Flavourants and Colourants	3	0	0	3
3	18FP3003	Food Safety Regulations and Control	3	0	0	3
4	18FP3004	Advanced Instrumentation for Food Quality and Safety	3	0	0	3
5	18FP3005	Design of Food Processing Equipments	3	0	0	3
6	18FP3006	Advances in Food Process Engineering	3	0	0	3
7	18FP3007	Food Analysis lab	0	0	3	1.5
8	18FP3008	Enzymology Lab	0	0	3	1.5
9	18FP3009	Food Product Technology Lab	0	0	3	1.5
10	18FP3010	Food Engineering and Transport Processes Lab	0	0	3	1.5
11	18FP3011	Advances in Dairy, Meat and Fish Processing	3	0	0	3
12	18FP3012	Advances in Processing of Cereals, Pulses and Oil seeds	3	0	0	3
13	18FP3013	Advances in Processing of Horticulture, Spices and Plantation Products	3	0	0	3
14	18FP3014	Refrigeration and Cold Storage Engineering	3	0	0	3
15	18FP3015	Engineering Properties of Food Materials	3	0	0	3
16	18FP3016	Milling, Bakery and Confectionery Technology	3	0	0	3
17	18FP3017	Advances in Packaging and Handling of Foods	3	0	0	3
18	18FP3018	Emerging Trends in Food Process Engineering	3	0	0	3
19	18FP3019	Storage Engineering of Food Materials	3	0	0	3
20	18FP3020	Food Material Science	3	0	0	3
21	18FP3021	Green Chemistry and Technology	3	0	0	3
22	18FP3022	Food Supply Chain Management	3	0	0	3
23	18FP3023	Food Plant Layout and Design	3	0	0	3

18FP1001 BASICS OF BIOLOGY FOR FOOD ENGINEERS

2L:0T:0P **Credits: 2:0:0**

Course Objectives:

1. To learn a variety of skills necessary to function as a biologist in the workplace or as a candidate for an advanced degree.
2. To develop an awareness of the impact that biology has had on society at large as well as the interactions of biology with other disciplines such as biotechnology and sociology
3. To demonstrate the ability to articulate, verbally and in writing, knowledge of biology, biological methods, and biological issues in context

Course Outcomes:

The students will be able to

1. Understand the metabolic processes of cells in terms of cellular organelles, membranes, and biological molecules.
2. Name and describe the basic principles of biology.
3. Demonstrate an ability to effectively convey, both orally and in writing, a knowledge of biological content, methods, and issues.
4. Demonstrate basic knowledge in the basic concepts of bioenergetics, photosynthesis, cellular respiration, nucleic acids and basic concepts of protein synthesis.
5. Describe cellular, biochemical, and physiological aspects of mircoorganisms and recognize the similarities and differences between microbial groups.
6. Apply problem-solving skills to biological problems and issues.

Module 1: Basics of Biology (6 hours)
Basics of Cell Biology (structure & function) – Discovery of cell and Cell Theory; Comparison between plant and animal cells; Cell wall; Plasma membrane; Modification of plasma membrane and intracellular junctions; Cytoskeleton; Protoplasm; Mitochondria; Chloroplast; ER; Golgi complex; Lysosome, endosome and microbodies; Ribosome; Centriole; Nucleus; Chemical components of a cell; Catalysis and use of energy by cells.
Module 2: Membrane Structure & Transport (3 hours)
Models of membrane structure, Membrane lipids, proteins and carbohydrates; Solute transport by Simple diffusion, Facilitated diffusion and Active transport
Module 3: Genetics (4 hours)
DNA is the genetic material, DNA is a double helix, DNA replication is semiconservative, mutations change the sequence of DNA, a gene codes for a single polypeptide, recombination occurs by physical exchange of DNA, genetic code is triplet.
Module 4: Cell Cycle (4 hours)
An overview of cell cycle; Components of cell cycle control system; Intracellular and Extra-cellular control of cell division, Programmed cell death (Apoptosis), intrinsic & extrinsic pathways of cell death, Apoptosis in relation with Cancer, Viral disease (AIDS) & Organ transplant.
Module 5: Common Mechanisms in Biological Chemistry (9 hours)
Overview of Digestion, Absorption, Metabolism [Anabolism & Catabolism], Nutrition, Photosynthesis, Respiration, Excretion. Body structure & homeostasis.
Module 6: Classification of Microbes (5 hours)
Systems of classification, Numerical taxonomy, Identifying characters for classification, General properties and principles of classification of microorganisms Systematics of bacteria, Nutritional types [Definition and examples]. Classification on the basis of factors required for the growth of microorganisms.

Text Books

1. Robert F., Weaver, Molecular Biology, 4th ed., McGraw-Hill, 2003. [ISBN-10: 0071275487 | ISBN-13: 978-0071275484]
2. B. Lewin., Genes IX. 9th ed., Jones and Bartlett Publishers, 2007. [ISBN-10: 0763740632 | ISBN-13: 978-0763740634]
3. H.Lodish et al., Molecular Cell Biology. 6th ed., W.H.Freeman, 2007. [ISBN-10: 0716776014 | ISBN-13: 978-0716776017]

Reference Books

1. Alan Cann. Principles of molecular virology, 5th edition. Amsterdam: Elsevier Academic Press, 2012. ISBN-9780123849403
2. Michael J. Pelczar, E.C.S. Chan, Jr.,Noel R. Krieg. Microbiology 7th edition. 2005 Published by Tata McGraw-Hill Education Pvt. Ltd. ISBN 10: 0074623206 / ISBN 13: 9780074623206
3. Karp G., Cell and Molecular Biology: Concepts and Experiments, 3rd Edition (John Wiley & Sons, Inc., 2002).

18FP2001 PRINCIPLES OF FOOD PROCESS ENGINEERING

3L:0T:0P **Credits: 3:0:0**

Course Objectives:

- To understand the basic principles involved in food process engineering.
- To apply the principles in food processing.
- To perform calculations for basic operations in food processing.

Course Outcomes:

The students will be able to

1. Enumerate the units and dimensions of various physical quantities.
2. Express the laws and theory of gases and vapours.
3. Describe the types and properties of fluid flow.
4. Calculate the material balance in food processing units.
5. Appraise the performance of processing units

6. Validate the energy balance involved in food processing operations.

Module 1: Dimensions and Unit (9 hours)

Fundamental -derived units. Definitions of some basic physical quantities – Force, momentum, pressure, work and energy, power, heat and enthalpy. Dimensional analysis. Mole – atomical molar mass. Moisture content.-water activity

Module 2: Gases and Vapors (9 hours)

Behavior of Gases – Kinetic Theory of gases – Perfect Gas – Gas laws – Ideal gas laws – Real gas- Van der Waal's equation -pure component vapour pressure- partial pressure Dalton's law. Pure component volume-Amagat's law – psychrometry -humidity, relative humidity, saturation humidity –wet and dry bulb temperature-dew point – psychrometric chart reading.

Module 3: Flow of Fluids (9 hours)

Fluids-Properties, vapor pressure, suface tension, capillary effect, concept of viscosity-types of fluid. Bernoulli equation-fluid flow-laminar, turbulent ; pressure drop in pipes, valves and bends, Orifice meter, Venturimeter , Rotameter, Pitot tube –working principles.

Module 4: Material Balance (9 hours)

Law of Conservation of mass- Process flow diagram-system boundaries -overall mass balance – component mass balance –basis and tie material- Continuous vs. Batch-Recycle and by pass-unsteady state -mass balance problems on concentration, dehydration, evaporation, crystallization, mixing –solvent extraction –multi stage process.

Module 5: Energy Balance (5 hours)

Heat capacity – gases – solids – liquids -Latent heat – sensible heat -energy balance for a closed system and open system -total energy balances.

Module 6: Energy Balance in Heat exchangers and Drying (4 hours)

Energy balance problems in heat exchangers –Drying.

Text Books

1. Romeo T. Toleda. "Fundamentals of Food Process Engineering". Chapman & Hall, USA, CBS publications, New Delhi, 2000.
2. Smith, PG. "Introduction to Food Process Engineering ", Springer, 2004.

Reference Book

1. Paul Singh R, and Dennis R.Heldman ."Introduction to Food Engineering". Academic Press – Elsevier India Private Ltd. New Delhi, 2004.

18FP2002 FOOD CHEMISTRY

3L:0T:0P **Credits: 3:0:0**

Course Objectives :

- To understand the chemistry of food constituents
- To apply fool molecules interaction in developing technologies / processes
- To develop skills for experimenting with food systems and to test various approaches for manipulating the chemical and/or functional properties of foods.

Course Outcomes :

The students will be able to

1. Name and describe the general chemical structures of major components of foods (water, proteins, carbohydrates, and lipids) and selected minor components (vitamins and minerals).
2. Understand, plan, perform and analyse a range of chemical investigations with emphasis on food analysis
3. Relate the chemical composition of foods to their functional properties
4. Examine a molecular rationalization for the observed physical properties and reactivity of major food components.
5. Predict how changes in overall composition are likely to change the reactivity of individual food components.
6. Evaluate and determine the approaches that may be used to control the reactivity of those food components that are likely to impact the overall quality of finished products.

Module 1: Water and Ice (9 hours)

Importance of water in foods - Structure of water & ice - concept of bound & free water. Sorption phenomena and sorption isotherms with example. Dispersed systems – Chemistry of gels & emulsion.

Module 2: Chemistry of Carbohydrates (8 hours)

Nomenclature, classification & structure of carbohydrates, chemical reactions of carbohydrates, General properties of monosaccharide, chemistry of polysaccharides, properties and preparation of pectic substances, gums, starch and its hydrolytic products, cellulose, process flowsheet for the production of cyclodextrins maltodextrins, HFCS.

Module 3: Chemistry of Lipids (8 hours)

Nomenclature and classification of lipids. Basic Structures and chemistry of fatty acids. physical & chemical characteristics of fats & oils Phospolipids, and unsaponifiables, auto oxidation and hydrolysis, antioxidants. Process flow sheet for the manufacture of edible oils (refined and hydrogenated), fat interesterification.

Module 4: Chemistry of Proteins (11 hours)

Nomenclature, classification, structure and chemistry of amino acids, peptides & Proteins. Functional properties of Protein.. Protein denaturation. Enzymes: Introduction, classification & nomenclature of enzymes. Specificity. amylases, pectic enzymes, proteases; glucose oxidases, catalases, peroxidases, lipoxygenases, xanthine oxidases. Immobilized enzyme - One example of working of each enzyme.

Module 5: Chemistry of Vitamins (5 hours)

Fat-soluble and water soluble vitamins – Choline, carnitine. Summary of vitamin stability – Toxicity and sources of vitamins – Bioavailability of vitamins – Reasons for the loss of vitamins in foods

Module 6: Chemistry of Natural Colourants (4 hours)

Overview of natural colourants, sources, chemistry and applications of anthocyanin, betalain, carotenoids and chlorophyll.

Text Books

1. Srinivasan Damodaran, Kirk L. Parkin, Owen R. Fennema. (2007), Fennema's Food Chemistry – 4th Edition, CRC Press, Taylor & Francis group, USA, ISBN- 9780849392726.
2. H.D. Belitz, W. Grosch, P. Schieberle (2009) Food Chemistry – 4th revised and extended edition, Springer-Verlag Berlin Heidelberg, ISBN 978-3-540-69933-0

Reference Books

1. John M deMan, (1999) Principles of Food Chemistry – 3rd edition, Springer New York Heidelberg Dordrecht London ISBN 9781461463900 (eBook).
2. **N. Michael Eskin.** (1990) Biochemistry Of Foods – 2nd Edition Academic Press, USA ISBN 13: 9780122423512
3. David S.Robinson: Food Biochemistry and Nutritional Value Longman Scientific and Technical Publishers, USA (1987)
4. Pieter Walstra: Physical Chemistry of Foods Marcel Dekker Publishing, New York (2003) ISBN 9780824793555
5. Zdzislaw and E.Sikroski: Chemical and functional Properties of Food Components: 3rd edition, CRC Press, Taylor & Francis group USA (2006), ISBN - ISBN 9780849396755.

18FP2003 FLUID MECHANICS FOR FOOD ENGINEERS

3L:0T:0P **Credits: 3:0:0**

Course Objectives:

- To have an in depth knowledge of fluid mechanics.
- To apply fluid mechanics to the area of food engineering.
- To perform basic design calculations for fluid flow in pipes

Course Outcomes:

The students will be able to

1. Recognize the various properties of fluids.
2. Express the units of different properties of fluids.
3. Describe the pressure and its measurement.
4. Calculate the forces acting on bodies submerged in different positions in liquids.
5. Identify the type of flow of fluid.

6. Solve problems on fluid flow measurement.

Module 1: Properties of Fluids (8 hours)

Introduction- Units and Dimensions – Properties of fluids-Density – Specific weight - Specific Volume- Specific gravity- Viscosity-Thermodynamic properties-Compressibility and Bulk modulus- Surface tension and Capillarity -Vapour pressure and cavitation.

Module 2: Pressure and its Measurement (9 hours)

Fluid pressure at a point- Pascal's law- Pressure variation in a fluid at rest-Absolute, Gauge, Atmospheric and vacuum pressures- Measurement of pressure-Simple manometers-Differential manometers.

Module 3: Fluid Statics (9 hours)

Hydro static forces on surfaces- Total pressure and centre of pressure- Vertical plane surface submerged in liquid- Horizontal plane surface submerged in liquid- Inclined plane surface submerged in liquid- curved surface submerged in liquid.

Module 4: Basic Concepts in Fluid Flow (6 hours)

Kinematics of flow-Types of fluid flow-Rate of flow-continuity equation- continuity equation in three dimensions- velocity and acceleration- velocity potential function and stream function- Dynamics of Fluid flow- Equations of motion- Euler's equation of motion

Module 5: Basic Concepts in Fluid Flow Measurement (3 hours)

Bernoulli's equation- Practical applications of Bernoulli's equation – Venturimeter- Orifice meter- Pitot tube.

Module 6: Flow through Pipes (10 hours)

Reynolds Experiment- Laminar and turbulent flow- Loss of energy in pipes- Loss of energy due to friction- Minor energy losses-Hydraulic gradient and Total Energy line- Flow through pipes in series- Equivalent pipe-Flow through parallel pipes- Flow through branched pipes-Power transmission through pipes- Water hammer in pipes.

Text Books

1. Bansal, R.K., "Fluid Mechanics and Hydraulic Machines", Laxmi Publications, New Delhi, 9th edition, 2011.
2. Modi, P.N. and Seth, S.M., "A Text book of Fluid Mechanics and Hydraulic Machines", Standard Book House, New Delhi, 2007.

Reference Books

1. Som, S.R and Biswas, "Introduction to Fluid Mechanics and Fluid Machines", Tata McGraw Hill, 2nd edition, 2007.
2. Rajput, R.K., "A Text book of Fluid Mechanics and Hydraulic Machines", S. Chand and Co., New Delhi, 2008.
3. Agarwal, S.K., "Fluid Mechanics and Machinery", Tata Mc Graw Hill Co.New Delhi, 2006.

18FP2004 FOOD MICROBIOLOGY

3L:0T:0P **Credits : 3:0:0**

Course Objectives:

- To understand the microorganisms associated with foods and isolation methods of microorganisms from foods.
- To know the methods of preservation of foods.
- To learn the fermentation process and microorganisms involved in the production of fermented foods.

Course Outcomes:

The students will be able to

1. Name and describe the beneficial and spoilage microorganisms associated with food.
2. Understand the growth and methods of isolation of microorganisms from food.
3. Summarize the factors affecting the growth of microbes in food.
4. Describe the principle of food fermentation.
5. Evaluate the role of microorganisms in various foods.
6. Predict the causative agent and pathogenesis of disease causing food borne pathogens and their toxins.

Module 1: History, Screening and Isolation of Microorganisms (9 hours)

History of microorganisms in food development - Micro organisms associated with foods: Bacteria, Molds, Yeast and their importance –Nutritional requirements of bacteria- Factors affecting the growth of bacteria in foods –

Growth curve of bacteria - Spoilage and contamination in various food commodities - General Microbiological Methods of enumeration and isolation of bacteria and fungi,-Identification of bacteria and fungi by staining methods.

Module 2: Conventional Methods of Preservation (6 hours)

Thermal mode of preservation – Pasteurization, sterilization and Canning – Heat resistance of microorganisms and their spores – spoilage of canned foods and types of spoiled cans – aseptic packaging - Low-temperature storage.

Module 3: Non Thermal Methods of Preservation (6 hours)

Non-thermal methods of preservation **:** High pressure processing – Pascalisation - Irradiation – Brief account of microwave, UV and ionizing radiation - Use of chemical preservatives, Natural food preservatives, Applications of Probiotics and Prebiotics.

Module 4: Microbiology of Fermented Foods (7 hours)

Traditional vegetable fermentation –Pickle, Sauerkraut – Organic acid Production - citric acid, and Acetic acid fermentation - Alcohol production – Beer, wine - Fermentation of oriental food products.

Module 5: Microbiology of Water and Food Commodities (9 hours)

Microbiology of water and their importance in processing of foods in industries. MPN of coliforms, Membrane filtration Technique. Microbiology of milk, Quality testing of milk – Phosphatase test, Methylene blue reduction test. Hetero and homo fermentative Lactic acid bacteria – Yogurt and Cheese fermenting organisms.

Module 6: Food Borne Diseases and Intoxication (9 hours)

Food Poisoning and intoxication – food borne diseases – Symptoms of diseases caused by *Bacillus* spp., *Clostridium botulinum, Escherichia coli*, *Salmonella* spp, *Staphylococcus aureus*, *Shigella*, Hepatitis, Gastroenteritis viruses, *Entamoeba histolytica*, Mycotoxins and Algal toxins.

Text Book

1. Adams M.R and Moss M.O, "Food Microbiology", Panima Publishing corporation, New Delhi, 2nd Edition, Third reprint, ISBN-13:9788122410143,978-8122410143, 2007.

Reference Books

1. Sivasankar B, "Food Processing and Preservation", PHI Learning Private Limited, Easterrn Economy Edition, 6th edition, ISBN- 97881203-2086-4, 2009.
2. William C Frazier and Dennis C. Westoff, "Food Microbiology", Special Edition, Springer, The Mc Graw-Hill Companies, ISBN-9780070667181, 2008.

18FP2005 FOOD ANALYSIS LAB - I

0L:0T:3P **Credits : 0:0:1.5**

Course Objectives:

- Demonstrate an ability to assess the most appropriate analytical procedure required for a particular food analysis problem.
- Demonstrate practical knowledge of selected food analysis techniques.

Course outcomes:

The students will be able to

1. Gain knowledge in the terminology used in food analysis
2. Learn relevant procedures and equipment
3. Understand how food analysis fits into the food industry.
4. Gain experience with proximate analysis of foods
5. Familiar with precision and accuracy through experiences with components of analysis and reporting results.
6. Demonstrate oral and written communication skills to effectively communicate scientific ideas related with food analysis

List of Experiments

1. Estimation of Reducing sugars by Willstatter' Iodometric Titration
2. Estimation of Reducing sugars by Lane and Eynon's method
3. Estimation of Total sugars by Lane and Eynon's method
4. Estimation of Free Fatty Acids in Fats and Oils

5. Saponification Value of Fats and Oils
6. Peroxide Value of Fats and oils
7. Iodine Value of Fats and Oils
8. Estimation of α – Amino Nitrogen by Sorenson's Formol Titration
9. Estimation of Nitrogen by Kjeldhal's Method
10. Estimation of Vitamin C
11. Estimation of iron
12. Estimation of Calcium
13. Qualitative Analysis of Sugars
14. Qualitative Analysis of Amino Acids
15. Identification of Sugars by Paper Chromatography
16. Identification of Aminoacids by Paper Chromatography

18FP2006 FLUID MECHANICS AND HEAT TRANSFER LAB

0L:0T:3P **Credits : 0:0:1.5**

Course Objectives:

- To provide extensive knowledge on various flow measuring equipments involved in food industries.
- To equip the students to operate and measurement of the heat transfer equipments.

Course Outcomes:

The students will be able to

1. Understand the importance of fluid flow in industrial applications.
2. Describe the use of flow measuring devices.
3. Demonstrate the loss of energy due to friction in pipes.
4. Calculate the losses of energy due to fittings in pipe flow systems.
5. Evaluate the required length of pipes for fluid flow.
6. Demonstrate the heat transfer equipments and their performance.

List of Experiments

1. Determination of coefficient of discharge of Venturi meter
2. Determination of coefficient of discharge of Orifice meter
3. Calibration of Rotameter
4. Determination of pipe friction and pressure drop due to sudden contraction and expansion during fluid flow
5. Determination of friction loss and pressure drop in Helical coil
6. Determination of Equivalent Length of pipe fittings during fluid flow
7. Determination of pressure drop in annular pipes
8. Pressure drop across Fluidized bed columns
9. Heat transfer studies in a tubular heat exchanger (Parallel and counter flow)
10. Heat transfer studies in a plate heat exchanger (Parallel and counter flow)
11. Heat transfer studies of a shell and tube heat exchanger
12. Heat transfer through composite walls

18FP2007 FOOD MICROBIOLOGY LAB

0L:0T:3P **Credits : 0:0:1.5**

Course Objectives:

- To understand the working principle of microscopes and sterilization techniques.
- To know the preparation of media for the cultivation of microorganisms.
- To identify the isolated strains using staining techniques and biochemical tests.

Course Outcomes:

The students will be able to

1. Use aseptic technique to properly handle microorganisms to avoid contamination.
2. Understand and apply the knowledge to handle microscopes to observe stained microorganisms.
3. Enumerate the microorganisms to check the quality characteristics of food.
4. Isolate the pure culture from mixed population found in contaminated foods.

5. Identify the microorganisms using staining techniques.
6. Assess the quality of raw milk by methylene blue reduction test.

List of Experiments

1. Microscopy
2. Sterilization and Disinfection
3. Preparation of culture media.
4. Methods of pure culture techniques for bacteria.
5. Staining techniques - Monochrome staining
6. Gram staining
7. Negative staining,
8. Lacto phenol cotton blue staining for fungi.
9. Hanging drop preparation to observe motility of bacteria
10. Enumeration of microorganisms from water/milk
11. Enumeration of microorganisms from any contaminated food.
12. MPN Test for coliforms.
13. Methylene blue reduction test for assessing the quality of raw milk.
14. Biochemical characterization of bacteria.

18FP2008 METABOLISM AND NUTRITION

03:0T:0P **Credits : 3:0:0**

Course Objectives :

- To understand about metabolic pathways and nutrition
- To apply knowledge on the legal aspects of formulating and labelling functional foods and dietary supplements.
- To develop a food product of high nutritive value

Course Outcomes :

The students will be able to

1. Describe the structure of ATP and identify the major class of macromolecules to which ATP belongs.
2. List the stages in the catabolism of food molecules and describe what occurs during each stage.
3. Describe the biochemistry process, basic concept of human nutrition and the relationship of the consumption of foods to nutritional status and health
4. Evaluate the biological functions of foods for health in addition to nutritional values
5. Evaluate the potential for adverse events related to dietary supplements
6. Apply their knowledge in food biochemistry and nutrition in designing new range of products with improved nutritional characteristics (Nutraceuticals and functional foods).

Module 1: Metabolism of Carbohydrates (9 hours)

Interconnection of pathways, glycolysis (EMP), TCA cycle, gluconeogenesis, Pentose phosphate shunt, Metabolic regulation, Electron transport chain & oxidative phosphorylation Bioenergetics: energy rich compounds

Module 2: Metabolism of Fatty Acids (6 hours)

Biosynthesis and degradation of fatty acids- Beta oxidation- Chain elongation – Biosynthesis of cholesterol

Module 3: Metabolism of Fatty Acids and Proteins (6 hours) Biosyntheses and degradation of amino acids (one example each for sulphur containing, aliphatic, aromatic, heterocyclic, basic and acidic amino acids); Biosynthesis and degradation of purines, pyrimidines and nucleic acids, urea cycle.

Module 4: Concepts of Nutrition (8 hours)

Basic concept of nutrition – Importance of nutrition and dietetics - Assessment of nutritional status – energy value of carbohydrates, proteins and fats – determination of energy value – balanced diet – Recommended dietary intake – Acceptable dietary intake – Protein efficiency ratio – Net protein utilisation and their determinations – Malnutrition and its problems – Nutrient supplementation & fortification - Nutritional labeling and its importance - Effect of processing on protein quality -carbohydrates in food and dietary fibre.

Module 5: Nutritional Disorders (8 hours)

Inborn errors of carbohydrate, protein and fat metabolisms - Nutrition and disorders associated with organs such as liver and kidney - Naturally occurring anti-nutritional factors – Cyanogens, lectins, enzyme inhibitors, phytoallexins, phytates.

Module 6: Specialized Nutrition (8 hours)

Nutrition for specialized purposes – Pediatric nutrition – geriatric nutrition – Sports nutrition – Nutrition during pregnancy. Ageing –Theories of ageing – Nutrition and ageing – Cancer and its prevention - Age-related metabolic disorders – Nutrition in the treatment of age-related disorders like hypertension, diabetes, alzheimer's disease.

Text Books

1. Voet D, Voet G, Principles of Biochemistry, 3rd edition, John Wiley and Sons, 2008. ISBN-13: 9780470233962, 978-0470233962.
2. Martin Eastwood, Principles of Human nutrition – 2nd edition. Wiley - Blackwell Publishing, 2003. ISBN: 978-0-632-05811-2

Reference Books

1. Ronald Ross Watson, Functional foods and Nutraceuticals in Cancer Prevention, Ed. Wiley – Blackwell, 2003. ISBN-13: 978-0813818542.
2. Nelson D.L., M.M. Cox, Lehninger Principles of Biochemistry, W.H. Freeman & Company Publications, 2013. ISBN-10: 1-4292-3414-8
3. Tymoczko, J.L., Berg, J.M., Stryer, L. Biochemistry – A short course, 3rd edition. W.H. Freeman. 2009. ISBN-10: 1-4641-2613-5
4. Sunetra Roday., "Food Science and Nutrition – 2nd edition, Oxford Higher Education/Oxford University Press, 2012, ISBN 10: 0198078862

18FP2009 APPLIED THERMODYNAMICS FOR FOOD ENGINEERS

3L:0T:0P **Credits : 3:0:0**

Course Objectives

- To understand the importance of thermodynamics in food system.
- To apply the concept of statistical thermodynamics for various food system
- To develop an efficient system using thermodynamic principle

Course Outcomes

The students will be able to

1. Identify the thermodynamic variables that will affect the food processing
2. Estimate the effect of various thermodynamic properties on food system
3. Solve the problems related to food processing using thermodynamic principles
4. Model food system based on thermodynamic properties
5. Develop an efficient food processing method
6. Predict the bottleneck using the thermodynamic principles

Module 1: Fundamental Concepts and Calculation of Thermodynamic Quantities (9 hours)

Thermodynamic terms, variables, processes and states. First and zeroth law of thermodynamics. State and path function. C_p and C_v. Joule Thomson porous plug experiment. Calculation of thermodynamic quantities - Isothermal expansion, free expansion and adiabatic reversible process.

Module 2: First and Second Law of Thermodynamics and its Application (9 hours) Steady flow energy equation and its application to steam generator, condenser, nozzles and air compressors. Second law of thermodynamics and its application to refrigerator, heat engine and heat pump. Concept of entropy and calculation of entropy changes.

Module 3: Thermodynamic Properties of Pure Fluids (6 hours)

Energy properties, Helmholtz and Gibbs free energy, fundamental property relations, Maxwell's equations - Clausius - Clapeyron equations. Differential equation for S, U, H. Gibbs- Helmholtz equation.

Module 4: Fugacity (4 hours)

Fugacity, fugacity coefficient, activity, effect of temperature and pressure on fugacity, determination of fugacity of real gases.

Module 5: Properties of Solutions (9 hours) Partial molar properties, concept of chemical potential, fugacity in solutions-Lewis Randall rule, Raoult's law, Henry's law. Activity in solutions- activity coefficients, pressure and temperature effects, Gibbs- Duhem equations.

Module 6: Psychrometry (8 hours)

Psychrometric properties of air. Psychometric charts, psychrometric process – sensible heat exchange process, latent heat exchange process, adiabatic mixing, evaporative cooling – problems.

Text Books

1. Narayanan K.V., A Text book of chemical engineering thermodynamics, PHI Learning Private Limited, 2015.
2. Rastogi R.P. and Misra R.R., An Introduction to chemical thermodynamics, Vikas Publishing House Pvt Ltd.,2015.

Reference Books

1. Nag P.K., Engineering Thermodynamics, McGraw Hill Education (India) Private Limited, 2014.
2. Roy Choudhury T., Basic Engineering Thermodynamics, Tata McGraw Hill, 2000
3. Vanwylen and Sontag, Fundamentals of Classical thermodynamics, Wiley Eastern, 2005.

18FP2010 HEAT AND MASS TRANSFER

3L:0T:0P **Credits : 3:0:0**

Course Objectives:

- To enable the student to basic study of the phenomena of heat and mass transfer, to develop methodologies for solving food engineering problems
- To understand the information concerning the performance and design of Heat exchangers
- To develop processes with better heat efficiency and economics

Course Outcomes :

The students will be able to

1. Understand the basic laws of heat transfer and account for the consequence of heat transfer in thermal analyses of engineering systems.
2. Analyze problems involving steady state heat conduction in simple geometries.
3. Evaluate heat transfer coefficients for natural convection.
4. Analyze heat exchanger performance by using the method of log mean temperature difference.
5. Analyze heat exchanger performance by using the method of heat exchanger effectiveness.
6. Understand the influence of radiation in food processing operations.

Module 1: Heat Transfer – Conduction (9 hours)

Modes of heat transfer – Conduction, Convection and Radiation. Fourier's Law of Heat conduction-Thermal Conductivity for gases, liquids and solids-Thermal diffusivity- Thermal resistance-Steady heat conduction in simple geometries: Plane wall, hollow cylinder and hollow sphere through solids in series -plane wall and multilayer cylinder. Heat conduction through materials in parallel. Theory of insulation, critical radius of insulation.

Module 2: Heat Transfer – Convection (9 hours)

Convection heat transfer – forced and natural; Evaluation of convection heat transfer coefficient, Dimensionless numbers- Forced convection- Heat Transfer Coefficient for Laminar flow inside a tube -heat transfer coefficient for turbulent flow inside a pipe. –Heat Transfer outside various Geometries in Forced Convection – Flow parallel to flat plate - Natural convection from vertical planes and cylinders –boiling and condensation-mechanisms

Module 3: Heat Transfer – Radiation (7 hours)

Basics of Radiation heat transfer- Types of surfaces – Kirchhoff's Law-radiation from a body and emissivity (Stephan Boltzmann Law) to a small object from surroundings –Planck's Distribution law-Wein's Displacement law- combined Radiation and Convection Heat Transfer.

Module 4: Heat Exchangers (8 hours)

Types-Overall Heat Transfer Coefficient-Shell and Tube1-1, 1-2, 2-4 passes –Plate Heat Exchanger-tubular heat exchanger-Parallel Flow and Counter Flow- Cross flow Types-Scraped surface exchangers-Compact

Heat exchanger- Heat exchanger Analysis-Log mean Temperature Difference

Module 5: Diffusion (6hours)

Physical Origin-Mixture composition- classification-concentration- velocities and fluxes. Fick's law- general equation of mass transfer in stationary media- steady state diffusion-equimolar diffusion-diffusion of water vapour through air

Module 6: Mass transfer (6 hours)

Theories of Mass transfer – Film, Penetration and Surface renewal theory – Determination of mass transfer coefficient – Correlations.

Text Book

1. Rao, D. G, "Fundamentals of Food Engineering", PHI Learning Pvt. Ltd., New Delhi. 2010.

Reference Books

1. McCabe W.L., Smit J.C and Harriott P, "Unit Operations of Chemical Engineering", McGraw-Hill International Edition, 7th Edition New York, ISBN-007-424-740-6, 2005.
2. Ballaney, P.L. "Thermal Engineering", Khanna Publishers, New Delhi. 2002
3. R.Palusingh, Dennis R. Heldman "Introduction to food engineering" 5th edition, Academic press 2014

18FP2011 DAIRY ENGINEERING AND TECHNOLOGY

3L:0T:0P **Credits : 3:0:0**

Course Objectives:

- To understand about milk, milk processing methodologies
- To provide knowledge about the milk processing equipments
- To provide technical know-how about the production of milk products (ice creams, fermented milk products)

Course Outcomes:

The students will be able to

1. Gain knowledge on milk source and composition
2. Understand the various milk processing methods.
3. Learn the milk processing equipments.
4. Develop an understanding on milk packaging machines
5. Demonstrate hands-on skills in manufacturing selected dairy products in a pilot plant setting
6. Evaluate the safety and quality factors that determine the acceptability of the dairy products by consumers.

Module 1: Dairy Chemistry and Microbiology (9 hours)

Introduction - Basic dairy terminology - milk as raw material – composition - nutritive value - Physico-chemical constituents of milk and its constituents – contaminants - microbiology of milk- milk collection - cooling and milk transport - milk reception -Quality control tests - applications of enzymes in dairy industry

Module 2: Dairy Processing and Equipments (9 hours)

Milk processing equipment – filtration/clarification – Pasteurization – HTST – LTLT - UHT methods - storage tanks - Cream separating Centrifuges - Homogenization – theory - working principle of homogenizers – homogenization efficiency - cream separation – principles – gravity and centrifugal separation – centrifugal separator – parts – construction and working principle – separation efficiency

Module 3: Bottle, Can Washing and Filling Equipments (9 hours)

Plant piping – Pumps - Bottle washers- and cappers- can washers-types of can washers-care and maintenance-factors affecting washing operation – Fillers - types of fillers-pouch filling form fill seal machines - aseptic filling - cleaning and sanitization - CIP cleaning- types of CIP systems - Energy use in Dairy plant - sources of energy - cost of energy - Control of energy losses and Energy conservation.

Module 4: Milk Product Processing (5 hours)

Butter – method of manufacture – theory of churning - operation of butter churn – over run—batch and continuous methods of butter making. Ghee – methods of manufacture - Cheese – classification – cheddar and cottage cheese - equipments – cheese vats and press- construction details.

Module 5: Frozen Milk Products (5 hours)

Ice cream - ingredients – preparation of ice cream mix - freezing – calculation of freezing point and refrigeration - batch and continuous freezers – Special milks - Quality aspects of dairy products.

Module 6: Fermented and Dehydrated Dairy Products (8 hours)
Fermented products – Yoghurt – Curd – cultured butter milk Bulgarian butter milk – Kefir – paneer - acidophilus milk etc. - Concept of Probiotics and prebiotic foods – Vacuum Evaporators - drying of milk - drum drier and spray drier - components - construction and working principles.

Text Books
1. Tufail Ahmad, " Dairy Plant Engineering and Management", Kitab Mahal Publishers, New Delhi, 2016.
2. Sukumar De, "Outlines of Dairy Technology", Oxford University Press, New Delhi, 23rd impression, 2006.

Reference Books
1. Farrall,A.W. 1963. Engineering for dairy and food products. John Wiley and Sons, New York.
2. G. Bylund: Dairy Processing Handbook. Tetrapack publishers.
3. Walstra. P et al " Dairy Technology"Taylor & Francis ISBN-0-203-90999-2, 2005

18FP2012 UNIT OPERATIONS IN FOOD PROCESS ENGINEERING - I

3L:0T:0P **Credits : 3:0:0**

Course Objectives:
- To know the various types of equipments used in the food industry.
- To learn the operation and utilization of equipments involved.
- To choose suitable techniques for the food processing operation.

Course Outcomes:
The students will be able to
1. Define the various unit operations in food processing.
2. Compute the moisture content of food materials.
3. Describe and demonstrate the various process equipments.
4. Evaluate the different operations in food processing.
5. Estimate the energy requirement for the different unit operations.
6. Develop unit operation system for food processing.

Module 1: Psychrometry (6 Hours)
Moisture and its measurements - direct and indirect methods – Equilibrium moisture – methods of determination – EMC Models – Henderson ,Kelvin, PET and GAB models – importance of EMC- water activity

Module 2: Drying (7 hours)
Drying theory – Drying rate – Mechanical Drying – hot air dryers – Types- fixed -fluidized bed – LSU drier-Spray drier- Osmotic dryer - vacuum shelf dryer – freeze dryer.

Module 3: Mechanical Separation (9 Hours)
Screening: Types, Equipments; Filtration: Filter media types and requirement – constant rate filtration – constant pressure filtration – filter cake resistance – filtration equipments – filter press – rotary drum filters – sedimentation – gravitational sedimentation – Stoke's law – sedimentation in cyclones. Centrifugal separations – rate of separation – centrifuge equipment.

Module 4: Evaporation (10 Hours)
Definition – liquid characteristics – Types of evaporators -single and multiple effect evaporators - once through and circulation evaporators – Agitated film evaporators. Performance – evaporator capacity – boiling point elevation and Duhring's rule. Heat transfer coefficients – Evaporators economy – enthalpy balance of single effect evaporator – multiple effect evaporator – methods of feeding. Capacity and economy of multiple effect evaporator.

Module 5: Size Reduction (8 Hours)
Principles of comminuting – characteristics of comminuted products – particle size distribution in comminuted products – energy and power requirements – Rittinger's, Kick's and Bond's law – Size reduction equipments – crushers – hammer mill – Ball mill-Colloidal mill-attrition mills.

Module 6: Mixing (7 Hours)
Definitions and principles– Basic equations standards. Evaluation of constants – work, energy and Power – Agitation and Mixing – Purpose of agitation – Agitated vessels – impellers – propellers – turbine –High efficiency impellers – Impellers for high viscosity liquids. Draft tubes – Power number – mixing and blending of miscible liquids, mixing index.

Text Books

1. DG Rao, "Fundamentals of Food Engineering" PHI Learning Private Limited, New Delhi.
2. Geankoplis CJ, "Transport Processes and Separation Processes Principles" .Printice Hall India, New Delhi, ISBN-978-81-203-2614-9, 2008
3. Warren,L McCabe, J.C. Smith and Peter Harriot,"Unit Operations of Chemical Engineering " McGraw Hill International Edition, Singapore, ISBN-007-424740-6, 2005

Reference Book

1. Earle, R.L, "Unit Operations in Food Processing". Pergamon Press,2nd Edition,UK, 2003

18FP2013 FRUIT AND VEGETABLE PROCESSING TECHNOLOGY

3L:0T:0P **Credits : 3:0:0**

Course Objectives:

- To enable the students to understand the processing of fruits and vegetables
- To impart technical knowledge of about how to develop products and preservation
- To understand the methods of dehydration

Course Outcomes:

The students will be able to

1. Understand the production status and post harvest handling methods of fruits and vegetables
2. Learn the methods of processing and preservation of freshly harvested and cut fruits and vegetables.
3. Enumerate the processing and preservation of fruits and vegetables by heat treatment.
4. Illustrate the production and preservation methods of fruit juices.
5. Understand the dehydration methods and design of driers used for drying fruit and vegetables.
6. Describe the aseptic technology for product preservation.

Module 1: Production and Post harvest operations (9 hours)

Production of Fruits and vegetables in India. Cause for heavy losses, Composition of each of the major fruits and vegetables produced in the country- Spoilage factors, Post harvest field operations, Preservation treatments for freshly harvested fruits and vegetables, Packaging of whole fruits and vegetables for internal and export markets. Processing and packaging of cut fruits and vegetables.

Module 2: Preservation techniques in Fruits and Vegetables (5 hours)

Canning operations of fruits and Vegetables.-Different filling, closing and sterilization operations- Blanching operations - Batch and Continuous Blanching. Concept of Hurdle technology as applied to fruit and vegetable preservation. Minimal processing.

Module 3: Processing of Bottled Products (5 hours)

Bottled Products: Preparation of products like Jams, Jellies, Marmalades, Pickles, Puree, Ketchup, Sauce, and Squashes etc. - FSSAI specifications.

Module 4: Processing of Fruit Juices (9 hours)

Common machinery for operations like Peeling, Slicing/Dicing and Pulping. Preparation of specialty products like, Fruit juice concentrates, Fruit Bars and Fruit powders. Clarification of juices -Tomato products – Hot and Cold Break processes. Tomato Deseeding and clarification. Clarification centrifuges – Decanters and desludgers. Fruit juice aroma recovery and its importance.

Module 5: Dehydration (9 hours)

Dehydration principles and equipment used for drying –Cabinet tray dryer,Tunnel dryer, Conveyor Belt dryer, Bin dryer, Fludised bed dryer, Freeze Dryers. Freeze drying Principles. Merits and demerits of Freeze Drying. Preparation of Fruit Powders. Working of Spray Dryer and Drum Dryer. Preparation of Dried slices, Intermediate Moisture Food.

Module 6: Aseptic Processing (9 hours)

Aseptic processing and Bulk packing of Fruit juice concentrates. Aseptic heat exchangers for sterilizing and concentrating the product. Aseptic fillers. Tetra pack for small quantities, Dole system and Scholle system for bulk storage in Bag and Boxes and Bag & Drums.Storage of Aseptically packed products.

Text Book

1. Hui Y.H and Others, "Hand Book of Vegetable Preservation and Processing", Mercel Dekker, New York, 2004

Reference Books

1. Chakraverty, A., Mujumdar A.S., Raghavan G.S.V and Ramaswamy H.S. "Handbook of Post-harvest Technology" Marcel Dekker Press, USA, 2001.
2. L.R.Verma and V.K.Joshi, (2000) Post Harvest Technlogy of fruits and vegetables.Indus Publishing Co, NewDelhi.
3. P.Fellows, (2000) Food processing Technology: Principles and Practice.Wood Head publishing Limited, Cambridge, England.
4. James G. Brennan, (2006) Food Processing Hand book. Wiley-Ych Verlag Gmbh&Co KgaA, Weinheim, Germany

18FP2014 UNIT OPERATIONS IN FOOD PROCESS ENGINEERING LAB

0L:0T:3P **Credits: 0:0:1.5**

Course Objectives:

- To know the various types of equipments used in the food industry.
- To learn the operation and utilization of equipments involved.
- To choose suitable techniques for the food processing operation.

Course Outcomes:

The students will be able to

1. Study the various unit operations in food processing.
2. Compute the moisture content and drying characteristics of food materials.
3. Describe and demonstrate the milling equipments.
4. Estimate the energy requirement for the grain milling operations.
5. Estimate the mixing properties of flours and grains.
6. Evaluate the performance of grain separators and rice mill.

List of Experiments

1. Studies on drying characteristics of vegetables using Cross flow dryer
2. Studies on drying characteristics of vegetables using Through flow dryer
3. Studies on drying characteristics of vegetables using Vibrofluidizer
4. Studies on size reduction of grains using multi mill
5. Studies on size reduction of grains using Disc/Pin mill
6. Studies on mixing properties using Ribbon mixer
7. Studies on mixing properties using Sigma mixer
8. Experiment on Dewatering Centrifuge
9. Studies on cleaning efficiency of specific gravity separator for grains
10. Experiment on milling efficiency using Rubber Roll Sheller
11. Experiment on Plate type pasteurizer
12. Experiment on oil extraction using oil expeller

18FP2015 FOOD BIOCHEMISTRY LAB

0L:0T:3P **Credits: 0:0:1.5**

Course Objectives:

- To gain knowledge of practices for proper literature reviews and evaluation of appropriate methods for analysis.
- To understand proper use of methods of analysis
- To interpret various methodologies for analysis of components in foods.

Course Outcomes:

The students will be able to

1. Demonstrate the presence of protein, lipid, carbohydrate and water in food using chemical methods
2. Describe various separation and quantification techniques frequently used for food analysis.

3. Evaluate proper selection and application of appropriate methods of analysis.
4. Aware of how analytical techniques may be used determine food composition and quality
5. Work with other students to successfully complete lab experiment
6. Apply their knowledge in food biochemistry and nutrition in designing new range of products with improved nutritional characteristics

List of Experiments

1. Estimation of sugars by DNS method
2. Estimation of crude fibre
3. Estimation of proteins by the Biuret method
4. Estimation of total free amino acid
5. Estimation of proteins by Lowry's method
6. Estimation of proteins by dye-binding method
7. Estimation of thiamine
8. Estimation of ascorbic acid
9. Estimation of riboflavin
10. Estimation of carotenoids
11. Estimation of cholesterol
12. Estimation of total carbohydrate by anthrone method
13. Qualitative tests for checking of milk and water

18FP2016 UNIT OPERATIONS IN FOOD PROCESS ENGINEERING – II

3L:0T:0P **Credits: 3:0:0**

Course Objectives:

- To understand the various unit operations involved in food industry.
- To learn the operation and utilization of equipments involved.
- To choose suitable techniques for the food processing operation.

Course Outcomes:

The students will be able to

1. Understand the engineering operations that are critical to the food processing operations and industrial growth.
2. Define the principles of food processing operations.
3. Learn the material and energy balance related to the unit operations.
4. Identify the factors affecting unit operations.
5. Select suitable unit operations for a specific purpose.
6. Appraise the performance of the mass transfer operations in food processing.

Module 1: Distillation (10 Hours)

Principles of diffusion and mass transfer -Fick's law – convective Mass transfer – Mass transfer for binary mixtures- definition of Distillation – Flash Distillation — continuous distillation with reflux – combined rectification and stripping- McCabe and Thiele method of determination of no of plates. – Advantages and limitations – distillation equipments – construction and operation – factors influencing the operation.

Module 2: Leaching (5 Hours)

Definitions – Leaching equipment leaching by percolation through stationary solid- moving bed leaching – Dispersed solid – counter current leaching – number of ideal stages.

Module 3: Extraction (6 Hours)

Liquid extraction – Extraction equipment – mixer settlers – packed extraction towers – perforated plate towers – baffle towers – Agitated tower. Pulse column – centrifugal extractor – Introduction to Super critical Fluid extraction

Module 4: Absorption and Adsorption (9 Hours)

Definition – rate of gas absorption – packing and packed tower for absorption – characteristics of packing- pressure drop and limiting flow rates – principles of absorption – mass balance.

Adsorption – equipment – fixed bed adsorber - pressure swing adsorption – Adsorption from liquids.

Module 5: Crystallization (7 Hours)

Crystallization equilibrium -rate of crystal growth – stage of crystallization – magma- nucleation crystallization equipment. Variations in crystallizers – vacuum crystallizers. Draft tube, baffle crystallizers.

Module 6: Membrane Separation (8 Hours)

Micro, Ultra and Nano filtration. Types of membranes. Permeate flux for ultrafiltration – concentration polarization – Application of ultrafiltration, diafiltration – membrane fouling – Separation of gases – porous membrane – Polymer membrane – Membrane structure -flow patterns. – Pervaporation – Reverse Osmosis.

Text Books

1. DG Rao, "Fundamentals od Food Engineering" PHI Learning Private Limited, New Delhi.

Reference Book

1. Earle, R.L. "Unit Operations in Food Processing". Pergamon Press,2nd Edition,UK, 2003.
2. Geankoplis, CJ, "Transport Processes and Separation Processes Principles" .Printice Hall India, New Delhi, ISBN-978-81-203-2614-9, 2008.
3. Warren,L McCabe, J.C. Smith and Peter Harriot."Unit Operations of Chemical Engineering " McGraw Hill International ,7thEdition ,Singapore, ISBN-007-424740-6, 2005.

18FP2017 REFRIGERATION, AIR CONDITIONING AND COLD STORAGE CONSTRUCTION

3L:0T:0P **Credits: 3:0:0**

Course Objectives:

- To enable the students to understand the various concepts behind refrigeration of food.
- To enable students to know about food freezing and equipment involved.
- To enable students to understand various aspects of cold storage.

Course Outcomes:

The students will be able to

1. Understand refrigeration of food and its operational components.
2. Gain knowledge on various forms of food refrigeration in plants, stores and logistics.
3. Learn advanced food freezing concepts and techniques.
4. Study food safety aspects of chilled foods and frozen foods.
5. Comprehend cold chain management in food distribution sector.
6. Evaluate the cold storage and packaging of frozen perishable products.

Module 1: Principles of Refrigeration (9 hours)

Refrigeration – Ton of refrigeration, refrigeration cycles, Vapour Compression and Vapour Absorption cycles, Refrigerants, characteristics of different refrigerants, net refrigerating effect -Components of a Refrigeration system: Compressor, condenser, Evaporator, Expansion valves piping and different controls.

Module 2: Cold Storage (7 hours)

Insulation, properties of insulating materials, air diffusion equipment, Cold load estimation; prefabricated systems, walk-in-coolers, and Refrigerated container trucks: Freezer Storages, Freezer room Temperatures, Cooling towers: introduction, Construction and Working; Cold Storage practice, Stacking and handling of materials, Optimum temperatures of storage for different food materials.

Module 3: Air-Conditioning (10 hours)

Psychrometry. Psychrometric Processes. Simple Air Conditioning System – State and Mass Rate of Air. Evaporative, Winter and All Year Air Conditioning Systems. Design Conditions. Load Calculation and Psychrometry of Air Conditioning Systems –Design of Air conditioning apparatus – Transmission and Distribution of Air. Selection of Air Conditioning Systems.

Module 4: Freezing of Foods (6 hours)

Freezing equipment, Freezing Time, Freezing Curve, Freezing rates, growth rate of ice crystals, crystal size and its effect of texture and quality of foods, Freezer types, Individual quick freezing. Cryogenic Freezing, Freezing practice as applied to different food sectors.

Module 5: Chilling of Foods (6 hours)

Chilling equipment for liquid foods. Secondary refrigerants, Evaporative cooling and direct expansion techniques in chilling. Chilled foods transport and retail cabinets - Basics of Chilled foods microbiology, Packaging of Chilled foods.

Module 6: Cold Chain Management (8 hours)

Supply chain system - Important Factors to consider- logistic supply- Protocols for Domestic, Sea and Airfreight- Traceability and barcode – Product Temperature and Moisture monitoring- Refrigeration systems and Refrigerant types during field chilling, transportation via land, air and sea. Grocery stores and display cases, Home refrigerators - Cooling chain summary - Storage and packaging

Text Book

1. Clive.V.J Dellino, "Cold and Chilled Storage Technology", Chapman Hall India , 1997.

Reference Books

1. C.P. Arora, "Refrigeration and Air conditioning", Tata McGraw Hill, 2009.
2. Da-Wen Sun, "Handbook of Frozen Food Processing and Packaging", CRC Press, 2009.
3. Florkowski W.J, Shewfelt R.L, Brueckner B and Prussia S.E, "Post Harvest Handling and Sytems Approach", Second edition, Academic Press, 2009.
4. Colin Dennis and Michael Stringer: Chilled Foods – A Comprehensive Guide Brown.M WoodHead Publishing, 2008.

18FP2018 MECHANICAL SYSTEMS FOR FOOD PROCESSING

3L:0T:0P **Credits: 3:0:0**

Course Objectives:

- To provide knowledge about types of pumps and their applications.
- To learn about types of power transmission elements, steam generators and chillers.
- To understand the principles of material handling systems.

Course outcomes:

The students will be able to

1. Understand the working principle of pumps and their applications
2. Know about the various power transmission elements and their design.
3. Gain knowledge on working principle of boilers and measurement of performance.
4. Study the working principle and applications of various mechanical refrigeration systems.
5. Learn about the principles and applications of different food chillers and freezers.
6. Appraise the construction and working principle of various material handling systems.

Module 1: Food Plant Pumps (9 hours)

Pumping theory- head developed-Types of pumps-Centrifugal pumps- Reciprocating pumps- piston pump- Rotary gear pumps- vane pumps- and diaphragm pumps-peristaltic pump-construction- working principles and applications (Simple problems).

Module 2: Mechanical Power Transmission Systems (9 hours)

Relation between torque, power speed – Velocity ratio. Types of shafts-design of shafts-solid and hollow shafts-types of coupling- belt drives-gear drives-chain drives and rope drives-types and materials (Simple problems).

Module 3: Steam Generation and Distribution (8 hours)

Types of Water tube and smoke tube boilers- Boiler capacity- boiler specification- automatic boilers- Boiler mountings. Performance of steam generators (Simple problems).

Module 4: Refrigeration Systems (8 hours)

Types of refrigeration systems- VCRs and VARs. Refrigerants, Components of refrigeration systems. Types of Chillers for Solid Foods, Types of Chillers for Liquid Foods, Types of Freezers. (Simple problems).

Module 5: Material Handling in Food Plants (6 hours)

Material handling in food plants & Importance, Belt Conveyor, Roller Conveyor, Vibratory Conveyor, Screw Conveyor, Slat Conveyor, Pneumatic Conveyor.

Module 6: Material Handling in Food Plants - Elevators (6 hours)

Types of elevators - Bucket, Slat, pneumatic and screw elevators, inclined elevators – Design configuration, power requirement and specific applications.

Text Books

1. P.G.Smith, "Introduction to Food Process Engineering", Springer international Edition, 2005

2. R.Paul Singh,Dennis R.Heldman; “Introduction to Food Engineering” (3rd edition), Academic press, Elsevier, 2001.

Reference Books

1. R.K Rajput, “Thermal Engineering”, Laxmi Publications, 2008.
2. R.K.Bansal; “Fluid Mechanics and Hydraulic Machines”, Laxmi publications (P) Ltd, 2004
3. C.P. Arora, “Refrigeration and Air conditioning”, Tata McGraw Hill, 2009.
4. R.S. Khurmi and J.K. Gupta, "A Text Book of Machine Design", Eurasia Publishing House, 2005.

18FP2019 CEREALS AND PULSES PROCESSING TECHNOLOGY

3L:0T:0P **Credits: 3:0:0**

Course Objectives:

- To create awareness about the processing of major cereals like paddy, maize etc.
- To study the milling techniques of cereals and pulses
- To study about the byproducts obtained during processing along with their uses.

Course Outcomes:

The students will be able to

1. Gain knowledge about the basic composition and structural parts of food grains.
2. Know about paddy processing and rice milling equipment which will help them for developing entrepreneurial skills.
3. Apply the knowledge to process food grains into value added products.
4. Acquire the skills of processing wheat, maize and corn.
5. Develop skills needed in the milling of pulses.
6. Study the processing and milling of maize which will promote gainful employment.

Module 1: Paddy Processing (9 hours)

Structure and Composition of paddy – Cleaning of paddy - Pre Cleaners, - Paddy Parboiling Processes. Physico-chemical changes during parboiling – effect of parboiling on cooking qualities - Parboiling methods - Methods of grain drying- LSU, rotary, columnar, recirculatory dryers – By-products of paddy processing - Paddy husk and its uses as husk ash, activated carbon, furfural and other by products – Value added products - Flattened and Puffed Rice.

Module 2: Rice Milling (9 hours)

Rice milling flow chart - Modern Rice Milling equipments – paddy milling - Dehusking of paddy - Engelberg Huller, Under runner disc shellers, rubber roll sheller and Centrifugal dehusker - Paddy Separators – Satake and Schule Designs – Rice Polishers - Cone polishers and other types - Bran and Brokens separators - Rice mill yields and loss due to brokens at different stages of milling – milling efficiency - Use of Rice Bran in Edible oil Industry – Quick cooking Technology.

Module 3: Wheat Milling (7 hours)

Structure and composition of wheat – flow chart for wheat milling – milling process - equipments used in wheat milling – parboiling of wheat – bulgur wheat – products and by products of wheat.

Module 4: Processing of Maize (6 hours)

Structure and composition of maize – milling methods - Pre-cleaning - cleaning equipment - degermination and dehusking - Dry milling of maize – wet milling – flow chart - Products of milling – Flour – Semolina - Brewers’ grits etc and their applications - Bran and fibre separation - Gluten and Starch Separation –

Module 5: Processing of Corn-based products (6 hours)

Popping of corn – Tortillas - Equipment used - Starch conversion into other value added products – Acid Hydrolysis, Enzyme Hydrolysis, Isomerization processes - Processing for Dextrose, Malto Dextrin and other products - Extraction and refining of Corn oil in brief.

Module 6: Milling of Pulses (8 hours)

Structure and composition – need for pulse milling – Unit operations of pulse milling – domestic and commercial scale pulse milling methods – Dry and wet milling, CFTRI, CIAE, Jadavpur methods - Process flow chart – Pulse milling machineries - dehusking in Pulse Pearler - splitting of pulses in Pulse splitter - Mini dhal mill - working principle - advantages and disadvantages – pulse milling efficiency - Grinding of split pulses - pulse flour products - their applications and equipments used.

Text Books

1. KM. Sahay and KK. Singh. Unit operations of Agricultural Processing, Vikash Publishing house PVT Ltd. Delhi, 2014.
2. Chakraverty, A.: Post Harvest Technology of Cereals, Pulses and Oilseeds. Oxford and IBH Publishing Co, Calcutta, 2014.

Reference Books

1. Samuel A .Matz: "The Chemistry and Technology of Cereals as Food and Feed", Chapman and Hall, 1992.
2. Bernard Godon and Claude Willm, "Primary Processing of Cereals" Berns and Noble Publishers, 1994.
3. Karel Kulp and Joseph P Pante, "Handbook of Cereal Science and Technology", Mercel Dekkar, USA, 2000.

18FP2020 BAKERY, BEVERAGES AND CONFECTIONERY TECHNOLOGY

3L:0T:0P **Credits: 3:0:0**

Course Objectives:

- To provide know how on the machinery and process involved in the baking and confectionery process
- To understand the various types of sugar and its grades
- To know the process and machinery involved in the manufacture of beverages.

Course Outcomes:

The students will be able to

1. Gain knowledge on the ingredients, process and machinery involved in bakery and confectionery and beverage technology.
2. Understand the importance and effect of quality of raw materials on the final products\
3. Apply the knowledge gained in formulating new types of products
4. Analyze the process for maintaining and improving the quality of the final product
5. Evaluate the steps involved in the process and improve existing technologies or develop newer technologies
6. Design and create newer process and products that are better economically, nutritionally or technologically.

Module 1: Overview of wheat quality and Equipments used for baking (9 hours)

Moisture tests, Grain hardness testing. Visco graph, Amylograph, Farinograph. Dough mixers, Dividers, rounders, Proofing, moulding, Ovens, Slicers, Packaging materials and equipment, Sanitation and safety

Module 2: Technology of Baking (10 hours)

Bread manufacturing process – Straight dough fermentation, Sponge and dough, Biscuit-Types of biscuit dough – Developed dough, short dough, semi-sweet, enzyme modified dough and batters- importance of the consistency of the dough- Cake – Flour specification – ingredients – manufacturing process – types of chemically aerated goods.

Module 3: Sugar Manufacture (8 hours)

Energy and material balance of cane sugar process. Extraction of juice, extraction yields, drying and uses of Bagasse, Purification of juices-juice filtration and chemical purification, Clarification stages, Lime addition, pH control, Treatment of clarified juice, evaporation –multiple effect evaporators, Vacuum pans, Crystallization, Washing of sugar crystals and centrifugal separation/dewatering of sugar and other related processes. Sugar Refining, Sugar analysis, Sugar recovery –improvement, /Sugar balance, energy conservation, Sugar plant sanitation.

Module 4: Beverage Technology – Alcoholic beverages (6 hours)

Manufacture of beer, wine and champagne - Quality characteristics, Manufacture of distilled beverages including whisky, brandy, rum and gin – Quality aspects

Module 5: Beverage Technology – Non-Alcoholic beverages (4 hours)

Manufacture of sugar-free, sugarless, carbonated beverages – Fruit based beverages- quality aspects and standards

Module 6: Confectionery Technology (8 hours)

Types of Confectionery, raw materials and processing of toffee, chocolates, fruit drops, hard boiled candies. Additives for Confectioneries. Equipments used in Confectionery manufacture.

Text Book

1. Samuel A. Matz, "Bakery Technology and Engineering", Chapman & Hall, 3rd Edition, 1992.

Reference Books

1. Bakery Products – Science and Technology, Ed., Y.H. Hui, Blackwell Publishing, 2006. ISBN-13: 978-0-8138-0187-2
2. Sumnu SG and Sahin S. Food Engineering aspects of Baking sweet goods. CRC Press,2008. ISBN 9781420052749
3. Hunsigi G. Production of Sugarcane Theory and Practice, Springer Verlag, 1993. e-ISBN-13: 978-3-642-78133-9
4. Varnam A.H. & Sutherland J.P. BEVERAGES - T*echnology, Chemistry and Microbiology,* Springer-Science+Business Media, B.V., 1994. ISBN 978-1-4615-2508-0 (eBook)
5. Lees R and Jackson EB. Sugar Confectionery and Chocolate Manufacture, Chapman and Hall Pub.,1992. e-ISBN-13: 978-1-4684-1495-0
6. Edwards, W .P. The Science of Sugar Confectionery, RSC Publishing, UK., 2000. **ISBN** 0-8 5404-593-7

18FP2021 FOOD SAFETY REGULATIONS

3L:0T:0P **Credits: 3:0:0**

Course Objectives:

- To study importance of Food Safety
- To understand the regulating authorities for food safety world over

Course Outcomes:

The students will be able to

1. Understand the regulations followed in various food industries.
2. Define the food labeling patterns.
3. Apply the knowledge in food industries.
4. Analyze the safety operations involved in food systems.
5. Evaluate the steps involved in the process operations in food industries.
6. Prepare HACCP standards for food industries.

Module 1: Food Regulations (8 hours)

World Trade order – Functioning and responsibilities of the WTO - Codex Alimentarius –History, operations of Codex alimentarius, Responsibilities – Codex standards and Maximum residue limits – Current Issues under consideration – SPS (Sanitary and phytosanitary measures) agreement. World Health Organisation – History and mandate – Operations and responsibilities. Concept of Six Sigma

Module 2: Food Safety Regulations in India Predating FSSAI (5 hours)

Introduction to Laws relating to Food Processing Industries in India - FPO, MMPO, PFA, AGMARK, Essential Commodities Act, BIS

Module 3: Food Authority in India (10 hours)

Food safety and Standards Act – organizational chart – role of individual authority –principles to be followed – Provisions as to articles of food –imported items – Responsibilities of the food business operator – Liability of manufacturers, packers, wholesalers, distributors and sellers –Enforcement of the act – Licensing and registration of food business – Food safety officer and their powers – Analysis of food – regulations regarding labs involved in food analysis – Offences and penalties – Adjudication and food safety appellate tribunal.

Module 4: Food Labeling (9 hours)

Need for labeling – Developing labeling standards at the world level – Limitations of labeling safety issues – Labeling regarding methods of processing – Irradiated products – Products derived from modern biotechnology – organic produce - Genetically modified foods – EU rules on nutritional labeling – US rules on nutritional labeling – Health claims – Approach of US and EU

Module 5: Microbiological Food Safety (7 hours)

Concept of HACCP – Assembling the team – Product description – Describing the product's intended use – Establishing a process flow diagram – on site confirmation - Listing potential hazards and control measures - Determination of critical points – decision tree for CCPs- Establishing monitoring procedures- establishing corrective actions – establishing verification Procedures

Module 6: Safety Aspects of Water (7 hours) Safety aspects of drinking water (microbiological and chemical) - the epidemiological triangle diseases caused by drinking of contaminated water , bottled water – setting of guideline

values (microbiological and chemical) – risks and advantages of chlorination of water-Bottled water –origin of water-nutritional and physiological aspect – safety aspects – microbiological and chemical quality – Regulations for bottled water –India

Text Books

1. Kees A. van der Heijden and Sanford Miller, "International Food Safety Handbook: Science, International Regulation, and Control", Published by CRC Press, ISBN 0824793544, 9780824793548, 1999.
2. Guide to the Food Safety and Standards Act, Tax-mann Allied Services Pvt. Ltd., ISBN 10-8184968288, 2006.

Reference Book

1. Mehta R. and George J., "Food Safety Regulation Concerns And Trade- The Developing Country Perspective", Published by Macmillan India Ltd., New Delhi. ISBN 1403925046, 9781403925046, 2005.

18FP2022 FOOD ENZYMOLOGY LAB

0L:0T:3P **Credits: 0:0:1.5**

Course Objective:

- To study the characteristics of various enzymes applicable in food industries.

Course Outcomes:

The students will be able to

1. Gain knowledge about enzymes
2. Understand the importance of each of the factors that affect enzyme activity
3. Apply the same to maximize enzyme action
4. Analyze when a problem arises and give a suitable and logical solution
5. Evaluate enzymes from different sources and select the right one depending on the type of food / condition
6. Make appropriate decision of evaluation and characterization when it comes to newer source of enzymes

List of experiments

1. Estimation of reducing sugars by dinitrosalicylic acid
2. Estimation of amylase activity
3. Effect of pH on amylase activity
4. Effect of temperature on amylase activity
5. Effect of substrate concentration on amylase activity
6. Effect of enzyme concentration on amylase activity
7. Determination of total and specific activity of amylase
8. Estimation of protein by Lowry's method
9. Estimation of protease activity
10. Effect of pH on protease activity
11. Effect of temperature on protease activity
12. Effect of substrate concentration on protease activity
13. Effect of enzyme concentration on protease activity
14. Determination of total and specific activity of protease
15. Studies on enzyme immobilisation

18FP2023 FOOD PRODUCT TECHNOLOGY LAB - I

0L:0T:3P **Credits: 0:0:1.5**

Course Objectives:

1. To gain knowledge of various products from fruits, vegetables and cereals.
2. To prepare the constituents required for making food products.
3. To acquire the skill of manufacturing various food products.

Course Outcomes:

The students will be able to

1. Gain knowledge about the manufacturing technology of food products.
2. Understand the importance of various ingredients required for preparation of products.

3. Calculate the quantity requirement of each constituent.
4. Prepare food product of desired specification.
5. Evaluate the sensory quality of the prepared food product.
6. Identify the method of improvement of the process.

List of Experiments

1. Preparation of RTS beverage
2. Preparation of squash
3. Preparation of cordial
4. Preparation of Jam and jellies
5. Preparation of marmalade
6. Preparation of ketchup
7. Preparation of basic bread
8. Preparation of French bread
9. Preparation of sweet atta biscuit
10. Preparation of butter scotch cookies
11. Preparation of sweet biscuits
12. Preparation of salt biscuits

18FP2024 ENGINEERING PROPERTIES OF FOOD MATERIALS

3L:0T:0P **Credits: 3:0:0**

Course Objectives:

- To study about the different methods of determining the quality and properties of different foods
- To gain knowledge of engineering properties during processing, packing, storage and transport.
- To impart knowledge about electrical properties of food and its applications in food engineering

Course Outcomes:

The students will be able to

1. Understand Engineering properties of food materials.
2. Identify the structure and chemical composition of foods.
3. Determine the physical properties of food materials.
4. Calculate the water activity, food stability sorption and desorption isotherm of food materials.
5. Study the difference between Newtonian and non-Newtonian fluids.
6. Examine the thermal properties, electrical and magnetic properties of food.

Module 1: Physical Properties of Foods (9 hours)

Methods of estimation of Shape, Size, volume, density, porosity and surface area, sphericity, roundness specific gravity. Frictional properties-coefficient of friction, Storage and flow pattern of agricultural crops

Module 2: Rheological Properties of Foods (9 hours) Definition – classification – Newton's law of viscosity – momentum-diffusivity-kinematic viscosity – viscous fluids – Newtonian and Non Newtonian fluids-Viscosity Measurements-Viscometers of different types and their applications-Texture measuring instruments-Hardness and brittleness of Food materials.

Module 3: Thermal Properties of Foods (8 hours)

Definitions of Heat capacity, specific heat, enthalpy, conductivity and diffusivity, surface heat transfer coefficient, Measurement of thermal properties like specific heat, enthalpy, conductivity and diffusivity, DTA, TGA, DSC.

Module 4: Aerodynamic Properties of Foods (4 hours)

Drag and lift coefficient, terminal velocity and their application in the handling and separation of food materials.

Module 5: Hydrodynamic Properties of Foods (6 hours)

Water activity- measurement-vapor pressure method –freezing point depression method- Effect of temperature, and pressure on water activity-moisture sorption isotherms- models-Henderson, PET and GAB models.

Module 6: Electrical Properties of Food (9 hours) Dielectric properties-dielectric constants-, Dielectric measurements-Ionic Interaction-Dipolar rotation. Effect of moisture, temperature and pressure on dielectric properties. Microwave heating-Infrared and Ohmic heating, Irradiation

Text Books

1. Serpil Sahin and Servet Gulum Sumnu "Physical Properties of Foods", Springer,USA, 2006.
2. Nuri N. Mohsenin: "Thermal Properties of Food & Agricultural materials", Gordon and Reach science publishers, 1970.

Reference Books

1. Rao, M.A and S.S.H. Rizvi:"Engineering Properties of Foods", Mercel Dekker inc. New York, 1998.
2. Lewis M.J, "Physical properties of foods and food processing systems" Woodhead publishing Cambridge, UK, 1990.
3. Reyond Jewitt and others: "Physical properties of foods "Allied science publishers, 1983.
4. Shafiur Rehman: Food Properties Hand book CRC press inc. New York, 1995.
5. Micha Peleg and Edward B. Bagley, "Physical Properties of Foods" AVI publishing company inc, Westport USA, 1983.
6. Kachru R.P.and R.K. Gupta, "Physico – Chemical Constituents and Engineering Properties of Food crops", Scientific publishers, Jodhpur.

18FP2025 ENGINEERING PROPERTIES OF FOOD MATERIALS LAB

0L:0T:3P **Credits: 0:0:1.5**

Course Objectives:

1. To study about the different methods of determining the quality and properties of different food materials.
2. To gain knowledge of engineering properties during processing, packing, storage and transport.
3. To impart knowledge about various properties of food and its applications in food engineering

Course Outcomes:

The students will be able to

1. Understand Engineering properties of food materials.
2. Identify the structure and chemical composition of foods.
3. Determine the physical properties of food materials.
4. Calculate the sorption and desorption isotherm of food materials.
5. Study the rheological behavior of Newtonian and non-Newtonian fluids.
6. Evaluate the properties and quality of food materials.

List of Experiments

1. Determination of viscosity of liquid food materials
2. Determination of surface area of grains by using planimeter.
3. Determination of porosity of food grains.
4. Determination of specific gravity, specific volume and density of foods.
5. Determination of friction.
6. Determination of sphericity, roundness of food grains.
7. Measurement of terminal velocity of food particles.
8. Measurement of angle of repose
9. Determination of hardness of grains.
10. Estimation of moisture content of food grains, fruits and vegetables.
11. Calculation of specific heat of food materials.
12. Calculation of thermal conductivity of food materials.
13. Determination of rehydration characteristics of dried foods.

18FP2026 FOOD ENGINEERING AND PACKAGING LAB

0L:0T:3P **Credits: 0:0:1.5**

Course Objectives:

1. To gain knowledge on characterization of dehydrated food products.
2. To understand the heat and mass transfer in food materials.
3. To acquire the skills on quality of packaging materials.

Course Outcomes:

The students will be able to

1. Gain knowledge about the characteristics of dehydrated and extruded food products.
2. Understand the importance of particle size of food products.
3. Determine the heat transfer in heat exchangers.
4. Identify suitable processes for the extraction of anthocyanin.
5. Evaluate the migration characteristics of packaging materials.
6. Develop suitable packaging methods for food products.

List of Experiments

1. Characterization of Dehydrated Products- Extruded Products
2. Characterization of Dehydrated Products-Extruded Ready-To-Cook and flaked Products.
3. Determination of Particle Size-Sieve Analysis
4. Determination of The Overall Heat Transfer Coefficient Of Plate Heat Exchanger – Co-Current Flow
5. Determination of The Overall Heat Transfer Coefficient Of Plate Heat Exchanger - Counter Current Flow
6. Determination of efficiency of a distillation column
7. Kinetics of Anthocyanin extraction
8. Kinetics of Anthocyanin degradation
9. Determination of viscosity by Ostwald's viscometer
10. Determination of the migration characteristics of the given material – acid as stimulant
11. Determination of the migration characteristics of the given material – alcohol as stimulant
12. Determination of the Water Vapour Transmission rate of the given packaging material.

18FP2027 FOOD PROCESS EQUIPMENT DESIGN

3L:0T:0P **Credits: 3:0:0**

Course Objectives

- To enable the student to design and develop equipments used in Food Processing operations.
- Identify and discuss critical design of typical processing equipment.
- Understand the relationship between process design and Safety

Course Outcomes

The students will be able to

1. Identify the factors that will affect the design of equipments
2. Classify the variables based on various properties
3. Interpret the relation between various process variables
4. Select the critical variables for the design of equipments
5. Develop a conceptual design model
6. Assess the validity of the conceptual model

Module 1: Basic Design Considerations and Materials of Construction (7 hours)

Basic considerations in process equipment design. Materials of construction – mechanical properties and materials. Design considerations - stresses created due to static and dynamic loads. Process flow diagrams (PFD) – symbols used in PFD.

Module 2: Design of Pressure Vessels (10 hours)

Design conditions and stresses – design stress, design criteria, corrosion allowance. Design of a shell and its components – cylindrical and spherical shells, head, nozzles and flange thickness. Vessels subjected to internal pressure and combined loading – cylindrical shell and spherical shell, stresses induced in vessel. Vessels subjected to external pressure. Optimum proportions of a vessel and optimum vessel size.

Module 3: Design of Storage Vessels (6 hours)

Storage of fluids – storage of volatile, non-volatile liquids and storage of gases. Design of rectangular tanks – with and without stiffeners. Design of tanks – bottom and shell design and self-supporting roof design.

Module 4: Design of reaction vessels (6 hours)

Classification of reaction vessels, heating system. Design considerations – jacket design, coil and channel design.

Module 5: Design of Heat Exchangers and Evaporators (8 hours)

Types of heat exchangers – double pipe heat exchangers, shell and tube heat exchangers, and special types of heat exchangers. Design of shell and tube heat exchanger. Design of calendria type evaporators.

Module 6: Design of Dryers and Mixers (8 hours) Types of agitators. Power requirements for agitation. Design of agitation system components – shaft design and agitator design. Design of tray dryers.

Text Books

1. Shrikant D Dawande. "Process design of equipments". Central Techno Publications, ISBN: 81-89188-14-8, Nagpur, 2005.
2. Mahajani V.V and Umarji S.B. "Joshi's process equipment design". Trinity Press. ISBN: 978-93-5138-091-1, New Delhi, 2014.

Reference Books

1. Singh & Heldman."Introduction to Food Engineering". Academic Press – Elsevier India Private Ltd. ISBN: 978- 0- 1240- 1675- 0 New Delhi, 2013
2. Jasim Ahmed, Mohammad Shafuir Rahman "Handbook of Food Process Design, 2 volume Set" Wiley-Blackwell, ISBN: 978-1-4443-3011-3, April 2012.
3. Rajesh Mehta and J. George "Food Safety Regulation Concerns and Trade- The Developing Country Perspective," Published by Macmillan India Ltd., New Delhi. 2005
4. Miguel A. Galan, Eva Martin del Valle. "Chemical Engineering: Trends and Developments" John Wiley & Sons, ISBN: 978-0-470-02498-0, 2005.
5. Maroulis Z.B. and Saravacos G.D. "Food Process Design", Marcel Dekker Inc. ISBN- 0824743113, 2003.

18FP2028 FOOD ANALYSIS LAB - II

0L:0T:3P **Credits: 0:0:1.5**

Course Objectives:

- To determine the quality of Food commodities
- To interpret the genuineness of the products based on the quality

Course Outcomes:

The students will be able to

1. Understand the quality parameters of different types of food products
2. Classify food products based on their quality
3. Interpret results and decide on the quality
4. Compare two brands of the same product and decide the best one based on the quality
5. Evaluate newer products based on quality
6. Design and develop newer and better methods of analysis for improving the quality of a Food Product

List of Experiments:

Sugar rich products like Jams, Squashes, Marmalades, Sugar and Jaggery

1. Analysis of total sugars
2. Determination of pectin
3. Determination of acidity
4. Determination of total fruit solids
5. Determination of Calcium
6. Estimation of Ascorbic acid

Bakery Products including wheat

7. Determination of gluten content
8. Determination of alcoholic acidity
9. Determination of maltose equivalent
10. Estimation of total nitrogen content by Kjeldahl method

Meat and meat products

11. Determination of Extract release volume
12. Determination of swelling ratio
13. Determination of TMA

Milk and Milk products

14. Determination of Fat content by Gerber method
15. Determination of lactose content by Lactometer

Plantation Products including Tea, Coffee and Cocoa

16. Determination of Total extractives
17. Determination of Tannin content
18. Determination of Caffeine

Vitamins, Minerals and Colourants

19. Estimation of anthocyanins
20. Estimation of Chlorophyll
21. Determination of Iron

18FP2029 COMPUTER AIDED FOOD PROCESS EQUIPMENT DESIGN LAB

0L:0T:3P **Credits: 0:0:1.5**

Course Objectives:

1. Design of plants using computing software.
2. Simulating process environment virtually.
3. Understanding relational database and design specific unit operations.

Course Outcomes:

The students will be able to

1. Provide the student with a good understanding of computer aided design principles and practice.
2. Learn effective approaches to building up knowledge about a process through simulation.
3. Acquire the skills needed to design a chemical plant using ANSYS FLUENT.
4. Design simulation models.
5. Analyze the heat flow in 2D and 3D.
6. Evaluate the heat transfer through a fluid using software applications.

List of Experiments:

1. Basic concept of simulation and CFD
2. Introduction to GAMBIT
3. Introduction to FLUENT
4. Heat transfer through laminar flow
5. Heat transfer through Turbulent flow.
6. Simulation of flow past sphere.
7. 2 dimensional heat flow analysis
8. 3 Dimensional heat flow analysis
9. Conjugate heat transfer study
10. Heat transfer through fluid.

18FP2030 FOOD ADDITIVES

3L:0T:0P **Credits: 3:0:0**

Course Objectives:

- To understand the Chemistry of the additives added to food
- To know the limits of addition as prescribed by FAO/WHO and PFA
- To develop newer additives with improved safety standards.

Course Outcomes:

The students will be able to

1. Know about importance of additives in maintaining or improving food quality.
2. Learn about the development of various instant premixes by addition of preservatives within the permissible limits.
3. Understand the applications of food additives and how to study the toxicity of food additives.
4. Study the importance of additives in maintaining or improving food quality.
5. Identify and design newer products, with better quality using additives which are economical and safe.

6. Describe the properties, levels of addition and toxicity data of various food additives.

Module 1: Classification and Regulations (6 hours)

Food additives - definition and classification, food safety levels as per the specifications, safety evaluation of additives – determination of acute and chronic toxicity - NOEL, ADI, LD50 value, PFA regulations, GRAS status.

Module 2: Acidulants, Preservatives, Emulsifiers and Antioxidants (12 hours)

Types, chemical properties, levels of additions in individual products, toxicity data of Acidulants – Preservatives – Emulsifiers and gums - Antioxidants – Limits of addition to food products

Module 3: Humectants (7 hours)

Types, chemical properties, levels of additions in individual products, toxicity data of Dough conditioners - flour improvers – Humectants – Limits of addition to food products

Module 4: Colorants, Flavourants and Fat Substitutes (6 hours)

Types, chemical properties, levels of additions in individual products, toxicity data of Colourants – Natural and artificial, Flavourants, Flavour enhancers

Module 5: Fat replacers / substitutes and Sweeteners (9 hours)

Fat substitutes and replacers – Cocoa butter substitutes and equivalents - Types, chemical properties, levels of additions in individual products, toxicity data of Sweeteners – Taste modifiers

Module 6: Chelating and Antibrowning agents (5 hours)

Natural and synthetic, Chelating agents, antibrowning agents, Nutritional additives – Levels of addition to Food products

Text book

1. Food additives by Brannen A.L., Davidson P.M., Salminen S. and Thorngate J.H. Second Edition, Revised and Expanded. Marcel dekker Inc. USA, 2002.

Reference Book

1. Newton, D.E. Food Chemistry. An Imprint of Infobase Publications, New York. 2007.

18FP2031 PLANTATION AND SPICES PRODUCT TECHNOLOGY

3L:0T:0P **Credits: 3:0:0**

Course Objectives:

- To study about the various methods of processing tea products.
- To demonstrate a basic knowledge on process of coffee, and cocoa.
- To develop an awareness of various processing procedure for major spices & minor spices.

Course Outcomes:

The students will be able to

1. Define the different unit operations and its equipments involved in coffee, tea and cocoa processing
2. Gain knowledge in processing of plantation crops and spices and also its value added products.
3. Outline ways in which quality loss can be minimised during preparation and processing
4. Develop value added products from plantation products and spices
5. Demonstrate appropriate technique for the extraction of spice oil and oleoresin with quality standards
6. Acquire a confident to get placement in any kind of cereals and spices industry with minimum post harvest losses and maximum benefit to the industry.

Module 1: Chemistry and Technology of Coffee (8 hours)

Coffee – Occurrence – chemical constituents – harvesting – fermentation of coffee beans – changes taking place during fermentation – drying – roasting – Process flow sheet for the manufacture of coffee powder – Instant coffee, technology – Chicory chemistry - Quality grading of coffee.

Module 2: Chemistry and Technology of Tea (8 hours)

Occurrence – chemistry of constituents – harvesting – types of tea – green, oolong and CTC – Chemistry and technology of CTC tea – Manufacturing process – Green tea manufacture – Instant tea manufacture – Grading of tea.

Module 3: Chemistry and Technology of Cocoa and Cocoa Products (9 hours) Occurrence – Chemistry of the cocoa bean – changes taking place during fermentation of cocoa bean – Processing of cocoa bean – cocoa powder

– cocoa liquor manufacture Chocolates – Types – Chemistry and technology of chocolate manufacture – Quality control of chocolates.

Module 4: Manufacture of oleoresins and essential oils (5 hours) Oleoresins and Essential oils – General methods of manufacture – Quality aspects – Differences – Flavour identical and their synthesis.

Module 5: Chemistry and Technology of Major Spices (7 hours)

Pepper, Cardamom, ginger, Chilli, mint, and turmeric – Oleoresins and essential oils – Method of manufacture – Chemistry of the volatiles –Quality control of major spices.

Module 6: Chemistry and Technology of Minor Spices (8 hours)

Cumin, Coriander, Cinnamon, fenugreek, Garlic, Clove Vanilla, Coconut, Areca nut, Oil palm and Cashew – Quality control of minor spices

Text Books

1. Peter, K.V. Hand book of herbs and spices. Volume 2. Wood head publishing Ltd., 2004. **eBook ISBN:** 9780857095688
2. Chakraverty, A., Mujumdar, A.S., Raghavan, G.S.V., Ramaswamy, H.S. Handbook of post harvest technology – cereals, fruits, vegetables, tea and spices. Marcel Dekker Inc., New York (Special Indian Reprint). 2010. ISBN 13: 9780824705145

Reference Books

1. Tainter, D.R. Grenis, A.T. Spices and Seasonings – A food technology hand book. 2nd edition. John Wiley and Sons, Inc., Canada. 2001. ISBN: 978-0-471-35575-5
2. Salunkhe, D.K. and Kadam S.S. Ed. 1998. Hand book of Vegetable Science and Technology, Marcel Dekker, New York, USA. ISBN: 0824701054
3. Minifie Bernard W. Chocolate, Cocoa and Confectionery Technology, 3rd Edition, Aspen Publication, 1999. ISBN: 9780834213012
4. Handbook on Spices, National Institute of Industrial Research (NIIR) Board, Asia Pacific Business Press Inc., New Delhi 2004. ISBN: 8188330946
5. Banerjee B. 2002. Tea Production and Processing – 3rd edition, Oxford & IBH Publishing Co.Pvt.Ltd., New Delhi.

18FP2032 FAT AND OIL PROCESSING TECHNOLOGY

3L:0T:0P **Credits: 3:0:0**

Course Objectives:

- To understand the physical and chemical properties of fats and oils.
- To study the extraction and refining processes of various oils and fats.
- To learn the packaging, quality standards of fats and oils.

Course Outcomes:

The students will be able to

1. Enumerate the importance of fats and oils.
2. Describe the manufacturing process of oils and fats.
3. Apply knowledge on manufacture of designer fats.
4. Appraise the quality attributes of oils and fats.
5. Design suitable packaging materials.
6. Invent methods for industrial applications of oils and fats.

Module 1: Physical and Chemical Properties (8 hours)

Fats and oils – formation – functions of oil in human body - fatty acids – double bonds and their position in oil – Geneva type classification - sources of vegetable oils – production status-oil content – coconut , palm, peanut , rice bran, sesame, mustard and sunflower seeds oil – physical and chemical properties of fats and oils - chemical reactions of oil – hydrolysis – hydrogenation, oxidation and polymerization.

Module 2: Extraction Methods (8 hours)

Oil extraction methods –mechanical expression – ghani , power ghani, rotary, hydraulic press, screw press, expellers, filter press - principle of operation and maintenance-solvent extraction process – steps involved, batch

and continuous-continuous solvent extraction process for rice bran, soy bean and sunflower-oil extraction process for groundnut and cotton seed-production of special oils – palm oil, virgin coconut oil – extraction process.

Module 3: Refining of Oils (7 hours) Refining of oils – objectives – characterization - degumming – Zeneath process – deacidification process – continuous acid refining-bleaching of oil –decolourising agents-deodorization and winterization processes- Hydrogenation of Fats – Vanaspati and Margarine – Ghee and butter

Module 4: Speciality oils and oil products (8 hours)

Conjugated Linoleic acid – Gamma linolenic acid – Oils from Microorganisms – Lecithin- Transgenic oils – Germ oils from different sources – Fish oil

Module 5: Packaging of Edible Oils (7 hours)

Packaging of edible oils – requirements – types – tinplate, semi rigid, glass, Polyethylene Terephthalate, Poly Vinyl Chloride, flexible pouches – packaging for Vanaspati and ghee changes during storage of oil –rancidity – causes – atmospheric oxidation and enzyme action – free fatty acid – colour-non edible oils – castor oil, linseed oil, vegetable waxes – production and processing.

Module 5: Industrial Applications and Quality Standards (7 hours)

Industrial applications of fats and oils – quality regulations - manufacture of soap, candle, paints and varnishes - ISI and AGMARK standards – site selection for oil extraction plant- safety aspects- HACCP standards in oil industries.

Text books

1. Harry Lawson, "Food oils and Fats - Technology, Utilization and Nutrition", CBS Publishers and Distributors, New Delhi, 1997.
2. Gunstone F.D., "Oils and Fats in Food Industry", Blackwell Publishing, United Kingdom, ISBN – 13: 9781405181212, 2008.

Reference book

1. **Gunstone** F.D., "Vegetable Oils in Food Technology: Composition, Properties and Uses", 2nd Edition, Wiley - Blackwell Publishing Ltd., ISBN 9781444332681, 2011.

18FP2033 TECHNOLOGY OF MEAT, POULTRY AND FISH

3L:0T:0P **Credits: 3:0:0**

Course Objectives:

- To understand about the composition and nutritive value of meat, poultry and fish
- To know about processing technology of meat, poultry and fish
- To understand the HACCP and GMP of meat plant.

Course Outcomes:

The students will be able to

1. Enumerate the composition and role of microorganisms in meat.
2. Understand the slaughtering, carcass processing methods and equipments used for processing meat.
3. Apply the technological ideas in preparation of various types of meat products and design of equipments used for processing meat.
4. Understand the HACCP and GMP of meat processing
5. Evaluate the processing of poultry meat, meat products and egg products.
6. Predict the role of microorganisms in spoilage, biochemistry, preservation and fishery products

Module 1: Chemistry and Microbiology of Meat (9 hours)

Meat composition from different sources; Definitions and measurements, Explanation of muscle structure and compositions and its modifiers, White and Red Meat, Description of animal fat and its modifiers, description of bone and its modifiers; Post mortem muscle chemistry, Meat colour, flavors of meat products, meat microbiology and safety.

Module 2: Slaughtering and Carcass Processing (9 hours)

Modern abattoirs and some features, Ante mortem handling and welfare of animals, design of handling facilities, Hoisting rail and traveling pulley system, and stunning methods, stunning pen, slaughtering equipment, Washing area, Sticking, bleeding, dressing, Beef/Sheep and Pig Dressing operations, Offal handling and inspection, Inedible

by products: Carcass processing equipment, Operational factors affecting meat quality, effects of processing on meat tenderization; meat processing equipment, electrical gadgets and manual gadgets; Typical lay outs.

Module 3: Meat Products (9 hours) Canned meat, Frozen meat, Cooked and Refrigerated meat, Dried and preserved meat, Cured meat, Prepared meat products, Production methods for Intermediate moisture and dried meat products, Different kinds of sausages – Equipment used for all the process operations; Meat plant hygiene, Good manufacturing practice and HACCP.

Module 4: Processing of Poultry Products (9 hours)

Poultry industry in India, measuring the yields and quality characteristics of poultry products, microbiology of poultry meat, spoilage factors; Plant sanitation; Poultry meat processing operations in detail along with equipment used – Defeathering, bleeding, Scalding etc.; Packaging of poultry products, refrigerated storage of poultry meat, by products – eggs, egg products, Whole egg powder, Egg yolk products, their manufacture, packaging and storage.

Module 5: Fish and other Marine Products Processing (9 hours)

Commercially important marine products from India, Basic biochemistry, spoilage factors of fish, field refrigeration and icing practice, merits and demerits, Use of dry ice and liquid nitrogen as preservation elements, use of Refrigerated Sea Water (RSW) for preservation, Changes during storage in RSW and CSW; Freeze preservation; freezing of prawn and shrimp, weighing, filling and glazing, Individual quick freezing - relative merits and demerits, Canning operations, Salting and drying of fish, pickling and preparation of fish protein concentrate and fish oil.

Text Book

1. Hui, Y.H., Nip, W.K., Rogers, R.W, "Meat Science and Applications". Marcel Dekkar Inc. New York,2001.

Reference Books

1. Joseph Kerry, John Kerry and David Ledwood, "Meat Processing", Woodhead Publishing Limited, CRC Press, 2002.
2. Balachandran, K.K, "Post Harvest Technology of Fish and Fish Products", Daya Publishing House, New Delhi, 2001.
3. Mead G, "Poultry meat processing and quality", Woodhead Publishing Limited, 2004.

18FP2034 DRYING TECHNOLOGY

3L:0T:0P **Credits: 3:0:0**

Course Objectives:

- To understand the basic theory of drying and its significance in food systems
- To understand the importance of drying as a method of food processing
- To learn about the relative advantages / disadvantages of each method of drying

Course Outcomes:

The students will be able to

1. Gain knowledge on drying principles and psychrometric chart
2. Apply the principles to solve problem on drying
3. Understand different types of dryers for different food materials
4. Design dryers for different types of foods
5. Assess the concept behind industrial dryers
6. Evaluate the dryer performance

Module 1: Theory of Drying (8 hours)

Principles of drying – Fundamentals of air-water mixtures – Psychrometric chart – Problems based on pyschrometry – Drying curves – constant and falling rate period - Heat and mass transfer in dryers – moisture content in foods – determination of moisture content and its measurement - methods of determination

Module 2: Principles of Drying Methods (7 hours)

Selection of dryers – Conduction drying – convection drying – Pneumatic or fluidized bed drying – natural air drying – heated air drying – recirculatory dryer (non mixing type) – Radiation drying – Sun drying and infrared drying – Dielectric drying -Thin layer and deep bed drying - dryer performance

Module 3: Drum Dryer, Foam Mat Dryer and Freeze Dryer (9 hours)

Drum driers - Types of Drum Dryers - Principles of Operation of the Drum Dryer – rotary dryers Cabinet drying – vacuum tray dryers - Foam Mat Drying- Principles- Equipments- Factors affecting Foam mat drying – Freeze dryers

- Fundamentals of freeze drying – Freezing – Primary drying stage – secondary drying stage -Changes during freeze drying – Condensation, defrosting – Industrial freeze driers.

Module 4: Fluidized Bed Dryer, Spray Dryer, Osmotic Drying (9 hours)

Fluidized bed dryer – Spouted bed dryer - spray drying of foods - Principles of Spray Drying Processes – Atomizers and nozzles - Reconstitution of powders – Foam spray drying - Osmotic dehydration – Principles – Factors affecting osmosis- Equipment used.

Module 5: Radiation and Dielectric Dryers (7 hours)

Infrared drying – principles - microwave drying of foods – Construction and working of Dielectric driers – Radio Frequency drying – principles – working - Flash Dryers - Design of Flash Dryers - Materials Dried in Flash Dryers

Module 6: Heat Pump drying –Principles and Equipments (6 hours)

Classification – Fundamentals – Heat and Mass transfer aspects – Types of heat pump drying systems and applications

Text Books

1. Arun S. Mujumdar, "Handbook of Industrial Drying", CHIPS, 3rd Edition, 2006.
2. Chakraverty. A. " Post Harvest Technology of Cereals, Pulses and Oil seeds", Oxford and IBH Publishing Co.Pvt. Ltd. New Delhi, 2014.

Reference Books

1. Paul Singh, R and Dennis R. Heldman.. Introduction to Food Engineering Academic Press, 2001
2. Hui Y. H,:"Food Drying Science and Technology, Microbiology, Chemistry, Application", CHIPS, 2008.
3. Loesecke,H. W. V, "Drying & Dehydration of Foods", Published by Agrobios, 2005.

18FP2035 FOOD PACKAGING TECHNOLOGY

3L:0T:0P **Credits: 3:0:0**

Course Objectives:

- To study about the functions of packaging along with the influence of various factors on food.
- To know about the different packaging materials, their manufacturing process and equipment.
- To study about the various methods of packaging to improve the shelf life of the products.

Course Outcomes:

The students will be able to

1. Understand the need and functions of packaging as a solution to various factors affecting food.
2. Gain knowledge on shelf life of food and various methods of estimating it.
3. Explain the different packaging materials, their manufacturing process and equipment involved.
4. Know about the various closures and sealing mechanisms for different packaging materials.
5. Select the different printing and labelling methods and legislative requirements.
6. Devise innovations in food packaging and their applications.

Module 1: Introduction to Food Packaging (9 hours)

Functions of packaging, Effect of environmental factors - light, Oxygen, Moisture, Temperature, mechanical forces and biological factors on quality of food. Estimation of shelf life. General Approach, analysis of storage requirement, accelerated storage studies: Vacuum and Inert Gas Packaging: Tests on packaging materials, Mechanical strength (Tension, notch and tearing strengths), Gas and water vapour transmission rates.

Module 2: Metal Cans as Packaging (9 hours)

Metallic can types - Tin cans and Aluminum cans. Specialty of Open top sanitary cans, Lacquers and their use, Three piece cans and Two piece cans, Aerosol Cans, Basics of Canning operations – Can Reformer, Flanger, Seaming, Can closures. Glass jars and Bottles in food packaging, Design features and applications, Sterilization of bottles.

Module 3: Flexible Films Packaging (6 hours)

Formation of Films and pouches, Plastics used and their Specific applications - Polyethylene (LDPE and HDPE), Cellulose, Polypropylene (PP), Polyesters, Poyvinylidene Chloride (PVDC - Diofan, Ixan and Saran), Polyvinyl chloride, Copolymers their applications. Co-extruded films and Laminates.

Module 4: Rigid & Semi rigid Films Packaging (6 hours)

Rigid and Semi rigid plastic packaging – fabrication methods – Thermo forming, Blow moulding, Injection

moulding, Extrusion – Retort pouch packaging. Laminated Paper board Cartons, Fibre Board and Corrugated Card Board packaging and their applications.

Module 5: Filling a nd Sealing Operations f or Various Types of Packages (7 hours)

Closing and sealing of Rigid plastic containers. Filling and sealing of Flexible plastic containers, Seal types- Bead seals, Lap Seals and Fin seals –Differences and advantages, Hot wire sealing, hot bar sealing and impulse sealing – differences and relative advantages, Form fill Seal equipment: Printing on packages, Bar codes, Nutrition labeling and legislative requirements. Filling and Sealing of pouches, pouch from fill seal machines.

Module 5: Innovations in Food Packaging (8 hours)

Aseptic Packaging. Active packaging, Moisture control, CO_2 and Oxygen scavenging. Modified atmosphere packaging – principles, applications. Permeability of gases in packs. Antimicrobial Packaging, Edible packaging films and coating. Packaging for non-thermal food processing. Intelligent Packaging – Time-temperature indicators, RFID, Tamper evident packaging.

Text Book

1. Coles, R., Dowell, D.M., Kirwan, J, Food Packaging Technology, Black Well Publishing Ltd., 2009

Reference Books

1. Gordon L. Robertson. Food Packaging Principles & Practice, CRC Press, 2013.
2. Kit L Yam and Dong Sun Lee, Emerging Food Packaging Technologies: Principles and Practice, Woodhead Publishing Ltd, 2012.
3. Jung H. Han, Innovations in Food Packaging, Academic Press, 2014.
4. Scott A. Morris,Food and package engineering, Wiley-Blackwell Publishing, 2011.
5. Takashi Kadoya, Food Packaging, Academic Press, Inc, 1990.

18FP2036 STORAGE ENGINEERING

3L:0T:0P **Credits: 3:0:0**

Course Objectives :

- To enable the student to understand: The need for effective and scientific storage of food commodities.
- To provide an opportunity for students to develop skills in evaluating storage structures and also to design structures for various perishable commodities.

Course Outcomes :

The students will be able to

1. Recognize the need for adaptation of scientific storage methodologies for food commodities.
2. Distinguish between traditional storage structures and modern storage structures.
3. Design and construct modified storage structure based on the requirement on the farm.
4. Calculate the amount of CO_2 & O_2 that can be permissible in systems that require a manipulation of the storage structures in terms of atmospheric conditions.
5. Criticize, evaluate and judge the efficiency of commercial storage structures.
6. Modify structures and environments to better fit the needs of commodities and consumer alike.

Module 1: Storage Engineering (7 hours)

Importance of scientific storage systems, post harvest physiology of semi-perishables and perishables, climacteric and non climacteric fruits, respiration, ripening, changes during ripening, ethylene bio-synthesis; Damages: Direct damages, indirect damages, causes of spoilage in storage (moisture, temperature, humidity, respiration loss, heat of respiration, sprouting).

Module 1: Insects, Pests and Rodents (7 hours)

Destructive agents (rodents, birds, insects, etc.). Physico chemical and biological changes due to infestation, sources of infestation; Damage caused by rodents; Storage pests

Module 2: Integrated Pest Control Mechanisms (7 hours)

Seed coating, fumigations- choice of fumigants, properties of fumigants, under wrap fumigation, fumigation of warehouses, detection of residual fumigants – mechanism and devices.. etc.

Module 3: Storage Structures (9 hours) Traditional storage structures, improved storage structures, modern storage structures; Farm silos: Horizontal silos, tower silos, pit silos, trench silos, size and capacity of silos; Design of storage

structures: pressure theories, pressure distribution in the bin, grain storage loads, pressure and capacities, warehouse and silos.

Module 4: Theory of Grain Storage (8 hours)

Storage of grains, respiration of grains, moisture and temperature changes in stored grains; conditioning of environment inside storage through ventilation; Aeration and stored grain management: purposes of aeration, aeration theory, aeration system design, aeration system operation.

Module 5: Storage of Perishables (8 hours)

Cold storage, controlled and modified atmospheric storage, hypobaric storage, evaporative cooling storage, conditions for storage of perishable products, control of temperature and relative humidity inside storage; functional, structural and thermal design of cold stores.

Text Books

1. P.H. Pandey. 2014. Principles and Practices of Agricultural Structures and Environmental Control. Kalyani Publishers, Ludhiana.
2. Sahay K.M and K.K.Singh. "Unit Operations of Agricultural Processing" Vikas Publications, New Delhi, ISBN-81-259-1142-1, 2007.
3. A.M. Michael and T.P. Ojha. 2004. Principal of Agricultural Engineering, Vol. I. Jain Brothers, New Delhi.

Reference Books

1. Myer Kutz. 2007. Handbook of Farm, Dairy, and Food Machinery. William Andrew, Inc., Norwich, NY, USA.
2. L.W. Newbaver and H.B. Walker. 2003. Farm Buildings Design. Prentice-Hall Inc., New Jersey,USA.
3. J. Whitaker. 2002. Agricultural Buildings and Structures. Reston Publishing Home, Reston, Virgenia, USA.

18FP2037 PROCESS ECONOMICS AND PLANT LAYOUT DESIGN

3L:0T:0P **Credits: 3:0:0**

Course Objectives :

- To enable the students understand various concepts of economics of food plant.
- To understand the processes involved in layout design.
- To understand the development and design consideration and cost estimation in food industry.

Course Outcomes :

The students will be able to

1. Gain knowledge on the various factors involved in setting up a Food Processing Industry.
2. Understand the process of food plant layout design.
3. Apply their knowledge to design projects for setting up a Food Processing Industry.
4. Analyse the problems involved in deciding the level of manufacture of a food product
5. Evaluate the options involved and decide on the right choice based on the economics of the system
6. Develop own industry or plan turn-key projects based on the request from customers

Module 1: Food Process Design Development (7 hours)

Technical feasibility survey of Food Industry, process development, Food Process flow sheets — Computed-aided process design – Principles of spread-sheet aided process design (Basic concepts only)

Module 2: Plant Layout (7 hours)

Marketability of the product, availability of technology, raw materials, equipments, human resources, land and utilities, site characteristics, waste disposal, Government regulations and other legal restrictions, community factors and other factors affecting investment and production costs. Plant Layout based on process and product. Richard Muther's Simple Systematic Plant Layout.

Module 3: Overview of Sanitary and Hygeinic Design and Layout (6 hours)

Hygienic food process design – Principles of Sanitary design - equipment design and specifications- Basic outline on FSMS

Module 4: Project Evaluation and Cost Estimation (9 hours) Capital investments – fixed capital investments including land, building, equipments and utilities, installation costs (including equipments, instrumentation, piping, electrical installation and other utilities), working capital investments. Methods of Cost estimation – Cost Indices.

Module 5: Product Cost and Plant Overheads (9 hours)

Manufacturing costs – Direct production costs(including raw materials, human resources, maintenance and repair, operating supplies, power and other utilities, royalties, etc.). – Process Profitability - Application to a Food Processing plant e.g. Tomato processing - Administration, safety and other auxiliary services, payroll overheads, warehouse and storage facilities etc. Depreciation, Amortization and methods of determining the same.

Module 6: Profitability Analysis (7 hours)

Return on original investment, interest rate of return, accounting for uncertainty and variations and future developments. Cash flow diagram and its importance - Optimization techniques – Linear and Dynamics programming, Optimization strategies.

Text Book

1. Peters and Timmerhaus, Plant design and Economics for Chemical Engineers, McGraw Hill 5th Edition, ISBN-007-124044-6, 2004 .

Reference Books

1. Rudd D F and Watson C C, Strategy of Process Engineering, John Wiley & Sons Inc, ISBN-978-0471844559, 2013
2. Maroulis Z.B. and Saravacos G.D. Food Process Design, Marcel Dekker Inc. ISBN-0824743113, 2003.
3. Towler G and Sinnott R.K. Chemical Engineering design principles, practice and Economics of Plant and Process. 2nd Edition. Elsevier, ISBN-9780080966595, 2012
4. Rudd and Watson, Strategy of Process Engineering, Wiley and Sons, 1987
5. Baasel W.D. Preliminary chemical engineering plant design, van Nostrand Reinhold, 2nd Edition, 1990
6. Heldman D.R. and Lund D B. Hand Book of Food Engineering, 2nd edition, CRC Press, Taylor and Francis Group, 2007

18FP2038 FOOD ADDITIVES LAB

0L:0T:3P **Credits: 0:0:1.5**

Course Objectives

1. To understand the Chemistry of the additives added to food
2. To understand the importance of additives in maintaining or improving food quality
3. To develop newer additives with improved safety standards.

Course Outcomes

The students will be able to

1. Know about the importance of additives in maintaining or improving food quality.
2. Learn the chemistry of the additives added to a food.
3. Express their knowledge on development of various instant premixes by addition of preservatives within the permissible limits.
4. Understand the properties, levels of addition and toxicity data of various food additives.
5. Demonstrate various applications of food additives and how to study the toxicity of food additives.
6. Evaluate the quality of food products by the application of additives.

List of Experiments

1. Estimation of Sulphur-Di-Oxide
2. Estimation of Sodium Benzoate
3. Estimation of Sorbic Acid
4. Estimation of Butylated hydroxyl toluene
5. Estimation of Propyl Gallate
6. Estimation of Ascorbic Acid
7. Estimation of Iron
8. Estimation of Copper
9. Determination of Saccharin
10. Estimation of curcumin in turmeric
11. Estimation of capsacin
12. Estimation of iodine in Iodised salt

13. Estimation of salt in pickled products
14. Estimation of baking powder.

18FP2039 FOOD PRODUCT TECHNOLOGY LAB - II

0L:0T:3P **Credits: 0:0:1.5**

Course Objectives:

1. To gain knowledge of various products from milk, vegetables and cereals.
2. To prepare the constituents required for making food products.
3. To acquire the skill of manufacturing various food products.

Course Outcomes:

The students will be able to

1. Gain knowledge about the manufacturing technology of food products.
2. Understand the importance of various ingredients required for preparation of products.
3. Calculate the quantity requirement of each constituent for product preparation.
4. Prepare food product of desired specification.
5. Evaluate the quality and sensory attributes of the prepared food product.
6. Identify the method of improvement of the process.

List of Experiments

1. Preparation of Rasagulla
2. Preparation of Sandesh
3. Preparation of Paneer
4. Preparation of Kalakhand
5. Preparation of Peda
6. Preparation of Gulab Jamun
7. Preparation of Bread and Butter Pickle
8. Preparation of Hot and Sour Tomato Pickle
9. Preparation of Chilly and Ginger Pickle
10. Preparation of Soanpapdi
11. Preparation of Mysorepak
12. Preparation of Gummies
13. Preparation of aerated confectionery

18FP2040 MATERIAL SCIENCE FOR FOOD ENGINEERS

3L:0T:0P **Credits: 3:0:0**

Course objectives:

- To understand the fundamentals of material science.
- To impart basic knowledge on the methods of analysis of materials.
- To know the biocompatible material for food industry.

Course outcomes:

The student will be able to

1. Enumerate the fundamentals of various bonds.
2. Understand the importance of strength of material.
3. Have a knowledge of the imperfections of metals
4. Have a knowledge of alloying and its importance in everyday life
5. Understand the various methods of characterization.
6. Examine the application of various techniques.

Module 1: Introduction to Materials (9 hours)

Introduction to materials, bonding between atoms: metallic bonding, ionic bonding, covalent bonding, Van der Waals bond, thermal expansion, elastic modulus and melting point of materials, Role of materials selection in design, structure-property-processing-performance relationships ; Imperfections in solids: vacancies, equilibrium

concentration of vacancies, interstitial and substitutional impurities in solids, dislocations, types and characteristics of dislocations, interfacial defects, stacking faults.

Module 2: Strength of Materials (8 hours)

Structure of materials and Strength of Materials: Yield strength, tensile strength, Hardness and ductility of materials: stress strain behaviour of metals, ceramics and polymers,

Module 3: Fast fracture, Toughness and Fatigue (5 hours)

Micromechanism of fast fracture – Mechanism of crack propogation – Fatigue failure – Fatigue of uncracked and cracked components

Module 4: Creep and Corrosion (6 hours)

Creep deformation and creep fracture – Mechanism of creep deformation in metals and designing to lower creep – wet corrosion in materials – Prevention of corrosion

Module 5: Carbon steels and Alloys (10 hours)

Microstructures produced by cooling – Mechanical Properties of normalized carbon steel- Quenched and tempered carbon steels – TTT diagram – Need for alloying – Hardenability and methods – Corrosion resistance – Passivation - Stainless steel and types

Module 6: Experimental Techniques (7 hours)

Introduction to experimental techniques: XRD, NMR, PSA, etc. for material characterization highlighting links between molecular structure and macroscopic properties.

Text Books

1. Michael F. Ashby and David R. H. Jones. "Engineering Materials -1. An Introduction to their Properties and Applications", 2002. 2nd Edition. Butterworth-Heinemann. ISBN 0 7506 3081 7.
2. Michael F. Ashby and David R. H. Jones. "Engineering Materials -2. An Introduction to Microstructures, Processing and Design". 2nd Edition. Reprinted 1999. Butterworth-Heinemann. ISBN 0 7506 4019 7.

Reference Books

1. V. Raghavan. "Materials Science and Engineering: A First Course", 2004. 5th Edition Prentice Hall India.
2. S. Upadhyaya and A. Upadhyaya, "Material Science and Engineering", 2007.Anshan Publications.
3. B. S. Mitchell. "An Introduction to Materials Engineering and Science for Chemical and Materials Engineers", 2004. John Wiley & Sons.

18FP2041 SIMULATION, MODELING AND STATISTICAL COMPUTING LAB

0L:0T:3P **Credits: 0:0:1.5**

Course objectives:

- To understand the fundamentals of simulation.
- To impart basic knowledge on simulation and modeling.
- To know the importance of dynamics and control.

Course outcomes:

The student will be able to

1. Understand the role of simulation in the design of equipments.
2. Study various methods of calculating the properties.
3. Compute various properties for distillation.
4. Know the transient behavior.
5. Predict the role of modeling and simulation of equipment design.
6. Solve various unit operations involved in food industry.

List of Experiments

1. Simulation of a Flash drum.
2. Computation of bubble point temperature.
3. Computation of dew point temperature.
4. T-x-y and P-x-y diagram of a binary mixture.
5. Simulation of Continuous Stirred Tank Reactor.
6. Simulation of Plug Flow Reactor.
7. Simulation of the binary distillation column.

8. Simulation of the multi component distillation column.
9. Simulation of the reactive distillation column.
10. Dynamics and control of Continuous Stirred Tank Reactor.
11. Dynamics and control of Plug Flow Reactor.
12. Dynamics and control of a reactive distillation column.

18FP2042 PRINCIPLES OF FOOD SCIENCE AND NUTRITION

3L:0T:0P **Credits: 3:0:0**

Course objectives:

- To understand the fundamentals of bio molecules
- To impart basic knowledge on the methods of analysis of fats and oils
- To know the food additives and microbes associated with food

Course outcomes:

The students will be able to

1. Enumerate and describe the fundamentals of food constituents and quality analysis.
2. Understand the types of food additives and their importance in food.
3. Examine the role of microorganisms associated with food and their importance in fermentation
4. Predict the role of food borne diseases and intoxication
5. Enumerate the factors responsible for spoilage of various foods.
6. Understand the methods of preservation of foods.

Module 1: Fundamentals of Food Constituents - Carbohydrates (5 hours)

Introduction to Proximate constituents of food -Carbohydrates – Classification – Simple & complex, mono-, di-, oligo- and polysaccharides; Important reaction of carbohydrates –Caramelisation, Maillard

Module 2: Fundamentals of Food Constituents – Fats and Vitamins (6 hours)

Fats – classification – Analysis of Fats and oils – Saponifcation value, Iodine value, Acid value, Acetyl value, Peroxide value – Principles and Importance of the analytical methods, Vitamins – Fat and water-soluble – nutritional significance

Module 23: Food Additives (9 hours)

Introduction to food additives - Classification, intentional and non-intentional additives, functional role in food processing and preservation; food colourants – natural and artificial; food flavours; enzymes as food processing aids.

Module 4: Microorganisms associated with Food (9 hours)

Bacteria, yeasts and molds – sources, types and species of importance in food processing and preservation; Oriental fermented foods and, Production of Sauerkraut, Wine, Lactic acid and single cell protein.-examples and their applications

Module 5: Food Borne Diseases and Intoxication (8 hours)

Food intoxications and poisonings – *Bacillus* spp., *Clostridium botulinum*,*Staphylococcus aureus*,Hepatitis, Gastroenteritis viruses, *Entamoeba histolytica*.Food spoilage – factors responsible for spoilage, spoilage of vegetable, fruit, meat, poultry, beverage and other food products.

Module 6: Food Preservation (8 hours)

Principles involved in the use of sterilization, pasteurization and blanching, thermal death point - methods of determination of thermal death time (Graphical, mathematical) – D, Z and F values – Importance of 12 D concept, Time – Temperature indicators - Canning; frozen storage-freezing methods, factors affecting quality of frozen foods; irradiation preservation of foods.

Text Books

1. Coultate T.P "Food – The Chemistry of its Components", 2nd Edition. Royal Society, London, 1992.
2. Sivasanker, B, "Food Processing and Preservation", Prentice-Hall of India Pvt. Ltd. New Delhi, ISBN-9788120320864, 2002.

Reference Books

1. Frazier W.C. and D.C. Westhoff, "Food Microbiology", 4th Ed., McGraw-Hill Book Co., New York, ISBN_9780070667181,2008.

2. Adams M.R and Moss M.O, "Food Microbiology", Panima Publishing corporation, New Delhi, 2nd Edition, Third reprint, ISBN-13:9788122410143,978-8122410143, 2007.

18FP2043 PROCESSING OF FOOD COMMODITIES

3L:0T:0P **Credits: 3:0:0**

Course Objectives:

- To study various processing methods for various food materials like fruits & vegetables, dairy products, cereals, meat, poultry, fish and bakery products .
- To study various innovative food processing techniques.

Course Outcomes:

The students will be able to

1. Understand the basics of food processing.
2. Know the various processing technologies involved in fruits and vegetables, dairy, cereals, meat, fish, egg and plantation products.
3. Learn the basics on microbiology of food products.
4. Describe the process of manufacture of various food products.
5. Recognize various methods of preservation of food.
6. Express the possible arena of entrepreneurial activity related to food products.

Module 1: Cereal, Pulses and Oil Seeds Technology (8 hours)

Rice milling, Pulse milling, Wheat milling - Oil extraction - Methods of manufacture of Bread - different processes of manufacture - types of breads - buns, biscuits, cakes and cookies -Pasta products -Tortilla - Method of manufacture.

Module 2: Fruits and Vegetable Processing (8 hours)

Production of Fruits and vegetables in India, Cause for heavy losses, preservation treatments - Basics of Canning, Minimal processing and Hurdle technology as applied to Vegetable and Fruit processing, Processing of fruit juices, Dehydration, Aseptic processing.

Module 3: Dairy Processing (8 hours)

Basic dairy terminology, composition, General tests at reception, Dairy Processing - Method of manufacture of Standardised, toned and double toned milk, milk powder - Equipments - Pasteurizers, homogenisers and pumps - Method of manufacture of dairy products - Icecream, Cheese, Paneer, Yoghurt - Pasteurisation and microorganisms involved in spoilage of milk.

Module 4: Meat, Poultry and Fish Processing (8 hours)

Meat composition from different sources, Definitions and measurements, Carcass Processing, Meat Products, Processing of Poultry Products, Fish and other Marine Products Processing .

Module 5: Plantation Product Technology (7 hours)

Processing of Tea, Coffee and Cocoa - Outline of the methods of manufacture of - green tea, black tea, instant tea, Instant coffee, Cocoa and Chocolate.

Module 6: Technology of Spices Processing (6 hours)

Outline of the methods of processing of Pepper, cardamom, ginger, vanilla and turmeric

Text Books

1. Srivastava, R.P. and Kumar, S.: Fruit and Vegetable Preservation: Principles and Practices. International Book Distributing Co. Lucknow (2nd Edition 1998).
2. Chakraverty, A., Mujumdar A.S., Raghavan G.S.V and Ramaswamy H.S. Handbook of Post-harvest Technology: Marcel Dekker Press, USA (2001)
3. James Harper W. and Carl W. Hall: Dairy Technology and Engineering AVI Publishing, Westport, USA (1976)
4. Karel Kulp and Joseph P Pante:Hand Book Of Cereal Science and Technology Mercel Dekkar USA (2000)
5. Samuel Matz: The Chemistry and Technology of Cereals as Food and Feed, Chapman & Hall (1992)

18FP2044 TECHNOLOGY OF PACKAGING

3L:0T:0P **Credits: 3:0:0**

Course Objectives:

- To provide knowledge on packaging and packaging materials.
- To understand the working of various packaging methods.
- To enable the students to understand applications of various packaging materials in food industry.

Course Outcomes:

The students will be able to

1. Understand food quality and need food packaging.
2. Classify food packaging design strategies and framework.
3. Explain the manufacturing process of various packaging materials.
4. Select common methods of sealing of various food packaging materials.
5. Apply the knowledge on advance food packaging methods and their applications in industry.
6. Adapt the principle and need for testing of packaging materials.

Module 1: Introduction to Food Packaging (7 hours)

Packaging developments–historical perspective. Food supply and the protective role of packaging. Definition of basic functions of packaging. Packaging strategy – Packaging design and development framework. Levels of Packaging. Food Package Environments. Factors affecting product quality and shelf life –Physical, Chemical and Biological processes.

Module 2: Metal and Glass as Food Packaging Materials (9 hours)

Metal cans - Raw materials for can-making. Container Making process – Three piece cans and Two piece cans – End-making processes. Protective and Decorative Coatings. Glass as Food Packaging Material – Types of Glasses and Composition – Glass Container Nomenclature – Glass and Container Manufacturing.

Module 3: Plastic as Food Packaging Materials (7 hours)

Plastics used in Food Packaging and their Specific applications – Polymers and Copolymers. Plastic Manufacturing - Extrusion and Calendaring. Extrusion – Monolayer – Cast and Blow film processes. Orientation of Films. Coextrusion. Coating and Lamination of Plastic Films. Rigid Plastic Packaging Manufacture.

Module 4: Paper as Food Packaging Materials (5 hours)

Paper Manufacturing Process. Types of Paper and applications. Laminated Paper board – Folding Cartons, Beverage Cartons and Molded Pulp Containers. Corrugated Fibre Board and Fibre Drum packaging.

Module 5: Filling and Sealing of various types of Packages (9 hours)

Closures for Glass and Plastic Containers. Sealing of Plastic Films. Heat Sealing and Types of Seal. Induction, Dielectric, and Ultrasonic sealing. Peelable Seals. Types of Pouch. Form fill Seal Equipment – Vertical and Horizontal.

Module 6: Advanced Packaging Methods and Testing of Materials (9 hours)

Vacuum and Inert Gas Packaging. Retort pouch packaging. Active packaging and Modified atmosphere packaging – principles and applications. Aseptic Packaging – principles and applications. Tests on packaging materials, Mechanical strength (Tension, notch and tearing strengths), Gas and water vapour transmission rates.

Text Book

1. Coles, R., Dowell, D.M., Kirwan, J, Food Packaging Technology, Black Well Publishing Ltd., 2009.

Reference Books

1. Gordon L. Robertson. Food Packaging Principles & Practice, CRC Press, 2013.
2. Scott A. Morris,Food and package engineering, Wiley-Blackwell Publishing, 2011.
3. Takashi Kadoya, Food Packaging, Academic Press, Inc, 1990.

18FP3001 MASS TRANSFER AND SEPARATION PROCESSES IN FOOD ENGIINEERING

3L:0T:0P **Credits: 3:0:0**

Course Objectives:

- To understand the basic principles involved in separation process.
- To apply the principles of mass transfer in food processing.
- To perform calculations for basic operations in food processing.

Course Outcomes:

The students will be able to

1. Enumerate the units and dimensions of various physical quantities.
2. Express the various mass transfer and separation processes.
3. Describe the types of separation processes in food engineering.
4. Calculate the material balance in food processing units.
5. Appraise the performance of processing unit operations
6. Provide solutions to the issues in food processing operations.

Module 1: BASIC PRINCIPLES OF SEPARATION PROCESSES (8 Hours)

Basic principles of food processing SI system of basics units, Conservation of mass and materials balances, energy and heat units, conservation of energy and heat balances. Pressure head in fluids-devices to measure pressures- U tube manometer- Pitot tube, types of flow-laminar-turbulent, simple mass balance and continuity equation, pressure drop due to friction, drag coefficient, flow in packed beds.

Module 2: VAPOR LIQUID SEPARATION PROCESSES (8 Hours)

Vapor- liquid equilibrium relations, single stage equilibrium contact for vapor liquid system, relative volatility of vapor liquid system Distillation - Steam distillation, applications and equipment, Mass transfer phenomenon applied to food systems. **Evaporation:** Needs, basic principles, Single and multiple effect evaporation, Heat economy, Vapour recompression, Thermo and mechanical systems, boiling point elevation, Falling film, climbing film tubular evaporators, plate evaporators, thin film and scraped surface evaporators.

Module 3: EXTRACTION AND LEACHING (8 Hours)

Mechanical extraction – Expellers, screw press, filter press. Liquid-liquid extraction, liquid-solid extraction, phase diagram determination of extraction steps by McCabe-Thiele method. Super critical Fluid extraction - Super critical Fluid State, Properties of Super critical CO2 , Density, Viscosity, Volatility etc. Supercritical Phase Equilibria, Solubility, SCFE systems and components, Applications; extraction of Fatty acids, oleoresins and essential oils; Relative advantages, limitations and economics

Module 4: MECHANICAL SEPARATIONS (7 Hours)

Mechanical separation-screeners - sedimentation, gravity sedimentation, Sedimentation of solid particles in gas media, stokes law. Filtration, constant volume filtration, Constant pressure filtration, Industrial applications and equipments for Filtration and Sedimentation.

Module 5: SEPARATION BY CENTRIFUGATION (7 Hours)

Centrifugal separation-Sedimentation, filtration centrifuges, Basic equations. Different types of centrifuges – Basket, Tubular Bowl, Decanting, Disk bowl, Desludging (Self Cleaning) Bowl Centrifuges, Nozzle centrifuges. Importance of balancing of rotating masses, feed and discharge arrangement in each case. Specific characteristics - advantages and applications.

Module 6: FILTRATION BY MEMBRANE SYSTEMS (7 Hours)

Definitions; Reverse Osmosis (RO), Nano filtration (NF), Diafiltration, Ultra filtration (UF) and Micro filtration (MF), Molecular weight cut off in each case. Membranes and their characteristics, Cross flow filtration; Configuration of membranes, membrane materials, Pumps and other membrane equipment. Applications in food industry, relative advantages and limitations.

Text Books

1. Geankoplis C.J., “Transport process and separation process principles”, PHI learning private limited, New Delhi, 4th edition, ISBN-978-81-203-2614-9, 2008.
2. McCabe, W.L., Smith, J.C., and Harriott, P., “Unit operations of chemical engineering”. McGrawhill Intl. Edition, Singapore, 7th edn. ISBN-007-424740-6, 2005.

Reference Books

1. Coulson J.M., Richardson J.F., Bachurst J.R., and J.H. Harker – “Coulson & Richardson's Chemical Engineering – Vol. 2 Particle Technology and Separation Processes”, Butterworth & Heinemann - Elsevier science Ltd., Fifth Edition, ISBN 0750644451, 2002.
2. Ramaswamy H.S. and Markotte M., “Food Processing Principles and Applications”, CRC Press Ltd. ISBN-1-58716-008-0, 2006.

18FP3002 TECHNOLOGY OF FOOD FLAVOURANTS AND COLOURANTS

3L:0T:0P **Credits : 3:0:0**

Course Objectives:

To enable the student to understand

- Basics of foods flavors and colours
- Chemistry & technology of natural flavours, pigments

Course Outcomes:

On completion of the course the student would be able

1. To understand the basics of flavours
2. To understand the basics of Natural colourants
3. To understand the correlation between appearance and taste
4. To develop methods for stabilization of natural colorants
5. To develop aroma chemicals
6. To develop techniques for analysis of colorants and aroma chemicals

Module 1: BASICS OF FLAVOURS AND COLOURS (8 hours)

Olfactory perception of flavour and taste – Theories of olfaction - Molecular structure and activity relationships of taste – Sweet, bitter, acid and salt, Chemicals causing pungency, astringency, cooling effect – properties. Classification of flavours – Natural, Nature identical and synthetic – Flavor potentiators. Basics of colour – Hue, chroma, brightness. Regulations regarding additions – Toxicology and safety aspects

Module 2: TECHNOLOGY OF NATURAL FLAVOURS (8 hours)

Classification – Alliaceous flavours – Bittering agents, Coffee and Cocoa, Fruit flavours.Evolution of flavours during processing – enzymatic development, effect of roasting, cooking frying on flavour developments- Essential oils and oleoresins –Extraction – Super critical fluid extraction - Continuous and semi-continuous methods- Effect of types of solvents used. Liquid and dry flavour production - Staling of flavours. Microbial and cell suspensions in the synthesis of flavours

Module 3: CHLOROPHYLL & CAROTENOIDS (7 hours)

Chlorophyll and chlorophyll derivatives, Haems and bilins, Carotenoids, annatto, saffron, turmeric- Stability to pH, temperature and other processing conditions - Technology for theproduction of dried colourants - Caramel colour. Microbial and cell suspensions in the synthesis of colours.

Module 4: ANTHOCYANINS & FLAVANOIDS (7 hours)

Anthocyanins and betalains, Less common colourants – Acylated β-ring substituted anthocyanins, Monascus, cochineal and related pigments, Stability to pH, temperature and other processing conditions. Technology for the production of dried colourants.

Module 5: TOTAL COMPONENT AND HEAD SPACE ANALYSIS OF FLAVOURS (7 hours)

Total component analysis– Basics and methods – Recent developments. Head space analysis – static and dynamic methods – basic principles – method and developments

Module 6: SPME, E-NOSE AND TRISTIMULUS COLORIMETRY (7 hours)

Solid phase micro extraction of aroma components - E nose technology. Tristimulus colorimetry – Basics and application to foods

Text Books:

1. Reineccius G. and Heath H.B., “Flavor Chemistry and Technology” , Taylor and Francis group, CRC Press, II Edition, 2006.
2. Socaciu C., “Food Colorants - Chemical and Functional Properties”, CRC Press, Taylor and Francis group, LLC, ISBN No. 9780849393570, 2008.

Reference Books

1. Rowe D.J., **“**Chemistry and Technology of Flavors and Fragrances”, Blackwell Publishing Ltd., U.K., ISBN No. 1405114509, 2005.
2. Marsili R., “Techniques for Analyzing Food Aroma”, Marcel Dekker Inc., 1997
3. Francisco D-V and Octavio P-L., “Natural Colorants for Food and Nutraceutical Uses”, CRC Press LLC, 2003.
4. Lauro G.J., “Natural Food Colorants”, Marcel Dekker Inc., 2000.

18FP3003 FOOD SAFETY REGULATIONS AND CONTROL

3L:0T:0P **Credits : 3:0:0**

Course Objectives:

1. To enable the students to understand the need for regulations and safety in Food Industries.
2. To enable the students to understand the basics of food safety and regulations governing the same, the world over.
3. To make the students to understand the role of individual personnel of the regulatory authority.

Course Outcomes:

Students will be able to develop

1. Manuals and Protocols for foods based on existing standards both national & international.
2. Labelling for novel food groups such as GMO, Irradiated Foods…. etc
3. Packaging and Processing Protocols for Drinking water.
4. Protocols based on GMP for Food Processing Industries
5. New innovative norms and
6. Steps to enforce implementation of adequate safety regulations and control at different food sectors.

Module 1 STRUCTURE, ORGANIZATION AND PRACTICAL OPERATION OF INTERNATIONAL INTERGOVERNMENTAL FOOD REGULATION BODIES: (8 hours) World Trade order – Functioning and responsibilities of the WTO - Codex Alimentarius – History, operations of Codex alimentarius, Responsibilities – Codex standards and Maximum residue limits – Current Issues under consideration – SPS (Sanitary and phytosanitary measures) agreement. World Health Organization – History and mandate – Operations and responsibilities. Concept of Six Sigma.

Module 2 REGULATIONS PREDATING FSSA, 2006: (8 hours)

History of Food Regulations in India - FPO, MMPO, PFA, AGMARK, Essential Commodities Act, BIS.

Module 3 FOOD SAFETY AND STANDARDS AUTHORITY OF INDIA AND ITS ROLE: (10 hours)

Food safety and Standards Act – organizational chart – role of individual authority – principles to be followed – Provisions as to articles of food –imported items – Responsibilities of the food business operator – Liability of manufacturers, packers, wholesalers, distributors and sellers – Enforcement of the act – Licensing and registration of food business – Food safety officer and their powers – Analysis of food – regulations regarding labs involved in food analysis – Offences and penalties – Adjudication and food safety appellate tribunal – Laws relating to Food Processing Industries in India –

Module 4 FOOD LABELING – REGULATIONS: (8 hours)

Need for labeling – Customers, Manufacturers and Legislators Perspective - Labeling regarding methods of processing – Irradiated products – organic produce - Genetically modified foods – EU rules on nutritional labeling – US rules on nutritional labeling – Health claims – Approach of US and EU.

Module 5 GENERAL ASPECTS OF FOOD SAFETY: (8 hours)

Concept of HACCP – Assembling the team – Product description – Describing the product's intended use – Establishing a process flow diagram – on site confirmation - Listing potential hazards and control measures - Determination of critical points – decision tree for CCPs- Establishing monitoring procedures- establishing corrective actions – establishing verification procedures.

Module 6 ISO 22000 REGULATIONS: (5 hours)

Implementing ISO 22000 for foods of Animal origin – Dairy Foods, Meat & Meat Products and Poultry. Safety aspects of drinking water (microbiological and chemical) - risks and advantages of chlorination of water. Bottled water – origin of water- safety aspects – microbiological and chemical quality – Regulations for bottled water – India.

Text Books

1. Kees A. van der Heijden and Sanford Miller- International Food Safety Handbook: Science, International Regulation, and Control. Published by CRC Press. ISBN 0824793544, 9780824793548. 1999.
2. Guide to the Food Safety and Standards Act. Tax-mann allied Services Pvt. Ltd., ISBN – 10 – 8174968288. 2006.

Reference Book:

1. Rajesh Mehta and J. George - Food Safety Regulation Concerns and Trade- The Developing Country Perspective. Published by Macmillan India Ltd., New Delhi. 2005

18FP3004 ADVANCED INSTRUMENTATION FOR FOOD QUALITY AND SAFETY

3L:0T:0P **Credits : 3:0:0**

Course Objectives:

1. To enable the students to understand the basics of various techniques available for the analysis of food commodity.
2. To make the students to know the various advanced instruments for food quality analysis.
3. To equip the students to operate the advanced testing instruments and analyze the food quality data.

Course Outcomes:

Students will be able to

1. Understand the importance of instrumental techniques
2. Apply the instrumental techniques learnt towards the analysis of food materials and
3. Develop / improve methods of analysis with improved sensitivity and reproducibility
4. Analyze samples of food materials.
5. Predict the behaviour of the analyzed samples.
6. Interpret the data from the results.

Module 1 BASIC CONCEPTS IN CHROMATOGRAPHY (8 hours)

Chromatogram, distribution coefficient, retention volume, capacity factor, Gaussian profile, theoretical plates, selectivity, resolution, kinetic processes – Physical forces and interactions – Ionic interactions, van der Waals forces, hydrogen bonding, charge transfer – Modes of separation – Adsorption, Partition, Ion exchange, size-exclusion

High performance liquid chromatography: Basic principles – Mobile phase – Instrumentation – Injector, Column, Pump, detector, Types of detector – advantages of HPLC over other techniques – Applications of HPLC to food analysis

Module 2 GAS CHROMATOGRAPHY AND FTIR SPECTROSCOPY (8 hours)

Principles – Definitions, terms relating to Retention of analytes, column efficiency, sample component separation- Theory of Gas chromatography – Instrumentation – Carrier gas source, inlet system, columns, types of detectors – FID, TCD, ECD, MSD – application of GC to food analysis

FTIR Spectroscopy: Principles of Infrared spectroscopy – Instrumentation- Data handling Techniques, Spectral rationing, co-adding, Baseline correction, peak measurements, measurement of overlapping bands, smoothing and interpolation, spectral subtraction – quantitative analysis- Sampling methods , transmission cells, attenuated total reflectance – Applications in foods

Module 3 ATOMIC ABSORPTION SPECTROSCOPY (8 hours)

Introduction to AAS – Components of an AA spectrometer – Overview, Light sources, Nebuliser / Atomiser assemblies, Nebulisers, flames, optics, detectors, support gases, AAS measurements- approaches to improving the S/N ratio – Interferences – Chemical, Physical, Ionisation, Background and spectral – Calibration techniques – External standards and Standard additions – Minimising uncertainities – Atomisation techniques. **Atomic emission spectrometry (AES):** ICP – Mass spectrometry - **Atomic Fluorescence Spectrometry (AFS) :** Trace metal determinations in Biological samples.

Module 4 NUCLEAR MAGNETIC RESONANCE SPECTROSCOPY (7 hours)

Electromagnetic spectrum – The NMR Phenomenon – Types of information provided by NMR spectra – Instrumental and Experimental Considerations – Solid state NMR – application of NMR to Food analysis

Module 5 MASS SPECTROMETRY (7 hours)

Process – Ionization techniques – Instrumentation – Linked scanning techniques – application of MS in Food Science – application of GC/MS, LC/MS / FAB/MS / MS/MS and linked scan techniques

Module 6 CAPILLARY ELECTROPHORESIS (7 hours)

Instrumentation and components – Modes of CE – Capillary zone electrophoresis, Micellar electrokinetic chromatography (MECK), Capillary gel electrophoresis (CGE), Capillary isoelectric focusing (CIEF), Capillary Isotachophoresis (CITP) – Applications of CE in analysis of food substances

Text book:

1. Pare J.R.J. and Belanger J.M.R.. "Instrumental Methods of Food Analysis", Elsevier Science B.V. The Netherlands. ISBN: 0-444-81868-5. 1997

Reference Books:

1. Rouessac F. and Rouessac A., "Chemical Analysis: Modern Instrumentation Methods and Techniques", 2nd Edition, John Wiley and Sons. Ltd. England. ISBN: 978-0- 470-85903-2 2007.
2. David L. B. Wetzel, George Charalambous. "Instrumental Methods of Food and Beverage Analysis", Elsevier Science BV. 1998

18FP3005 DESIGN OF FOOD PROCESSING EQUIPMENTS

3L:0T:0P **Credits : 3:0:0**

Course Objectives

- To enable the student to design and develop equipments used in Food Processing operations.
- Identify and discuss critical design of typical processing equipment.
- Understand the relationship between process design and Safety

Course Outcomes

The students will be able to

1. Identify the factors that will affect the design of equipments
2. Classify the variables based on various properties
3. Interpret the relation between various process variables
4. Select the critical variables for the design of equipments
5. Develop a conceptual design model
6. Assess the validity of the conceptual model

Module 1: Basic Design Considerations and Materials of Construction (7 hours)

Basic considerations in process equipment design. Materials of construction – mechanical properties and materials. Design considerations - stresses created due to static and dynamic loads. Process flow diagrams (PFD) – symbols used in PFD.

Module 2: Design of Pressure Vessels (10 hours)

Design conditions and stresses – design stress, design criteria, corrosion allowance. Design of a shell and its components – cylindrical and spherical shells, head, nozzles and flange thickness. Vessels subjected to internal pressure and combined loading – cylindrical shell and spherical shell, stresses induced in vessel. Vessels subjected to external pressure. Optimum proportions of a vessel and optimum vessel size.

Module 3: Design of Storage Vessels (6 hours)

Storage of fluids – storage of volatile, non-volatile liquids and storage of gases. Design of rectangular tanks – with and without stiffeners. Design of tanks – bottom and shell design and self-supporting roof design.

Module 4: Design of reaction vessels (6 hours)

Classification of reaction vessels, heating system. Design considerations – jacket design, coil and channel design.

Module 5: Design of Heat Exchangers and Evaporators (8 hours)

Types of heat exchangers – double pipe heat exchangers, shell and tube heat exchangers, and special types of heat exchangers. Design of shell and tube heat exchanger. Design of calendria type evaporators.

Module 6: Design of Dryers and Mixers (8 hours)

Types of agitators. Power requirements for agitation. Design of agitation system components – shaft design and agitator design. Design of tray dryers.

Text Books

1. Shrikant D Dawande. "Process design of equipments". Central Techno Publications, ISBN: 81-89188-14-8, Nagpur, 2005.
2. Mahajani V.V and Umarji S.B. "Joshi's process equipment design". Trinity Press. ISBN: 978-93-5138-091-1, New Delhi, 2014.

Reference Books

1. Singh & Heldman."Introduction to Food Engineering". Academic Press – Elsevier India Private Ltd. ISBN: 978- 0- 1240- 1675- 0 New Delhi, 2013

2. Jasim Ahmed, Mohammad Shafuir Rahman "Handbook of Food Process Design, 2 volume Set" Wiley-Blackwell, ISBN: 978-1-4443-3011-3, April 2012.
3. Rajesh Mehta and J. George "Food Safety Regulation Concerns and Trade- The Developing Country Perspective," Published by Macmillan India Ltd., New Delhi. 2005
4. Miguel A. Galan, Eva Martin del Valle. "Chemical Engineering: Trends and Developments" John Wiley & Sons, ISBN: 978-0-470-02498-0, 2005.
5. Maroulis Z.B. and Saravacos G.D. "Food Process Design", Marcel Dekker Inc. ISBN- 0824743113, 2003.

18FP3006 ADVANCES IN FOOD PROCESS ENGINEERING

3L:0T:0P **Credits : 3:0:0**

Course Objectives:

To enable the students to learn the

- High and Low temperature preservation and processing methods
- Novel drying methods for heat sensitive foods
- Aseptic Packaging of processed foods

Course Outcomes:

After completion of the course the students will

- Gain knowledge on Food Engineering to conserve and minimize the losses of food produced.
- Express the primary goal on food preservation can be achieved
- Interpret the novel drying process for sensitive food materials
- Analyze the better physical separation process for liquid foods
- Recommend the suitable method for specific foods
- Design a novel dryer for specific foods

Module 1: THERMAL METHODS OF FOOD PRESERVATION (7 hours)

Thermal processing of foods – principles – methods – cooking – blanching – pasteurization – sterilization - thermo bacteriology – thermal process calculations – Ball formula method – problems on thermal process calculation.

Module 2 LOW TEMPERATURE PRESERVATION OF FOODS (9 hours)

Low temperature preservation - microbiological aspects- Freezing of foods – changes occur during freezing – heat and mass transfer during freezing – Freeze driers working and construction – types of freeze driers - Freeze concentration of foods – methods – advantages - cold storage

Module 3 ADVANCEMENT IN DRYING PROCESS (9 hours)

Spraying drying principle – Equipment construction and working – design aspects of spray drier – configuration of nozzles and other parts – methods of spray drying based on air movement – recent advancement in spray drying – merits and demerits of spray drying - construction and working of heat pump dryer – suitability of heat pump dryer – advantages and disadvantages – Foam mat drying – principles and process involved in osmotic dehydration

Module 4 EXTRUSION COOKING PROCESS (7 hours)

Extrusion cooking method – principles – equipment used – single screw and twin screw extruder - design criteria of extruders – changes occur during extrusion process

Module 5 MEMBRANE SEPARATION PROCESS (7 hours) Need for physical separation process – filtration – membrane separation technique - principles – membrane materials – membrane modules - types of membrane – microfiltration – ultrafiltration – nanofiltration – reverse osmosis – desalinization of sea water - applications of the process

Module 6 ASEPTIC AND RETORT PACKAGING OF FOODS (6 hours)

Advances in aseptic processing and packaging - - processes - design of process – different methods of aseptic processing – Retort packaging of foods – working on retort packaging machines

Text Books

1. Sun D-W, "Emerging Technologies for Food Processing", Published by Academic Press, 2005.
2. Ohlsson T. and Bengtsson N., "Minimal Processing Technologies in the Food
3. Industry", Published by Woodhead Publishing Ltd.,ISBN No. 0849312078, England, 2002.

Reference Books

1. Guy R. "Extrusion cooking – Technologies and Applications" Woodhead Publishing Ltd., CRC Press LLC, England, 2000.
2. Asiedu, J.J., "Processing tropical crops - a technological approach", MacMillan Publishers, ISBN No. 033344857X, 1989.
3. Gould G.W., "New Methods Of Food Preservation", Aspen Publishers, Great Britain, ISBN No. 0834213419, 1999.

18FP3007 FOOD ANALYSIS LAB

0L:0T:3P **Credits: 0:0:1.5**

Course Objectives:

- To determine the quality of Food commodities
- To interpret the genuineness of the products based on the quality

Course Outcomes:

The students will be able to

1. Understand the quality parameters of different types of food products
2. Classify food products based on their quality
3. Interpret results and decide on the quality
4. Compare two brands of the same product and decide the best one based on the quality
5. Evaluate newer products based on quality
6. Design and develop newer and better methods of analysis for improving the quality of a Food Product

List of Experiments:

Sugar rich products like Jams, Squashes, Marmalades, Sugar and Jaggery

22. Analysis of total sugars
23. Determination of pectin
24. Determination of acidity
25. Determination of total fruit solids
26. Determination of Calcium
27. Estimation of Ascorbic acid

Bakery Products including wheat

28. Determination of gluten content
29. Determination of alcoholic acidity
30. Determination of maltose equivalent
31. Estimation of total nitrogen content by Kjeldahl method

Meat and meat products

32. Determination of Extract release volume
33. Determination of swelling ratio
34. Determination of TMA

Milk and Milk products

35. Determination of Fat content by Gerber method
36. Determination of lactose content by Lactometer

Plantation Products including Tea, Coffee and Cocoa

37. Determination of Total extractives
38. Determination of Tannin content
39. Determination of Caffeine by HPLC

Vitamins, Minerals and Colourants

40. Estimation of anthocyanins
41. Estimation of Chlorophyll
42. Determination of Iron

18FP3008 ENZYMOLOGY LAB

0L:0T:3P **Credits: 0:0:1.5**

Course Objective:

- To study the characteristics of various enzymes applicable in food industries.

Course Outcomes:

The students will be able to

1. Gain knowledge about enzymes
2. Understand the importance of each of the factors that affect enzyme activity
3. Apply the same to maximize enzyme action
4. Analyze when a problem arises and give a suitable and logical solution
5. Evaluate enzymes from different sources and select the right one depending on the type of food / condition
6. Make appropriate decision of evaluation and characterization when it comes to newer source of enzymes

List of experiments

16. Estimation of reducing sugars by dinitrosalicylic acid
17. Estimation of amylase activity
18. Effect of pH on amylase activity
19. Effect of temperature on amylase activity
20. Effect of substrate concentration on amylase activity
21. Effect of enzyme concentration on amylase activity
22. Determination of total and specific activity of amylase
23. Estimation of protein by Lowry's method
24. Estimation of protease activity
25. Effect of pH on protease activity
26. Effect of temperature on protease activity
27. Effect of substrate concentration on protease activity
28. Effect of enzyme concentration on protease activity
29. Determination of total and specific activity of protease
30. Studies on enzyme immobilisation

18FP3009 FOOD PRODUCT TECHNOLOGY LAB

0L:0T:3P **Credits: 0:0:1.5**

Course Objectives:

1. To gain knowledge of various products from milk, fruits, vegetables and cereals.
2. To prepare the constituents required for making food products.
3. To acquire the skill of manufacturing various food products.

Course Outcomes:

The students will be able to

1. Gain knowledge about the manufacturing technology of food products.
2. Understand the importance of various ingredients required for preparation of milk based food products.
3. Understand the importance of various ingredients required for preparation of cereal, fruit and vegetable based food products.
4. Calculate the quantity requirement of each constituent.
5. Prepare food product of desired specification.
6. Evaluate the sensory quality of the prepared food product.

List of Experiments

1. Preparation of RTS beverages
2. Preparation of squash
3. Preparation of Jam, jellies and marmalades
4. Preparation of ketchup
5. Preparation of breads
6. Preparation of biscuits
7. Preparation of thermally coagulated dairy products – *Kalakhand, Peda and Gulab Jamun*

8. Preparation of acid coagulated dairy products – *Rosagulla, Paneer, Sandesh*
9. Preparation of Sohanpapdi
10. Preparation of Mysorepak
11. Peparation of Chikki
12. Preparation of Gummies
13. Preparation of aerated confectionery
14. Premixes
15. Frying Technology

18FP3010 FOOD ENGINEERING AND TRANSPORT PROCESSES LAB

0L:0T:3P **Credits: 0:0:1.5**

Course Objectives:

1. To provide extensive knowledge on the operation of various processing equipments.
2. To know the various flow measuring equipments involved in food industries.
3. To equip the students to operate and measurement of the heat transfer equipments.

Course Outcomes:

The students will be able to

1. Understand the importance of fluid flow in industrial applications.
2. Compute the moisture content and drying characteristics of food materials.
3. Describe and demonstrate the various process equipments.
4. Determine the loss of energy due to friction in pipes.
5. Evaluate the different operations in food processing.
6. Estimate the energy requirement for the different unit operations.

List of Experiments

1. Drying studies using through flow dryer – drying rate and drying curve.
2. Determination of overall heat-transfer co-efficient of a tubular pasteurizer.
3. Determination of crushing efficiency of sugar cane crusher.
4. Performance evaluation of an extruder.
5. Calibration of rota meter.
6. Determination of heat transfer through composite walls.
7. Determination of pressure losses in pipes due to sudden enlargement and contraction..
8. Calibration of venturi meter and orifice meter.
9. Determination of friction coefficient in annular pipe.
10. Determination of overall heat transfer coefficient in shell and tube heat exchanger.
11. Determination of aerodynamic properties using fluidised bed column.
12. Determination of mixing index of a mixer – sigma, ribbon, planetary mixers.
13. Determination of mass transfer coefficient using Fick's law.
14. Determination of enthalpy balances in single effect evaporator.
15. Determination of mass transfer rate in leaching / extraction

18FP3011 ADVANCES IN DAIRY, MEAT AND FISH PROCESSING

3L:0T:0P **Credits : 3:0:0**

Course Objectives

1. To understand about the composition, nutritive value of meat, poultry and fish
2. To know about processing technology of meat, poultry and fish
3. To learn the value addition and packaging of meat, fish and poultry products

Course Outcomes

The student will be able to understand

1. Precautions that need to be taken while handling products from this segment.
2. The Different types of meat, poultry and fish and the processes involved in their processing.
3. The challenges in developing new value-added products from this segment.
4. Hygienic and safe handling of Meat, Fish and Dairy Products.

5. The machinery involved in the Meat, Fish and Dairy Products processing segment.
6. The Quality checks involved in Meat, Fish and Dairy Products processing segment.

Module 1: DAIRY CHEMISTRY AND MICROBIOLOGY (9 hours)

Introduction - Basic dairy terminology - milk as raw material – composition - nutritive value - physico-chemical constituents of milk and its constituents – contaminants - microbiology of milk- milk collection - cooling and milk transport - milk reception -Quality control tests - applications of enzymes in dairy industry

Module 2: DAIRY PROCESSING AND EQUIPMENTS (9 hours)

Milk processing equipment – filtration/clarification – Pasteurization – HTST – LTLT – UHT methods - storage tanks - Cream separating Centrifuges - Homogenization – theory – working principle of homogenizers – homogenization efficiency - cream separation – principles – gravity and centrifugal separation – centrifugal separator – parts – construction and working principle – separation efficiency

Module 3: CHEMISTRY AND MICROBIOLOGY OF MEAT (5 hours)

Meat composition from different sources; Definitions and measurements, Explanation of muscle structure and compositions and its modifiers, White and Red Meat, Description of animal fat and its modifiers, description of bone and its modifiers; Post mortem muscle chemistry, Meat colour, flavors of meat products, meat microbiology and safety.

Module 4: SLAUGHTERING AND PROCESSING OF MEAT PRODUCTS (8 hours)

Modern abattoirs and some features, Ante mortem handling and welfare of animals, design of handling facilities, Carcass processing equipment, Operational factors affecting meat quality, effects of processing on meat tenderization; meat processing equipment. Canned meat, Frozen meat, Cooked and Refrigerated meat, Dried and preserved meat, Cured meat.

Module 5: MEAT PRODUCTS AND SAFETY (6 hours)

Production methods for Intermediate moisture and dried meat products, Different kinds of sausages – Equipment used for all the process operations; Meat plant hygiene, Good manufacturing practice and HACCP.

Module 6: FISH AND OTHER MARINE PRODUCTS PROCESSING (9 hours)

Commercially important marine products from India, Basic biochemistry, spoilage factors of fish, field refrigeration and icing practice, merits and demerits, Use of dry ice and liquid nitrogen as preservation elements, use of Refrigerated Sea Water (RSW) for preservation, Changes during storage in RSW and CSW; Freeze preservation; freezing of prawn and shrimp, weighing, filling and glazing, Individual quick freezing - relative merits and demerits, Canning operations, Salting and drying of fish, pickling and preparation of fish protein concentrate and fish oil.

Text Books

1. Hui, Y.H., Nip, W.K., Rogers, R.W, "Meat Science and Applications". Marcel Dekkar Inc. New York,2001.

Reference Books

1. Leo M. L. Nollet, "Handbook of Meat, Poultry and Seafood Quality", Blackwell Publishing, 2007.
2. Garret Smit. G., Dairy Processing. Woodhead Publishing Limited, England. 2005.
3. Mead G, "Poultry meat processing and quality", Woodhead Publishing Limited, 2004.
4. National Institute of Industrial Research, Modern Technology of Milk processing and Dairy products, II Edition, NIIR Publications, India, 2004
5. Joseph Kerry, John Kerry and David Ledwood, "Meat Processing", Woodhead Publishing Limited, CRC Press, 2002.
6. Sukumar De. Outlines of Dairy Technology, Oxford University Press. 2001. ISBN: 9780195611946
7. Balachandran, K.K, "Post Harvest Technology of Fish and Fish Products", Daya Publishing House, New Delhi, 2001.

18FP3012 ADVANCES IN PROCESSING OF CEREALS, PULSES AND OIL SEEDS

3L:0T:0P **Credits : 3:0:0**

Course Objectives:

- To create awareness about the processing of major cereals like paddy, maize etc.
- To study the milling techniques of cereals and pulses
- To study about the byproducts obtained during processing along with their uses.

Course Outcomes:

At the end of this course, the student will be able to:

1. Gain knowledge about the basic composition and structural parts of food grains, pulses and oil seeds
2. Know about Paddy Processing and Rice milling equipment which will help them for developing entrepreneurial skills.
3. Apply the knowledge to process food grains into value added products
4. Develop skills needed in the milling of pulses and in the processing and milling of maize which will promote gainful employment.
5. Recommend a better equipment for processing the raw materials
6. Acquainted with traditional and modern oil milling methods

MODULE 1- PADDY PROCESSING (8 Hours)

Structure and Composition of paddy – Cleaning of paddy -Pre Cleaners, - Paddy Parboiling processes. Physico-chemical changes during parboiling – effect of parboiling on cooking qualities - Parboiling methods - Methods of grain drying- LSU, rotary, columnar, recirculatory dryers

MODULE 2 - RICE MILLING (8 Hours)

Rice milling flow chart - Modern RiceMilling equipments– paddy milling - Dehuskingof paddy - Engelberg Huller, Under runner disc shellers, rubber roll sheller and Centrifugaldehusker- Paddy Separators – Satake and Schule Designs – Rice Polishers - Cone polishers and othertypes - Bran and Brokens separators - Rice mill yields and loss due to brokens at different stages of milling – milling efficiency - Use of Rice Bran in Edible oil Industry - By-products of paddy processing - Paddy husk and its uses as husk ash, activated carbon, furfural and other by products – Value added products - Flattened and Puffed Rice.

MODULE 3 – WHEAT MILLING (7 Hours)

Structure and composition of wheat – flow chart for wheat milling – milling process - equipments used in wheat milling – parboiling of wheat – bulgur wheat – wheat flour milling - products and by products of wheat.

MODULE 4 - PROCESSING OF MAIZE/CORN (8 Hours)

Structure and composition of maize – milling methods - Pre-cleaning - cleaning equipment – degermination and dehusking - Dry milling of maize – wet milling – flow chart - Products of milling – Flour – Semolina - Brewers' grits etc and their applications – Bran and Fibre separation - Gluten and Starch Separation - Equipment used - Starch conversion into other value added products – Acid Hydrolysis - Enzyme Hydrolysis - Isomerization processes - Processing for Dextrose - Malto dextrin and other products - Extraction and refining of Corn oil in brief.

MODULE 5- MILLING OF PULSES (8 Hours)

Structure and composition – need for pulse milling – Unit operations of pulse milling – domestic and commercial scale pulse milling methods –Dry and wet milling, CFTRI, CIAE, Jadavpur methods - Process flow chart –Pulse milling machineries - dehusking in Pulse Pearler - splitting of pulses in Pulse splitter - Mini dhal mill - working principle - advantages and disadvantages –pulse milling efficiency - Grinding of split pulses - pulse flour products - their applications and equipments used.

MODULE 6 - MILLING OF OIL SEEDS (7 Hours)

Structure and composition of oil seeds – Oil expression and extraction - Traditional milling equipments – Ghani – Improvement over conventional method of expression – Mechanical expression devices – hydraulic press – screw press – Solvent extraction method – Extraction of oil from soyabean– sunflower – palm and coconut kernel – Utilization of by products from oil milling industries.

Text Books

3. KM. Sahay and KK. Singh. Unit operations of Agricultural Processing, Vikash Publishing house PVT Ltd. Delhi, 2014.
4. Chakraverty, A.: Post Harvest Technology of Cereals, Pulses and Oilseeds. Oxford and IBH Publishing Co, Calcutta, 2014.

Reference Books

4. Samuel A .Matz: "The Chemistry and Technology of Cereals as Food and Feed", Chapmanand Hall, 1992.
5. Bernard Godon and Claude Willm, "Primary Processing of Cereals" Berns and Noble Publishers, 1994.
6. Karel Kulp and Joseph P Pante, "Handbook of Cereal Science and Technology", MercelDekkar, USA, 2000.

18FP3013 ADVANCES IN PROCESSING OF HORTICULTURE, SPICES AND PLANTATION PRODUCTS

3L:0T:0P **Credits : 3:0:0**

Course Objectives:

- To study about the various methods of processing tea products.
- To demonstrate a basic knowledge on process of coffee, and cocoa.
- To develop an awareness of various processing procedure for major spices & minor spices.

Course Outcomes:

The students will be able to

1. Define the different unit operations and its equipments involved in coffee, tea and cocoa processing
2. Gain knowledge in processing of plantation crops and spices and also its value added products.
3. Outline ways in which quality loss can be minimised during preparation and processing
4. Develop value added products from plantation products and spices
5. Demonstrate appropriate technique for the extraction of spice oil and oleoresin with quality standards
6. Acquire a confident to get placement in any kind of cereals and spices industry with minimum post harvest losses and maximum benefit to the industry.

Module 1: Preservation techniques in Fruits and Vegetables (6 hours)

Canning operations of fruits and Vegetables.-Different filling, closing and sterilization operations- Blanching operations - Batch and Continuous Blanching. Concept of Hurdle technology as applied to fruit and vegetable preservation. Minimal processing.

Module 2: Processing of Bottled Products (6 hours)

Bottled Products: Preparation of products like Jams, Jellies, Marmalades, Pickles, Puree, Ketchup, Sauce, and Squashes etc. - FSSAI specifications.

Module 3: Chemistry and Technology of Coffee (8 hours)

Coffee – Occurrence – chemical constituents – harvesting – fermentation of coffee beans – changes taking place during fermentation – drying – roasting – Process flow sheet for the manufacture of coffee powder – Instant coffee, technology – Chicory chemistry - Quality grading of coffee.

Module 4: Chemistry and Technology of Tea (8 hours)

Occurrence – chemistry of constituents – harvesting – types of tea – green, oolong and CTC – Chemistry and technology of CTC tea – Manufacturing process – Green tea manufacture – Instant tea manufacture – Grading of tea.

Module 5: Chemistry and Technology of Cocoa and Cocoa Products (9 hours)

Occurrence – Chemistry of the cocoa bean – changes taking place during fermentation of cocoa bean – Processing of cocoa bean – cocoa powder – cocoa liquor manufacture Chocolates – Types – Chemistry and technology of chocolate manufacture – Quality control of chocolates.

Oleoresins and Essential oils – General methods of manufacture – Quality aspects – Differences – Flavour identical and their synthesis.

Module 6: Chemistry and Technology of Major and Minor Spices (8 hours)

Pepper, Cardamom, ginger, Chilli, mint, and turmeric – Oleoresins and essential oils – Method of manufacture – Chemistry of the volatiles –Quality control of major spices.

Cumin, Coriander, Cinnamon, fenugreek, Garlic, Clove Vanilla, Coconut, Areca nut, Oil palm and Cashew – Quality control of minor spices

Text Books

1. L.R.Verma and V.K.Joshi, (2000) Post Harvest Technlogy of fruits and vegetables.Indus Publishing Co, NewDelhi.
2. Peter, K.V. Hand book of herbs and spices. Volume 2. Wood head publishing Ltd., 2004. **eBook ISBN:** 9780857095688
3. Chakraverty, A., Mujumdar, A.S., Raghavan, G.S.V., Ramaswamy, H.S. Handbook of post harvest technology – cereals, fruits, vegetables, tea and spices. Marcel Dekker Inc., New York (Special Indian Reprint). 2010. ISBN 13: 9780824705145

Reference Books

1. Tainter, D.R. Grenis, A.T. Spices and Seasonings – A food technology hand book. 2nd edition. John Wiley and Sons, Inc., Canada. 2001. ISBN: 978-0-471-35575-5
2. Salunkhe, D.K. and Kadam S.S. Ed. 1998. Hand book of Vegetable Science and Technology, Marcel Dekker, New York, USA. ISBN: 0824701054
3. Minifie Bernard W. Chocolate, Cocoa and Confectionery Technology, 3rd Edition, Aspen Publication, 1999. ISBN: 9780834213012
4. Handbook on Spices, National Institute of Industrial Research (NIIR) Board, Asia Pacific Business Press Inc., New Delhi 2004. ISBN: 8188330946
5. Banerjee B. 2002. Tea Production and Processing – 3rd edition, Oxford & IBH Publishing Co.Pvt.Ltd., New Delhi.

18FP3014 REFRIGERATION AND COLD STORAGE ENGINEERING

3L:0T:0P **Credits : 3:0:0**

Course Objectives:

- To enable the students to understand the various concepts behind refrigeration of food.
- To enable students to know about food freezing and equipment involved.
- To enable students to understand various aspects of cold storage.

Course Outcomes:

The students will be able to

1. Understand refrigeration of food and its operational components.
2. Gain knowledge on various forms of food refrigeration in plants, stores and logistics.
3. Learn advanced food freezing concepts and techniques.
4. Study food safety aspects of chilled foods and frozen foods.
5. Comprehend cold chain management in food distribution sector.
6. Evaluate the cold storage and packaging of frozen perishable products.

Module 1: Principles of Refrigeration (9 hours)

Refrigeration – Ton of refrigeration, refrigeration cycles, Vapour Compression and Vapour Absorption cycles, Refrigerants, characteristics of different refrigerants, net refrigerating effect -Components of a Refrigeration system: Compressor, condenser, Evaporator, Expansion valves piping and different controls.

Module 2: Cold Storage (7 hours)

Insulation, properties of insulating materials, air diffusion equipment, Cold load estimation; prefabricated systems, walk-in-coolers, and Refrigerated container trucks: Freezer Storages, Freezer room Temperatures, Cooling towers: introduction, Construction and Working; Cold Storage practice, Stacking and handling of materials, Optimum temperatures of storage for different food materials.

Module 3: Air-Conditioning (10 hours)

Psychrometry. Psychrometric Processes. Simple Air Conditioning System – State and Mass Rate of Air. Evaporative, Winter and All Year Air Conditioning Systems. Design Conditions. Load Calculation and Psychrometry of Air Conditioning Systems –Design of Air conditioning apparatus – Transmission and Distribution of Air. Selection of Air Conditioning Systems.

Module 4: Freezing of Foods (6 hours)

Freezing equipment, Freezing Time, Freezing Curve, Freezing rates, growth rate of ice crystals, crystal size and its effect of texture and quality of foods, Freezer types, Individual quick freezing. Cryogenic Freezing, Freezing practice as applied to different food sectors.

Module 5: Chilling of Foods (6 hours)

Chilling equipment for liquid foods. Secondary refrigerants, Evaporative cooling and direct expansion techniques in chilling. Chilled foods transport and retail cabinets - Basics of Chilled foods microbiology, Packaging of Chilled foods.

Module 6: Cold Chain Management (8 hours)

Supply chain system - Important Factors to consider- logistic supply- Protocols for Domestic, Sea and Airfreight- Traceability and barcode – Product Temperature and Moisture monitoring- Refrigeration systems and Refrigerant types during field chilling, transportation via land, air and sea. Grocery stores and display cases,

Home refrigerators - Cooling chain summary - Storage and packaging

Text Book

1. Clive.V.J Dellino, "Cold and Chilled Storage Technology", Chapman Hall India , 1997.

Reference Books

1. C.P. Arora, "Refrigeration and Air conditioning", Tata McGraw Hill, 2009.
2. Da-Wen Sun, "Handbook of Frozen Food Processing and Packaging", CRC Press, 2009.
3. Florkowski W.J, Shewfelt R.L, Brueckner B and Prussia S.E, "Post Harvest Handling and Sytems Approach", Second edition, Academic Press, 2009.
4. Colin Dennis and Michael Stringer: Chilled Foods – A Comprehensive Guide Brown.M WoodHead Publishing, 2008.

18FP3015 ENGINEERING PROPERTIES OF FOOD MATERIALS

3L:0T:0P **Credits : 3:0:0**

Course Objectives:

- To study about the different methods of determining the quality and properties of different foods
- To gain knowledge of engineering properties during processing, packing, storage and transport.
- To impart knowledge about electrical properties of food and its applications in food engineering

Course Outcomes:

The students will be able to

1. Understand Engineering properties of food materials.
2. Identify the structure and chemical composition of foods.
3. Determine the physical properties of food materials.
4. Calculate the water activity, food stability sorption and desorption isotherm of food materials.
5. Study the difference between Newtonian and non-Newtonian fluids.
6. Examine the thermal properties, electrical and magnetic properties of food.

Module 1: Physical Properties of Foods (9 hours)

Methods of estimation of Shape, Size, volume, density, porosity and surface area, sphericity, roundness specific gravity. Frictional properties-coefficient of friction, Storage and flow pattern of agricultural crops

Module 2: Rheological Properties of Foods (9 hours)

Definition – classification – Newton's law of viscosity – momentum-diffusivity-kinematic viscosity – viscous fluids – Newtonian and Non Newtonian fluids- Viscosity Measurements-Viscometers of different types and their applications-Texture measuring instruments-Hardness and brittleness of Food materials.

Module 3: Thermal Properties of Foods (8 hours)

Definitions of Heat capacity, specific heat, enthalpy, conductivity and diffusivity, surface heat transfer coefficient, Measurement of thermal properties like specific heat, enthalpy, conductivity and diffusivity, DTA, TGA, DSC.

Module 4: Aerodynamic Properties of Foods (4 hours)

Drag and lift coefficient, terminal velocity and their application in the handling and separation of food materials.

Module 5: Hydrodynamic Properties of Foods (6 hours)

Water activity- measurement-vapor pressure method –freezing point depression method- Effect of temperature, and pressure on water activity-moisture sorption isotherms- models-Henderson, PET and GAB models.

Module 6: Electrical Properties of Food (9 hours)

Dielectric properties-dielectric constants-, Dielectric measurements-Ionic Interaction-Dipolar rotation. Effect of moisture, temperature and pressure on dielectric properties. Microwave heating-Infrared and Ohmic heating, Irradiation

Text Books

1. Serpil Sahin and Servet Gulum Sumnu "Physical Properties of Foods", Springer,USA, 2006.
2. Nuri N. Mohsenin: "Thermal Properties of Food & Agricultural materials", Gordon and Reach science publishers, 1970.

Reference Books

1. Rao, M.A and S.S.H. Rizvi:"Engineering Properties of Foods", Mercel Dekker inc. New York, 1998.
2. Lewis M.J, "Physical properties of foods and food processing systems" Woodhead publishing Cambridge, UK, 1990.
3. Reyond Jewitt and others: "Physical properties of foods "Allied science publishers, 1983.
4. Shafiur Rehman: Food Properties Hand book CRC press inc. New York, 1995.
5. Micha Peleg and Edward B. Bagley, "Physical Properties of Foods" AVI publishing company inc, Westport USA, 1983.
6. Kachru R.P.and R.K. Gupta, "Physico – Chemical Constituents and Engineering Properties of Food crops", Scientific publishers, Jodhpur.

18FP3016 MILLING, BAKERY AND CONFECTIONERY TECHNOLOGY

3L:0T:0P **Credits : 3:0:0**

Course Objectives:

- To provide know how on the machinery and process involved in the baking and confectionery process
- To understand the various types of sugar and its grades
- To know the process and machinery involved in the manufacture of beverages.

Course Outcomes:

The students will be able to

1. Gain knowledge on the ingredients, process and machinery involved in bakery and confectionery and beverage technology.
2. Understand the importance and effect of quality of raw materials on the final products\
3. Apply the knowledge gained in formulating new types of products
4. Analyze the process for maintaining and improving the quality of the final product
5. Evaluate the steps involved in the process and improve existing technologies or develop newer technologies
6. Design and create newer process and products that are better economically, nutritionally or technologically.

Module 1: Overview of wheat quality and Equipments used for baking (9 hours)

Moisture tests, Grain hardness testing. Visco graph, Amylograph, Farinograph. Dough mixers, Dividers, rounders, Proofing, moulding, Ovens, Slicers, Packaging materials and equipment, Sanitation and safety

Module 2: Technology of Baking (6 hours)

Bread manufacturing process – Straight dough fermentation, Sponge and dough, Biscuit-Types of biscuit dough – Developed dough, short dough, semi-sweet, enzyme modified dough and batters- importance of the consistency of the dough

Module 3: Technology of Baking (4 hours)

Cake – Flour specification – ingredients – manufacturing process – types of chemically aerated goods.

Module 4: Beverage Technology – Alcoholic beverages (6 hours) Manufacture of beer, wine and champagne - Quality characteristics, Manufacture of distilled beverages including whisky, brandy, rum and gin – Quality aspects

Module 5: Beverage Technology – Non-Alcoholic beverages (4 hours) Manufacture of sugar-free, sugarless, carbonated beverages – Fruit based beverages- quality aspects and standards

Module 6: Confectionery Technology (8 hours) Types of Confectionery, raw materials and processing of toffee, chocolates, fruit drops, hard boiled candies. Additives for Confectioneries. Equipments used in Confectionery manufacture.

Text Book

1. Samuel A. Matz, "Bakery Technology and Engineering", Chapman & Hall, 3rd Edition, 1992.

Reference Books

1. Bakery Products – Science and Technology, Ed., Y.H. Hui, Blackwell Publishing, 2006. ISBN-13: 978-0-8138-0187-2
2. Sumnu SG and Sahin S. Food Engineering aspects of Baking sweet goods. CRC Press,2008. ISBN 9781420052749

3. Hunsigi G. Production of Sugarcane Theory and Practice, Springer Verlag, 1993. e-ISBN-13: 978-3-642-78133-9
4. Varnam A.H. & Sutherland J.P. BEVERAGES - T*echnology, Chemistry and Microbiology*, Springer-Science+Business Media, B.V., 1994. ISBN 978-1-4615-2508-0 (eBook)
5. Lees R and Jackson EB. Sugar Confectionery and Chocolate Manufacture, Chapman and Hall Pub.,1992. e-ISBN-13: 978-1-4684-1495-0
6. Edwards, W .P. The Science of Sugar Confectionery, RSC Publishing, UK., 2000. **ISBN** 0-8 5404-593-7

18FP3017 ADVANCES IN PACKAGING AND HANDLING OF FOODS

3L:0T:0P **Credits : 3:0:0**

Course Objectives:

- To study about the functions of packaging along with the influence of various factors on food.
- To know about the different packaging materials, their manufacturing process and equipment.
- To study about the various methods of packaging to improve the shelf life of the products.

Course Outcomes:

The students will be able to

1. Understand the need and functions of packaging as a solution to various factors affecting food.
2. Gain knowledge on shelf life of food and various methods of estimating it.
3. Explain the different packaging materials, their manufacturing process and equipment involved.
4. Know about the various closures and sealing mechanisms for different packaging materials.
5. Select the different printing and labelling methods and legislative requirements.
6. Devise innovations in food packaging and their applications.

Module 1: Introduction to Food Packaging (9 hours)

Functions of packaging, Effect of environmental factors - light, Oxygen, Moisture, Temperature, mechanical forces and biological factors on quality of food. Estimation of shelf life. General Approach, analysis of storage requirement, accelerated storage studies: Vacuum and Inert Gas Packaging: Tests on packaging materials, Mechanical strength (Tension, notch and tearing strengths), Gas and water vapour transmission rates.

Module 2: Metal Cans as Packaging (9 hours)

Metallic can types - Tin cans and Aluminum cans. Specialty of Open top sanitary cans, Lacquers and their use, Three piece cans and Two piece cans, Aerosol Cans, Basics of Canning operations – Can Reformer, Flanger, Seaming, Can closures. Glass jars and Bottles in food packaging, Design features and applications, Sterilization of bottles.

Module 3: Flexible Films Packaging (6 hours)

Formation of Films and pouches, Plastics used and their Specific applications - Polyethylene (LDPE and HDPE), Cellulose, Polypropylene (PP), Polyesters, Poyvinylidene Chloride (PVDC - Diofan, Ixan and Saran), Polyvinyl chloride, Copolymers their applications. Co-extruded films and Laminates.

Module 4: Rigid & Semi rigid Films Packaging (6 hours)

Rigid and Semi rigid plastic packaging – fabrication methods – Thermo forming, Blow moulding, Injection moulding, Extrusion – Retort pouch packaging. Laminated Paper board Cartons, Fibre Board and Corrugated Card Board packaging and their applications.

Module 5: Filling and Sealing Operations for Various Types of Packages (7 hours)

Closing and sealing of Rigid plastic containers. Filling and sealing of Flexible plastic containers, Seal types-Bead seals, Lap Seals and Fin seals –Differences and advantages, Hot wire sealing, hot bar sealing and impulse sealing – differences and relative advantages, Form fill Seal equipment: Printing on packages, Bar codes, Nutrition labeling and legislative requirements. Filling and Sealing of pouches, pouch from fill seal machines.

Module 5: Innovations in Food Packaging (8 hours)

Aseptic Packaging. Active packaging, Moisture control, CO_2 and Oxygen scavenging. Modified atmosphere packaging – principles, applications. Permeability of gases in packs. Antimicrobial Packaging, Edible packaging films and coating. Packaging for non-thermal food processing. Intelligent Packaging – Time-temperature indicators, RFID, Tamper evident packaging.

Text Book

1. Coles, R., Dowell, D.M., Kirwan, J, Food Packaging Technology, Black Well Publishing Ltd., 2009

Reference Books

1. Gordon L. Robertson. Food Packaging Principles & Practice, CRC Press, 2013.
2. Kit L Yam and Dong Sun Lee, Emerging Food Packaging Technologies: Principles and Practice, Woodhead Publishing Ltd, 2012.
3. Jung H. Han, Innovations in Food Packaging, Academic Press, 2014.
4. Scott A. Morris,Food and package engineering, Wiley-Blackwell Publishing, 2011.
5. Takashi Kadoya, Food Packaging, Academic Press, Inc, 1990.

18FP3018 EMERGING TRENDS IN FOOD PROCESS ENGINEERING

3L:0T:0P **Credits : 3:0:0**

Course Objectives:

To enable the student to

1. Understand the food preservation techniques
2. Acquire knowledge on Pulse light techniques, ohmic heating and microwave processing
3. Gain ideas related to Food irradiation, high pressure processing and biocatalysts.

Course Outcomes

On completion of the course the student would be able to

1. Recall the principles of preservation
2. Interpret the various emerging techniques available for food processing
3. Apply the techniques for preservation of foods
4. Analyze the most suitable method for processing foods
5. Evaluate the suitability of the techniques for specific foods
6. Create a novel food preservation technique

Module 1 : Hurdle Technology (6 hours)

Hurdle technology - principles and applications - hurdle effect in fermented food - shelf stable Products - intermediate moisture foods - minimally processed foods - total quality of foods - optimal range of hurdles and potential safety -application of hurdle technology - fruit preservation, dairy products and meat

Module 2: Pulse light and UV Technique (8 hours)

High-intensity pulse technique- Processing systems- design of static chambers- continuous chambers- other chamber designs- generation of different voltage waveforms-oscillation magnetic fields for food processing- generation of magnetic fields - mechanisms of inactivation of microorganisms in food preservation – UV treatment – principle involved – mechanism of inactivation – Pulsed electric field – principles of microbial inactivation – Generation of PEF – application in food processing.

Module 3: Microwave and Ohmic Heating (7 hours)

Microwave properties – principle – design aspects of microwave equipment - interaction with food materials, material properties - application of microwave in food processing – merits and demerits – recent advancement in microwave processing - inactivation of microorganisms and enzymes – electrical resistance heating of food - ohmic heating - treatment of products - Elsteril process - influence on microorganisms - food ingredients

Module 4: Ultrasound & High Pressure Processing (8 hours)

Ultra sound – introduction – types of pressure waves – generation of ultrasound – mechanism of microbial inactivation – application in food processing – High pressure processing – Principles –concepts – basic laws related to HPP - design of equipment - processing of food using HPP - effect on microorganisms – Application in industry

Module 5: Food irradiation and recent non thermal methods (9 hours)

Food irradiation – principle of irradiation – radioactive substances – types of irradiation – construction and working of equipment – effect of irradiation on the nutritional and biochemical changes – application in food sectors – social and ethical issues – cold plasma technology – electron beam radiation - application in food processing.

Module 6: Biocatalysts and Biosensor (7 hours)

Biocatalysts- Sources-Types- Processes in Food Industry- Enzymatic – Biocatalysis using enzymes-flavors and fragrance – Biosensors types- application of biosensors to food industry requirements- Development of Biosensors – e- nose and e- tongue and their applications in sensory evaluation of foods.

Text Books:

1. Nonthermal Preservation of Foods. Gustavo V. Barbosa-Canovas, Usha R. Pothakamury, Enrique Palou and Barry G. Swanson. Published by Marcel Dekker, Inc., 270, Madison Avenue, New Yorkm 10016, 1998.
2. Biosensors for food analysis, A O Scott, The Tetley Group Limited, UK, Woodhead Publishing Limited, Abington Hall, Abington, Cambridge, CB21 6AH, England, 2008.

Reference Books

1. Trends in Food Engineering, Jorge E. Lozano, Cristina Anon, Efren Parada-Arias, Gustavo V. Barbosa-Canovas, Contributor Jorge E. Lozano, Published by CRC Press, 2000.
2. Gould G.W., "New Methods of Food Preservation", Aspen Publishers, Great Britain, ISBN No. 0834213419, 1999.

18FP3019 STORAGE ENGINEERING OF FOOD MATERIALS

3L:0T:0P **Credits : 3:0:0**

Course Objectives:

To enable the students to understand

1. Different Storage techniques
2. Design of Storage Structures
3. The techniques involved in perishable crop storage

Course Outcomes:

Students will be able to

1. Identify the specific storage needs of a variety of foods and crops.
2. Ascertain the pre-requisites for the safe handling and storage of grains in particular.
3. Design structures for storage of grains and other major crops.
4. Identify rodents, insects and pests that are prevailing in storage structures.
5. Choose the right control technique for rodents, insects and pests.
6. Monitor residual effects of fumigation especially in warehouses and storage structures that have undergone fumigation.

Module 1 STORAGE ENGINEERING PRINCIPLES (7hours)

Storage of grains–biochemical changes during storage–production, distribution and storage capacity estimate models–storage capacity models–ecology, storage factors affecting losses.

Module 2 STORAGE STRUCTURES (8 hours)

Traditional storage structures, improved storage structures, modern storage structures; Farm silos: Horizontal silos, tower silos, pit silos, trench silos, size and capacity of silos

Module 3 STORAGE STRUCTURE DESIGN PRINCIPLES (9 hours)

Storage requirements, bag and bulk storage– pressure distribution– theories–design of silos - pressure theories, pressure distribution in the bin. Design of warehouses - method of stacking– preventive method, bio-engineering properties of stored products–function structural and thermal design of structures.

Module 4: INSECTS, PESTS AND RODENTS (7 hours)

Destructive agents (rodents, birds, insects, etc.). Physico chemical and biological changes due to infestation, sources of infestation; Damage caused by rodents; Storage pests

Module 5: INTEGRATED PEST CONTROL MECHANISMS (7 hours)

Seed coating, fumigations- choice of fumigants, properties of fumigants, under wrap fumigation, fumigation of warehouses, detection of residual fumigants – mechanism and devices.. etc.

Module 6 COLD, MA & CA STORAGES: (7 hours)

Cold storage controlled and modified atmosphere storage – effects of nitrogen, oxygen, and carbon–di–oxide on storage of durable and perishable commodities – storage of dehydrated products – food spoilage and prevention.

Text Books:

1. Kirwan M.J., Derek McDowell D., and Coles R., "Food Packaging Technology", Blackwell Publication, ISBN No. 084939788X, 2003.

2. Robertson G.L., "Food packaging: Principles and practice", Taylor & Francis/CRC Press, ISBN No. 0849337755, 2006

Reference Books:

1. Ahvenainen R., "Novel Food Packaging Techniques", Woodhead Publishing, ISBN No. 1855736756, 2003.
2. Morris S.A., "Food and Package Engineering", Wiley – Blackwell, ISBN No. 1119949777, 2011

18FP3020 FOOD MATERIAL SCIENCE

3L:0T:0P **Credits : 3:0:0**

Course Objectives:

- To enable students understand the physical chemistry and kinetics of food systems
- To make the students understand the interaction of food constituents in maintaining the texture and structure of a food

Course Outcomes:

Students would be able

1. To understand the importance of glass transitions and its relation to stability
2. To understand the theory of gelling and its effect on texture of foods
3. To develop new products which are nutritional and cost effective
4. To understand the relationship between structure and properties of foods
5. To predict their behavior during storage
6. To develop cheaper sources of raw materials for a product

Module 1: GLASS TRANSITIONS IN FOODS (8 hours)

Basics of theory of glass transitions – crystalline and amorphous polymers, - difference, Glass transition temperature, crystallite melting point, Crystal melting point – Key elements of the food polymer science approach – Fringed micelle structural model – the dynamics map – Effect of molecular weight on Tg – Plasticizer – water as a plasticizer - Crystallisation – gelation mechanism – Polymer crystallization kinetics theory - Importance in food systems

Module 2: PHYSICAL CHEMISTRY OF FOOD GELS AND GELLING (8 hours)

Nature of the gel state – Mechanism of gel formation in food systems – point cross linking, extended junction zone formation, particle association and spinodal decomposition – gel network types. Basic Theories of gelation – Flory –Stockmayer theory – percolation theory, diffusion –limited aggregation model – mechanical properties of cured gels – Small deformation studies – differentiation between strong and weak gels - frequency dependence, strain dependence and temperature dependence of visco-elastic modulus – Large deformation studies – failure envelopes

Module 3: GENERATION OF ENGINEERED GEL STRUCTURES (7 hours)

Foods as composite materials – Characteristics of composite materials – solid foams and sponges – Fibrous structures – Reinforcement by solid particles and fibers – Mixed dairy gels – filled dairy gels – Cellular structures of fruits and vegetables

Module 4 : STRUCTURES & PROPERTIES OF FOOD EMULSIONS (7 hours)

General aspects of emulsions – Types of food emulsions – Oil in water, water in oil, water in oil in water- Measurement of particle size and size distributions in emulsions - Factors affecting stability of emulsions – Structures of adsorbed layers on the surfaces of emulsion droplets -Importance of interfacial layer – Protein stabilized emulsions and foams

Module 5: STRUCTURE –PROPERTY RELATIONSHIPS IN FOODS (7 hours)

Structure property relationships in foods- axes for food properties-texture-to axes quantifying texture in solid foods-food micro structure-structure property relationships in food structure-formation of structure in processed foods-modeling-simple models for viscoelastic foods-structure property relationships in nutrition and health-gastronomical engineering

Module 6: FOOD POWDERS AND THEIR CHARACTERISTICS (8 hours)

Processing of food powders-powder properties and functionality –production of food powders-spray drying-communition-processing food powders-coating-principles and mechanism-micro encapsulation-fluidized bed coating-granulation of food powders-segregation-process and mechanism-caking-particle breakage-degradation of ingredients and functionality

Text Books

1. Aguilera JM and LillfordP.J., "Food Materials Science - Principles And Practice", Springer, USA. e- ISBN No. 978-0-387-71947-4. 2008.
2. Schwartzberg H.G., and Hartel R.W., "Physical Chemistry of Foods", Marcel Dekker Inc., New York, ISBN No. 0824786939, 1992.

Reference Books

1. Bhandari B. and Roos Y.J. "Food Materials Science And Engineering", Wiley Blackwell Publishing Ltd., UK. ISBN 978-1-4051-9922-3. 2012
2. Friberg S., Larsson K. and Sjoblom S. "Food Emulsions" Marcel Dekker Inc., Fourth Edition, ISBN No. 0824746961, 2004.
3. Damodaran S., Parkin K. and Fennema O.R.,"Fennema's Food Chemistry", CRC Press, ISBN No. 0849392721, 9780849392726, 2008.
4. Belitz H-D., Grosch W.and Schieberle P., "Food Chemistry"- Springer Verlag, Berlin Heidelberg, Germany, III Revised Edition, ISBN No. 3540408177, 2004.

18FP3021 GREEN CHEMISTRY AND TECHNOLOGY

3L:0T:0P **Credits : 3:0:0**

Course Objectives:

To enable the students understand

- the basics of Green chemistry
- the importance of eco-friendly methods of manufacture of various products

Course Outcomes:

On completion of the course, the students will be able to

1. Understand the basics of Green chemistry
2. Gain knowledge on sustainability and life cycle assessment
3. Gain knowledge and apply solid acid catalysts in synthesis
4. Choose an eco-friendly and cost-effective method of manufacture of products
5. Improve existing methods for improved efficiency and economics
6. Develop novel methods for improved efficiency and economics

Module 1 INTRODUCTION AND PRINCIPLES OF GREEN CHEMISTRY (8 hours)

Chemistry Past, Present and Future – The Costs of Waste – The Greening of Chemistry – Green chemistry and Industry – Waste Minimization and Atom Economy – Atom Economy, Some Inherently atom economic reactions and Some Inherently Atom Uneconomic reaction - Reduction of energy requirement – Some energy efficiency improvements and Alternate energy sources - Chemistry of Atmosphere – Chemistry of oceans

Module 2: SUSTAINABILITY AND LIFE CYCLE ASSESSMENT (LCA) (8 hours)

Concept of Sustainability – Green Chemistry and Sustainabilitys parameters – LCA methodology – Methodological Framework – Applications of LCA – Product Oriented LCA – Process Oriented LCA

Module 3: SOLID ACID CATALYSTS (7 hours)

Concepts in Acidity and Solid Acid Catalysts – Industrial Applications of Solid Acid Catalysts – Zeolite based Solid Acid Catalyst, HeteroPolyacid based Solid Acid Catalyst, Sulphated Zirconia, Ion Exchange Resins and Acidic Pillared Clays - Recent Developments in Catalytic Materials and processes

Module 4: MICELLE TEMPLATED SILICAS AS CATALYSTS (7 hours)

Structured Mesoporous Materials – Synthesis of Micelle Templated Materials, Post Functionalisation of Micelle Templed Materials and Direct Preparation of Organically Modified Micelle Templated Silicas - Catalytic Applications

Module 5: BIOCATALYSIS AND GREEN CATALYSTS FOR INDUSTRY (8 hours)

Chemical production by Biocatalysts – Bulk chemicals, Pharmaceuticals, Flavour and Fragrance Compounds, Carbohydrates and Polymers - Green Biocatalystic processes – Biocatalysis in Supercritical Carbon dioxide, Biocatalysis in Waste treatment and Biodesulfarisation - Supported Reagents – Envirocats – Advantages – Activation – General methods for using Envirocats - Commercial Applications of Envirocats – Benzoylations, OlefinAlkylation, Sulfonylation, Esterificatins and Aerobic oxidation

Module 6: PROCESS INTENSIFICATION FOR GREEN CHEMISTRY (7 hours)

Relevance to Green Chemistry – Spinning Disc reactor – Microreactors – Intensified Cross-Corrugated Multifunctional Membranes - Properties of Superheated water – Extraction of materials other than natural products – Chromatography with Superheated Water – Extraction of Rosemary – Extraction of other plant materials

Text Book:

1. James Clark and Duncan Macquarrie, "Handbook of Green Chemistry and Technology", Blackwell Publishing, First Edition, ISBN – 0632057157, 2002.

Reference book

1. Stanley E. Manahan. "Green Chemistry and the Ten commandments of Sustainability", ChemChar Res. Inc., 2006. ISBN 0-9749522-4-9

18FP3022 FOOD SUPPLY CHAIN MANAGEMENT

3L:0T:0P **Credits : 3:0:0**

Course Objectives:

To enable the students understand

- fundamentals on logistics and supply chain management.
- to take up the logistics and supply chain activities in food industries.
- the various methods of supply chain management.

Course Outcomes:

On completion of the course, the students will be able to

1. Learn the methods of logistics.
2. Understand the concepts of supply chain management.
3. Get technical and IT exposure in LSCM.
4. Empower the students in the field of logistics and supply chain management.
5. Design logistics and supply chain management for food industries.
6. Handle supply chain in corporate arena.

Module 1 INTRODUCTION (9 hours)

Logistics and supply chain management - Scope, Significance and Drivers; Basic Model – Primary and Secondary Activities; Role and Challenges of Logistics and supply chain management in food industry.

Module 2- PROCUREMENT AND WAREHOUSING (9 hours)

Demand and supply management, Forecasting techniques, Strategic planning for material sourcing, Outsourcing strategies, Warehouse strategies, Inventory models and control techniques

Module 3 - DISTRIBUTION AND TRANSPORTATION (9 hours)

Various sources of distribution channels, Distribution models, 3PL and 4PL, Distribution network planning, Modes of transportation, Design of transshipment .

Module 4- PACKAGING AND INFORMATION TECHNOLOGY (9 hours)

Applications of Packaging in logistics, Types of packaging and packaging materials, Export & import packaging and labeling details, Containerization, Pervasiveness of IT in Supply Chain Management – ERP, Bar-coding, RFID, GPS, E-Procurement.

Module 5 - GLOBAL LSCM (5 hours)

Export and import procedure and Documentation, Risk management in global logistics, Customer relationship management in LSCM

Module 6 PERFORMANCE ANALYSIS (4 hours)

Performance metrics in Supply Chain, Indian agencies- EIC, EIA, APEDA, MEPEDA. Rapid alert system.

Text Book

1. D K Agarwal, Logistics and supply chain management, Macmillan Publishers India Ltd., Eighth Impressions, 2010.

Reference Books

1. Sunil Chopra and Peter Meindi, Supply chain management Pearson Education publishers, 2010.

2. David Taylor and David Brunt, Manufacturing Operations and Supply chain Management, Vikas Thomson Learning publishers, 2009.

18FP3023 FOOD PLANT LAYOUT AND DESIGN

3L:0T:0P **Credits : 3:0:0**

Course Objectives :

- To enable the students understand various concepts of economics of food plant.
- To understand the processes involved in layout design.
- To understand the development and design consideration and cost estimation in food industry.

Course Outcomes :

The students will be able to

1. Gain knowledge on the various factors involved in setting up a Food Processing Industry.
2. Understand the process of food plant layout design.
3. Apply their knowledge to design projects for setting up a Food Processing Industry.
4. Analyse the problems involved in deciding the level of manufacture of a food product
5. Evaluate the options involved and decide on the right choice based on the economics of the system
6. Develop own industry or plan turn-key projects based on the request from customers

Module 1: Food Process Design Development (7 hours)

Technical feasibility survey of Food Industry, process development, Food Process flow sheets — Computed-aided process design – Principles of spread-sheet aided process design (Basic concepts only)

Module 2: Plant Layout (7 hours)

Marketability of the product, availability of technology, raw materials, equipments, human resources, land and utilities, site characteristics, waste disposal, Government regulations and other legal restrictions, community factors and other factors affecting investment and production costs. Plant Layout based on process and product. Richard Muther's Simple Systematic Plant Layout.

Module 3: Overview of Sanitary and Hygeinic Design and Layout (6 hours)

Hygienic food process design – Principles of Sanitary design - equipment design and specifications- Basic outline on FSMS

Module 4: Project Evaluation and Cost Estimation (9 hours)

Capital investments – fixed capital investments including land, building, equipments and utilities, installation costs (including equipments, instrumentation, piping, electrical installation and other utilities), working capital investments. Methods of Cost estimation – Cost Indices.

Module 5: Product Cost and Plant Overheads (9 hours)

Manufacturing costs – Direct production costs(including raw materials, human resources, maintenance and repair, operating supplies, power and other utilities, royalties, etc.). – Process Profitability - Application to a Food Processing plant e.g. Tomato processing - Administration, safety and other auxiliary services, payroll overheads, warehouse and storage facilities etc. Depreciation, Amortization and methods of determining the same.

Module 6: Profitability Analysis (7 hours)

Return on original investment, interest rate of return, accounting for uncertainty and variations and future developments. Cash flow diagram and its importance - Optimization techniques – Linear and Dynamics programming, Optimization strategies.

Text Book

1. Peters and Timmerhaus, Plant design and Economics for Chemical Engineers, McGraw Hill 5th Edition, ISBN-007-124044-6, 2004 .

Reference Books

1. Rudd D F and Watson C C, Strategy of Process Engineering, John Wiley & Sons Inc, ISBN-978-0471844559, 2013
2. Maroulis Z.B. and Saravacos G.D. Food Process Design, Marcel Dekker Inc. ISBN-0824743113, 2003.
3. Towler G and Sinnott R.K. Chemical Engineering design principles, practice and Economics of Plant and Process. 2nd Edition. Elsevier, ISBN-9780080966595, 2012
4. Rudd and Watson, Strategy of Process Engineering, Wiley and Sons, 1987

5. Baasel W.D. Preliminary chemical engineering plant design, van Nostrand Reinhold, 2nd Edition, 1990
6. Heldman D.R. and Lund D B. Hand Book of Food Engineering, 2nd edition, CRC Press, Taylor and Francis Group, 2007

LIST OF COURSES

Sl. No.	Course Code	Name of the Course	Credits
1	17FP2001	Principles of Food Process Engineering	3:0:0
2	17FP2002	Applied Thermodynamics for Food Engineers	3:1:0
3	17FP2003	Food Chemistry	3:0:0
4	17FP2004	Fluid Mechanics for Food Engineers	3:0:0
5	17FP2005	Food Microbiology	3:0:0
6	17FP2006	Food Microbiology Lab	0:0:2
7	17FP2007	Fluid Mechanics and Heat Transfer Lab	0:0:2
8	17FP2008	Food Analysis Lab –I	0:0:2
9	17FP2009	Food Biochemistry and Nutrition	3:0:0
10	17FP2010	Heat and Mass Transfer	3:0:0
11	17FP2011	Dairy Engineering and Technology	3:0:0
12	17FP2012	Unit Operations in Food Process Engineering - I	3:0:0
13	17FP2013	Fruit and Vegetable Processing Technology	3:0:0
14	17FP2014	Unit Operations in Food Process Engineering and Grain Processing Lab	0:0:2
15	17FP2015	Food Biochemistry Lab	0:0:2
16	17FP2016	Unit Operations in Food Process Engineering - II	3:0:0
17	17FP2017	Refrigeration, Air conditioning and Cold Storage Construction	3:0:0
18	17FP2018	Mechanical Systems for Food Processing	3:0:0
19	17FP2019	Cereals and Pulses Technology	3:0:0
20	17FP2020	Bakery, Beverages and Confectionery Technology	3:0:0
21	17FP2021	Food Safety Regulations	3:0:0
22	17FP2022	Food Enzymology Lab	0:0:2
23	17FP2023	Food Product Technology Lab - I	0:0:2
24	17FP2024	Engineering Properties of Food Materials	3:0:0
25	17FP2025	Engineering Properties of Food Materials Lab	0:0:2
26	17FP2026	Food Engineering and Packaging Lab	0:0:2
27	17FP2027	Food Process Equipment Design	3:0:0
28	17FP2028	Food Analysis Lab – II	0:0:2
29	17FP2029	Computer Aided Food Process Equipment Design Lab	0:0:2
30	17FP2030	Food Additives	3:0:0
31	17FP2031	Plantation Products and Spices Technology	3:0:0
32	17FP2032	Fat and Oil Processing Technology	3:0:0
33	17FP2033	Technology of Meat, Poultry and Fish	3:0:0
34	17FP2034	Drying Technology	3:0:0
35	17FP2035	Food Packaging Technology	3:0:0
36	17FP2036	Storage Engineering	3:0:0
37	17FP2037	Process Economics and Plant Layout Design	3:0:0
38	17FP2038	Non Thermal Techniques of Food Preservation	3:0:0
39	17FP2039	Functional Foods and Nutraceuticals	3:0:0
40	17FP2040	Food Additives Lab	0:0:2
41	17FP2041	Food Product Technology Lab – II	0:0:2
42	17FP2042	Principles of Food Science and Nutrition	3:0:0
43	17FP2043	Processing of Food Commodities	3:0:0
44	17FP2044	Technology of Packaging	3:0:0
45	17FP2045	Nutrition and Food Science	3:0:0

17FP2001 PRINCIPLES OF FOOD PROCESS ENGINEERING

Credits: 3:0:0

Course Objectives:

- To understand the basic principles involved in food process engineering.
- To apply the principles in food processing.
- To perform calculations for basic operations in food processing.

Course Outcomes:

- To enumerate the units and dimensions of various physical quantities.
- To express the laws and theory of gases and vapours.
- To describe the types and properties of fluid flow.

- To calculate the material balance in food processing units.
- To appraise the performance of processing units
- To validate the energy balance involved in food processing operations.

Unit I - DIMENSIONS AND UNIT : Fundamental -derived units. Definitions of some basic physical quantities – Force, momentum, pressure, work and energy, power, heat and enthalpy. Dimensional analysis. Mole – atomical molar mass. Moisture content.-water activity

Unit II - GASES AND VAPORS : Behavior of Gases – Kinetic Theory of gases – Perfect Gas – Gas laws – Ideal gas laws – Real gas- Van der Waal's equation -pure component vapour pressure- partial pressure Dalton's law. Pure component volume-Amagat's law – psychrometry -humidity, relative humidity, saturation humidity –wet and dry bulb temperature-dew point –psychrometric chart reading.

Unit III - FLOW OF FLUIDS : Fluids-Properties, vapor pressure, suface tension, capillary effect, concept of viscosity-types of fluid. Bernoulli equation-fluid flow-laminar, turbulent ; pressure drop in pipes, valves and bends, Orifice meter, Venturimeter , Rotameter, Pitot tube –working principles.

Unit IV - MATERIAL BALANCE : Law of Conservation of mass- Process flow diagram-system boundaries -overall mass balance – component mass balance –basis and tie material- Continuous vs. Batch-Recycle and by pass-unsteady state -mass balance problems on concentration, dehydration, evaporation, crystallization, mixing –solvent extraction –multi stage process.

Unit V - ENERGY BALANCE : Heat capacity – gases – solids – liquids -Latent heat – sensible heat -energy balance for a closed system and open system -total energy balances. Energy balance problems in heat exchangers –Drying.

Text Books

1. Romeo T. Toleda. "Fundamentals of Food Process Engineering". Chapman & Hall, USA, CBS publications, New Delhi, 2000.
2. Smith, PG. "Introduction to Food Process Engineering ", Springer, 2004.

Reference Book

1. Paul Singh R, and Dennis R.Heldman ."Introduction to Food Engineering". Academic Press – Elsevier India Private Ltd. New Delhi, 2004.

17FP2002 APPLIED THERMODYNAMICS FOR FOOD ENGINEERS

Credits: 3:1:0

Course Objectives

- To understand the importance of thermodynamics in food system.
- To apply the concept of statistical thermodynamics for various food system
- To develop an efficient system using thermodynamic principle

Course Outcomes

- To identify the thermodynamic variables that will affect the food processing
- To estimate the effect of various thermodynamic properties on food system
- To solve the problems related to food processing using thermodynamic principles
- To model food system based on thermodynamic properties
- To develop an efficient food processing method
- To predict the bottleneck using the thermodynamic principles

Unit I - FUNDAMENTAL CONCEPTS AND CALCULATION OF THERMODYNAMIC QUANTITIES: Thermodynamic terms, variables, processes and states. First and zeroth law of thermodynamics. State and path function. C_p and C_v. Joule Thomson porous plug experiment. Calculation of thermodynamic quantities - Isothermal expansion, free expansion and adiabatic reversible process.

Unit II - FIRST AND SECOND LAW OF THERMODYNAMICS AND ITS APPLICATION : Steady flow energy equation and its application to steam generator, condenser, nozzles and air compressors. Second law of thermodynamics and its application to refrigerator, heat engine and heat pump. Concept of entropy and calculation of entropy changes.

Unit III - THERMODYNAMIC PROPERTIES OF PURE FLUIDS : Energy properties, Helmholtz and Gibbs free energy, fundamental property relations, Maxwell's equations - Clausius - Clapeyron equations. Differential equation for S, U, H. Gibbs- Helmholtz equation. Fugacity, fugacity coefficient, activity, effect of temperature and pressure on fugacity, determination of fugacity of real gases.

Unit IV - PROPERTIES OF SOLUTIONS : Partial molar properties, concept of chemical potential, fugacity in solutions-Lewis Randall rule, Raoult's law, Henry's law. Activity in solutions- activity coefficients, pressure and temperature effects, Gibbs- Duhem equations.

Unit V - PSYCHROMETRY : Psychrometric properties of air. Psychometric charts, psychrometric process – sensible heat exchange process, latent heat exchange process, adiabatic mixing, evaporative cooling – problems.

Text Books

1. Narayanan K.V., A Text book of chemical engineering thermodynamics, PHI Learning Private Limited, 2015.
2. Rastogi R.P. and Misra R.R., An Introduction to chemical thermodynamics, Vikas Publishing House Pvt Ltd.,2015.

Reference Books

1. Nag P.K., Engineering Thermodynamics, McGraw Hill Education(India) Private Limited, 2014.
2. Roy Choudhury T., Basic Engineering Thermodynamics, Tata McGraw Hill, 2000
3. Vanwylen and Sontag, Fundamentals of Classical thermodynamics, Wiley Eastern, 2005.

17FP2003 FOOD CHEMISTRY

Credits : 3:0:0

Course Objectives :

- To understand the chemistry of food constituents
- To apply fool molecules interaction in developing technologies / processes
- To develop skills for experimenting with food systems and to test various approaches for manipulating the chemical and/or functional properties of foods.

Course Outcomes :

- To name and describe the general chemical structures of the major components of foods (water, proteins, carbohydrates, and lipids) and selected minor components (vitamins and minerals).
- To relate the chemical composition of foods to their functional properties
- To understand, plan, perform and analyse a range of chemical investigations with an emphasis on food analysis
- To give a molecular rationalization for the observed physical properties and reactivity of major food components.
- To predict how changes in overall composition are likely to change the reactivity of individual food components.
- To evaluation and to determine approaches that may be used to control the reactivity of those food components that are likely to impact the overall quality of finished products.

Unit I - WATER AND ICE : Importance of water in foods - Structure of water & ice - concept of bound & free water. Sorption phenomena and sorption isotherms with example. Dispersed systems - gels & emulsion.

Unit II - CHEMISTRY OF CARBOHYDRATES : Nomenclature, classification & structure of carbohydrates, chemical reactions of carbohydrates, physical & chemical properties of sugars, chemistry of polysaccharides, properties and preparation of pectic substances, gums, starch and its hydrolytic products, cellulose, cyclodextrins maltodextrins, HFCS.

Unit III - CHEMISTRY OF LIPIDS : Nomenclature, classification of lipids. Basic Structures and chemistry of fatty acids & glycerides. physical & chemical characteristics of fats & oils Phospolipids, and unsaponifiables, auto oxidation and hydrolysis, antioxidants. Process flow sheet for the manufacture of edible oils (refined and hydrogenated)

Unit IV - CHEMISTRY OF PROTEINS : Nomenclature, classification, structure and chemistry of amino acids, peptides & Proteins. Functional properties of Protein. Isolation, identification & purity of Proteins. Protein denaturation. Enzymes: Introduction, classification & nomenclature of enzymes. Specificity. amylases, pectic enzymes, proteases; glucose oxidases, catalases, peroxidases, lipoxygenases, xanthine oxidases. Immobilized enzyme - One example of working of each enzyme.

Unit V - CHEMISTRY OF VITAMINS AND NATURAL COLOURANTS : Fat-soluble and water soluble vitamins – Choline, carnitine. Summary of vitamin stability – Toxicity and sources of vitamins – Bioavailability of vitamins – Reasons for the loss of vitamins in foods – Overview of natural colourants, sources, chemistry and applications of anthocyanin, betalain, carotenoids and chlorophyll.

Text Books

1. Srinivasan Damodaran, Kirk L. Parkin, Owen R. Fennema. (2007), Fennema's Food Chemistry – 4th Edition, CRC Press, Taylor & Francis group, USA, ISBN- 9780849392726.
2. H.D. Belitz, W. Grosch, P. Schieberle (2009) Food Chemistry – 4th revised and extended edition, Springer-Verlag Berlin Heidelberg, ISBN 978-3-540-69933-0

Reference Books

1. John M deMan, (1999) Principles of Food Chemistry – 3rd edition, Springer New York Heidelberg Dordrecht London ISBN 9781461463900 (eBook).
2. **N. Michael Eskin.** (1990) Biochemistry Of Foods – 2nd Edition Academic Press, USA ISBN 13: 9780122423512
3. David S.Robinson: Food Biochemistry and Nutritional Value Longman Scientific and Technical Publishers, USA (1987)

4. Pieter Walstra: Physical Chemistry of Foods Marcel Dekker Publishing, New York (2003) ISBN 9780824793555
5. Zdzislaw and E.Sikroski: Chemical and functional Properties of Food Components: 3rd edition, CRC Press, Taylor & Francis group USA (2006), ISBN - ISBN 9780849396755.

17FP2004 FLUID MECHANICS FOR FOOD ENGINEERS

Credits: 3:0:0

Course Objectives:

- To have an in depth knowledge of fluid mechanics.
- To apply fluid mechanics to the area of food engineering.
- To perform basic design calculations for fluid flow in pipes

Course Outcomes:

- To recognize the various properties of fluids.
- To express the units of different properties of fluids.
- To describe the pressure and its measurement.
- To calculate the forces acting on bodies submerged in different positions in liquids.
- To identify the type of flow of fluid.
- To solve problems on fluid flow measurement.

Unit I - PROPERTIES OF FLUIDS : Introduction- Units and Dimensions – Properties of fluids-Density – Specific weight - Specific Volume- Specific gravity- Viscosity-Thermodynamic properties-Compressibility and Bulk modulus- Surface tension and Capillarity -Vapour pressure and cavitation.

Unit II - PRESSURE AND ITS MEASUREMENT : Fluid pressure at a point- Pascal's law- Pressure variation in a fluid at rest-Absolute, Gauge, Atmospheric and vacuum pressures- Measurement of pressure-Simple manometers-Differential manometers.

Unit III - FLUID STATICS : Hydro static forces on surfaces- Total pressure and centre of pressure- Vertical plane surface submerged in liquid- Horizontal plane surface submerged in liquid- Inclined plane surface submerged in liquid- curved surface submerged in liquid.

Unit IV - BASIC CONCEPTS OF FLUID FLOW AND MEASUREMENT : Kinematics of flow-Types of fluid flow-Rate of flow-continuity equation- continuity equation in three dimensions- velocity and acceleration-velocity potential function and stream function- Dynamics of Fluid flow- Equations of motion- Euler's equation of motion- Bernoulli's equation- Practical applications of Bernoulli's equation – Venturimeter- Orifice meter-Pitot tube.

Unit V - FLOW THROUGH PIPES : Reynolds Experiment- Laminar and turbulent flow- Loss of energy in pipes- Loss of energy due to friction- Minor energy losses-Hydraulic gradient and Total Energy line- Flow through pipes in series- Equivalent pipe-Flow through parallel pipes- Flow through branched pipes-Power transmission through pipes- Water hammer in pipes.

Text Books

1. Bansal, R.K., "Fluid Mechanics and Hydraulic Machines", Laxmi Publications, New Delhi, 9th edition, 2011.
2. Modi, P.N. and Seth, S.M., "A Text book of Fluid Mechanics and Hydraulic Machines", Standard Book House, New Delhi, 2007.

Reference Books

1. Som, S.R and Biswas, "Introduction to Fluid Mechanics and Fluid Machines", Tata McGraw Hill, 2nd edition, 2007.
2. Rajput, R.K., "A Text book of Fluid Mechanics and Hydraulic Machines", S. Chand and Co., New Delhi, 2008.
3. Agarwal, S.K., "Fluid Mechanics and Machinery", Tata Mc Graw Hill Co.New Delhi, 2006.

17FP2005 FOOD MICROBIOLOGY

Credits : 3:0:0

Course Objectives:

- To understand the microorganisms associated with foods and isolation methods of microorganisms from foods.
- To know the methods of preservation of foods.
- To learn the fermentation process and microorganisms involved in the production of fermented foods.

Course Outcomes:

- To name and describe the beneficial and spoilage microorganisms associated with food.
- To understand the growth and methods of isolation of microorganisms from food.

- To enumerate the spoilage factors and the conventional methods of preservation fermentation process and fermented food products.
- To evaluate the role of microorganisms in various foods and water.
- To predict the causative agent and pathogenesis of disease causing foodborne pathogens and their toxins.

Unit I - INTRODUCTION, SCREENING AND ISOLATION OF MICROORGANISMS: Basic of Microbial existence - Micro organisms associated with foods: Bacteria, Molds, Yeast and their importance – Nutritional requirements of bacteria- Factors affecting the growth of bacteria –Growth curve of bacteria - antimicrobial barriers and constituent- .Spoilage and contamination in various food commodities- General Microbiological Methods of enumeration and isolation of bacteria and fungi,-Identification of bacteria and fungi by staining methods.

Unit II - CONVENTIONAL METHODS OF PRESERVATION: Thermal mode of preservation – Pasteurisation ,sterilization and Canning – Heat resistance of microorganisms and their spores – spoilage of canned foods and types of spoiled cans – aseptic packaging - Low-temperature storage. Non-thermal methods of preservation **:** High pressure processing – Pascalisation - Irradiation – Brief account of microwave, UV and ionizing radiation - Use of chemical preservatives, Natural food preservatives.

Unit III - MICROBIOLOGY OF FERMENTED FOODS: Traditional vegetable fermentation –Sauerkraut - Lactic acid, citric acid, and Acetic acid fermentation - Alcohol production – Beer, wine - Fermentation of oriental food products.

Unit IV - MICROBIOLOGY OF WATER AND FOOD COMMODITIES: Microbiology of water and their importance in processing of foods in industries. MPN of coliforms, Membrane filtration Technique. Microbiology of milk –Phosphatase test. Hetero and homo fermentative Lactic acid bacteria – Yogurt and Cheese fermenting organisms –Aflatoxin producing organisms and their importance in foods.

Unit V - FOOD BORNE PATHOGENS: Food Poisoning and intoxication – food borne diseases – Symptoms of diseases caused by Bacillus spp., Clostridium botulinum, Escherichia coli, Salmonella spp, Staphylococcus aureus, Shigella spp., Hepatatis, Gastroenteritis viruses, Entamoeba histolytica.

Text Book

1. Adams M.R and Moss M.O, "Food Microbiology", Panima Publishing corporation, New Delhi, 2nd Edition, Third reprint, ISBN-13:9788122410143,978-8122410143, 2007.

Reference Books

1. Sivasankar B, "Food Processing and Preservation", PHI Learning Private Limited, Easterrn Economy Edition, 6th edition, ISBN- 97881203-2086-4, 2009.
2. William C Frazier and Dennis C. Westoff, "Food Microbiology", Special Edition, Springer, The Mc Graw-Hill Companies, ISBN-9780070667181, 2008.

17FP2006 FOOD MICROBIOLOGY LAB

Credits : 0:0:2

Course Objectives:

- To understand the working principle of microscopes and sterilization techniques.
- To know the preparation of media for the cultivation of microorganisms.
- To identify the isolated strains using staining techniques and biochemical tests.

Course Outcomes:

- Use aseptic technique to properly handle microorganisms to avoid contamination.
- Understand and apply the knowledge to handle microscopes to observe stained microorganisms.
- Enumerate the microorganisms to check the quality characteristics of food.
- Isolate the pure culture from mixed population found in contaminated foods.
- Identify the microorganisms using staining techniques.
- Assess the quality of raw milk by methylene blue reduction test.

List of Experiments

1. Microscopy
2. Sterilization and Disinfection
3. Preparation of culture media.
4. Methods of pure culture techniques for bacteria.
5. Staining techniques - Monochrome staining
6. Gram staining
7. Negative staining,
8. Lacto phenol cotton blue staining for fungi.
9. Hanging drop preparation to observe motility of bacteria
10. Enumeration of microorganisms from water/milk
11. Enumeration of microorganisms from any contaminated food.

12. MPN Test for coliforms.
13. Methylene blue reduction test for assessing the quality of raw milk.
14. Biochemical characterization of bacteria.

17FP2007 FLUID MECHANICS AND HEAT TRANSFER LAB

Credits : 0:0:2

Course Objective:

- To provide extensive knowledge on various flow measuring equipments involved in food industries.
- To equip the students to operate and measurement of the heat transfer equipments.

Course Outcomes:

The students will be able to

- Understand the importance of fluid flow in industrial applications.
- Describe the use of flow measuring devices.
- Demonstrate the loss of energy due to friction in pipes.
- Calculate the losses of energy due to fittings in pipe flow systems.
- Evaluate the required length of pipes for fluid flow.
- Demonstrate the heat transfer equipments and their performance.

List of Experiments

1. Determination of coefficient of discharge of Venturi meter
2. Determination of coefficient of discharge of Orifice meter
3. Calibration of Rotameter
4. Determination of pipe friction and pressure drop due to sudden contraction and expansion during fluid flow
5. Determination of friction loss and pressure drop in Helical coil
6. Determination of Equivalent Length of pipe fittings during fluid flow
7. Determination of pressure drop in annular pipes
8. Pressure drop across Fluidized bed columns
9. Heat transfer studies in a tubular heat exchanger (Parallel and counter flow)
10. Heat transfer studies in a plate heat exchanger (Parallel and counter flow)
11. Heat transfer studies of a shell and tube heat exchanger
12. Heat transfer through composite walls

17FP2008 FOOD ANALYSIS LAB - I

Credits : 0:0:2

Course Objectives:

- Demonstrate an ability to assess the most appropriate analytical procedure required for a particular food analysis problem.
- Demonstrate practical knowledge of selected food analysis techniques.

Course outcomes:

Learners who successfully complete this course will be able to:

- Gain knowledge in the terminology used in food analysis
- Understand how food analysis fits into the food industry.
- Learn relevant procedures and equipment
- Gain experience with proximate analysis of foods
- Familiar with precision and accuracy through experiences with components of analysis and reporting results.
- Demonstrate oral and written communication skills to effectively communicate scientific ideas related with food analysis

List of Experiments

1. Estimation of Reducing sugars by Willstatter' Iodometric Titration
2. Estimation of Reducing sugars by Lane and Eynon's method
3. Estimation of Total sugars by Lane and Eynon's method
4. Estimation of Free Fatty Acids in Fats and Oils
5. Saponification Value of Fats and Oils
6. Peroxide Value of Fats and oils
7. Iodine Value of Fats and Oils
8. Estimation of α – Amino Nitrogen by Sorenson's Formol Titration
9. Estimation of Nitrogen by Kjeldhal's Method
10. Estimation of Vitamin C
11. Estimation of iron
12. Estimation of Calcium

13. Qualitative Analysis of Sugars
14. Qualitative Analysis of Amino Acids
15. Identification of Sugars by Paper Chromatography
16. Identification of Aminoacids by Paper Chromatography

17FP2009 FOOD BIOCHEMISTRY AND NUTRITION

Credits : 3:0:0

Course Objectives :

- To understand about metabolic pathways and nutrition
- To apply knowledge on the legal aspects of formulating and labelling functional foods and dietary supplements.
- To develop a food product of high nutritive value

Course Outcomes :

- To describe the structure of ATP and identify the major class of macromolecules to which ATP belongs.
- To list the stages in the catabolism of food molecules and describe what occurs during each stage.
- To describe the biochemistry process, basic concept of human nutrition and the relationship of the consumption of foods to nutritional status and health
- To evaluate the biological functions of foods for health in addition to nutritional values
- To evaluate the potential for adverse events related to dietary supplements
- To apply their knowledge in food biochemistry and nutrition in designing new range of products with improved nutritional characteristics (Nutraceuticals and functional foods).

Unit I - METABOLISM OF CARBOHYDRATES: Electron transport chain – glycolysis (EMP) pathway, TCA cycle, gluconeogenesis, Pentose phosphate shunt, interconnection of pathways, Metabolic regulation, Bioenergetics: Respiratory chain ATP cycle, energy rich compounds

Unit II - METABOLISM OF FATTY ACIDS AND PROTEINS: Biosynthesis and degradation of fatty acids and cholesterol - Biosyntheses and degradation of amino acids (one example each for sulphur containing, aliphatic, aromatic, heterocyclic, basic and acidic amino acids), peptides and proteins; Biosynthesis and degradation of purines, pyrimidines and nucleic acids, urea cycle.

Unit III - CONCEPTS OF NUTRITION: Basic concept of nutrition – Importance of nutrition and dietetics - Assessment of nutritional status – energy value of carbohydrates, proteins and fats – determination of energy value – balanced diet – Recommended dietary intake – Acceptable dietary intake – Protein efficiency ratio – Net protein utilisation and their determinations – Malnutrition and its problems – Nutrient supplementation & fortification - Nutritional labeling and its importance - Effect of processing on protein quality -carbohydrates in food and dietary fibre.

Unit IV - NUTRITIONAL DISORDERS: Inborn errors of carbohydrate, protein and fat metabolisms - Nutrition and disorders associated with organs such as liver and kidney - Naturally occurring anti-nutritional factors – Cyanogens, lectins, enzyme inhibitors, phytoallexins, phytates.

Unit V - SPECIALIZED NUTRITION: Nutrition for specialized purposes – Pediatric nutrition – geriatric nutrition – Sports nutrition – Nutrition during pregnancy. Ageing –Theories of ageing – Nutrition and ageing – Cancer and its prevention - Age-related metabolic disorders – Nutrition in the treatment of age-related disorders like hypertension, diabetes, alzheimer's disease.

Text Books

1. Voet D, Voet G, Principles of Biochemistry, 3rd edition, John Wiley and Sons, 2008. ISBN-13: 9780470233962, 978-0470233962.
2. Martin Eastwood, Principles of Human nutrition – 2nd edition. Wiley - Blackwell Publishing, 2003. ISBN: 978-0-632-05811-2

Reference Books

1. Ronald Ross Watson, Functional foods and Nutraceuticals in Cancer Prevention, Ed. Wiley – Blackwell, 2003. ISBN-13: 978-0813818542.
2. Nelson D.L., M.M. Cox, Lehninger Principles of Biochemistry, W.H. Freeman & Company Publications, 2013. ISBN-10: 1-4292-3414-8
3. Tymoczko, J.L., Berg, J.M., Stryer, L. Biochemistry – A short course, 3rd edition. W.H. Freeman. 2009. ISBN-10: 1-4641-2613-5
4. Sunetra Roday., "Food Science and Nutrition – 2nd edition, Oxford Higher Education/Oxford University Press, 2012, ISBN 10: 0198078862

17FP2010 HEAT AND MASS TRANSFER

Credits : 3:0:0

Course Objectives:

- To enable the student to basic study of the phenomena of heat and mass transfer, to develop methodologies for solving food engineering problems
- To understand the information concerning the performance and design of Heat exchangers
- To develop processes with better heat efficiency and economics

Course Outcomes :

- To understand the basic laws of heat transfer and account for the consequence of heat transfer in thermal analyses of engineering systems.
- To analyze problems involving steady state heat conduction in simple geometries.
- To evaluate heat transfer coefficients for natural convection.
- To analyze heat exchanger performance by using the method of log mean temperature difference.
- To analyze heat exchanger performance by using the method of heat exchanger effectiveness.
- To understand the influence of radiation in food processing operations.
- To understand basics of diffusion mass transfer and its application in food processing.

Unit I - HEAT TRANSFER – CONDUCTION: Modes of heat transfer – Conduction, Convection and Radiation. Fourier's Law of Heat conduction-Thermal Conductivity for gases, liquids and solids-Thermal diffusivity- Thermal resistance-Steady heat conduction in simple geometries:
Plane wall, hollow cylinder and hollow sphere through solids in series -plane wall and multilayer cylinder. Heat conduction through materials in parallel. Theory of insulation, critical radius of insulation.
Unit II - HEAT TRANSFER – CONVECTION: Convection heat transfer – forced and natural; Evaluation of convection heat transfer coefficient, Dimensionless numbers- Forced convection- Heat Transfer Coefficient for Laminar flow inside a tube -heat transfer coefficient for turbulent flow inside a pipe. – Heat Transfer outside various Geometries in Forced Convection – Flow parallel to flat plate - Natural convection from vertical planes and cylinders –boiling and condensation-mechanisms
Unit III - HEAT TRANSFER – RADIATION: Basics of Radiation heat transfer- Types of surfaces – Kirchhoff's Law-radiation from a body and emissivity (Stephan Boltzmann Law) to a small object from surroundings –Planck's Distribution law-Wein's Displacement law- combined Radiation and Convection Heat Transfer.
Unit IV - HEAT EXCHANGERS: Types-Overall Heat Transfer Coefficient-Shell and Tube1-1, 1-2, 2-4 passes –Plate Heat Exchanger-tubular heat exchanger-Parallel Flow and Counter Flow- Cross flow Types-Scraped surface exchangers-Compact Heat exchanger- Heat exchanger Analysis-Log mean Temperature Difference
Unit V - MASS TRANSFER: Physical Origin-Mixture composition-classification-concentration- velocities and fluxes. Fick's law- general equation of mass transfer in stationary media- steady state diffusion-equimolar diffusion-diffusion of water vapour through air-mass transfer coefficient –convective mass transfer

Text Book

1. Rao, D. G, "Fundamentals of Food Engineering", PHI Learning Pvt. Ltd., New Delhi. 2010.

Reference Books

1. McCabe W.L., Smit J.C and Harriott P, "Unit Operations of Chemical Engineering", McGraw-Hill International Edition, 7th Edition New York, ISBN-007-424-740-6, 2005.
2. Ballaney, P.L. "Thermal Engineering", Khanna Publishers, New Delhi. 2002
3. R.Palusingh, Dennis R. Heldman "Introduction to food engineering" 5th edition, Academic press 2014

17FP2011 DAIRY ENGINEERING AND TECHNOLOGY

Credits: 3:0:0

Course Objectives:

- To understand about milk, milk processing methodologies
- To provide knowledge about the milk processing equipments
- To provide technical know-how about the production of milk products (ice creams, fermented milk products)

Course Outcomes:

- To gain knowledge on milk source and composition
- To understand the various milk processing methods.
- To learn the milk processing equipments.
- To develop an understanding on milk packaging machines

- To demonstrate hands-on skills in manufacturing selected dairy products in a pilot plant setting
- To evaluate the safety and quality factors that determine the acceptability of the dairy products by consumers.

Unit I - DAIRY CHEMISTRY AND MICROBIOLOGY : Introduction - Basic dairy terminology - milk as raw material – composition - nutritive value - Physico-chemical constituents of milk and its constituents – contaminants - microbiology of milk- milk collection - cooling and milk transport - milk reception -Quality control tests - applications of enzymes in dairy industry

Unit II - DAIRY PROCESSING AND EQUIPMENTS : Milk processing equipment – filtration/clarification – Pasteurization – HTST – LTLT - UHT methods - storage tanks - Cream separating Centrifuges - Homogenization – theory - working principle of homogenizers – homogenization efficiency - cream separation – principles – gravity and centrifugal separation – centrifugal separator – parts – construction and working principle – separation efficiency

Unit III - BOTTLE, CAN WASHING AND FILLING EQUIPMENTS : Plant piping – Pumps - Bottle washers- and cappers- can washers-types of can washers-care and maintenance-factors affecting washing operation – Fillers - types of fillers-pouch filling form fill seal machines - aseptic filling - cleaning and sanitization - CIP cleaning- types of CIP systems - Energy use in Dairy plant - sources of energy - cost of energy - Control of energy losses and Energy conservation.

Unit IV - MILK PRODUCT PROCESSING : Butter – method of manufacture – theory of churning - operation of butter churn – over run—batch and continuous methods of butter making. Ghee – methods of manufacture - Cheese – classification – cheddar and cottage cheese - equipments – cheese vats and press-construction details. Ice cream - ingredients – preparation of ice cream mix - freezing – calculation of freezing point and refrigeration - batch and continuous freezers – Special milks - Quality aspects of dairy products.

Unit V - FERMENTED AND DEHYDRATED DAIRY PRODUCTS : Fermented products – Yoghurt – Curd – cultured butter milk Bulgarian butter milk – Kefir – paneer - acidophilus milk etc. - Concept of Probiotics and prebiotic foods – Vacuum Evaporators - drying of milk - drum drier and spray drier - components - construction and working principles.

Text Books

1. Tufail Ahmad, " Dairy Plant Engineering and Management", Kitab Mahal Publishers, New Delhi, 2016.
2. Sukumar De, "Outlines of Dairy Technology", Oxford University Press, New Delhi, 23rd impression, 2006.

Reference Books

1. Farrall,A.W. 1963. Engineering for dairy and food products. John Wiley and Sons, New York.
2. G. Bylund: Dairy Processing Handbook. Tetrapack publishers.
3. Walstra. P et al " Dairy Technology"Taylor & Francis ISBN-0-203-90999-2, 2005

17FP2012 UNIT OPERATIONS IN FOOD PROCESS ENGINEERING - I

Credits: 3:0:0

Course Objectives:

- To know the various types of equipments used in the food industry.
- To learn the operation and utilization of equipments involved.
- To choose suitable techniques for the food processing operation.

Course Outcomes:

- To define the various unit operations in food processing.
- To compute the moisture content of food materials.
- To describe and demonstrate the various process equipments.
- To evaluate the different operations in food processing.
- To estimate the energy requirement for the different unit operations.
- To develop unit operation system for food processing.

Unit I - DRYING AND DEHYDRATION : Moisture and its measurements - direct and indirect methods – Equilibrium moisture – methods of determination – EMC Models – Henderson ,Kelvin, PET and GAB models – importance of EMC- water activity – psychrometry — Drying theory – Drying rate – Mechanical Drying – hot air dryers – Types- fixed -fluidized bed – LSU drier-Spray drier- Osmotic dryer - vacuum shelf dryer – freeze dryer.

Unit II - MECHANICAL SEPARATION : Screening: Types, Equipments; Filtration: Filter media types and requirement – constant rate filtration – constant pressure filtration – filter cake resistance – filtration equipments – filter press – rotary drum filters – sedimentation – gravitational sedimentation – Stoke's law – sedimentation in cyclones. Centrifugal separations – rate of separation – centrifuge equipment.

Unit III - EVAPORATION : Definition – liquid characteristics – Types of evaporators -single and multiple effect evaporators - once through and circulation evaporators – Agitated film evaporators. Performance – evaporator capacity – boiling point elevation and Duhring's rule. Heat transfer coefficients – Evaporators economy – enthalpy balance of single effect evaporator – multiple effect evaporator – methods of feeding. Capacity and economy of multiple effect evaporator.

Unit IV - SIZE REDUCTION: Principles of comminuting – characteristics of comminuted products – particle size distribution in comminuted products – energy and power requirements – Rittinger's, Kick's and Bond's law – Size reduction equipments – crushers – hammer mill – Ball mill-Colloidal mill-attrition mills.

Unit V - MIXING : Definitions and principles– Basic equations standards. Evaluation of constants – work, energy and Power – Agitation and Mixing – Purpose of agitation – Agitated vessels – impellers – propellers – turbine –High efficiency impellers – Impellers for high viscosity liquids. Draft tubes – Power number – mixing and blending of miscible liquids, mixing index.

Text Books

1. DG Rao, "Fundamentals of Food Engineering" PHI Learning Private Limited, New Delhi.
2. Geankoplis CJ, "Transport Processes and Separation Processes Principles" .Printice Hall India, New Delhi, ISBN-978-81-203-2614-9, 2008
3. Warren,L McCabe, J.C. Smith and Peter Harriot,"Unit Operations of Chemical Engineering " McGraw Hill International Edition, Singapore, ISBN-007-424740-6, 2005

Reference Book

1. Earle, R.L, "Unit Operations in Food Processing". Pergamon Press,2nd Edition,UK, 2003

17FP2013 FRUIT AND VEGETABLE PROCESSING TECHNOLOGY

Credits: 3:0:0

Course Objectives:

- To enable the students to understand the processing of fruits and vegetables
- To impart technical knowledge of about how to develop products and preservation
- To understand the methods of dehydration

Course Outcomes:

- To understand the production status and post harvest handling methods of fruits and vegetables
- To learn the methods of processing and preservation of freshly harvested and cut fruits and vegetables.
- To enumerate the processing and preservation of fruits and vegetables by heat treatment.
- To illustrate the production and preservation methods of fruit juices.
- To understand the dehydration methods and design of driers used for drying fruit and vegetables.
- To describe the aseptic technology for product preservation.

Unit I - INTRODUCTION: Production of Fruits and vegetables in India. Cause for heavy losses, Composition of each of the major fruits and vegetables produced in the country- Spoilage factors, Post harvest field operations, Preservation treatments for freshly harvested fruits and vegetables, Packaging of whole fruits and vegetables for internal and export markets. Processing and packaging of cut fruits and vegetables.

Unit II - PRESERVATION OF FRUITS AND VEGETABLES: Canning operations of fruits and Vegetables.-Different filling, closing and sterilization operations- Blanching operations - Batch and Continuous Blanching. Concept of Hurdle technology as applied to fruit and vegetable preservation. Minimal processing. Bottled Products: Preparation of products like Jams, Jellies, Marmalades, Pickles, Puree, Ketchup, Sauce, and Squashes etc. - FSSAI specifications.

Unit III - PROCESSING OF FRUIT JUICES: Common machinery for operations like Peeling, Slicing/Dicing and Pulping. Preparation of specialty products like, Fruit juice concentrates, Fruit Bars and Fruit powders. Clarification of juices -Tomato products – Hot and Cold Break processes. Tomato Deseeding and clarification. Clarification centrifuges – Decanters and desludgers. Fruit juice aroma Recovery and its importance.

Unit IV - DEHYDRATION: Dehydration principles and equipment used for drying –Cabinet tray dryer,Tunnel dryer, Conveyor Belt dryer, Bin dryer, Fludised bed dryer, Freeze Dryers. Freeze drying Principles. Merits and demerits of Freeze Drying. Preparation of Fruit Powders. Working of Spray Dryer and Drum Dryer. Preparation of Dried slices, Intermediate Moisture Food.

Unit V - ASEPTIC PROCESSING: Aseptic processing and Bulk packing of Fruit juice concentrates. Aseptic heat exchangers for sterilizing and concentrating the product. Aseptic fillers. Tetra pack for small quantities, Dole system and Scholle system for bulk storage in Bag and Boxes and Bag & Drums.Storage of Aseptically packed products.

Text Book

1. Hui Y.H and Others, "Hand Book of Vegetable Preservation and Processing", Mercel Dekker, New York, 2004

Reference Books

1. Chakraverty, A., Mujumdar A.S., Raghavan G.S.V and Ramaswamy H.S. "Handbook of Post-harvest Technology" Marcel Dekker Press, USA, 2001.
2. L.R.Verma and V.K.Joshi, (2000) Post Harvest Technlogy of fruits and vegetables.Indus Publishing Co, NewDelhi.
3. P.Fellows, (2000) Food processing Technology: Principles and Practice.Wood Head publishing Limited, Cambridge, England.
4. James G. Brennan, (2006) Food Processing Hand book. Wiley-Ych Verlag Gmbh&Co KgaA, Weinheim, Germany

17FP2014 UNIT OPERATIONS IN FOOD PROCESS ENGINEERING AND GRAIN PROCESSING LABORATORY

Credits : 0:0:2

Course Objectives:

- To know the various types of equipments used in the food industry.
- To learn the operation and utilization of equipments involved.
- To choose suitable techniques for the food processing operation.

Course Outcomes:

- To study the various unit operations in food processing.
- To compute the moisture content and drying characteristics of food materials.
- To describe and demonstrate the milling equipments.
- To estimate the energy requirement for the grain milling operations.
- To estimate the mixing properties of flours and grains.
- To evaluate the performance of grain separators and rice mill.

List of Experiments

1. Studies on drying characteristics of vegetables using Cross flow dryer
2. Studies on drying characteristics of vegetables using Through flow dryer
3. Studies on drying characteristics of vegetables using Vibrofluidizer
4. Studies on size reduction of grains using multi mill
5. Studies on size reduction of grains using Disc/Pin mill
6. Studies on mixing properties using Ribbon mixer
7. Studies on mixing properties using Sigma mixer
8. Experiment on Dewatering Centrifuge
9. Studies on cleaning efficiency of specific gravity separator for grains
10. Experiment on milling efficiency using Rubber Roll Sheller
11. Experiment on Plate type pasteurizer
12. Experiment on oil extraction using oil expeller

17FP2015 FOOD BIOCHEMISTRY LAB

Credits : 0:0:2

Course Objectives:

- To gain knowledge of practices for proper literature reviews and evaluation of appropriate methods for analysis.
- To understand proper use of methods of analysis
- To interpret various methodologies for analysis of components in foods.

Course outcomes:

Learners who successfully complete this course will be able to:

- Demonstrate the presence of protein, lipid, carbohydrate and water in food using chemical methods
- Describe various separation and quantification techniques frequently used for food analysis.
- Evaluate proper selection and application of appropriate methods of analysis.
- Aware of how analytical techniques may be used determine food composition and quality
- Work with other students to successfully complete lab experiment
- Apply their knowledge in food biochemistry and nutrition in designing new range of products with improved nutritional characteristics

List of Experiments

1. Estimation of sugars by DNS method
2. Estimation of crude fibre
3. Estimation of proteins by the Biuret method
4. Estimation of total free amino acid
5. Estimation of proteins by Lowry's method
6. Estimation of proteins by dye-binding method
7. Estimation of thiamine

8. Estimation of ascorbic acid
9. Estimation of riboflavin
10. Estimation of carotenoids
11. Estimation of cholesterol
12. Estimation of total carbohydrate by anthrone method
13. Qualitative tests for checking of milk and water

17FP2016 UNIT OPERATIONS IN FOOD PROCESS ENGINEERING – II

Credits: 3:0:0

Course Objectives:

- To understand the various unit operations involved in food industry.
- To learn the operation and utilization of equipments involved.
- To choose suitable techniques for the food processing operation.

Course Outcomes:

- To understand the engineering operations that are critical to the food processing operations and industrial growth.
- To define the principles of food processing operations.
- To learn the material and energy balance related to the unit operations.
- To identify the factors affecting unit operations.
- To select suitable unit operations for a specific purpose.
- To appraise the performance of the mass transfer operations in food processing.

Unit I - DISTILLATION : Principles of diffusion and mass transfer -Fick's law – convective Mass transfer – Mass transfer for binary mixtures- definition of Distillation – Flash Distillation — continuous distillation with reflux – combined rectification and stripping- McCabe and Thiele method of determination of no of plates. – Advantages and limitations – distillation equipments – construction and operation – factors influencing the operation.

Unit II - LEACHING AND EXTRACTION : Definitions – Leaching equipment leaching by percolation through stationary solid- moving bed leaching –Dispersed solid – counter current leaching – number of ideal stages. Liquid extraction – Extraction equipment – mixer settlers – packed extraction towers – perforated plate towers – baffle towers – Agitated tower. Pulse column – centrifugal extractor.

Unit III - ABSORPTION AND ADSORPTION : Definition – rate of gas absorption – packing and packed tower for absorption – characteristics of packing- pressure drop and limiting flow rates – principles of absorption – mass balance.

Adsorption – equipment – fixed bed adsorber - pressure swing adsorption – Adsorption from liquids.

Unit IV - CRYSTALLIZATION : Crystallization equilibrium -rate of crystal growth – stage of crystallization – magma- nucleation crystallization equipment. Variations in crystallizers – vacuum crystallizers. Draft tube, baffle crystallizers.

Unit V - MEMBRANE SEPARATION : Micro, Ultra and Nano filtration. Types of membranes. Permeate flux for ultrafiltration – concentration polarization – Application of ultrafiltration, diafiltration – membrane fouling – Separation of gases – porous membrane – Polymer membrane – Membrane structure -flow patterns. – Pervaporation – Reverse Osmosis.

Text Books

1. DG Rao, " Fundamentals od Food Engineering" PHI Learning Private Limited, New Delhi.

Reference Book

1. Earle, R.L. "Unit Operations in Food Processing". Pergamon Press,2nd Edition,UK, 2003.
2. Geankoplis, CJ, "Transport Processes and Separation Processes Principles" .Printice Hall India, New Delhi, ISBN-978-81-203-2614-9, 2008.
3. Warren,L McCabe, J.C. Smith and Peter Harriot."Unit Operations of Chemical Engineering " McGraw Hill International ,7thEdition ,Singapore, ISBN-007-424740-6, 2005.

17FP2017 REFRIGERATION, AIR CONDITIONING AND COLD STORAGE CONSTRUCTION

Credits: 3:0:0

Course Objectives:

- To enable the students to understand the various concepts behind refrigeration of food.
- To enable students to know about food freezing and equipment involved.
- To enable students to understand various aspects of cold storage.

Course Outcomes:

- To understand refrigeration of food and its operational components.

- To gain knowledge on various forms of food refrigeration in plants, stores and logistics.
- To learn advanced food freezing concepts and techniques.
- To study food safety aspects of chilled foods and frozen foods.
- To comprehend cold chain management in food distribution sector.
- To evaluate the cold storage and packaging of frozen perishable products.

Unit I - PRINCIPLES OF RERRIGERATION: Refrigeration – Ton of refrigeration, refrigeration cycles, Vapour Compression and Vapour Absorption cycles, Refrigerants, characteristics of different refrigerants, net refrigerating effect -Components of a Refrigeration system: Compressor, condenser, Evaporator, Expansion valves piping and different controls.

Unit II - COLD STORAGE: Insulation, properties of insulating materials, air diffusion equipment, Cold load estimation; prefabricated systems, walk-in-coolers, and Refrigerated container trucks: Freezer Storages, Freezer room Temperatures,

Cooling towers: introduction, Construction and Working; Cold Storage practice, Stacking and handling of materials, Optimum temperatures of storage for different food materials.

Unit III - AIR-CONDITIONING: Psychrometry. Psychrometric Processes. Simple Air Conditioning System – State and Mass Rate of Air. Evaporative, Winter and All Year Air Conditioning Systems. Design Conditions. Load Calculation and Psychrometry of Air Conditioning Systems –Design of Air conditioning apparatus – Transmission and Distribution of Air. Selection of Air Conditioning Systems.

Unit IV - FREEZING AND CHILLING OF FOODS: Freezing equipment, Freezing Time, Freezing Curve, Freezing rates, growth rate of ice crystals, crystal size and its effect of texture and quality of foods, Freezer types, Individual quick freezing. Cryogenic Freezing, Freezing practice as applied to different food sectors. Chilling equipment for liquid foods. Secondary refrigerants, Evaporative cooling and direct expansion techniques in chilling. Chilled foods transport and retail cabinets - Basics of Chilled foods microbiology, Packaging of Chilled foods.

Unit V - COLD CHAIN MANAGEMENT: Supply chain system - Important Factors to consider- logistic supply- Protocols for Domestic, Sea and Airfreight- Traceability and barcode – Product Temperature and Moisture monitoring- Refrigeration systems and Refrigerant types during field chilling, transportation via land, air and sea. Grocery stores and display cases, Home refrigerators - Cooling chain summary - Storage and packaging

Text Book

1. Clive.V.J Dellino, "Cold and Chilled Storage Technology", Chapman Hall India, 1997.

Reference Books

1. C.P. Arora, "Refrigeration and Air conditioning", Tata McGraw Hill, 2009.
2. Da-Wen Sun, "Handbook of Frozen Food Processing and Packaging", CRC Press, 2009.
3. Florkowski W.J, Shewfelt R.L, Brueckner B and Prussia S.E, "Post Harvest Handling and Sytems Approach", Second edition, Academic Press, 2009.
4. Colin Dennis and Michael Stringer: Chilled Foods – A Comprehensive Guide Brown.M WoodHead Publishing, 2008.

17FP2018 MECHANICAL SYSTEMS FOR FOOD PROCESSING

Credits: 3:0:0

Course Objectives:

- To provide knowledge about types of pumps and their applications.
- To learn about types of power transmission elements, steam generators and chillers.
- To understand the principles of material handling systems.

Course outcomes:

- To understand the working principle of pumps and their applications
- To know about the various power transmission elements and their design.
- To gain knowledge on working principle of boilers and measurement of performance.
- To study the working principle and applications of various mechanical refrigeration systems.
- To learn about the principles and applications of different food chillers and freezers.
- To appraise the construction and working principle of various material handling systems.

Unit I - FOOD PLANT PUMPS: Pumping theory- head developed-Types of pumps-Centrifugal pumps-Reciprocating pumps- piston pump-Rotary gear pumps- vane pumps- and diaphragm pumps-peristaltic pump-construction- working principles and applications (Simple problems).

Unit II - MECHANICAL POWER TRANSMISSION SYSTEMS: Types of shafts-design of shafts-solid and hollow shafts- types of coupling- belt drives-gear drives-chain drives and rope drives-types and materials (Simple problems).

Unit III - STEAM GENERATION AND DISTRIBUTION: Types of Water tube and smoke tube boilers-

Boiler capacity- boiler specification- automatic boilers- Boiler mountings. Performance of steam generators (Simple problems).

Unit IV - REFRIGERATION SYSTEMS: Types of refrigeration systems- VCRs and VARs. Refrigerants, Components of refrigeration systems. Types of Chillers for Solid Foods, Types of Chillers for Liquid Foods, Types of Freezers. (Simple problems).

Unit V - MATERIAL HANDLING IN FOOD PLANTS: Material handling in food plants & Importance, Belt Conveyor, Roller Conveyor, Vibratory Conveyor, Screw Conveyor, Slat Conveyor, Pneumatic Conveyor, Bucket Elevator.

Text Books

1. P.G.Smith, "Introduction to Food Process Engineering", Springer international Edition, 2005
2. R.Paul Singh,Dennis R.Heldman; "Introductin to Food Engineering" (3rd edition), Academic press, Elsevier, 2001.

Reference Books

1. R.K Rajput, "Thermal Engineering", Laxmi Publications, 2008.
2. R.K.Bansal; "Fluid Mechanics and Hydraulic Machines", Laxmi publications (P) Ltd, 2004
3. C.P. Arora, "Refrigeration and Air conditioning", Tata McGraw Hill, 2009.
4. R.S. Khurmi and J.K. Gupta, "A Text Book of Machine Design", Eurasia Publishing House, 2005.

17FP2019 CEREALS AND PULSES TECHNOLOGY

Credits: 3:0:0

Course Objectives:

- To create awareness about the processing of major cereals like paddy, maize etc.
- To study the milling techniques of cereals and pulses
- To study about the byproducts obtained during processing along with their uses.

Course Outcomes:

- To gain knowledge about the basic composition and structural parts of food grains.
- To know about paddy processing and rice milling equipment which will help them for developing entrepreneurial skills.
- To apply the knowledge to process food grains into value added products.
- To acquire the skills of processing wheat, maize and corn.
- To develop skills needed in the milling of pulses.
- To study the processing and milling of maize which will promote gainful employment.

Unit I - PADDY PROCESSING : Structure and Composition of paddy – Cleaning of paddy - Pre Cleaners, - Paddy Parboiling Processes. Physico-chemical changes during parboiling – effect of parboiling on cooking qualities - Parboiling methods - Methods of grain drying- LSU, rotary, columnar, recirculatory dryers – By-products of paddy processing - Paddy husk and its uses as husk ash, activated carbon, furfural and other by products – Value added products - Flattened and Puffed Rice.

Unit II - RICE MILLING : Rice milling flow chart - Modern Rice Milling equipments – paddy milling - Dehusking of paddy - Engelberg Huller, Under runner disc shellers, rubber roll sheller and Centrifugal dehusker - Paddy Separators – Satake and Schule Designs – Rice Polishers - Cone polishers and other types - Bran and Brokens separators - Rice mill yields and loss due to brokens at different stages of milling – milling efficiency - Use of Rice Bran in Edible oil Industry.

Unit III - WHEAT MILLING : Structure and composition of wheat – flow chart for wheat milling – milling process - equipments used in wheat milling – parboiling of wheat – bulgur wheat – products and by products of wheat.

Unit IV - PROCESSING OF MAIZE/CORN : Structure and composition of maize – milling methods - Pre-cleaning - cleaning equipment - degermination and dehusking - Dry milling of maize – wet milling – flow chart - Products of milling – Flour – Semolina - Brewers' grits etc and their applications - Bran and Fibre separation - Gluten and Starch Separation - Equipment used - Starch conversion into other value added products – Acid Hydrolysis, Enzyme Hydrolysis, Isomerization processes - Processing for Dextrose, Malto Dextrin and other products - Extraction and refining of Corn oil in brief.

Unit V - MILLING OF PULSES : Structure and composition – need for pulse milling – Unit operations of pulse milling – domestic and commercial scale pulse milling methods – Dry and wet milling, CFTRI, CIAE, Jadavpur methods - Process flow chart – Pulse milling machineries - dehusking in Pulse Pearler - splitting of pulses in Pulse splitter - Mini dhal mill - working principle - advantages and disadvantages – pulse milling efficiency - Grinding of split pulses - pulse flour products - their applications and equipments used.

Text Books

1. KM. Sahay and KK. Singh. Unit operations of Agricultural Processing, Vikash Publishing house PVT Ltd. Delhi, 2014.

2. Chakraverty, A.: Post Harvest Technology of Cereals, Pulses and Oilseeds. Oxford and IBH Publishing Co, Calcutta, 2014.

Reference Books

1. Samuel A .Matz: "The Chemistry and Technology of Cereals as Food and Feed", Chapman and Hall, 1992.
2. Bernard Godon and Claude Willm, "Primary Processing of Cereals" Berns and Noble Publishers, 1994.
3. Karel Kulp and Joseph P Pante, "Handbook of Cereal Science and Technology", Mercel Dekkar, USA, 2000.

17FP2020 BAKERY, BEVERAGES AND CONFECTIONERY TECHNOLOGY

Credits: 3:0:0

Course Objectives:

- To provide know how on the machinery and process involved in the baking and confectionery process
- To understand the various types of sugar and its grades
- To know the process and machinery involved in the manufacture of beverages.

Course Outcomes:

- To gain knowledge on the ingredients, process and machinery involved in bakery and confectionery and beverage technology.
- To understand the importance and effect of quality of raw materials on the final products\
- To apply the knowledge gained in formulating new types of products
- To critically analyze the process for maintaining and improving the quality of the final product
- To evaluate the steps involved in the process and improve existing technologies or develop newer technologies
- To design and create newer process and products that are better economically, nutritionally or technologically.

Unit I - LABORATORY TESTING OF WHEAT GRAIN QUALITY: Moisture tests, Grain hardness testing. Visco graph, Amylograph, Farinograph. Dough mixers, Dividers, rounders, Proofing, moulding, Ovens, Slicers, Packaging materials and equipment, Sanitation and safety.

Unit II - MATERIALS OF BAKING : Bread manufacturing process – Straight dough fermentation, Sponge and dough, Biscuit-Types of biscuit dough – Developed dough, short dough, semi-sweet, enzyme modified dough and batters- importance of the consistency of the dough- Cake – Flour specification – ingredients – manufacturing process – types of chemically aerated goods.

Unit III - SUGAR MANUFACTURE : Energy and material balance of cane sugar process. Extraction of juice, extraction yields, drying and uses of Bagasse, Purification of juices-juice filtration and chemical purification, Clarification stages, Lime addition, pH control, Treatment of clarified juice, evaporation –multiple effect evaporators, Vacuum pans, Crystallization, Washing of sugar crystals and centrifugal separation/dewatering of sugar and other related processes. Sugar Refining, Sugar analysis, Sugar recovery – improvement, Sugar balance, energy conservation, Sugar plant sanitation.

Unit IV - MANUFACTURE OF ALCOHOLIC AND CARBONATED BEVERAGES : Manufacture of beer, wine and champagne - Quality characteristics, Manufacture of distilled beverages including whisky, brandy, rum and gin – Quality aspects

Manufacture of sugar-free, sugarless, carbonated beverages - quality aspects

Unit V - CONFECTIONERY TECHNOLOGY: Types of Confectionery, raw materials and processing of toffee, chocolates, fruit drops, hard boiled candies. Additives for Confectioneries. Equipments used in Confectionery manufacture.

Text Book

1. Samuel A. Matz, "Bakery Technology and Engineering", Chapman & Hall, 3rd Edition, 1992.

Reference Books

1. Bakery Products – Science and Technology, Ed., Y.H. Hui, Blackwell Publishing, 2006. ISBN-13: 978-0-8138-0187-2
2. Sumnu SG and Sahin S. Food Engineering aspects of Baking sweet goods. CRC Press,2008. ISBN 978- 1- 4200- 5274- 9
3. Hunsigi G. Production of Sugarcane Theory and Practice, Springer Verlag, 1993. e-ISBN-13: 978-3-642-78133-9
4. Varnam A.H. & Sutherland J.P. BEVERAGES - T*echnology, Chemistry and Microbiology,* Springer-Science+Business Media, B.V., 1994. ISBN 978-1-4615-2508-0 (eBook)
5. Lees R and Jackson EB. Sugar Confectionery and Chocolate Manufacture, Chapman and Hall Pub.,1992. e-ISBN-13: 978-1-4684-1495-0
6. Edwards, W .P. The Science of Sugar Confectionery, RSC Publishing, UK., 2000. **ISBN** 0-8 5404-593-7

17FP2021 FOOD SAFETY REGULATIONS

Credits: 3:0:0

Course Objectives:

- To study importance of Food Safety
- To understand the regulating authorities for food safety world over

Course Outcomes:

- To understand the regulations followed in various food industries.
- To define the food labeling patterns.
- To apply the knowledge in food industries.
- To analyze the safety operations involved in food systems.
- To evaluate the steps involved in the process operations in food industries.
- To prepare HACCP standards for food industries.

Unit I - FOOD REGULATIONS: World Trade order – Functioning and responsibilities of the WTO - Codex Alimentarius –History, operations of Codex alimentarius, Responsibilities – Codex standards and Maximum residue limits – Current Issues under consideration – SPS (Sanitary and phytosanitary measures) agreement. World Health Organisation – History and mandate – Operations and responsibilities – ICGFI – Functions and responsibilities. Concept of Six Sigma

Unit II - FOOD AUTHORITY IN INDIA: Food safety and Standards Act – organizational chart – role of individual authority –principles to be followed –Provisions as to articles of food –imported items – Responsibilities of the food business operator – Liability of manufacturers, packers, wholesalers, distributors and sellers –Enforcement of the act – Licensing and registration of food business – Food safety officer and their powers – Analysis of food – regulations regarding labs involved in food analysis – Offences and penalties – Adjudication and food safety appellate tribunal – Laws relating to Food Processing Industries in India - FPO, MMPO, PFA, AGMARK, Essential Commodities Act, BIS

Unit III - FOOD LABELING : Need for labeling – Developing labeling standards at the world level – Limitations of labeling safety issues – Labeling regarding methods of processing – Irradiated products – Products derived from modern biotechnology – organic produce - Genetically modified foods – EU rules on nutritional labeling – US rules on nutritional labeling – Health claims – Approach of US and EU

Unit IV - MICROBIOLOGICAL FOOD SAFETY : Concept of HACCP – Assembling the team – Product description – Describing the product's intended use – Establishing a process flow diagram – on site confirmation - Listing potential hazards and control measures - Determination of critical points – decision tree for CCPs- Establishing monitoring procedures- establishing corrective actions – establishing verification Procedures

Unit V - SAFETY ASPECTS OF WATER: Safety aspects of drinking water (microbiological and chemical) - the epidemiological triangle diseases caused by drinking of contaminated water , bottled water – setting of guideline values (microbiological and chemical) – risks and advantages of chlorination of water-Bottled water – origin of water- nutritional and physiological aspect – safety aspects – microbiological and chemical quality – Regulations for bottled water – EU, US and India

Text Books

1. Kees A. van der Heijden and Sanford Miller, "International Food Safety Handbook: Science, International Regulation, and Control", Published by CRC Press, ISBN 0824793544, 9780824793548, 1999.
2. Guide to the Food Safety and Standards Act, Tax-mann Allied Services Pvt. Ltd., ISBN 10-8174968288, 2006.

Reference Book

1. Mehta R. and George J., "Food Safety Regulation Concerns And Trade- The Developing Country Perspective", Published by Macmillan India Ltd., New Delhi. ISBN 1403925046, 9781403925046, 2005.

17FP2022 FOOD ENZYMOLOGY LAB

Credits : 0:0:2

Course Objective:

- To study the characteristics of various enzymes applicable in food industries.

Course Outcome:

- The students will be able to have a clear knowledge about enzymes
- The students will be able to understand the importance of each of the factors that affect enzyme activity
- The students will be able to apply the same to maximize enzyme action
- The students will be able to analyze when a problem arises and give a suitable and logical solution

- The students will be able to evaluate enzymes from different sources and select the right one depending on the type of food / condition
- The students would be able to make appropriate decision of evaluation and characterization when it comes to newer source of enzymes

List of experiments

1. Estimation of reducing sugars by dinitrosalicylic acid
2. Estimation of amylase activity
3. Effect of pH on amylase activity
4. Effect of temperature on amylase activity
5. Effect of substrate concentration on amylase activity
6. Effect of enzyme concentration on amylase activity
7. Determination of total and specific activity of amylase
8. Estimation of protein by Lowry's method
9. Estimation of protease activity
10. Effect of pH on protease activity
11. Effect of temperature on protease activity
12. Effect of substrate concentration on protease activity
13. Effect of enzyme concentration on protease activity
14. Determination of total and specific activity of protease
15. Studies on enzyme immobilisation

17FP2023 FOOD PRODUCT TECHNOLOGY LAB - I

Credits : 0:0:2

List of Experiments

1. Preparation of RTS beverage
2. Preparation of squash
3. Preparation of cordial
4. Preparation of Jam and jellies
5. Preparation of marmalade
6. Preparation of ketchup
7. Preparation of basic bread
8. Preparation of French bread
9. Preparation of sweet atta biscuit
10. Preparation of butter scotch cookies
11. Preparation of sweet biscuits
12. Preparation of salt biscuits

17FP2024 ENGINEERING PROPERTIES OF FOOD MATERIALS

Credits: 3:0:0

Course Objectives:

- To study about the different methods of determining the quality and properties of different foods
- To gain knowledge of engineering properties during processing, packing, storage and transport.
- To impart knowledge about electrical properties of food and its applications in food engineering

Course Outcomes:

- To understand Engineering properties of food materials.
- To identify the structure and chemical composition of foods.
- To determine the physical properties of food materials.
- To calculate the water activity, food stability sorption and desorption isotherm of food materials.
- To study the difference between Newtonian and non-Newtonian fluids.
- To examine the thermal properties, electrical and magnetic properties of food.
- To measure the aero- and hydrodynamic characteristics and the application of frictional properties in grain handling, processing and conveying.

Unit I - PHYSICAL PROPERTIES OF FOODS: Methods of estimation of Shape, Size, volume, density, porosity and surface area, sphericity, roundness specific gravity. Frictional properties-coefficient of friction, Storage and flow pattern of agricultural crops

Unit II - RHEOLOGICAL PROPERTIES OF FOODS: Definition – classification – Newton's law of viscosity – momentum-diffusivity-kinematic viscosity – viscous fluids – Newtonian and Non Newtonian fluids- Viscosity Measurements-Viscometers of different types and their applications-Texture measuring instruments-Hardness and brittleness of Food materials.

Unit III - THERMAL PROPERTIES OF FOODS: Definitions of Heat capacity, specific heat, enthalpy, conductivity and diffusivity, surface heat transfer coefficient, Measurement of thermal properties like specific heat, enthalpy, conductivity and diffusivity, DTA, TGA, DSC.

Unit IV - AERODYNAMIC AND HYDRODYNAMIC PROPERTIES OF FOODS: Drag and lift coefficient, terminal velocity and their application in the handling and separation of food materials. Water activity- measurement-vapor pressure method –freezing point depression method- Effect of temperature, and pressure on water activity-moisture sorption isotherms- models-Henderson, PET and GAB models.

Unit V - ELECTRICAL PROPERTIES OF FOODS: Dielectric properties-dielectric constants-, Dielectric measurements-Ionic Interaction-Dipolar rotation. Effect of moisture, temperature and pressure on dielectric properties. Microwave heating-Infrared and Ohmic heating, Irradiation

Text Books

1. Serpil Sahin and Servet Gulum Sumnu "Physical Properties of Foods", Springer,USA, 2006.
2. Nuri N. Mohsenin: "Thermal Properties of Food & Agricultural materials", Gordon and Reach science publishers, 1970.

Reference Books

1. Rao, M.A and S.S.H. Rizvi:"Engineering Properties of Foods", Mercel Dekker inc. New York, 1998.
2. Lewis M.J, "Physical properties of foods and food processing systems" Woodhead publishing Cambridge, UK, 1990.
3. Reyond Jewitt and others: "Physical properties of foods "Allied science publishers, 1983.
4. Shafiur Rehman: Food Properties Hand book CRC press inc. New York, 1995.
5. Micha Peleg and Edward B. Bagley, "Physical Properties of Foods" AVI publishing company inc, Westport USA, 1983.
6. Kachru R.P.and R.K. Gupta, "Physico – Chemical Constituents and Engineering Properties of Food crops", Scientific publishers, Jodhpur.

17FP2025 ENGINEERING PROPERTIES OF FOOD MATERIALS LAB

Credits : 0:0:2

List of Experiments

1. Determination of viscosity of liquid food materials
2. Determination of surface area of grains by using planimeter.
3. Determination of porosity of food grains.
4. Determination of specific gravity, specific volume and density of foods.
5. Determination of friction.
6. Determination of sphericity, roundness of food grains.
7. Measurement of terminal velocity of food particles.
8. Measurement of angle of repose
9. Determination of hardness of grains.
10. Estimation of moisture content of food grains, fruits and vegetables.
11. Calculation of specific heat of food materials.
12. Calculation of thermal conductivity of food materials.
13. Determination of rehydration characteristics of dried foods.

17FP2026 FOOD ENGINEERING AND PACKAGING LAB

Credits : 0:0:2

List of Experiments

1. Characterization of Dehydrated Products- Extruded Products
2. Characterization of Dehydrated Products-Extruded Ready-To-Cook and flaked Products.
3. Determination of Particle Size-Sieve Analysis
4. Determination of The Overall Heat Transfer Coefficient Of Plate Heat Exchanger – Co-Current Flow
5. Determination of The Overall Heat Transfer Coefficient Of Plate Heat Exchanger - Counter Current Flow
6. Determination of efficiency of a distillation column
7. Kinetics of Anthocyanin extraction
8. Kinetics of Anthocyanin degradation
9. Determination of viscosity by Ostwald's viscometer
10. Determination of the migration characteristics of the given material – acid as stimulant
11. Determination of the migration characteristics of the given material – alcohol as stimulant
12. Determination of the Water Vapour Transmission rate of the given packaging material.

17FP2027 FOOD PROCESS EQUIPMENT DESIGN

Credits: 3:0:0

Course Objectives

- To enable the student to design and develop equipments used in Food Processing operations.
- Identify and discuss critical design of typical processing equipment.
- Understand the relationship between process design and Safety

Course Outcomes

- To identify the factors that will affect the design of equipments
- To classify the variables based on various properties
- To interpret the relation between various process variables
- To select the critical variables for the design of equipments
- To develop a conceptual design model
- To assess the validity of the conceptual model

Unit I - BASIC DESIGN CONSIDERATIONS AND MATERIALS OF CONSTRUCTION : Basic considerations in process equipment design. Materials of construction – mechanical properties and materials. Design considerations - stresses created due to static and dynamic loads. Process flow diagrams (PFD) – symbols used in PFD.

Unit II - DESIGN OF PRESSURE VESSELS : Design conditions and stresses – design stress, design criteria, corrosion allowance. Design of a shell and its components – cylindrical and spherical shells, head, nozzles and flange thickness. Vessels subjected to internal pressure and combined loading – cylindrical shell and spherical shell, stresses induced in vessel. Vessels subjected to external pressure. Optimum proportions of a vessel and optimum vessel size.

Unit III - DESIGN OF STORAGE VESSELS AND REACTION VESSELS : Storage of fluids – storage of volatile, non-volatile liquids and storage of gases. Design of rectangular tanks – with and without stiffeners. Design of tanks – bottom and shell design and self-supporting roof design. Classification of reaction vessels, heating system. Design considerations – jacket design, coil and channel design.

Unit IV - DESIGN OF HEAT EXCHANGERS AND EVAPORATORS : Types of heat exchangers – double pipe heat exchangers, shell and tube heat exchangers, and special types of heat exchangers. Design of shell and tube heat exchanger. Design of calendria type evaporators.

Unit V - DESIGN OF DRYERS AND MIXERS : Types of agitators. Power requirements for agitation. Design of agitation system components – shaft design and agitator design. Design of tray dryers.

Text Books

1. Shrikant D Dawande. “Process design of equipments”. Central Techno Publications, ISBN: 81-89178-14-8, Nagpur, 2005.
2. Mahajani V.V and Umarji S.B. “Joshi’s process equipment design”. Trinity Press. ISBN: 978-93-5138-091-1, New Delhi, 2014.

Reference Books

1. Singh & Heldman.”Introduction to Food Engineering”. Academic Press – Elsevier India Private Ltd. ISBN: 978- 0- 1240- 1675- 0 New Delhi, 2013
2. Jasim Ahmed, Mohammad Shafuir Rahman “Handbook of Food Process Design, 2 volume Set” Wiley-Blackwell, ISBN: 978-1-4443-3011-3, April 2012.
3. Rajesh Mehta and J. George “Food Safety Regulation Concerns and Trade- The Developing Country Perspective,” Published by Macmillan India Ltd., New Delhi. 2005
4. Miguel A. Galan, Eva Martin del Valle. “Chemical Engineering: Trends and Developments” John Wiley & Sons, ISBN: 978-0-470-02498-0, 2005.
5. Maroulis Z.B. and Saravacos G.D. “Food Process Design”, Marcel Dekker Inc. ISBN- 0824743113, 2003.

17FP2028 FOOD ANALYSIS LAB - II

Credits : 0:0:2

Course Objective:

- To determine the quality of Food commodities
- To interpret the genuineness of the products based on the quality

Course Outcome:

- The students will have a knowledge of the quality parameters of different types of food products
- The students will be able to classify food products based on their quality
- The students would be able to interpret results and decide on the quality

- The students would be able to compare two brands of the same product and decide the best one based on the quality
- The students will be able to evaluate newer products based on quality
- The students will be able to design and develop newer and better methods of analysis for improving the quality of a Food Product

List of Experiments:

Sugar rich products like Jams, Squashes, Marmalades, Sugar and Jaggery

1. Analysis of total sugars
2. Determination of pectin
3. Determination of acidity
4. Determination of total fruit solids
5. Determination of Calcium
6. Estimation of Ascorbic acid

Bakery Products including wheat

7. Determination of gluten content
8. Determination of alcoholic acidity
9. Determination of maltose equivalent
10. Estimation of total nitrogen content by Kjeldahl method

Meat and meat products

11. Determination of Extract release volume
12. Determination of swelling ratio
13. Determination of TMA

Milk and Milk products

14. Determination of Fat content by Gerber method
15. Determination of lactose content by Lactometer

Plantation Products including Tea, Coffee and Cocoa

16. Determination of Total extractives
17. Determination of Tannin content
18. Determination of Caffeine

Vitamins, Minerals and Colourants

19. Estimation of anthocyanins
20. Estimation of Chlorophyll
21. Determination of Iron

17FP2029 COMPUTER AIDED FOOD PROCESS EQUIPMENT DESIGN LAB

Credits : 0:0:2

Course Objectives

- Design of plants using computing software.
- Simulating process environment virtually.
- Understanding relational database and design specific unit operations.

Course Outcomes:

- Provide the student with a good understanding of computer aided design principles and practice.
- Learn effective approaches to building up knowledge about a process through simulation.
- Acquire the skills needed to design a chemical plant using ANSYS FLUENT.

List of Experiments:

1. Basic concept of simulation and CFD
2. Introduction to GAMBIT
3. Introduction to FLUENT
4. Heat transfer through laminar flow
5. Heat transfer through Turbulent flow.
6. Simulation of flow past sphere.
7. 2 dimensional heat flow analysis
8. 3 Dimensional heat flow analysis
9. Conjugate heat transfer study
10. Heat transfer through fluid.

17FP2030 FOOD ADDITIVES

Credits: 3:0:0

Course Objectives:

- To understand the Chemistry of the additives added to food
- To know the limits of addition as prescribed by FAO/WHO and PFA
- To develop newer additives with improved safety standards.

Course Outcomes:

- To know about importance of additives in maintaining or improving food quality.
- To learn about the development of various instant premixes by addition of preservatives within the permissible limits.
- To understand the applications of food additives and how to study the toxicity of food additives.
- To study the importance of additives in maintaining or improving food quality.
- To identify and design newer products, with better quality using additives which are economical and safe.
- To describe the properties, levels of addition and toxicity data of various food additives.

Unit I - INTRODUCTION : Food additives - definition and classification, food safety levels as per the specifications, safety evaluation of additives – determination of acute and chronic toxicity - NOEL, ADI, LD50 value, PFA regulations, GRAS status.

Unit II - ACIDULANTS: Types, chemical properties, levels of additions in individual products, toxicity data of Acidulants – Preservatives – Emulsifiers and gums - Antioxidants

Unit III - HUMECTANTS: Types, chemical properties, levels of additions in individual products, toxicity data of Dough conditioners - flour improvers – Humectants

Unit IV - FAT SUBSTITUTES AND REPLACERS: Types, chemical properties, levels of additions in individual products, toxicity data of Colourants – Natural and artificial, Flavourants, Flavour enhancers, Fat substitutes and replacers

Unit V - NUTRITIONAL ADDITIVES: Types, chemical properties, levels of additions in individual products, toxicity data of Sweeteners – Natural and synthetic, Chelating agents, antibrowning agents, Nutritional additives

Text book

1. Food additives by Brannen A.L., Davidson P.M., Salminen S. and Thorngate J.H. Second Edition, Revised and Expanded. Marcel dekker Inc. USA, 2002.

Reference Book

1. Newton, D.E. Food Chemistry. An Imprint of Infobase Publications, New York. 2007.

17FP2031 PLANTATION PRODUCTS AND SPICES TECHNOLOGY

Credits: 3:0:0

Course Objectives:

- To study about the various methods of processing tea products.
- To demonstrate a basic knowledge on process of coffee, and cocoa.
- To develop an awareness of various processing procedure for major spices & minor spices.

Course Outcomes:

- To define the different unit operations and its equipments involved in coffee, tea and cocoa processing
- To gain knowledge in processing of plantation crops and spices and also its value added products.
- To outline ways in which quality loss can be minimised during preparation and processing
- To develop value added products from plantation products and spices
- To demonstrate appropriate technique for the extraction of spice oil and oleoresin with quality standards
- To acquire a confident to get placement in any kind of cereals and spices industry with minimum post harvest losses and maximum benefit to the industry.

Unit I - CHEMISTRY AND TECHNOLOGY OF COFFEE : Coffee – Occurrence – chemical constituents – harvesting – fermentation of coffee beans – changes taking place during fermentation – drying – roasting – Process flow sheet for the manufacture of coffee powder – Instant coffee, technology – Chicory chemistry - Quality grading of coffee.

Unit II - CHEMISTRY AND TECHNOLOGY OF TEA : Occurrence – chemistry of constituents – harvesting – types of tea – green, oolong and CTC – Chemistry and technology of CTC tea – Manufacturing process – Green tea manufacture – Instant tea manufacture – Grading of tea.

Unit III - CHEMISTRY AND TECHNOLOGY OF COCOA AND COCOA PRODUCTS : Occurrence – Chemistry of the cocoa bean – changes taking place during fermentation of cocoa bean – Processing of cocoa

bean – cocoa powder – cocoa liquor manufacture Chocolates – Types – Chemistry and technology of chocolate manufacture – Quality control of chocolates.

Unit IV - CHEMISTRY AND TECHNOLOGY OF MAJOR SPICES : Pepper, Cardamom, ginger, Chilli, mint, and turmeric – Oleoresins and essential oils – Method of manufacture – Chemistry of the volatiles – Enzymatic synthesis of flavor identicals - Quality control of major spices.

Unit V - CHEMISTRY AND TECHNOLOGY OF MINOR SPICES : Cumin, Coriander, Cinnamon, fenugreek, Garlic, Clove Vanilla, Coconut, Areca nut, Oil palm and Cashew - Oleoresins and essential oils – Method of manufacture – Chemistry of the volatiles – Quality control of minor spices

Text Books

1. Peter, K.V. Hand book of herbs and spices. Volume 2. Wood head publishing Ltd., 2004**.** eBook ISBN**:** 9780857095688
2. Chakraverty, A., Mujumdar, A.S., Raghavan, G.S.V., Ramaswamy, H.S. Handbook of post harvest technology – cereals, fruits, vegetables, tea and spices. Marcel Dekker Inc., New York (Special Indian Reprint). 2010. ISBN 13: 9780824705145

Reference Books

1. Tainter, D.R. Grenis, A.T. Spices and Seasonings – A food technology hand book. 2nd edition. John Wiley and Sons, Inc., Canada. 2001. ISBN: 978-0-471-35575-5
2. Salunkhe, D.K. and Kadam S.S. Ed. 1998. Hand book of Vegetable Science and Technology, Marcel Dekker, New York, USA. ISBN: 0824701054
3. Minifie Bernard W. Chocolate, Cocoa and Confectionery Technology, 3rd Edition, Aspen Publication, 1999. ISBN: 9780834213012
4. Handbook on Spices, National Institute of Industrial Research (NIIR) Board, Asia Pacific Business Press Inc., New Delhi 2004. ISBN: 8178330946
5. Banerjee B. 2002. Tea Production and Processing – 3rd edition, Oxford & IBH Publishing Co.Pvt.Ltd., New Delhi.

17FP2032 FAT AND OIL PROCESSING TECHNOLOGY

Credits: 3:0:0

Course Objectives:

- To understand the physical and chemical properties of fats and oils.
- To study the extraction and refining processes of various oils and fats.
- To learn the packaging, quality standards of fats and oils.

Course Outcomes:

- To enumerate the importance of fats and oils.
- To describe the manufacturing process of oils and fats.
- To apply knowledge on manufacture of designer fats.
- To appraise the quality attributes of oils and fats.
- To design suitable packaging materials.
- To invent methods for industrial applications of oils and fats.

Unit I - PHYSICAL AND CHEMICAL PROPERTIES : Fats and oils – formation – functions of oil in human body - fatty acids – double bonds and their position in oil – Geneva type classification - sources of vegetable oils – production status-oil content – coconut , palm, peanut , rice bran, sesame, mustard and sunflower seeds oil – physical and chemical properties of fats and oils - chemical reactions of oil – hydrolysis – hydrogenation, oxidation and polymerization.

Unit II - EXTRACTION METHODS : Oil extraction methods –mechanical expression – ghani , power ghani, rotary, hydraulic press, screw press, expellers, filter press - principle of operation and maintenance-solvent extraction process – steps involved, batch and continuous-continuous solvent extraction process for rice bran, soy bean and sunflower-oil extraction process for groundnut and cotton seed-production of special oils – palm oil, virgin coconut oil – extraction process.

Unit III - REFINING OF OILS : Refining of oils – objectives – characterization - degumming – Zeneath process – deacidification process – continuous acid refining-bleaching of oil – continuous bleaching process – decolourising agents-deodorization process winterization processes-hydrogenation of oil –selectivity – catalyst – batch type hydrogenation – regeneration of catalyst-vanaspati, ghee and margarine – production process-partial sterilization, emulsification, chilling, kneading and rolling, incorporation of salt, colouring substances-production of special fats – butter – types - production and storage.

Unit IV - PACKAGING OF EDIBLE OILS : Packaging of edible oils – requirements – types – tinplate, semi rigid, glass, Polyethylene Terephthalate, Poly Vinyl Chloride, flexible pouches – packaging for Vanaspati and ghee changes during storage of oil –rancidity – causes – atmospheric oxidation and enzyme action – free fatty acid – colour-non edible oils – castor oil, linseed oil, vegetable waxes – production and processing.

Unit V - INDUSTRIAL APPLICATIONS AND QUALITY STANDARDS : Industrial applications of fats and oils – quality regulations - manufacture of soap, candle, paints and varnishes - ISI and Agmark standards – site selection for oil extraction plant- safety aspects- HACCP standards in oil industries.

Text books

1. Harry Lawson, "Food oils and Fats - Technology, Utilization and Nutrition", CBS Publishers and Distributors, New Delhi, 1997.
2. Gunstone F.D., "Oils and Fats in Food Industry", Blackwell Publishing, United Kingdom, ISBN – 13: 9781405171212, 2008.

Reference book

1. Gunstone F.D., "Vegetable Oils in Food Technology: Composition, Properties and Uses", 2nd Edition, Wiley - Blackwell Publishing Ltd., ISBN 9781444332681, 2011.

17FP2033 TECHNOLOGY OF MEAT, POULTRY AND FISH

Credits: 3:0:0

Course Objectives:

- To understand about the composition and nutritive value of meat, poultry and fish
- To know about processing technology of meat, poultry and fish
- To understand the HACCP and GMP of meat plant.

Course Outcomes:

- To enumerate the composition and role of microorganisms in meat.
- To understand the slaughtering, carcass processing methods and equipments used for processing meat.
- To apply the technological ideas in preparation of various types of meat products and design of equipments used for processing meat.
- To understand the HACCP and GMP of meat processing
- To evaluate the processing of poultry meat, meat products and egg products.
- To predict the role of microorganisms in spoilage, biochemistry, preservation and fishery products

Unit I - CHEMISTRY AND MICROBIOLOGY OF MEAT: Meat composition from different sources; Definitions and measurements, Explanation of muscle structure and compositions and its modifiers, White and Red Meat, Description of animal fat and its modifiers, description of bone and its modifiers; Post mortem muscle chemistry, Meat colour, flavors of meat products, meat microbiology and safety.

Unit II - SLAUGHTERING AND CARCASS PROCESSING: Modern abattoirs and some features, Ante mortem handling and welfare of animals, design of handling facilities, Hoisting rail and traveling pulley system, and stunning methods, stunning pen, slaughtering equipment, Washing area, Sticking, bleeding, dressing, Beef/Sheep and Pig Dressing operations, Offal handling and inspection, Inedible by products: Carcass processing equipment, Operational factors affecting meat quality, effects of processing on meat tenderization; meat processing equipment, electrical gadgets and manual gadgets; Typical lay outs.

Unit III - MEAT PRODUCTS: Canned meat, Frozen meat, Cooked and Refrigerated meat, Dried and preserved meat, Cured meat, Prepared meat products, Production methods for Intermediate moisture and dried meat products, Different kinds of sausages – Equipment used for all the process operations; Meat plant hygiene, Good manufacturing practice and HACCP.

Unit IV - PROCESSING OF POULTRY PRODUCTS: Poultry industry in India, measuring the yields and quality characteristics of poultry products, microbiology of poultry meat, spoilage factors; Plant sanitation; Poultry meat processing operations in detail along with equipment used – Defeathering, bleeding, Scalding etc.; Packaging of poultry products, refrigerated storage of poultry meat, by products – eggs, egg products, Whole egg powder, Egg yolk products, their manufacture, packaging and storage.

Unit V - FISH AND OTHER MARINE PRODUCTS PROCESSING: Commercially important marine products from India, Basic biochemistry, spoilage factors of fish, field refrigeration and icing practice, merits and demerits, Use of dry ice and liquid nitrogen as preservation elements, use of Refrigerated Sea Water (RSW) for preservation, Changes during storage in RSW and CSW; Freeze preservation; freezing of prawn and shrimp, weighing, filling and glazing, Individual quick freezing - relative merits and demerits, Canning operations, Salting and drying of fish, pickling and preparation of fish protein concentrate and fish oil.

Text Book

1. Hui, Y.H., Nip, W.K., Rogers, R.W, "Meat Science and Applications". Marcel Dekkar Inc. New York,2001.

Reference Books

1. Joseph Kerry, John Kerry and David Ledwood, "Meat Processing", Woodhead Publishing Limited, CRC Press, 2002.
2. Balachandran, K.K, "Post Harvest Technology of Fish and Fish Products", Daya Publishing House, New Delhi, 2001.

3. Mead G, "Poultry meat processing and quality", Woodhead Publishing Limited, 2004.

17FP2034 DRYING TECHNOLOGY

Credits: 3:0:0

Course Objectives:

- To understand the basic theory of drying and its significance in food systems
- To understand the importance of drying as a method of food processing
- To learn about the relative advantages / disadvantages of each method of drying

Course Outcomes:

- To gain knowledge on drying principles and psychrometric chart
- To apply the principles to solve problem on drying
- To understand different types of dryers for different food materials
- To design dryers for different types of foods
- To assess the concept behind industrial dryers
- To evaluate the dryer performance

Unit I - THEORY OF DRYING: Principles of drying – Fundamentals of air-water mixtures – Psychrometric chart – Problems based on pyschrometry – Drying curves – constant and falling rate period - Heat and mass transfer in dryers – moisture content in foods – determination of moisture content and its measurement - methods of determination - Equilibrium moisture content – methods of determination – EMC models

Unit II - DRYING METHODS : Selection of dryers – design of dryers - Conduction drying – convection drying – Pneumatic or fluidized bed drying – natural air drying – heated air drying – recirculatory dryer (non mixing type) – LSU dryer (continuous mixing type) – Baffle dryer - Radiation drying – Sun drying and infrared drying – Dielectric drying – chemical drying -Thin layer and deep bed drying - dryer performance

Unit III - DRUM DRYER, FOAM MAT DRYER AND FREEZE DRYER : Drum driers - Types of Drum Dryers - Principles of Operation of the Drum Dryer – rotary dryers Cabinet drying – vacuum tray dryers - Foam Mat Drying- Principles- Equipments- Factors affecting Foam mat drying – Freeze dryers - Fundamentals of freeze drying – Freezing – Primary drying stage – secondary drying stage -Changes during freeze drying – Condensation, defrosting – Industrial freeze driers.

Unit IV - FLUIDIZED BED DRYER, SPRAY DRYER, OSMOTIC DRYING : Fluidized bed dryer – Spouted bed dryer - spray drying of foods - Principles of Spray Drying Processes – Atomizers and nozzles - Reconstitution of powders – Foam spray drying - Osmotic dehydration – Principles – Factors affecting osmosis- Equipment used.

Unit V - RADIATION AND DIELECTRIC DRYERS : Infrared drying – principles - microwave drying of foods – dielectric concepts – construction and working – Radio Frequency drying – principles – working - Flash Dryers - Design of Flash Dryers - Materials Dried in Flash Dryers.

Text Books

1. Arun S. Mujumdar, "Handbook of Industrial Drying", CHIPS, 3rd Edition, 2006.
2. Chakraverty. A. " Post Harvest Technology of Cereals, Pulses and Oil seeds", Oxford and IBH Publishing Co.Pvt. Ltd. New Delhi, 2014.

Reference Books

1. Paul Singh, R and Dennis R. Heldman.. Introduction to Food Engineering Academic Press, 2001
2. Hui Y. H,:"Food Drying Science and Technology, Microbiology, Chemistry, Application", CHIPS, 2008.
3. Loesecke,H. W. V, "Drying & Dehydration of Foods", Published by Agrobios, 2005.

17FP2035 FOOD PACKAGING TECHNOLOGY

Credits: 3:0:0

Course Objectives:

- To study about the functions of packaging along with the influence of various factors on food.
- To know about the different packaging materials, their manufacturing process and equipment.
- To study about the various methods of packaging to improve the shelf life of the products.

Course Outcomes:

- To understand the need and functions of packaging as a solution to various factors affecting food.
- To gain knowledge on shelf life of food and various methods of estimating it.
- To explain the different packaging materials, their manufacturing process and equipment involved.
- To know about the various closures and sealing mechanisms for different packaging materials.
- To select the different printing and labelling methods and legislative requirements.
- To devise innovations in food packaging and their applications.

Unit I - INTRODUCTION TO FOOD PACKAGING: Functions of packaging, Effect of environmental factors - light, Oxygen, Moisture, Temperature, mechanical forces and biological factors on quality of food. Estimation of shelf life. General Approach, analysis of storage requirement, accelerated storage studies: Vacuum and Inert Gas Packaging: Tests on packaging materials, Mechanical strength (Tension, notch and tearing strengths), Gas and water vapour transmission rates.

Unit II - METAL CANS AS PACKAGING: Metallic can types - Tin cans and Aluminum cans. Specialty of Open top sanitary cans, Lacquers and their use, Three piece cans and Two piece cans, Aerosol Cans, Basics of Canning operations – Can Reformer, Flanger, Seaming, Can closures. Glass jars and Bottles in food packaging, Design features and applications, Sterilization of bottles.

Unit III - FLEXIBLE FILMS PACKAGING: Formation of Films and pouches, Plastics used and their Specific applications - Polyethylene (LDPE and HDPE), Cellulose, Polypropylene (PP), Polyesters, Poyvinylidene Chloride (PVDC - Diofan, Ixan and Saran), Polyvinyl chloride, Copolymers their applications. Co-extruded films and Laminates. Rigid and Semi rigid plastic packaging – abrication methods – Thermo forming, Blow moulding, Injection moulding, Extrusion – Retort pouch packaging. Laminated Paper board Cartons, Fibre Board and Corrugated Card Board packaging and their applications.

Unit IV - FILLING AND SEALING OPERATIONS FOR VARIOUS TYPES OF PACKAGES: Closing and sealing of Rigid plastic containers. Filling and sealing of Flexible plastic containers, Seal types-Bead seals, Lap Seals and Fin seals –Differences and advantages, Hot wire sealing, hot bar sealing and impulse sealing – differences and relative advantages, Form fill Seal equipment: Printing on packages, Bar codes, Nutrition labeling and legislative requirements. Filling and Sealing of pouches, pouch from fill seal machines.

Unit V - INNOVATIONS IN FOOD PACKAGING: Aseptic Packaging. Active packaging, Moisture control, CO_2 and Oxygen scavenging. Modified atmosphere packaging – principles, applications. Permeability of gases in packs. Antimicrobial Packaging, Edible packaging films and coating. Packaging for non-thermal food processing. Intelligent Packaging – Time-temperature indicators, RFID, Tamper evident packaging.

Text Book

1. Coles, R., Dowell, D.M., Kirwan, J, Food Packaging Technology, Black Well Publishing Ltd., 2009

Reference Books

1. Gordon L. Robertson. Food Packaging Principles & Practice, CRC Press, 2013.
2. Kit L Yam and Dong Sun Lee, Emerging Food Packaging Technologies: Principles and Practice, Woodhead Publishing Ltd, 2012.
3. Jung H. Han, Innovations in Food Packaging, Academic Press, 2014.
4. Scott A. Morris,Food and package engineering, Wiley-Blackwell Publishing, 2011.
5. Takashi Kadoya, Food Packaging, Academic Press, Inc, 1990.

17FP2036 STORAGE ENGINEERING

Credits : 3:0:0

Course Objectives :

- To enable the student to understand: The need for effective and scientific storage of food commodities.
- To provide an opportunity for students to develop skills in evaluating storage structures and also to design structures for various perishable commodities.

Course Outcomes :

- To recognize the need for adaptation of scientific storage methodologies for food commodities.
- To distinguish between traditional storage structures and modern storage structures.
- To design and construct modified storage structure based on the requirement on the farm.
- To calculate the amount of CO_2 & O_2 that can be permissible in systems that require a manipulation of the storage structures in terms of atmospheric conditions.
- To criticize, evaluate and judge the efficiency of commercial storage structures.
- To modify structures and environments to better fit the needs of commodities and consumer alike.

Unit I - PHYSICO - CHEMICAL AND THERMAL PROPERTIES OF GRAINS: Grain dimensions, bulk density, true density, porosity, coefficient of friction, angle of repose, thermal conductivity and aerodynamic properties. Psychrometry: humidity, % relative humidity, humid heat, deterioration index, wet bulb temperature, use of psychrometric charts.

Unit II - INSECTS AND PESTS: Types, extent of losses during storage, causes and control measures, Insecticides- principles, scope of application in warehouses; requirements, group of active ingredients, choice, toxicity, resistance, application techniques, Fumigants - chemicals, areas of application, choice, toxicity, application rates, exposure time and resistance. Rodenticides - Types and effectiveness and limitations, important moulds and bacteria involved in spoilage of grains; effect on physico- chemical and sensory quality of grains; mycotoxins.

Unit III - GRAIN STORAGE STRUCTURES: Grain storage structures - location and material selection for storage building, Types - traditional, modern; temporary and permanent storage structures; design considerations - pressure distribution in storage bins.

Unit IV - GRAIN STORAGE THEORY: Principles, moisture movement during bulk storage of grains, methods of aeration, various theories, Physical, chemical, microbiological and sensory changes occurring during storage.

Unit V - CONTROLLED ATMOSPHERE STORAGE: Air tight, controlled atmosphere and modified atmospheric storage; differences, principles, optimization of storage gas composition, rate of supply, control systems for oxygen and carbon dioxide- their effect on microbes and limitations.

Text Book

1. Sahay K.M and K.K.Singh. "Unit Operations of Agricultural Processing" Vikas Publications, New Delhi, ISBN-81-259-1142-1, 2007.

Reference Book

1. Shejbal, J. (ed) 1980. Controlled atmosphere storage of grains. Elsevier Scientific Publishing Co. London

17FP2037 PROCESS ECONOMICS AND PLANT LAYOUT DESIGN

Credits: 3:0:0

Course Objectives :

- To enable the students understand various concepts of economics of food plant.
- To understand the processes involved in layout design.
- To understand the development and design consideration and cost estimation in food industry.

Course Outcomes :

- To gain knowledge on the various factors involved in setting up a Food Processing Industry.
- To understand the process of food plant layout design.
- To apply their knowledge to design projects for setting up a Food Processing Industry.
- To analyse the problems involved in deciding the level of manufacture of a food product
- To evaluate the options involved and decide on the right choice based on the economics of the system
- To develop own industry or plan turn-key projects based on the request from customers

Unit I - FOOD PROCESS DESIGN DEVELOPMENT: Technical feasibility survey of Food Industry, process development, Food Process flow sheets – Hygienic food process design - equipment design and specifications – Computed-aided process design – Principles of spread-sheet aided process design (Basic concepts only)

Unit II - PLANT LAYOUT: Marketability of the product, availability of technology, raw materials, equipments, human resources, land and utilities, site characteristics, waste disposal, Government regulations and other legal restrictions, community factors and other factors affecting investment and production costs. Plant Layout based on process and product. Richard Muther's Simple Systematic Plant Layout.

Unit III - PROJECT EVALUATION AND COST ESTIMATION: Capital investments – fixed capital investments including land, building, equipments and utilities, installation costs (including equipments, instrumentation, piping, electrical installation and other utilities), working capital investments. Methods of Cost estimation – Cost Indices.

Unit IV - PRODUCT COST AND PLANT OVERHEADS: Manufacturing costs – Direct production costs(including raw materials, human resources, maintenance and repair, operating supplies, power and other utilities, royalties, etc.). – Process Profitability - Application to a Food Processing plant e.g. Tomato processing - Administration, safety and other auxiliary services, payroll overheads, warehouse and storage facilities etc. Depreciation, Amortization and methods of determining the same. Introduction to Food Safety Management System.

Unit V - PROFITABILITY ANALYSIS: Return on original investment, interest rate of return, accounting for uncertainty and variations and future developments. Cash flow diagram and its importance - Optimization techniques – Linear and Dynamics programming, Optimization strategies.

Text Book

1. Peters and Timmerhaus, Plant design and Economics for Chemical Engineers, McGraw Hill 5th Edition, ISBN-007-124044-6, 2004 .

Reference Books

1. Rudd D F and Watson C C, Strategy of Process Engineering, John Wiley & Sons Inc, ISBN-978-0471744559, 2013
2. Maroulis Z.B. and Saravacos G.D. Food Process Design, Marcel Dekker Inc. ISBN-0824743113, 2003.
3. Towler G and Sinnott R.K. Chemical Engineering design principles, practice and Economics of Plant and Process. 2nd Edition. Elsevier, ISBN-9780080966595, 2012

4. Rudd and Watson, Strategy of Process Engineering, Wiley and Sons, 1987
5. Baasel W.D. Preliminary chemical engineering plant design, van Nostrand Reinhold, 2nd Edition, 1990
6. Heldman D.R. and Lund D B. Hand Book of Food Engineering, 2nd edition, CRC Press, Taylor and Francis Group, 2007

17FP2038 NON THERMAL TECHNIQUES OF FOOD PRESERVATION

Credits: 3:0:0

Course Objectives:

- To impart understanding about different Emerging technology in Food Processing.
- To enable the students to apply the knowledge in real time Food Processing Innovations.
- To innovate new technologies or hurdle combinations for unexplored realms of food processing.

Course Outcomes:

- To know the emerging technologies applied to food processing
- To understand the relative advantages and disadvantages of emerging technologies over existing technologies
- To visualize the equipment used and process stages of emerging technologies
- To apply the non thermal technologies as alternative food processing methods
- To identify the potential of newer technologies for commercialization
- To develop strategies for applying the technologies to wide range of food

Unit I - HIGH PRESSURE PROCESSING OF FOODS: Principles – applications to food systems – effect on quality – textural, nutritional and Microbiological quality – factors affecting the quality – modelling of high pressure processes – High Pressure Freezing, Principles and Applications

Unit II - RADIATION PROCESSING OF FOODS : Principle, Types of radiation sources. Biological effects of irradiation, Irradiation of Foods–Gamma Irradiation, X-Ray Irradiation, UV Irradiation–Combined treatments. Applications and Limitations.

Unit III - OSMOTIC DEHYDRATION OF FOODS: Principle – Mechanism of osmotic dehydration – Effect of process parameters on mass transfer – Methods to increase the rate of mass transfer – Applications – Limitations of osmotic Dehydration – Management of osmotic solutions

Unit IV - OHMIC AND ULTRASOUND PROCESSING OF FOODS: Principle of ultrasound – Fundamentals – Ultrasound as a processing and preservation aid – Effect on properties of foods Basics of ohmic heating – Electrical conductivity - generic configurations- treatment of products

Unit V - PULSED LIGHT AND HURDLE TECHNOLOGY: Basics of hurdle technology – Mechanism Application to foods - Newer Chemical and Biochemical hurdles- organic acids – Plant derived antimicrobials – Antimicrobial enzymes – bacteriocins – chitin / chitosan (only one representative example for each group of chemical and biochemical hurdle)

PULSED ELECTRIC FIELD PROCESSING OF FOODS: Principles – Mechanism of action – PEF treatment systems – Main processing parameters – PEF Technology – Equipments – Mechanism of microbial and enzyme inactivation- safety aspects– Processing of liquid foods using PEF – Process models – Comparison of High pressure processing and PEF – Enzymatic Inactivation by PEF, Examples – Microbiological and chemical safety of PEF foods

Text Book

1. Da-wen Sun: Emerging Technologies for Food Processing, Elsevier Academic Press and Marcel Dekker Inc, 2014.

Reference Books

1. Leistner L. and Gould G. Hurdle Technologies – Combination treatments for food stability safety and quality, Kluwer Academics / Plenum Publishers, 2002.
2. Gustavo V. Barbosa-Canovas, Maria S. Tapia, M. Soledad Tapia, M. Pilar Cano, Novel Food Processing Technologies (Food Science and Technology Series), CRC Press, 2004.

17FP2039 FUNCTIONAL FOODS AND NUTRACEUTICALS

Credits: 3:0:0

Course Objectives:

- To understand the basics of nutraceuticals and functional foods
- To study the significance of nutraceuticals and their role in disease prevention
- To hypothesize the safety and efficacy of individual nutraceuticals and functional foods products,
- To emphasize regulatory issues that influences the development and commercialization of nutraceuticals and functional foods in global markets
- To identify new strategies for marketing of traditionally known nutraceuticals

Course Outcomes:

- To understand the meaning of functional foods and nutraceuticals.
- To recognize the structures of the major bioactive food constituents that are being incorporated into functional foods.
- To describe current state of the knowledge with regards to the application of functional foods for risk reduction of chronic diseases.
- To evaluate critically the methods for extraction and identification of nutraceutically significant molecules.
- To distinguish functional food products that are nutritionally logical, technically feasible, and that also are in compliance with FDA regulatory guidelines.
- To reorganize the issues related to development and commercialization of nutraceuticals and functional foods products.

Unit I - NUTRACEUTICALS-HISTORICAL, TECHNOLOGICAL ASPECTS AND CLASSIFICATIONS: Introduction – Historical reviews - Teleology of nutraceuticals - Organization models for nutraceuticals – Classification of nutraceuticals based on the sources– animal, plant and microbial – Nutraceuticals in specific foods - Mechanism of action - chemical nature.

Unit II - FLAVANOIDS AND CAROTENOIDS AS ANTIOXIDANTS: General background on phytochemicals as antioxidants - flavonoids and lipoprotein oxidation - Evidence for specific Antioxidant mechanisms of flavonoids - Dietary carotenoid and carotenoid absorption - Approaches to measurement of absorption - Metabolism of Carotenoids – Carotenoids as anticancer agents.

Unit III - OMEGA-3 FATTY ACIDS AND CLA: Introduction to Lipoprotein metabolism - PUFA and Cardiac arrhythmias - Preventative role of n-3 fatty acids in cardiac arrhythmias - Mechanism of action on n-3 PUFA's - ω – 3 fish oils and their role in glycemic control- ω – 3 fatty acids and rheumatoid arthritis - Chemistry and nomenclature of CLA – Analysis of CLA in food and biological samples – CLA in food products and biological samples – Biological actions and potential health benefits of CLA – Mechanisms of CLA action – Potential adverse effects of CLA.

Unit IV - LYCOPENE, GARLIC, OLIVE OIL, NUTS, PROBIOTICS AND PREBIOTICS: Lycopene overview, lycopene and disease - Garlic – Chemistry and its implication in Health - Olive oil – CHD – Cancer - Nuts – Nutrient components and composition - Nut consumption and CHD, Human nutritional studies on nut consumption and serum lipid changes, Mechanism of action- Probiotics- products on market – Microbiology of the gastrointestinal tract - Prebiotics – future for probiotics and prebiotics.

Unit V - HERBS AS FUNCTIONAL FOODS, STABILITY, TESTING AND MARKETING ISSUES FOR NUTRACEUTICALS AND FUNCTIONAL FOODS: Herbal medicine – Herbs as ingredients in functional foods – actions of herbal and evidence of efficacy - Kinetic modelling of chemical reactions – Accelerated shelf life testing - Evolution of marketing environment for functional foods and nutraceuticals - Regulatory background - Introduction to consumer marketing issues for nutraceuticals - Potential product positioning.

Text Books

1. Wildman, R.E.C. (2001) "Handbook of Nutraceuticals and Functional Foods", CRC Press LLC. ISBN-0849387345.
2. Schmidl, M.K. and T.P. Labuza. (2000). Essentials of Functional Foods. Aspen Publishers, inc., Gaithersburg, MD. ISBN 978-0-8342-1261-9

Reference Book

1. Tomris Altug. (2003). Introduction to Toxicology and Food. CRC Press, Boca Raton, FL. ISBN 9780849314568
2. Stanley T. Omaye . (2004). Food and Nutritional Toxicology CRC Press, Boca Raton, London. eBook ISBN: 978-0-203-48530-9
3. Ho, C.T. and Q.Y. Zheng. (2001). Quality Management of Nutraceuticals. ACS Symposium Series 803, ACS, Washington DC. eISBN: 9780841218840
4. M.A.Eskin, S. Tamir S. (2006) Dictionary of Nutraceuticals and Functional Foods. CRC Press. ISBN 0849315727

17FP2040 FOOD ADDITIVES LAB

Credits : 0:0:2

Course Objectives

- To understand the Chemistry of the additives added to food
- To understand the importance of additives in maintaining or improving food quality To develop newer additives with improved safety standards.

Course Outcomes

- To know about the importance of additives in maintaining or improving food quality.

- To learn the chemistry of the additives added to a food.
- To express their knowledge on development of various instant premixes by addition of preservatives within the permissible limits.
- To understand the properties, levels of addition and toxicity data of various food additives.
- To demonstrate various applications of food additives and how to study the toxicity of food additives

List of Experiments

1. Estimation of Sulphur-Di-Oxide
2. Estimation of Sodium Benzoate
3. Estimation of Sorbic Acid
4. Estimation of Butylated hydroxyl toluene
5. Estimation of Propyl Gallate
6. Estimation of Ascorbic Acid
7. Estimation of Iron
8. Estimation of Copper
9. Determination of Saccharin
10. Estimation of curcumin in turmeric
11. Estimation of capsacin
12. Estimation of iodine in Iodised salt
13. Estimation of salt in pickled products
14. Estimation of baking powder.

17FP2041 FOOD PRODUCT TECHNOLOGY LAB - II

Credits : 0:0:2

List of Experiments

1. Preparation of Rasagulla
2. Preparation of Sandesh
3. Preparation of Paneer
4. Preparation of Kalakhand
5. Preparation of Peda
6. Preparation of Gulab Jamun
7. Preparation of Bread and Butter Pickle
8. Preparation of Hot and Sour Tomato Pickle
9. Preparation of Chilly and Ginger Pickle
10. Preparation of Soanpapdi
11. Preparation of Mysorepak
12. Preparation of Gummies
13. Preparation of aerated confectionery

17FP2042 PRINCIPLES OF FOOD SCIENCE AND NUTRITION

Credits: 3:0:0

Course objectives:

- To understand the fundamentals of bio molecules
- To impart basic knowledge on the methods of analysis of fats and oils
- To know the food additives and microbes associated with food

Course outcomes:

- To enumerate and describe the fundamentals of food constituents and quality analysis.
- To understand the types of food additives and their importance in food.
- To examine the role of microorganisms associated with food and their importance in fermentation
- To predict the role of food borne diseases and intoxication
- To enumerate the factors responsible for spoilage of various foods.
- To understand the methods of preservation of foods.

Unit I - FUNDAMENTALS OF FOOD CONSTITUENTS: Introduction to Proximate constituents of food - Carbohydrates – Classification – Simple & complex, mono-, di-, oligo- and polysaccharides; Important reaction of carbohydrates –Caramelisation, Maillard. Fats – classification – Analysis of Fats and oils – Saponifcation value, Iodine value, Acid value, Acetyl value, Peroxide value – Principles and Importance of the analytical methods, Vitamins – Fat and water-soluble – nutritional significance

Unit II - FOOD ADDITIVES: Introduction to food additives - Classification, intentional and non-intentional additives, functional role in food processing and preservation; food colourants – natural and artificial; food flavours; enzymes as food processing aids.

Unit III - MICROORGANISMS ASSOCIATED WITH FOOD: Bacteria, yeasts and molds – sources, types and species of importance in food processing and preservation; Oriental fermented foods and, Production of Sauerkraut, Wine, Lactic acid and single cell protein.-examples and their applications

Unit IV - FOOD BORNE DISEASES AND INTOXICATION: food intoxications and poisonings – *Bacillus* spp., *Clostridium botulinum*,*Staphylococcus aureus*,Hepatitis, Gastroenteritis viruses, *Entamoeba histolytica*.Food spoilage – factors responsible for spoilage, spoilage of vegetable, fruit, meat, poultry, beverage and other food products.

Unit V - FOOD PRESERVATION: Principles involved in the use of sterilization, pasteurization and blanching, thermal death point - methods of determination of thermal death time (Graphical, mathematical) – D, Z and F values – Importance of 12 D concept, Time – Temperature indicators - Canning; frozen storage-freezing methods, factors affecting quality of frozen foods; irradiation preservation of foods.

Text Books

1. Coultate T.P "Food – The Chemistry of its Components", 2nd Edition. Royal Society, London, 1992.
2. Sivasanker, B, "Food Processing and Preservation", Prentice-Hall of India Pvt. Ltd. New Delhi, ISBN-9788120320864, 2002.

Reference Books

1. Frazier W.C. and D.C. Westhoff, "Food Microbiology", 4th Ed., McGraw-Hill Book Co., New York, ISBN_9780070667181,2008.
2. Adams M.R and Moss M.O, "Food Microbiology", Panima Publishing corporation, New Delhi, 2nd Edition, Third reprint, ISBN-13:9788122410143,978-8122410143, 2007.

17FP2043 PROCESSING OF FOOD COMMODITIES

Credits: 3:0:0

Course Objectives:

- To study various processing methods for various food materials like fruits & vegetables, dairy products, cereals, meat, poultry, fish and bakery products .
- To study various innovative food processing techniques.

Course Outcomes:

- To understand the basics of food processing.
- To know the various processing technologies involved in fruits and vegetables, dairy, cereals, meat, fish, egg and plantation products.
- To learn the basics on microbiology of food products.
- To describe the process of manufacture of various food products.
- To recognize various methods of preservation of food.
- To express the possible arena of entrepreneurial activity related to food products.

Unit I - CEREAL, PULSES AND OIL SEEDS TECHNOLOGY: Rice milling, Pulse milling, Wheat milling - Oil extraction - Methods of manufacture of Bread - different processes of manufacture - types of breads - buns, biscuits, cakes and cookies -Pasta products -Tortilla - Method of manufacture.

Unit II - FRUITS AND VEGETABLE PROCESSING: Production of Fruits and vegetables in India, Cause for heavy losses, preservation treatments - Basics of Canning, Minimal processing and Hurdle technology as applied to Vegetable and Fruit processing, Processing of fruit juices, Dehydration, Aseptic processing.

Unit III - DAIRY PROCESSING : Basic dairy terminology, composition, General tests at reception, Dairy Processing - Method of manufacture of Standardised, toned and double toned milk, milk powder - Equipments - Pasteurizers, homogenisers and pumps - Method of manufacture of dairy products - Icecream, Cheese, Paneer, Yoghurt - Pasteurisation and microorganisms involved in spoilage of milk.

Unit IV - MEAT, POULTRY AND FISH PROCESSING: Meat composition from different sources, Definitions and measurements, Carcass Processing, Meat Products, Processing of Poultry Products, Fish and other Marine Products Processing .

Unit V - PLANTATION PRODUCT TECHNOLOGY: Processing of Tea, Coffee and Cocoa - Outline of the methods of manufacture of - green tea, black tea, instant tea, Instant coffee, Cocoa and Chocolate. Outline of the methods of processing of Pepper, cardamom, ginger, vanilla and turmeric

Text Books

1. Srivastava, R.P. and Kumar, S.: Fruit and Vegetable Preservation: Principles and Practices. International Book Distributing Co. Lucknow (2nd Edition 1998).
2. Chakraverty, A., Mujumdar A.S., Raghavan G.S.V and Ramaswamy H.S. Handbook of Post-harvest Technology: Marcel Dekker Press, USA (2001)
3. James Harper W. and Carl W. Hall: Dairy Technology and Engineering AVI Publishing, Westport, USA (1976)

4. Karel Kulp and Joseph P Pante:Hand Book Of Cereal Science and Technology Mercel Dekkar USA (2000)
5. Samuel Matz: The Chemistry and Technology of Cereals as Food and Feed, Chapman & Hall (1992)

17FP2044 TECHNOLOGY OF PACKAGING

Credits: 3:0:0

Course Objectives:

- To provide knowledge on packaging and packaging materials.
- To understand the working of various packaging methods.
- To enable the students to understand applications of various packaging materials in food industry.

Course Outcomes:

- To understand food quality and need food packaging.
- To classify food packaging design strategies and framework.
- To explain the manufacturing process of various packaging materials.
- To select common methods of sealing of various food packaging materials.
- To apply the knowledge on advance food packaging methods and their applications in industry.
- To adapt the principle and need for testing of packaging materials.

Unit I - INTRODUCTION TO FOOD PACKAGING: Packaging developments–historical perspective. Food supply and the protective role of packaging. Definition of basic functions of packaging. Packaging strategy – Packaging design and development framework. Levels of Packaging. Food Package Environments. Factors affecting product quality and shelf life –Physical, Chemical and Biological processes.

Unit II - METAL AND GLASS FOOD PACKAGING MATERIALS: Metal cans - Raw materials for can-making. Container Making process – Three piece cans and Two piece cans – End-making processes. Protective and Decorative Coatings. Glass as Food Packaging Material – Types of Glasses and Composition – Glass Container Nomenclature – Glass and Container Manufacturing.

Unit III - PLASTIC AND PAPER FOOD PACKAGING MATERIALS: Plastics used in Food Packaging and their Specific applications – Polymers and Copolymers. Plastic Manufacturing - Extrusion and Calendaring. Extrusion – Monolayer – Cast and Blow film processes. Orientation of Films. Coextrusion. Coating and Lamination of Plastic Films. Rigid Plastic Packaging Manufacture. Paper Manufacturing Process. Types of Paper and applications. Laminated Paper board – Folding Cartons, Beverage Cartons and Molded Pulp Containers. Corrugated Fibre Board and Fibre Drum packaging.

Unit IV - FILLING AND SEALING OF VARIOUS TYPES OF PACKAGES: Closures for Glass and Plastic Containers. Sealing of Plastic Films. Heat Sealing and Types of Seal. Induction, Dielectric, and Ultrasonic sealing. Peelable Seals. Types of Pouch. Form fill Seal Equipment – Vertical and Horizontal.

Unit V - ADVANCED PACKAGING METHODS AND TESTING OF MATERIALS: Vacuum and Inert Gas Packaging. Retort pouch packaging. Active packaging and Modified atmosphere packaging – principles and applications. Aseptic Packaging – principles and applications. Tests on packaging materials, Mechanical strength (Tension, notch and tearing strengths), Gas and water vapour transmission rates.

Text Book

1. Coles, R., Dowell, D.M., Kirwan, J, Food Packaging Technology, Black Well Publishing Ltd., 2009.

Reference Books

1. Gordon L. Robertson. Food Packaging Principles & Practice, CRC Press, 2013.
2. Scott A. Morris,Food and package engineering, Wiley-Blackwell Publishing, 2011.
3. Takashi Kadoya, Food Packaging, Academic Press, Inc, 1990.

17FP2045 NUTRITION AND FOOD SCIENCE

Credits: 3:0:0

Course Objectives:

- To learn the nutrients required for health, and their sources in diets.
- To learn how nutrients in foods affect and are affected by metabolic functions of the human body.
- To learn how variability among research results leads to consumer perceptions of changing or conflicting recommendations for dietary practices from the nutrition community.

Course Outcomes:

- To understand the basis in the area of nutritional assessment in health and disease
- To evaluate the biological functions of foods for health in addition to nutritional values
- To judge the potential for adverse events related to dietary supplements
- To identify which nutrients are sources of energy for the body and how an excess or a deficiency of energy can affect the body.
- To formulate nutrition therapy for chronic disease

- To compare the various types of nutrition research with respect to type and reliability of information produced.

Unit I - HUMAN NUTRITION : Historical perspective of nutrient requirements – Assessment of nutritional status - recommended dietary allowances of macronutrients for all age groups - Assessment of protein quality – Malnutrition and related disorders – Balanced Diet. Factors influencing dietary intake: Food habits, food fads and fallacies, their influence on health and wellbeing.

Unit II - BIOMOLECULES : Carbohydrates- Definition, classification, Functions, Sources of Carbohydrates, Deficienc. Lipids – Definition, classification, function, sources, Refined & Hydrogenated fats process. Proteins – Definitions, Classification, Function, Amino Acids, Sources of Proteins,

Unit III - VITAMINS : Physiological role, bio-availability, requirements, sources and deficiency of Fat soluble Vitamins: Vitamin A, Vitamin D, E & K. *ƒ* Water soluble vitamins: Vitamin C, Thiamine, Riboflavin, Niacin, Pantothenic acid, Biotin, Folic acid, Vitamin B12, VitaminB6.

Unit IV - MINERALS : Physiological role, bio-availability, requirements, sources and deficiency of Macro minerals: Calcium, Phosphorus Magnesium, Sodium, Potassium chloride. *ƒ* Micro minerals: Iron, Zinc, copper, selenium, chromium, iodine, manganese, Molybdenum and fluoride.

Unit V - RECENT TRENDS IN NUTRITION : Principles of dietary management in gout, rheumatism, AIDS/HIV - Cancer-risk factors, symptoms, dietary management, role of food in prevention of Cancer. Role of functional foods, health foods and novel foods, organically grown foods, recent concepts in human nutrition like nutrigenomics, nutraceuticals etc.

Text Books

1. Gordon M. Wardlaw – 2004. Perspectives in Nutrition, 6th edition, WCB McGraw-Hill Publishers, Boston (ISBN 007-244212-3)
2. Shubhangini A. Joshi -1992. "Nutrition and Dietetics"Tata Mc Grow- Hill publishing Company Ltd, New Delhi.
3. Srilakshmi. B – 2016. "Nutrition Science", 5th edition, New Age International (P) Ltd, Publishers, Chennai

Reference books

1. Ronald Ross Watson, Functional foods and Nutraceuticals in Cancer Prevention, Ed. Wiley – Blackwell, 2003. ISBN-13: 978-0813818542.
2. Nelson D.L., M.M. Cox, Lehninger Principles of Biochemistry, W.H. Freeman & Company Publications, 2013. ISBN-10: 1-4292-3414-8
3. Tymoczko, J.L., Berg, J.M., Stryer, L. Biochemistry – A short course, 3rd edition. W.H. Freeman. 2009. ISBN-10: 1-4641-2613-5
4. Sunetra Roday., "Food Science and Nutrition – 2nd edition, Oxford Higher Education/Oxford University Press, 2012, ISBN 10: 0198078862

LIST OF COURSES

Sl.No	Course Code	Name of the Course		Credits
1	15FP3001	Stability and Shelf Life Testing of Foods		3:0:0
2	15FP3002	Technology of Fresh Cut Fruits and Vegetables		3:0:0
3	16FP1001	Basics of Food Science and Technology		3:0:0
4	16FP2001	Food and Nutrition Security of GM Crops		3:0:0
5	16FP2002	Post Harvest Technology of Foods		3:0:0
6	16FP2003	Mechanization and Post Harvest Technology Lab		0:0:2
	REVISED VERSION COURSES			
1	14FP3017	1.1	Food Industry Waste Management	3:0:0
2	14FP3024	1.1	Food Processing and Biotechnology	3:0:0
3	14FP3025	1.1	Advances in Processing of Horticultural Products	3:0:0

15FP3001 STABILITY AND SHELF LIFE TESTING OF FOODS

Credit: 3:0:0

Course Objectives:

- To enable the student to know the importance of sorption isotherms in stability of Food products.
- To provide knowledge on methods of shelf life testing of Food products
- To make the students acquire knowledge on effect of packaging materials on the shelf life of products

Course Outcomes:

- The students would be able to develop skills on determining the shelf life of new products
- The students would apply their knowledge in developing newer and cost-effective packaging materials for improved quality of processed products
- The students would be able to develop foods that are wholesome and safe

Factors affecting shelf life and spoilage – Physical, chemical and microbial – Methods used to predict microbial stability – Sorption isotherms - The glass transition approach – Temperature and food stability – Arrhenius model – the Q10 concept – Shelf life testing and indices – Modelling shelf life – Predictive models and their application to certain foods – Software systems – Sensory evaluation methods of shelf life testing - Accelerated shelf life testing – Predicting packaging characteristics for shelf life improvement – Practical application of shelf life testing of fruits and vegetables, dry mixes, high fat foods, dairy and confectionery products.

Text books

1. Kilcast D and P Subramaniam. The Stability And Shelf-Life Of Food. Woodhead Publishing Ltd. 2000. ISBN 1 85573 500 8.
2. Kilcast D and P Subramaniam. Food and Beverage Stability and Shelf Life. Woodhead Publishing Ltd. 2011. ISBN-13: 978-1845697013
3. R. Steele. Understanding and Measuring the Shelf-life of Food. Woodhead Publishing Ltd. 2004. ISBN 1 85573 732 9.

15FP3002 TECHNOLOGY OF FRESH CUT FRUITS AND VEGETABLES

Credit: 3:0:0

Course Objectives:

- To enable the student to know about importance of fresh cut fruits and vegetables.
- To provide knowledge on processing & preservation techniques of the same
- To make the students acquire knowledge on fruit and vegetable processing

Course Outcomes:

- The students would be able to develop skills on cut fruits and vegetables preservation techniques.
- The students would apply their knowledge in developing newer and cost-effective strategies of fruit and vegetable preservation
- The students would be able to develop foods that are wholesome and safe

Course Description:

Fresh-cut Produce: Tracks and Trends – Regulatory issues - Quality Parameters – Safety aspects – Physiology of fresh cut produce – Enzymatic effects of flavor and texture – Microbiology of fresh cut produce – Microbial enzymes associated with fresh cut produce – Preservative treatments – Packaging and Modified atmosphere packaging of fresh cut produce – Flavour and aroma of fresh cut produce – Sensory quality evaluation of fresh cut produce

Reference Books

1. Olusola Laminkanra. Fresh-Cut Fruits And Vegetables – Science, Technology and Market. CRC Press LLC, 2002. ISBN 1-58716-030-7.
2. Robert Soliva – Fortuny, Advances in Fresh-cut Fruits and Vegetables Processing. CRC Press, 2010. ISBN 978 – 1 – 4200 – 7121 – 4.
3. Brody A L, Zhuang, H, Han, J H. Modified Atmosphere Packaging for Fresh-Cut Fruits and Vegetables. Blackwell Publishing Ltd. 2011. ISBN 978-0-8138-1274-8

16FP1001 BASICS OF FOOD SCIENCE AND TECHNOLOGY

Credits: 3:0:0

Course Objectives:

- To understand about nutrition and its importance
- To impart knowledge of Food Safety and its scope in quality control of foods
- To study the basic knowledge about food processing and preservation techniques

Course Outcomes:

- To get exposure about nutrition and nutritive value of different food sources
- To develop skills to identify and examine the food- borne microorganisms
- Apply knowledge about various processing methods in Food Industries

Description:

Basic constituents of foods, Carbohydrates, Fats, Proteins, Vitamins, aminoacids, Sugars – simple, complex, Practical importance of sugars, Complex sugars (starch, cellulose), Maillard reaction, Frying, Vitamins and minerals importance. Calculation of BMR,PER,NPU - Basics of ADI, RDA, RDI - **Nutritional disorders** - Effect of processing on nutrients - **Role of microorganism** in food processing and preservation - Role of microorganism in food spoilage - Food borne illness and intoxication - Food quality analysis - Role of microorganism in health promotion – Blanching – Pasteurization & Sterilization – Canning – Drying - Retort Pouching - Refrigeration and Freezing - Hurdle Technology - Minimal Processing - Cut Fruits and vegetables - Irradiation - Emerging / Novel non-thermal technologies

Reference Books

1. Potter, Norman N., Hotchkiss, Joseph H. (1995), Food Science, Fifth Edition, ISBN 978-1-4615-4985-7
2. William C. Frazier and Dennis C. Westhoff, "Food Microbiology" Tata Mcgraw – Hill Ltd., New Delhi, Fourth Edition, ISBN – 9780070667181.
3. P. Fellows, (2000) Food Processing Technology: Principles and Practice. Wood Head Publishing Limited, Cambridge, England.
4. Srilakshmi, B. (2003), Food Science, Fifth Edition, New Age International (P) Publishers Ltd., Chennai, ISBN 13: 9788122427240

16FP2001 FOOD AND NUTRITION SECURITY OF GM CROPS

Credits: 3:0:0

Course Objectives:

- To provide foundation in Food safety regulations
- To create awareness on the importance of GM crops
- To develop basic knowledge on techniques in nutrition security of GM crops.

Course Outcomes:

- The student would acquire knowledge on International food safety regulations.
- The student acquires knowledge in current research achievements in the field of nutritional safety of GM crops

Description:

International aspects of the quality and safety of Foods derived from modern Biotechnology, Application of ELISA for detection of Toxins in food, Biosensors for food quality Assessment, Malnutrition, consequences, causes, prevention and control. Applied community nutrition. Food safety and food faddism. safety testing for toxicity, allergenicity, anti nutritional effects. Native toxins and toxins produce during storage, health hazards.

References Books

1. Matin Qaim, *Genetically Modified Crops and Agricultural Development*, Palgrave Macmillan US, 2016.
2. Watson and Preedy, *Genetically Modified Organisms in Food: Production, Safety, Regulation and Public Health*, Academic Press, 2015.
3. Roland Norer. *Genetic Technology and Food Safety*, International Congress of Comparative Law, Springer, 2016.
4. Tutelyan, Victor. *Genetically Modified Food Sources Safety Assessment and Control*. Amsterdam: Elsevier/Academic Press, 2013.
5. Carter, Colin Andre, Giancarlo Moschini, and Ian M. Sheldon. *Genetically Modified Food and Global Welfare*. Bingley, UK: Emerald, 2011.
6. Lawrence, Geoffrey, Kristen Lyons, and Tabatha Wallington. *Food Security, Nutrition and Sustainability*. Sterling, VA: EARTHSCAN, 2010.
7. Stahl, Ulf, Ute E. B. Donalies, Elke Nevoigt, and D. B. Archer. *Food Biotechnology*. Berlin: Springer, 2008.
8. Bielecki, Stanisław, J. Tramper, and Jacek Polak. *Food Biotechnology*. Amsterdam: Elsevier, 2000.
9. Gutiérrez-López, Gustavo F., and Gustavo V. Barbosa-Cánovas. *Food Science and Food Biotechnology*. Boca Raton, Fla: CRC Press, 2003.

16FP2002 POST-HARVEST TECHNOLOGY OF FOODS

Credits: 3:0:0

Course Objectives:

- To study the principles of Post-Harvest technology
- To provide knowledge on food processing techniques

Course Outcomes:

- The student get knowledge on Post-Harvest techniques of food crops
- The student become aware on research in post harvest crop management

Description:

Classification, chemical composition and nutritional values of food grains (cereals including millets, legumes and pulses). Anti-nutritional factors in food-methods for their removal- aflatoxins and their removal. Contamination, processing and preservation of food products: bakery, fruits and vegetables, meat, fish and poultry, dairy. Thermal and Non-thermal methods of food preservation: Principles and applications-Canning, evaporation, drying, freezing, irradiation and HPP. Post harvest technology of cereals and pulses, fruits and vegetables, milk and milk products, meat, fish and poultry, plantation products and spices.

References Books

1. Florkowski, Wojciech J., and Robert L. Shewfelt. *Postharvest Handling A Systems Approach*. Amsterdam: Elsevier/Academic Press, 2009.
2. Rees, Debbie, Graham Farrell, and J. E. Orchard. *Crop Post-Harvest Science and Technology : Perishables*. Hoboken: Wiley-Blackwell, 2012.
3. Chakraverty, Amalendu. *Handbook of Postharvest Technology: Cereals, Fruits, Vegetables, Tea, and Spices*. New York: Marcel Dekker, 2003.
4. Golob, P. *Crop Post-Harvest Science and Technology*. Oxford, UK: Blackwell Science, 2002.
5. Ahmad, Mohammad Shamsher, and Mohammed Wasim Siddiqui. *Postharvest Quality Assurance of Fruits: Practical Approaches for Developing Countries*. 2015.
6. Simson, Sharon Pastor, and Martha C. Straus. *Post-Harvest Technology of Horticultural Crops*. Jaipur, India: Oxford Book Co, 2010.

16FP2003 MECHANIZATION AND POST-HARVEST TECHNOLOGY LAB

Credits: 0:0:2

Co-requisite: 16FP2002 Post Harvest Technology of Foods

Course Objectives:

- To expose the students to the importance of post harvest technology
- To expose the students to food preservation techniques

Course Outcomes:

- The student would acquire knowledge on Post-Harvest techniques
- The student would know about the techniques in food preservation
- The student would be able to develop different kinds of food products

The faculty conducting the laboratory will prepare a list of 12 experiments and get the approval of HoD/ Director and notify it at the beginning of each semester.

14FP3017 FOOD INDUSTRY WASTE MANAGEMENT

Credit 3:0:0 **(Version 1.1)**

Course Objectives

- To enable the student, understand the extent of wastes produced in a food industry and its environmental effects
- To enable the student, understand the nature of food wastes and methods of treatment
- To enable the student, know the importance of waste utilization in Food industries

Course Outcomes

- Students will attain knowledge about various legalizations on food industry and its environmental impact
- Students will attain knowledge about the methods of managing food wastes
- Students will gain knowledge on the methods for utilization of food wastes
- Students will gain knowledge on getting value-added products from wastes

Sources of Food Industry Wastes – BOD and COD – Characterization, and Composition of Food Industry Wastes. Environmental Management Systems for Food Industries – ISO14000 for Food Industries – Legislations pertaining to Environmental Interaction of Food Industries – Key drivers for waste management and co-product recovery in Food Processing–Strategies to be followed for optimizing manufacturing to minimize wastes – Key issues and technologies for Food waste separation and Co-product recovery – Methods of solid and liquid waste treatment – Impact of water footprint and rehabilitation of Food industry waste water – Waste water treatment – Unit operations in waste water treatment – Waste management in specific food industries–Methods to obtain value-added products from wastes from specific food industries.

Reference Books

1. Kosseva M and C Webb, Food Industry Wastes, Assessment and Recuperation of Commodities, Academic Press, 2013. ISBN: 978-0-12-391921-2
2. Panda H. The Complete Book on Managing Food Processing Industry Waste, Asia Pacific Business Press Inc, 2011. ISBN: 9788178331454.
3. Waldron K.W., Handbook of waste management and co-product recovery in food processing (Volume 1), Woodhead Publishing Ltd., 2007. ISBN - 1 84569 025 7
4. Arvanitoyannis I., Waste Management for the Food Industries, Academic Press, 2007.ISBN: 978-0-12- 373654-3.
5. Vasso Oreopoulou, Utilization of By-Products and Treatment of Waste in the Food Industry, Springer Science, 2007. ISBN-13: 978-0387-33511-7.
6. Wang L.K. , Y-T Hung, H H. Lo and C Yapijakis, Waste Treatment in the Food Processing Industry, CRC Press, 2005. ISBN 9781420037128.

14FP3024 FOOD PROCESSING AND BIOTECHNOLOGY

Credit 3:0:0 **(Version 1.1)**

Course Objectives:

- To provide knowledge about the chemistry and microbial aspects of food.
- To teach the various processing methods of foods.
- To equip knowledge with the various equipments for processing of foods.

Course Outcomes:

- The student will gain knowledge about the chemistry and microbial aspects of food.
- The student will have the knowledge of various processing techniques and related equipments.
- The students will be able to develop new products with improved quality.

Food Chemistry -Constituents of food – Enzymatic and Non-enzymatic browning - Food additives: intentional and non-intentional and their functions; Enzymes in food processing. **Food Microbiology** - food fermentation; Food borne diseases – infections and intoxications, food spoilage – causes and prevention. **Thermal and non-thermal methods of food** preservation : Principles and Applications in Food System - Technology of Manufacture of **Food Products-** Bakery and confectionery , vegetable and fruit products, Plantation products and spices, Milk and Milk products , edible oils and fats; meat, poultry and fish products.

Reference Books

1. Saravacos GD and Maroulis ZB, Food Process Engineering Operations, Taylor and Francis group, 2011. ISBN 9781420083538.
2. Campbell-Platt, G. Food Science and Technology, Wiley-Blackwell, 2009. ISBN: 978-0-632-06421-2.
3. Damodaran S, Parkin KL, Fennema OR, Fennema's Food Chemistry, CRC Press/Taylor & Francis, 2008
4. Adams MR and Moss MO, Food Microbiology, 3rd ed. RSC Publishing, 2008. ISBN 978-0-854042845.

14FP3025 ADVANCES IN PROCESSING OF HORTICULTURAL PRODUCTS

Credit 3:0:0 **(Version 1.1)**

Course Objectives:

- To enable the student to know about post harvest technology of fruits and vegetables.
- To provide knowledge on processing & preservation techniques of fruits and vegetables.
- To make the students acquire knowledge on fruit and vegetable processing

Course Outcomes:

- The students would be able to develop skills on various preservation techniques.
- The students would apply their knowledge in developing newer and cost-effective strategies of food preservation.
- The students would be able to develop foods that are wholesome and safe.

Importance of post harvest technology of fruits and vegetables -Post harvest handling- Physiology -Fruit ripening - Spoilage -Deteriorative factors and their control. Minimal processing: Cut fruits and vegetables. Hurdle technology: Osmotic dehydration, Canning, Technology of value addition and preservation – beverages and preserves. Thermal methods of preservation- Freezing- methods, freeze concentration, freeze drying, pre-cooling and chilling techniques. Drying and dehydration methods- Different types of dryers- components and working - Foam mat drying, spray drying. Non-thermal preservation - Emerging preservation techniques- Microwave heating – Radiation preservation –Ohmic heating -High pressure processing - Aseptic processing. Packaging and storage: storage systems for horticultural products -Cold storage - Modified and Control Atmosphere Storage.

Reference Books

1. Rodrigues FS and Fernandes AN. Advances in Fruit Processing Technologies, CRC Press, Taylor and Francis group, 2012. ISBN 978 – 1 – 4398- 5152 – 4.
2. Hui Y.H. Handbook of Fruits and Fruit Processing. Blackwell Publishing, 2006. ISBN 13: 978 – 0 – 8138- 1981-5.
3. W Jongen. Fruit and Vegetable Processing: Improving Quality, Woodhead Publishing Ltd., England. 2002. ISBN 185573548.
4. Shafiur Rahman. Handbook of Food Preservation. Replika Press Pvt. Ltd. India.2006.

LIST OF SUBJECTS

Subject Code	Name of the Subject	Credits
14FP2001	Principles of Food Process Engineering	3:0:0
14FP2002	Food Chemistry	3:0:0
14FP2003	Fluid Mechanics and Heat Transfer Lab	0:0:2
14FP2004	Food Analysis Lab –I	0:0:2
14FP2005	Heat and Mass Transfer	3:0:0
14FP2006	Dairy Engineering and Technology	3:0:0
14FP2007	Unit Operations in Food Process Engineering - I	3:0:0
14FP2008	Fruit and Vegetable Processing Technology	3:0:0
14FP2009	Unit Operations in Food Process Engineering and Grain Processing Lab	0:0:2
14FP2010	Unit Operations in Food Process Engineering - II	3:0:0
14FP2011	Refrigeration, Air conditioning and Cold Storage	3:0:0
14FP2012	Food Packaging Technology	3:0:0
14FP2013	Storage Engineering	3:0:0
14FP2014	Enzymology Lab	0:0:2
14FP2015	Food Product Technology Lab - I	0:0:2
14FP2016	Physical Properties of Food Materials	3:0:0
14FP2017	Supply Chain Management	3:0:0
14FP2018	Food Safety Regulations	3:0:0
14FP2019	Engineering Properties of Food Materials Lab	0:0:2
14FP2020	Food Engineering and Packaging Lab	0:0:2
14FP2021	Food Process Equipment Design	3:0:0
14FP2022	Food Analysis Lab – II	0:0:2
14FP2023	Computer Aided Food Process Equipment Design Lab	0:0:2
14FP2024	Mechanical Systems for Food Processing	3:0:0
14FP2025	Cereals and Pulses Technology	3:0:0
14FP2026	Plantation Products and Spices Technology	3:0:0
14FP2027	Food Additives	3:0:0
14FP2028	Fat and Oil Processing Technology	3:0:0
14FP2029	Technology of Meat, Poultry and Fish	3:0:0
14FP2030	Bakery and Confectionery Technology	3:0:0
14FP2031	Drying Technology	3:0:0
14FP2032	Process Economics and Plant Layout Design	3:0:0
14FP2033	Food Additives Lab	0:0:2
14FP2034	Food Product Technology Lab - II	0:0:2
14FP2035	Food Preservation Principles	3:0:0
14FP2036	Processing of Food Commodities	3:0:0
14FP2037	Technology of Packaging	3:0:0
14FP2038	Functional Foods and Nutraceuticals	3:0:0
14FP2039	Material Science for Food Engineers	3:0:0
14FP2040	Food Industry Waste Management	3:0:0
14FP2041	Emerging Technologies in Food Process Engineering	3:0:0
14FP2042	Computational Fluid Dynamics Lab	0:0:2
14FP3001	Separation Processes in Food Engineering	3:0:0
14FP3002	Mass Transfer Processes in Food Engineering	3:0:0
14FP3003	Technology of Food Flavourants and Colourants	3:0:0
14FP3004	Food Plant Layout and Design	3:0:0
14FP3005	Instrumental Techniques for Food Quality and Safety	3:0:0
14FP3006	Storage Engineering of Grains	3:0:0
14FP3007	Food Laws and Safety Regulations	3:0:0

14FP3008	Logistics and Distribution Management in Food Industry	3:0:0
14FP3009	Food Analysis Lab	0:0:2
14FP3010	Food Engineering and Transport Processes Lab	0:0:2
14FP3011	Food Product Technology Lab	0:0:2
14FP3012	Advances in Dairy, Meat and Fish Processing	3:0:0
14FP3013	Advances in Food Microbiology	3:0:0
14FP3014	Advances in Processing of Cereals, Pulses and Oil seeds	3:0:0
14FP3015	Advances in Processing of Horticulture, Spices and Plantation Products	3:0:0
14FP3016	Milling and Bakery Technology	3:0:0
14FP3017	Food Industry Waste Management	3:0:0
14FP3018	Refrigeration and Cold storage Engineering	3:0:0
14FP3019	Advances in Food Process Engineering	3:0:0
14FP3020	Engineering Properties of Food	3:0:0
14FP3021	Design of Food Processing Equipments	3:0:0
14FP3022	Advances in Packaging and Handling of Foods	3:0:0
14FP3023	Food Material Science	3:0:0
14FP3024	Food Processing and Biotechnology	3:0:0
14FP3025	Advances in Processing of Horticulture Products	3:0:0
14FP3026	Food Analysis and Agro biotechnology Lab	0:0:4

14FP2001 PRINCIPLES OF FOOD PROCESS ENGINEERING

Credits: 3:0:0

Course Objectives

- To enable the students to solve problems in Food Engineering process of value addition and quality improvement.
- To impart knowledge on the principles of Food Process Engineering and its importance for the Food Industry.
- To make the student to understand units and dimensions, ability to solve engineering problems related to food processing, and familiarization with some food processing unit operations.

Course Outcomes

- The students understand the principles in formulating solutions to solve problems in food industry.
- The students understood the importance of Food Process Engineering as one of the major pillars of Food Science and Technology discipline.
- The students acquired the required skills in dealing with units and dimensions, solving problems of Food Process Engineering.

Dimensions and unit - Force, momentum, pressure, work and energy, power, heat and enthalpy. Dimensional analysis. Mole – atomical molar mass. Gases and vapors: Behavior of Gases – Gas laws – Van der Waal's equation -Amagat's law – psychrometry. Flow of fluids: Fluids-Properties - concept of viscosity-types of fluid. Bernoulli equation-fluid flow- pressure drop due to fittings, flow measurement principles- Material Balance : Process flow diagram-system boundaries - Continuous vs. Batch-Recycle and by pass-unsteady state -mass balance problems. Energy Balance: Heat capacity -energy balance for a closed system and open system Energy balance problems in heat exchangers –Drying.

Reference Books

1. Albert Ibarz, Gustavo V. Barbosa-Canovas, "Unit Operations in Food Engineering". 2nd Edition, Taylor & Francis, 2014.
2. Smith, PG. "Introduction to Food Process Engineering", 2nd Edition, Springer, 2011.
3. Paul Singh R, and Dennis R.Heldman "Introduction to Food Engineering" 4th Edition. Academic Press – Elsevier India Private Ltd. New Delhi, 2008.
4. Chapman & Hall, USA, CBS publications, New Delhi, 2007.

5. Frank P. Incropera, David P. DeWitt, Theodore L. Bergman, Adrienne S. Lavine,"Fundamentals of Heat and Mass Transfer", Published by Wiley; 6th edition, 2006.

14FP2002 FOOD CHEMISTRY

Credits: 3:0:0

Course Objectives

- To enable the students understand the chemistry and importance of water, carbohydrates, lipids, proteins and vitamins
- To impart knowledge on the methods of manufacture of oils and the methods of determining the quality of oils and fats
- To understand the role of vitamins in human nutrition and the effect of various processing methods in maintaining the vitamin content in foods.

Course Outcomes

- The students understood the importance of various food constituents, and their role in a food.
- The students understood the chemical changes that takes place during food processing
- The students understood to develop a basic idea in new food product development

Structure of water & ice - Sorption isotherms – Dispersed systems – Carbohydrates: nomenclature, classification, structures and physical & chemical properties - Process flow sheet for the maltodextrin and cyclodextrin production - Lipids: Classification, basic structures and properties - Auto oxidation and hydrolysis - Proteins: Nomenclature, classification, structure and chemistry of proteins and amino acids- Isolation, identification & purification - Enzymes: Classification, nomenclature and functions of enzymes – Specificity – Immobilization - Importance of enzymes in food industry –Vitamins and minerals: Fat and water-soluble vitamins -RDA – Bioavailability – Effect of processing

Reference Books

1. De Man J.M., "Principles of Food Chemistry", Springer, 3rd Edn., ISBN 978-1-4614- 6389-4, 2013
2. Belitz, H.D., Grosch, W., Schieberle, P. Food Chemistry. 4th and Revised and Extended Edition, Springer Verlag, Germany, ISBN 978-3-540-69933-0, 2009.
3. Damodaran S., Parkin K. and Fennema O.R.,"Fennema's Food Chemistry", CRC Press, ISBN 0849392721, 9780849392726, 2008.
4. Vaclavik V.A. and Christian E.W., "Essentials of Food Science", Springer, 3rd Edn.,ISBN 978-0-387-69939-4, 2008.

14FP2003 FLUID MECHANICS AND HEAT TRANSFER LAB

Credits: 0:0:2

Co Requisite: 14CE2003- Mechanics of Fluids

Course Objectives

- To enable the students to understand the means of pressure loss in fluid dynamics
- To enable the students to understand the means of heat losses in food systems

Course Outcomes

- Students would be able to develop systems that minimize pressure losses in flow systems
- Students would be able to judge the efficiency of a system and develop suitable technologies

The faculty conducting the laboratory will prepare a list of 12 experiments and get the approval of HoD/Director and notify it at the beginning of each semester.

14FP2004 FOOD ANALYSIS LAB – 1

Credits: 0:0:2

Co Requisite: 14FP2002-Food Chemistry

Course Objectives

- To train the student to analyse food components
- To make the students aware of the standards of food quality

Course Outcomes

- Students would be able to assess the quality of the food
- Students would be able to develop newer methods of food analysis

The faculty conducting the laboratory will prepare a list of 12 experiments and get the approval of HoD/Director and notify it at the beginning of each semester.

14FP2005 HEAT AND MASS TRANSFER

Credits: 3:0:0

Course Objectives

- To enable the student to understand the basics of fluid mechanics and thermal flow
- To understand the Importance of thermal fluid sciences in processing of food
- To develop processes with better heat efficiency and economics

Course Outcomes

- Learn to design heat exchangers for food processing
- Learn to design cold storage for food preservation
- Learn to Select suitable processing equipment

Modes of heat transfer-Fourier's law of heat conduction-Heat conduction through simple geometry-Theory of insulation, critical radius of insulation-Forced and natural convection. Boiling and condensation-mechanisms-Radiation heat transfer-Heat exchangers-overall heat transfer coefficient- log mean temperature difference in Shell and tube heat exchanger and double pipe heat exchanger. Heat exchanger Analysis-Fick's law- mass transfer and coefficient –convective mass transfer.

Reference Books

1. Incropera F.P. Fundamentals Of Heat And Mass Transfer. 7th Edition, John Wiley. ISBN 13-978-0470-0297-9, 2011.
2. M. Thirumaleshwar; Fundamentals of heat and mass transfer-Sai print-O-pak. Ltd, 2009
3. Geankoplis CJ, "Transport Processes and Separation Processes Principles" .Prentice Hall India, New Delhi, ISBN-978-81-203-2614-9, 2008
4. Warren,L McCabe, J.C. Smith and Peter Harriot,"Unit Operations of Chemical Engineering " McGraw Hill International Edition, Singapore, ISBN-007-424740-6, 2005
5. Yunus A.Cengel, Robert H.Turner.," Fundamentals of Thermal Fluid Science", Tata McGraw Hill,New Delhi, 2005.

14FP2006 DAIRY ENGINEERING AND TECHNOLOGY

Credits: 3:0:0

Course Objectives

- To understand about milk, milk processing methodologies
- To provide knowledge about the processing equipments
- To provide technical know-how about the production of milk products.

Course Outcomes

- The students learn the technology of milk and its processing methods.
- The students gain knowledge about the various milk processing equipments.
- The students understand the production of various milk products.

Dairy Chemistry and Microbiology- Classification of milk - Milk transport and storage in dairy plants-Applications of enzymes in dairy industry - Dairy Processing Equipments- Milk processing - Milk Chillers, Ice Cream Freezers. Vacuum Evaporators, Spray and Drum Dryers, Product instantizing equipment. Packaging of milk -Manufacture of dairy products- Butter, Ghee, paneer, Khoa, Milk powder,ice cream- Fermented dairy products– Yoghurt, Curd, acidophilus milk etc.- Concept of Probiotic and prebiotic foods, Energy use in Dairy plant, sources of energy, cost of energy, Control of energy losses and Energy conservation.

Reference Books

1. Trevor J.Britz & Richard K.Robinson "Advanced Dairy Science and Technology" Blackwell Publishing Ltd. 2008.
2. Sukumar De, "Outlines of Dairy Technology", Oxford University Press, New Delhi, 23rd impression, 2006.
3. Garret Smit G, "Dairy Processing", Woodhead Publishing Limited, England. 2005.
4. Edger Spreer, "Milk and Dairy Product Technology" Marcel Dekkar Inc. New York, USA, 2005.
5. Walstra. P et al " Dairy Technology"Taylor & Francis ISBN-0-203-90999-2, 2005

14FP2007 UNIT OPERATIONS IN FOOD PROCESS ENGINEERING –I

Credits: 3:0:0

Prerequisite: 14FP2001 Principles of Food Process Engineering

Course Objectives

- To understand the principle involved in food processing engineering
- To the principle and working of various processing equipments
- To know the methods of product recovery

Course Outcomes

- The students understand the operation of equipment
- The students know various factors affecting food processing equipments
- The students learn to select suitable processing equipment

Agitation and mixing agitated vessels, mixing and blending of miscible liquids, mixing index and effectiveness of mixing. Types of evaporators, single and multiple effect evaporators. Evaporator capacity, multiple effect evaporator – methods of feeding. Moisture and its measurements. Drying rate – Mechanical Drying. Types fixed – and Fluidized Bed. Filtration – types of filtration, constant pressure filtration and constant volume filtration and filtration aids. Principles of comminution. Energy and power requirements. Size reduction equipments.

Reference Books

1. Zeki Berk, "Food Process engineering and technology". ISBN- 978-0-12-373660-4 Elsevier, 2009,
2. Fellows, P. Food Processing Technology. CRC Press 2009
3. Geankoplis CJ, "Transport Processes and Separation Processes Principles" .Printice Hall India, New Delhi, ISBN-978-81-203-2614-9, 2008
4. Sahay, K. M. & K. K. Singh. Unit Operations of Agricultural Processing (II revised) Vikas Publishing House Pvt. Ltd., New Delhi. 2007.
5. Richardson, J.F, J. H. Harker & J. R. Backhurst. Coulson & Richardson's Chemical Engineering – Vol. 2. Elsevier Publications. 2006.
6. Warren,L McCabe, J.C. Smith and Peter Harriot,"Unit Operations of Chemical Engineering " McGraw Hill International Edition, Singapore, ISBN-007-424740-6, 2005

14FP2008 FRUIT AND VEGETABLE PROCESSING TECHNOLOGY

Credits: 3:0:0

Course Objectives

- To know the status of fruit and vegetable production in India with importance to losses.
- To study the canning of fruits and vegetables and to impart knowledge about the various products.
- To study the various methods of drying of fruits and vegetables.

Course Outcomes

- Students have attained knowledge on various preservation treatments and operations involved in processing.
- Students have attained knowledge on the various preparation of the products and its standard specifications.
- The students are enabled to apply their knowledge on various technological advancements in the field of product development.

Production and composition of Fruits and vegetables in India, Spoilage factors, Post harvest field operations, preservation treatments for freshly harvested fruits and vegetables, Packaging of whole fruits and vegetables for internal and export markets. General methods of preservation of whole fruits/Vegetables and processed fruits and vegetables. Canning of fruit and vegetables, Preparation of products like Jams, Jellies, Marmalades, Pickles, Puree, Ketchup, Sauce, Squashes etc. – FSSAI specifications. Blanching operations, Processing of fruit juices, Concentrates, Fruit Bars and Fruit powders. Clarification of juices, Minimal processing, Dehydration, Reverse osmosis, Aseptic processing-Basic concepts and principles.

Reference Books

1. Nirmal K. Sinha, "Hand Book of Vegetable and Vegetable Processing", 978-0-8138-1541-1, Wiley-BlackWell 2011
2. Fellows P. J. "Food processing technology principles and practice".3rd Edition Published by Woodhead Publishing Limited, Cambridge, England, 2009.
3. John, P Jacob. "A handbook on post harvest management of fruits and vegetables" ISBN- 71-7035-532-X, Daya Publication, 2008.
4. M. Shafiur Rahman," Handbook of Food Preservation", Second Edition, ISBN-13:978-1-5-7444-606,2007
5. Srivastava, R.P. and Kumar S, "Fruit and Vegetable Preservation: Principles and Practices", International Book Distributing Co. Lucknow 2006.

14FP2009 UNIT OPERATIONS IN FOOD PROCESS ENGINEERING AND GRAIN PROCESSING LAB

Credits: 0:0:2

Co Requisite: 14FP2007-Unit Operations in Food Process Engineering-I

Course Objectives

- To understand the principle involved in food processing engineering
- To the principle and working of various processing equipments
- To know the methods of product recovery of different equipments

Course Outcomes

- Students can learn the material and energy balance related to the unit operations
- Students can understand the factors affecting unit operations
- Students can select suitable unit operations for a specific purpose

The faculty conducting the laboratory will prepare a list of 12 experiments and get the approval of HoD/Director and notify it at the beginning of each semester.

14FP2010 UNIT OPERATIONS IN FOOD PROCESS ENGINEERING – II

Credits: 3:0:0

Prerequisite: 14FP2001 Principles of Food Process Engineering

Course Objectives

- To understand the role of unit operations in food processing engineering
- To know the working principle of various equipments
- To know the methods of product recovery

Course Outcomes

- Students can learn the material and energy balance related to the unit operations
- Students can understand the factors affecting unit operations
- Students can select suitable unit operations for a specific purpose

Principles of diffusion. Distillation – flash Distillation, rectification and stripping. Distillation equipments. Calculation of theoretical plates. Leaching and liquid liquid extraction. Liquid liquid equilibria and solid liquid equilibria. Extraction equipments. Absorption – packing and packed tower for absorption. Adsorption equipment. Crystallization and crystallization equipment. Membrane separation. Types of membranes.Separation of gases. Pervaporation and Reverse Osmosis

Reference Books

1. George D. Saravacos, Zacharias B. Maroulis" Food processing engineering operation "Taylor and Francis, 2011.
2. Geankoplis CJ, "Transport Processes and Separation Processes Principles" .Printice Hall India, New Delhi, ISBN-978-81-203-2614-9, 2008
3. Maria Margarida Cortez Vieira, Peter Ho, "Experiments in Unit Operations and Processing of Foods", ISBN 978-0387-33513-1, Springer, 2008.
4. Sahay, K. M. & K. K. Singh. Unit Operations of Agricultural Processing (II revised) Vikas Publishing House Pvt. Ltd., New Delhi, 2007.
5. Richardson, J.F, J. H. Harker & J. R. Backhurst. Coulson & Richardson's Chemical Engineering – Vol. 2. Elsevier Publications, 2006.
6. Warren,L McCabe, J.C. Smith and Peter Harriot,"Unit Operations of Chemical Engineering " McGraw Hill International Edition, Singapore, ISBN-007-424740-6, 2005.

14FP2011 REFRIGERATION, AIRCONDITIONING AND COLD STORAGE

Credits: 3:0:0

Prerequisite: 14FP2005 Heat and Mass Transfer

Course Objectives

- To enable the students to understand the various concepts behind refrigeration and air conditioning.
- To enable the students to solve simple problems in refrigeration and air conditioning.
- To enable the students to understand the various concepts behind cold storage construction, design, maintenance, and applications in food industry.

Course Outcomes

- The students are knowledgeable to construct refrigeration and air conditioning.
- The students will be able to solve problems on refrigeration and air conditioning and design cold storage for food applications.
- The students will be able to apply their knowledge on cold storage of perishable products.

Refrigeration – Basic concepts and Psychrometrics, Air conditioning – Cold Storage Design And Construction - Cooling load estimation, prefabricated cold storage systems and mobile refrigeration systems. Freezer Storages - Pre-cooling and pre freezing - Freezer types. Chilling equipment for liquid foods. Secondary refrigerants and direct

expansion techniques in chilling. Chilled foods transport and display cabinets - Chilled foods microbiology, Packaging of Chilled foods - Design considerations for chillers and chilled Storages. Evaporative cooling.

Reference Books

1. Ibrahim Dincer and Mehmet Kanoglu, "Refrigeration Systems and Applications", 2nd Edition, John Wiley and Sons Publication, ISBN-9780470747407, 2010.
2. Florkowski W.J, Shewfelt R.L, Brueckner B and Prussia S.E, "Post Harvest Handling and Sytems Approach", Second edition, Academic Press, USA, ISBN- 9780123741127, 2009.
3. Martyn Brown, "Chilled foods – A Comprehensive Guide", 3rd edition, WoodHead publishing, ISBN-9781845692438, 2008.
4. Ahmadul Ameen, "Refrigeration and Air Conditioning", Prentice Hall of India, New Delhi, ISBN-8788120326712, 2006.

14FP2012 FOOD PACKAGING TECHNOLOGY

Credits: 3:0:0

Course Objectives

- To study about the functions of packaging along with the influence of various factors on food.
- To know about the different packaging materials like cans, bottles, flexible films etc.
- To study about the various methods of packaging and the equipments used for packaging.

Course Outcomes

- Students will attain knowledge about the testing of various packaging materials and also suitability of packaging materials with respect to the products.
- Students understand the designing of various storage structures and theories related to it.
- Students are updated of the recent technological advancements in the field of Food Packaging.

Introduction to Food packaging, Effect of environmental factors in packaging, testing of packaging materials, Shelf Life Estimation, Vacuum Packaging, Manufacturing of Metal cans, glass containers, plastic containers and pouches, paper and paperboard. Properties of plastics, .Filling and sealing of Flexible plastic containers, Form fill Seal equipment: Printing on packages, Bar codes, Nutrition labeling and legislative requirements Extrusion – Retort pouch packaging, Active packaging, Moisture control, CO2 and Oxygen scavenging, Modified atmosphere packaging – principles, applications.

Reference Books

1. Gordon L. Robertson, "Food Packaging and Shelf life –A Practical Guide", CRC Press, ISBN-9781420078442, 2010.
2. Coles, R., Dowell, D.M., Kirwan, J. "Food Packaging Technology", Wiley-Blackwell Publishing Ltd, ISBN-9781405147712, 2009.
3. Chiellini, E., "Environmentally Compatible Food Packaging", Wood Head Publishing Ltd and CRC press, ISBN-9781845691943, 2008.

14FP2013 STORAGE ENGINEERING

Credits: 3:0:0

Course Objectives

- To expose the students to the large scale handling and storage mechanism of grains.
- To make the students understand the engineering operations involved in control of physical, chemical and biological spoilage during storage of grains.

- To impart knowledge on design of storage structures.

Course Outcomes

- The students have understood the various spoilage factors of grains during storage.
- The students have gained knowledge on the various aspects of storage of grains and storage structures.
- The students can apply their technical know-how in designing and layout of grain storage structures.

Introduction about the importance of storage, Physico - chemical and thermal properties of grains, Effect of moisture content and drying on storage of grains, Grain storage principles, changes occurring during storage, types of storage structures, theory of storage – Rankine and Janssen theories, design of storage structures, Extent of losses during storage, types of pests and insects, their effect on quality of grains and control measures, Controlled and modified atmosphere storage.

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Reference Books

1. Donald B. Brooker F.W. Bakker-Arkema Carl W. Hall "Drying and Storage of Grains and Oil Seeds" – AVI Book, ISBN-9780870551611, 2013.
2. Sahay K.M and K.K.Singh. "Unit Operations of Agricultural Processing" Vikas Publications, New Delhi, ISBN-81-259-1142-1, 2009.
3. Chakraverty, A.: Post Harvest Technology of Cereals, Pulses and Oilseeds. Oxford and IBH Publishing Co, Calcutta, ISBN-8120402898, 9788120402898. 2009.

14FP2014 ENZYMOLOGY LAB

Credits: 0:0:2

Co Requisite: 14FP2002-Food Chemistry & 14BT2001 Basics of Biochemistry

Course Objectives

- To understand the importance of enzymes in foods.
- To know the application of various enzymes in foods.

Course Outcomes

- The students learn about different enzymes.
- The students apply their knowledge of incorporating enzymes in foods and their actions in foods

The faculty conducting the laboratory will prepare a list of 12 experiments and get the approval of HoD/Director and notify it at the beginning of each semester.

14FP2015 FOOD PRODUCT TECHNOLOGY LAB – I

Credits: 0:0:2

Co Requisite: 14FP2008-Fruit and Vegetable Processing Technology

Course Objectives

- To understand the ingredients needed for preparations of food products.
- To calculate the quantity of ingredients for preparations of food products.

Course Outcomes

- The students are able to list the various ingredients needed for preparations of food products.
- The students are able to calculate the quantity of ingredients for preparations of food products.

The faculty conducting the laboratory will prepare a list of 12 experiments and get the approval of HoD/Director and notify it at the beginning of each semester.

14FP2016 PHYSICAL PROPERTIES OF FOOD MATERIALS

Credits: 3:0:0

Course Objectives

- To study about the different engineering properties of foods.
- To study the methods of determining the quality and properties of different foods.
- To gain knowledge and apply engineering properties in the design of processing, transport and storage equipments.

Course Outcomes

- The students have gained knowledge of engineering properties of food materials.
- The students have gained skills measurement techniques of engineering properties of foods.
- The students have acquired technical know-how on the design of processing, transport and storage structures.

Physical Properties of Foods: Methods of estimation of physical characteristics - Frictional properties-Rheological Properties - Viscosity and Texture measurement techniques-Hardness and brittleness testing - Thermal Properties – concepts and measurement techniques - Aerodynamic and Hydrodynamic Properties- Drag and lift coefficient, terminal velocity and their application in the handling and separation of food materials- Sorption isotherms – Models

Reference Books

1. Jasim Ahmed and Mohammad Shafi ur Rahman, Handbook of Food Process Design, Blackwell Publishing Ltd, ISBN-9781444330113,2012.
2. Serpil Sahin and Servet Gulum Sumnu "Physical Properties of Foods", Springer,USA, ISBN-9780387308081 2006.
3. Rao, M.A and S.S.H. Rizvi:"Engineering Properties of Foods", Marcel Dekker inc. New York, ISBN-97841824753283, 2005.

14FP2017 SUPPLY CHAIN MANAGEMENT

Credits: 3:0:0

Course Objectives

- To understand the fundamentals of supply chain management
- To learn the importance of supply chain management in Food preservation
- To learn about the opportunities available in the country

Course Outcomes

- The students have gained skills on methods to improve supply chain management
- The students are able to develop newer and cost-effective strategies
- The students are able to develop better quality systems.

Supply chain management – Basic concepts – Global supply chain operation - Planning and sourcing – Lean supply management and Six sigma quality– Agile supply management - Making and delivering – Coordination and use of Technology – Supply chain metrics – Opportunities – Developing a supply chain system – Relationship and integration – Third Party logistics in Supply chain – Sustainable supply chain management – Outsourcing – Internationalisation of the supply chain and retailing - Temperature controlled supply chains – Future perspectives

Reference Books:

1. Sanders N.R., Supply chain management: A global perspective, Wiley Publications, ISBN-0470141174, 9780470141175,2011.
2. Scott C., H Lundgren, and P Thompson. Guide to Supply Chain Management, Springer Verlag, ISBN: 978-3-642-17675-3, 2011.

14FP2018 FOOD SAFETY REGULATIONS

Credits: 3:0:0

Course Objectives

- To create awareness about the importance of Food Safety.
- To impart knowledge about the Regulating authorities for food safety world over.
- To provide knowledge on HACCP in food industries.

Course Outcomes

- The students have gained knowledge on importance of food safety.
- The students have acquired sufficient knowledge about the regulations and authorizes for food safety.
- The students have developed their skills in the safety aspects to be implemented in food industries.

Food Regulations World Trade order – Functioning and responsibilities of the WTO - Codex Alimentarius –Current Issues under consideration – SPS (Sanitary and phytosanitary measures) agreement. World Health Organisation – ICGFI – Functions and responsibilities. Concept of Six Sigma – FSSAI – Organisational chart and role of individual authority – Enforcement of the act – Food safety officers and their powers – Regulations pertaining to Food analysis labs - Offences and penalties – Adjudication and Food safety appellate tribunal – Food labelling – Safety issues – Labelling of GM foods – Approach of US and EU – HACCP and Food safety – Effluent treatment and laws governing the same.

Reference Books:

1. Craig VanGrasstek, The History and Future of the World Trade Organization., WTO Publications, , ISBN-13: 978-9287038715, 2013.
2. Guide to the Food Safety and Standards Act, Tax-mann Allied Services Pvt. Ltd., ISBN 10-8174968288, 2006.
3. Mehta R. and George J., "Food Safety Regulation Concerns And Trade- The Developing Country Perspective", Published by Macmillan India Ltd., New Delhi. ISBN 1403925046, 9781403925046, 2005.
4. Enhancing participation in Codex Activities: FAO/WHO training package, ISBN 92 5 1052778, 2005.

14FP2019 ENGINEERING PROPERTIES OF FOOD MATERIALS LAB

Credits: 0:0:2

Co Requisite: 14FP2010-Unit Operations in Food Process Engineering – II &
14FP2016- Physical Properties of Food Materials

Course Objectives

- To study about the different engineering properties of foods.
- To study the methods of determining the quality and properties of different foods.
- To gain knowledge and apply engineering properties in the design of processing, transport and storage equipments.

Course Outcomes

- The students have gained knowledge of engineering properties of food materials.
- The students have gained skills measurement techniques of engineering properties of foods.
- The students have acquired technical know-how on the design of processing, transport and storage structures.

The faculty conducting the laboratory will prepare a list of 12 experiments and get the approval of HoD/Director and notify it at the beginning of each semester.

14FP2020 FOOD ENGINEERING AND PACKAGING LAB

Credits: 0:0:2

Co Requisite: 14FP2012- Food Packaging Technology

Course Objectives

- To understand the principle and working of various food engineering operations and machinery.
- To provide knowledge on packaging and packaging materials.

Course Outcomes

- To students are able to operate food processing machinery and find the efficiency.
- The students will get exposure about packaging, packaging materials and packaging methods.

The faculty conducting the laboratory will prepare a list of 12 experiments and get the approval of HoD/Director and notify it at the beginning of each semester.

14FP2021 FOOD PROCESS EQUIPMENT DESIGN

Credits: 3:0:0

Prerequisite: 14FP2007 Unit Operations in Food Process Engineering -I
14FP2010 Unit Operations In Food Process Engineering-II

Course Objectives

- To enable the student to design and develop equipments used in Food Processing operations.
- Identify and discuss critical design of typical processing equipment.
- Understand the relationship between process design and Safety

Course Outcomes

- The students will gain technical know-how about the material requirements and design of various equipments needed in Food industries.
- The students will understand the practical applications of basic design engineering principles.
- The students will understand the content and applications of process flow diagrams, (PFDs) and piping and instrument diagrams (P&IDs).

Materials: Metals and non-metals, design of pressure vessels- Numerical problem and design of pressure vessel. Storage Vessels: Design of storage vessels – Rectangular Tank with and without stiffeners – shell design. Reaction Vessels: Design of Reaction vessels – materials -classification – jackets. Heat Exchangers: Design of Heat exchangers – types – materials – Evaporator: Materials of construction – types – design-consideration – Design of agitators – power requirements. Dryers: Types - General considerations – Design of Tray dryer- Equipment Ancillaries – Piping system – Flow control devices.

Reference Books

1. Singh & Heldman.”Introduction to Food Engineering”. Academic Press – Elsevier India Private Ltd. ISBN: 978- 0- 1240- 1675- 0 New Delhi, 2013
2. Jasim Ahmed, Mohammad Shafuir Rahman “Handbook of Food Process Design, 2 volume Set” Wiley-Blackwell, ISBN: 978-1-4443-3011-3, April 2012.
3. Rajesh Mehta and J. George “Food Safety Regulation Concerns and Trade- The Developing Country Perspective,” Published by Macmillan India Ltd., New Delhi. 2005
4. Miguel A. Galan, Eva Martin del Valle. “Chemical Engineering: Trends and Developments” John Wiley & Sons, ISBN: 978-0-470-02498-0, 2005.
5. Maroulis Z.B. and Saravacos G.D. “Food Process Design”, Marcel Dekker Inc. ISBN- 0824743113, 2003.

14FP2022 FOOD ANALYSIS LAB-II

Credits: 0:0:2

Co Requisite: 14FP2006 Dairy Engineering and Technology

Course Objectives

- To train the student to analyse food components
- To make the students aware of the standards of food quality

Course Outcomes

- Students would be able to assess the quality of the food
- Students would be able to develop newer methods of food analysis

The faculty conducting the laboratory will prepare a list of 12 experiments and get the approval of HoD/Director and notify it at the beginning of each semester.

14FP2023 COMPUTER AIDED FOOD PROCESS EQUIPMENT DESIGN LAB

Credits: 0:0:2

Co Requisite : 14FP2021-Food Process Equipment Design

Course Objectives

- Design of plants using computing software.
- Simulating process environment virtually.
- Understanding relational database and design specific unit operations.

Course Outcomes

- The students have understood computer aided design principles and practice.
- The students have learnt the effective approaches to building up knowledge about a process through simulation.
- The students have acquired the skills needed to design a chemical plant using ASPEN HYSYS.

The faculty conducting the laboratory will prepare a list of 12 experiments and get the approval of HoD/Director and notify it at the beginning of each semester.

14FP2024 MECHANICAL SYSTEMS FOR FOOD PROCESSING

Credits: 3:0:0

Course Objectives

- To provide knowledge about types of pumps and their applications.
- To learn about types of power transmission elements, steam generators, chillers, refrigeration and material handling systems.
- To enable the students to solve simple problems in mechanical systems.

Course Outcomes

- The students have understood the working principle of pumps and their applications.
- The students have understood the various power transmission elements and working principle of boilers, refrigeration and material handling systems.
- The students have acquired knowledge to solve simple problems in pumps, power transmission systems and refrigeration systems.

Pumping theory- head developed-Types of pumps-Centrifugal pumps- Reciprocating pumps- Rotary gear pumps-vane pumps- and diaphragm pumps-construction- working principles and applications. Mechanical power

transmission systems: shafts-solid and hollow shafts- types of coupling- belt drives-gear drives-chain drives and rope drives. Chilled water and ice production. Material handling. Types of elevators-Design configuration-power requirement and applications- handling of wet products- SS and plastic conveyors and elevators.

Reference Books:

1. Albert Ibarz and Gustavo V. Barbosa - Canovas, "Introduction to Food Process Engineering", Taylor & Francis, ISBN 1439809186, 9781439809181, 2013.
2. R.Paul Singh and Dennis R. Heldman, "Introduction to Food Engineering", 5th edition, Academic press, Elsevier, ISBN: 978 – 0- 12- 398530- 9, 2013.
3. Sadhu Singh, "Handbook of Mechanical Engineering", S.Chand & Company Ltd, New Delhi, 2011.
4. V.B.Bhandari, "Design of Machine Elements", 3rd edition, Tata McGraw- Hill Publishing private Limited, 2010.
5. R K Rajput, "Fluid Mechanics and Hydraulic Machines", S. Chand & Co, ISBN: 8121916666, 9788121916660, 2008.

14FP2025 CEREALS AND PULSES TECHNOLOGY

Credits: 3:0:0

Course Objectives

- To create awareness and knowledge about the processing of major cereals like paddy, maize, pulses etc.
- To study the storage and handling techniques of cereals.
- To study about the byproducts obtained during processing along with their uses.

Course Outcomes

- The students have understood the Paddy Processing and Rice milling equipment which will help them for developing entrepreneurial skills.
- The students have developed skills in the milling and processing of pulses, maize.
- The students have learnt the grain storage and handling processes including the spoilage and problems associated with different methods of storage, which will enable them to promote protective measures against rodents and pests.

Paddy processing-Parboiling process-Methods of grain drying-Products and byproducts of paddy processing-Rice milling- Dehusking process-Modern rice mills and their components-Rice Mill yields and loss due to brokens at different stages of milling-Milling of pulses-Traditional milling process-Modern milling process-Machinery and equipment employed-Pulse flour products-Dry milling of maize-wet milling of maize and corn-value added products-Grain storage and handling.

Reference Books

1. Jan A. Delcour and R. Carl Hoseney, "Principles of Cereal Science and Technology," ISBN: 1891127632, 9781891127632, AACC International, 2010.
2. P. S. Kendurkar, "Post-Harvest Technology and Value Addition in Cereals, Pulses and Oilseeds" Indian Society of Agricultural Biochemists, Indian Society of Agricultural Biochemists, 2008
3. Amalendu Chakraverty, "Post-Harvest Technology of Cereals, Pulses and Oilseeds", 3rd Edn., Oxford and IBH Publishing Company Pvt. Limited, 2006
4. Amalendu Chakraverty, Arun S. Mujumdar, Hosahalli S. Ramaswamy, "Handbook of Postharvest Technology: Cereals, Fruits, Vegetables, Tea, and Spices" CRC Press, 2003.

14FP2026 PLANTATION PRODUCTS AND SPICES TECHNOLOGY

Credits: 3:0:0

Course Objectives

- To understand about Coffee, its processing techniques and coffee products.
- To learn the different types of tea, its manufacturing techniques and quality parameters.

- To learn Cocoa, its processing and chocolate manufacturing technology.
- To know the processing and chemistry of major and minor spices.

Course Outcomes

- The students have understood the processing steps involved for different plantation products and spices.
- The students will apply their knowledge in processing industries related to plantation crops and spices.
- The students will gain skills on identifying the quality aspects of plantation crops and spices.

Coffee: Occurrence – chemical constituents – Harvesting and Technology of coffee and related products - Chicory chemistry – Quality grading of coffee. Tea: Occurrence – harvesting and Technology of various types of tea – Grading of tea. Cocoa and Cocoa Products: Occurrence Chemistry – Processing of cocoa and related products - Chemistry and technology of chocolate manufacture – Quality control of chocolates. Chemistry and Technology of Major & minor Spices: Chemistry of the volatiles –Enzymatic synthesis of flavour identical – Quality control-Synthesis of volatiles using micro-organisms, plant suspension cultures.

Reference Books

1. K.V. Peter, "Handbook of herbs & spices", Volume2, ISBN: 0857095684, 9780857095688, Elsevier, 2012.
2. Chi-Tang Ho, Jen-Kun Lin, Fereidoon Shahidi. "Tea and Tea Products: Chemistry and Health-Promoting Properties, Nutraceutical Science and Technology", CRC Press, 2008.
3. Susheela Raghavan, "Handbook Seasoning, Spices & Flavoring", Second Edition, CRC Press, Publication, 2006.
4. Amalendu Chakraverty, Arun S. Mujumdar, G. S. Vijaya Raghavan & Hosahalli S. Ramaswamy: "Handbook of Postharvest Technology: Cereals, Fruits, Vegetables, Tea, and Spices", CRC Press, 2003.

14FP2027 FOOD ADDITIVES

Credits: 3:0:0

Course Objectives

- To understand the Chemistry of the additives added to food
- To understand the importance of additives in maintaining or improving food quality
- To Know the limits of addition as prescribed by FAO/WHO and PFA
- Develop newer additives with improved safety standards.

Course Outcomes

- The Students acquire knowledge about importance of additives in maintaining or improving food quality.
- The students are able to apply their knowledge on development of various instant premixes by addition of preservatives within the permissible limits.
- The Students understand about the properties, levels of addition and toxicity data of various food additives.

Food additives - definition and classification, food safety levels as per the specifications, safety evaluation of additives – determination of acute and chronic toxicity- NOEL, ADI, LD50 value, PFA regulations, GRAS status. Acidulants, Preservatives ,Emulsifiers and gums, Antioxidants, Humectants, Dough conditioners , flour improvers, Fat substitutes and replacers, Colourants, Flavourants, Flavour enhancers, Nutritional additives, Sweeteners – Natural and synthetic, Chelating agents, antibrowning agents : Types, chemical properties, levels of additions in individual products and toxicity data

Reference Books

1. H.-D. Belitz, Werner Grosch, Peter Schieberle. "Food Chemistry" Springer, ISBN: 3540699333, 9783540699330, 2009.
2. S.N.Mahindru. "Food additives". APH Publishing, ISBN: 8131304183, 9788131304181, 2009.
3. Damodaran S., Parkin K. and Fennema O.R.,"Fennema's Food Chemistry", CRC Press, ISBN 0849392721,, 2008.
4. Thomas Furia "Handbook of Food additives" CRC Press LLC, 2003

5. Francisco D-V and Octavio P-L., "Natural Colorants for Food and Nutraceutical Uses", CRC Press LLC, 2003.

14FP2028 FAT AND OIL PROCESSING TECHNOLOGY

Credits: 3:0:0

Course Objectives

- To understand the physical and chemical properties of fats and oils
- To study the extraction and refining processes
- To learn the packaging, quality standards of fats and oils.

Course Outcomes

- The students have understood to appreciate the importance of fats and oils and their manufacture.
- The students can develop technology for manufacture of designer fats.
- The students can develop newer methods of analysis of oils and fats.

Physical and chemical properties of fats and oils - sources of vegetable oils - chemical reactions of oil – Oil extraction methods –mechanical expression - principle of operation and maintenance-solvent extraction process – batch and continuous-continuous -production of special oils –extraction process. Refining of oils - Production methods of vanaspati, ghee, butter and margarine colouring substances. Packaging of edible oils, vanaspati and ghee. Changes during storage of oil. Non edible oils– production and processing. Industrial applications of fats and oils – quality regulations - manufacture of soap, candle, paints and varnishes - ISI and Agmark standards –oil extraction plant- safety aspects- HACCP standards in oil industries.

Reference books

1. Gunstone F.D., "Vegetable Oils in Food Technology: Composition, Properties and Uses", 2nd Edition, Wiley - Blackwell Publishing Ltd., ISBN 9781444332681, 2011.
2. Gunstone F.D., "Oils and Fats in Food Industry", Blackwell Publishing, United Kingdom, ISBN – 13: 9781405171212, 2008.

14FP2029TECHNOLOGY OF MEAT, POULTRY AND FISH

Credits: 3:0:0

Course Objectives

- To understand about the composition, nutritive value of meat, poultry and fish
- To know about processing technology of meat, poultry and fish
- To learn the technology of meat products and eggs

Course Outcomes

- The student will be able to understand about the composition of meat, poultry and fish,
- The student will have knowledge on the processing of meat, poultry and fish and their by products.
- The students will have knowledge about meat plant sanitation, hygiene and standards.

Meat composition- muscle structure and compositions- Post mortem muscle chemistry. Meat color, flavors of meat products, meat microbiology and safety. Slaughtering and carcass processing-Modern abattoirs- Carcass processing equipment, meat processing equipment. Meat Products. Meat plant hygiene, Good manufacturing practice and HACCP. Processing of Poultry Products. Spoilage factors. Plant sanitation; Poultry meat processing operations. Packaging of poultry products. Fish and other marine products processing. Basic biochemistry, spoilage factors of fish, field refrigeration and icing practice, Freeze preservation. Canning operations, Salting and drying of fish.

Reference Books

1. Leo M.L. Nollet, Fidel Toldra, "Advance Technologies for Meat Processing", Woodhead Publishing Limited, CRC Press, ISBN: 1420017314, 9781420017311, 2006.

2. Mead G, "Poultry meat processing and quality", Woodhead Publishing Limited, CRC Press, ISBN: 18555737272, 9781855737273, 2004.
3. Hui, Y.H., Nip, W.K. and Rogers, R.W, "Meat Science and Applications". Marcel Dekkar Inc. New York, ISBN: 0203908082, 9780203908082, 2001.
4. Balachandran, K.K, "Post-Harvest Technology of Fish and Fish Products", Daya Publishing House, New Delhi, ISBN: 8170352371, 9788170352372, 2001.

14FP2030 BAKERY AND CONFECTIONERY TECHNOLOGY

Credits: 3:0:0

Course Objectives

- To provide know how on the machinery and process involved in the baking process
- To understand the various types of sugar and its grades
- To know the confectionery product manufacture

Course Outcomes

- The students have gained knowledge on the ingredients of baking.
- The students have gained knowledge of the process and machinery involved in bakery and confectionery technology.
- The students have acquired experience of entrepreneur skills of bakery

Testing of Flour For Grains and flour for bakery applications – Bakery equipments – Sanitation and safety aspects- Bread manufacturing process – Process for the manufacture of cakes and biscuits – Importance of consistency of the dough and batter – Importance of the type of flour involved in the manufacture – Quality aspects of baked products - Process for the manufacture of cane sugar – Equipments involved in sugar manufacture - Sugar Refining – Quality standards for sugar - Sugar plant sanitation – Technology for the manufacture of Alcoholic and Non-alcoholic beverages – Quality aspects – Confectionery Technology – Types of confectionery – Additives and Equipments used in Confectionery manufacture – Quality aspects.

Reference Books

1. Stanley Cauvain and Linda S. Young, "Technology of Bread making", Springer, ISBN: 038785657, 9780387385655, 2007.
2. Leo M.L. Nollet, Fidel Toldra, "Advance Technologies for Meat Processing", Woodhead Publishing Limited, CRC Press, ISBN: 1420017314, 9781420017311, 2006.

14FP2031 DRYING TECHNOLOGY

Credits: 3:0:0

Course Objectives

- To understand the basic theory of drying and its significance in food systems
- To understand the importance of drying as a method of food processing
- To learn about the relative advantages / disadvantages of each method of drying

Course Outcomes

- The students have understood the theory of drying.
- The students have understood the principle and working of various types of dryers.
- The students are able to apply their knowledge on drying technology in various food industries.

Principles of drying –pyschrometry – Drying curves –Heat and mass transfer in dryers. Drying models - Water content in foods and its determination – Drying methods and types of dryers- Types of Feeding –Fundamentals of freeze drying – Freezing – Primary drying stage – secondary drying stage -Changes during freeze drying – Condensation, defrosting – Industrial freeze driers. Fundamentals of microwave and dielectric drying - Equipment for microwave and dielectric heating and drying. Fluidized bed drying– Effect of operating parameters –

conventional and modified fluidized bed dryer – Pneumatic / Flash dryers - Basic Operation Principle and Applications of Flash Dryers - Design of Flash Dryers - Materials Dried in Flash Dryers.

Reference Books

1. Singh and Heldman, "Introduction to Food Engineering" Academic Press, ISBN 9780123985309, 2013
2. Sahay K.M and K.K.Singh. "Unit Operations of Agricultural Processing" Vikas Publications, New Delhi, ISBN-81-259-1142-1, 2009.
3. Hui Y. H,:"Food Drying Science and Technology, Microbiology, Chemistry, Application", CHIPS, 2008.
4. Arun S. Mujumdar, "Handbook of Industrial Drying", CHIPS, 3rd Edition, 2006.
5. Loesecke,H. W. V, "Drying & Dehydration of Foods", Published by Agrobios, 2005.
6. Donald B. Brooker F.W. Bakker-Arkema Carl W. Hall "Drying and Storage of Grains and Oil Seeds" – AVI Book, ISBN 0- 442-20515-5,2002

14FP2032 PROCESS ECONOMICS AND PLANT LAYOUT DESIGN

Credits: 3:0:0

Course Objectives

- To enable the students understand the various concepts of economics of food plant.
- To understand the processes involved in layout design.
- To understand the development and design consideration and cost estimation in food industry.

Course Outcomes

- The students will gain knowledge on the various aspects of economics involved in Food Processing Industry.
- The students will understand the process of food plant layout design.
- The students will be able to apply their knowledge to design projects for setting up a Food Processing Industry.

Technical feasibility survey of Food Industry, process development, Food Process flow sheets – Hygienic food process design - equipment design and specifications – Plant layout – Factors to be considered while deciding the plant layout - Process and Product layout – Project evaluation and Cost estimations – Process profitability Application to a Food Plant - Plant Overheads - Profitability Analysis**:** Optimization techniques – Linear and Dynamics programming, Optimization strategies.

Reference Books

1. Dale F.Rudd and Charles Churchill Watson, Strategy of Process Engineering, John Wiley & Sons Inc, ISBN-978-0471744559, 2013
2. Gavin Towler, R.K. Sinnott, Chemical Engineering design principles, practice and Economics of Plant and Process. 2nd Edition. Elsevier, ISBN-9780080966595, 2012
3. Jasmin Ahmed, Mohammad Shafuir Rahman, Hand Book of Food Process Design, 2 Volume Set, Wiley Black Well, ISBN-978-1-4443-3011-3, 2012

14FP2033 FOOD ADDITIVES LAB

Credits: 0:0:2

Co Requisite: 14FP2027-Food Additives

Course Objectives

- To understand the Chemistry of the additives added to food
- To understand the importance of additives in maintaining or improving food quality
- To develop newer additives with improved safety standards.

Course Outcomes

- The students acquire knowledge about importance of additives in maintaining or improving food quality.
- The students are able to apply their knowledge on development of various instant premixes by addition of preservatives within the permissible limits.
- The students understand about the properties, levels of addition and toxicity data of various food additives.

The faculty conducting the laboratory will prepare a list of 12 experiments and get the approval of HoD/Director and notify it at the beginning of each semester.

14FP2034 FOOD PRODUCT TECHNOLOGY LAB – II

Credits: 0:0:2

Co Requisite: 14FP2006-Dairy Engineering and Technology &
14FP2026-Plantation Products and Spices Technology

Course Objectives

- To understand the ingredients needed for preparations of food products.
- To calculate the quantity of ingredients for preparations of food products.

Course Outcomes

- The students are able to list the various ingredients needed for preparations of food products.
- The students are able to calculate the quantity of ingredients for preparations of food products.

The faculty conducting the laboratory will prepare a list of 12 experiments and get the approval of HoD/Director and notify it at the beginning of each semester.

14FP2035 FOOD PRESERVATION PRINCIPLES

Credits: 3:0:0

Course Objectives

- To understand the fundamentals of bio molecules
- To impart basic knowledge on the methods of analysis of fats and oils
- To learn about the food borne diseases , food poisoning and food preservation principle

Course Outcomes

- The students gain knowledge on the fundamentals of food constituents.
- The students get skills on various principles of food processing.
- The students acquire knowledge of various preservation techniques.

Fundamentals of food constituents: Carbohydrates – Classification - Analysis of Fats and oils -Vitamins–Fat– nutritional significance. Food additives: Classification, intentional and non- intentional additives, food colorants – natural and artificial; food flavors. Microorganisms associated with food-fermented foods and food chemicals, single cell protein. Food borne diseases- factors responsible for spoilage of vegetable, fruit, meat, poultry, beverage. Food preservation-Sterilization, pasteurization and blanching, thermal death point– Canning; frozen storage-freezing methods, factors affecting quality of frozen foods.

Reference Books

1. Tom Coultate , Food the Chemistry of its Components 5th Edition, RSC Publishing, ISBN: 978-0-85404-111-4, 2009
2. Frazier W.C. and D.C. Westhoff, "Food Microbiology", 4th Ed., McGraw-Hill Book Co., New York, ISBN-9780070667181,2008
3. Neelam Khetarpaul, Food Processing and Preservation, Daya Publishing House, ISBN-81-7035-4135-418-8, 2005.

4. James M. Jay, Martin J. Loessner, David A. Golden, Modern Food Microbiology, 7th Edition, Springer Science and Business Media Inc, ISBN-0-387-23180-3, 2005

14FP2036 PROCESSING OF FOOD COMMODITIES

Credits: 3:0:0

Course Objectives

- To impart knowledge on the basics of food processing
- To study various processing methods for various food materials like fruits & vegetables, dairy products, cereals, meat, poultry, fish and bakery products .
- To study various innovative food processing techniques

Course Outcomes

- Students will have a know-how on the various processing technologies involving fruits and vegetables, dairy, cereals, meat, fish, egg and plantation products
- Students have acquired basic knowledge on microbiology of food products
- Students will have an overview of the possible arena of entrepreneurial activity related to food products.

Technology of Rice, Pulse milling and Wheat milling-Oil extraction-Methods of manufacture of bread-Fruits and vegetable processing - Preservation treatments-Basics of Canning, Minimal processing and Hurdle technology. Processing of fruit juices. Dairy processing-manufacture of milk and milk products - Meat, poultry and fish processing and their products- Processing of Plantation products -Processing of Tea, Coffee and Cocoa and chocolate Processing of spices-. Pepper, cardamom, ginger, vanilla and turmeric.

Reference Books

1. Srivastava, R.P. and Kumar, Sanjeev: Fruit and Vegetable Preservation: Principles and Practices. International Book Distributing Co (3rd Edition 2006).
2. Chakraverty, A., Mujumdar A.S., Raghavan G.S.V and Ramaswamy H.S. Handbook of Post-harvest Technology: Marcel Dekker Press, USA (2001)
3. W. James Harper and Carl W. Hall: Dairy Technology and Engineering AVI Publishing, Westport, USA (1976)
4. Karel Kulp and Joseph P Pante:Hand Book Of Cereal Science and Technology Mercel Dekkar USA (2000)
5. Samuel Matz: The Chemistry and Technology of Cereals as Food and Feed, Chapman & Hall (1992)

14FP2037 TECHNOLOGY OF PACKAGING

Credits: 3:0:0

Course Objectives

- To provide knowledge on packaging and packaging materials.
- To understand the working of various packaging material manufacturing methods.
- To enable the students to understand the interaction of food items with packaging materials and packaging material testing.

Course Outcomes

- The students will get exposure about packaging, packaging materials and packaging methods.
- The students will develop knowledge on manufacturing of packaging materials and testing.
- The students will be familiar about the food distribution chain and sustainable packaging.

Packaging functions, strategy, design, need and environmental effects. Properties of packaging media. Effect of environmental factors and biological factors on quality of food products. Vacuum and Inert Gas Packaging. Metal cans for packaging. Glass in food packaging. Flexible films, co-extruded films and Laminates in packaging. Rigid and Semi rigid plastic-Retort pouch. Paper and Paperboard. Filling and sealing. Interaction of food and packaging material: Active and Modified atmosphere packaging. Speciality packages. Tests for packaging materials.

Reference Books

1. M.L.Rooney, "Active Food Packaging", Blackie Academic & Professional Publisher, London, 2012.
2. Coles, R., Dowell, D.M., Kirwan, J. "Food Packaging Technology", Black Well Publishing Ltd., 2009.
3. Chiellini, E., "Environmentally Compatible Food Packaging", Wood Head Publishing Ltd., 2008.
4. Gordon L. Robertson, "Food Packaging Principles & Practice", CRC Press, 2006.
5. NIIR Board, "Food Packaging Technology Handbook", National Institute of Industrial Research, New Delhi, 2004.

14FP2038 FUNCTIONAL FOODS AND NUTRACEUTICALS

Credits: 3:0:0

Course Objectives

- To understand the basics of nutraceuticals and functional foods
- To study the significance of nutraceuticals and their role in disease prevention
- To identify new strategies for marketing of traditionally known nutraceuticals

Course Outcomes

- The students have understood the importance of Functional food for preventive therapy.
- The students have learnt methods for extraction of nutraceuticals
- The students have learnt methods for identification nutraceutically significant molecules..

Teleology and Organization models for nutraceuticals – Classification of Nutraceuticals - Flavonoids And Carotenoids As Antioxidants and anti cancer agents- Omega-3 Fatty Acids and Cardiac Arrhythmias, Glycemic control and rheumatoid arthritis – CLA as a nutraceutical – Mechanism - Potential health benefits and adverse effects of CLA – Lycopene, Garlic, Olive oil, and Nuts as functional Foods – Probiotics and Prebiotics – Herbs as functional Foods - Kinetic modelling of chemical reactions – Accelerated shelf life testing – Regulatory and marketing issues for nutraceuticals

Reference Books

1. Aluko R.E., Functional Foods and Nutraceuticals, Springer, 2012. ISBN 978-1-4614-3480-1.
2. D Bagchi, F C. Lau, D K. Ghosh, Biotechnology in Functional Foods and Nutraceuticals, CRC Press, 2010. ISBN 9781420087116.
3. John Shi, Functional Food Ingredients and Nutraceuticals: Processing Technologies, CRC Press, Taylor and Francis Group, 2007. ISBN: 0 – 8493 – 2441 – 6.
4. Wildman, R.E.C., "Handbook of Nutraceuticals and Functional Foods", II edition, CRC Press LLC. 2006. ISBN--10: 0849364094.
5. Hasler C M., Regulation of Functional Foods and Nutraceuticals: A Global Perspective, IFT Press, Blackwell Publishing, 2005. ISBN: 9780813811772.

14FP2039 MATERIAL SCIENCE FOR FOOD ENGINEERS

Credits 3:0:0

Course Objectives

- To enable students understand the basics of material science
- To enable them understand the importance of it in food equipment design
- To enable students understand the current trends in developing food grade materials

Course Outcomes

- The Students will attain knowledge about designing of food grade equipments
- The Students will be able to develop newer materials for food use
- The Students will be able to develop cost-effective methods of developing food-grade materials

Properties of Crystals and Solids : Classification of Engineering materials –Crystal geometry– Structure determination by X-ray Diffraction- Crystalline and Non-crystalline states – Inorganic solids – Metals and Alloys - Imperfection in Crystals and Phase diagram – Iron-Iron carbide systems and applications – Fick's second law of diffusion and its importance in alloy manufacture – Phase transformations and its applications –Manufacture and properties of different types of steel – Basics of SS Fabrication – Deformations – Creep, Fatigue, and Fracture – Oxidation and Corrosion and methods of protection

Reference Books

1. Khanna O.P., "A Textbook of Material Science and Metallurgy", Dhanpat Rai Publications, 2013.
2. Rajput R.K., Fundamentals of Materials Science, S.K. Kataria and Sons, 2011.
3. Mittemeijer, Eric J., Fundamentals of Materials Science, Springer Publications, 2011.
4. Khurmi R. S. & R.S. Sedha, Materials Science, S. Chand and Co., 2008.
5. Raghavan V.. "Materials Science and Engineering -A First course", Fifth Edition, Prentice – Hall of India Private Ltd., New Delhi. 2008.

14FP2040 FOOD INDUSTRY WASTE MANAGEMENT

Credits 3:0:0

Course Objectives

- To enable the student understand the extent of wastes produced in a food industry and its environmental effects
- To enable the student understand the nature of food wastes and methods of treatment
- To enable the student know the importance of waste utilization in Food industries

Course Outcomes

- Students will attain knowledge about the methods of managing food wastes
- Students will gain knowledge on the methods for utilization of food wastes.
- Students will gain knowledge on getting value-added products from wastes

Legislations pertaining to Food waste disposal - Key drivers for waste management and co-product recovery in Food Processing – Strategies to be followed for optimizing manufacturing to minimize wastes – Key issues and technologies for Food waste separation and Co-product recovery – Methods of solid and liquid waste treatment – Impact of water footprint and rehabilitation of Food industry waste water - Waste management in specific food industries – Methods to obtain value-added products from wastes.

Reference Books

1. Kosseva M and C Webb, Food Industry Wastes, Assessment and Recuperation of Commodities, Academic Press, 2013. ISBN: 978-0-12-391921-2
2. Panda H. The Complete Book on Managing Food Processing Industry Waste, Asia Pacific Business Press Inc, 2011. ISBN: 9788178331454
3. Waldron K.W., Handbook of waste management and co-product recovery in food processing (Volume 1), Woodhead Publishing Ltd., 2007. ISBN - 1 84569 025 7
4. Arvanitoyannis I., Waste Management for the Food Industries, Academic Press, 2007.ISBN: 978-0-12-373654-3.
5. Wang L.K., Y-T Hung, H H. Lo and C Yapijakis, Waste Treatment in the Food Processing Industry, CRC Press, 2005. ISBN 9781420037128

14FP2041 EMERGING TECHNOLOGIES IN FOOD PROCESS ENGINEERING

Credits: 3:0:0

Course Objectives

- To study about the concepts and principles of various techniques such as High Intensity Pulse Techniques, Light Pulses and emerging aspects in food process engineering.

- To learn about the equipments used and working principle for the emerging aspects in food process engineering.
- To know the various applications of the new technologies in food process engineering.

Course Outcomes

- Students are updated of the recent technological advancements in the field of Food Technology.
- Students are appraised of the alternate technologies in Thermal Processing of foods.
- The students are able to apply their knowledge on various technological advancements in the field of Food Technology.

Introduction to High Pressure Processing of foods, effect on textural, nutritional and Microbiological quality of foods. Application in the food systems. High Pressure Freezing, Principles, Working and Applications. Pulsed Electric Field processing of foods Principles – Mechanism of action – PEF treatment systems. Principle and Mechanism of osmotic dehydration– Applications. Principle of ultrasound. Basics of ohmic heating-equipment-applications. Hurdle technology- Basics, mechanism, applications and effect of hurdles in foods.

Reference Books

1. Shafiur Rahman. 2007. Handbook of food preservation. Published by Taylor & Francis Group, LLC.
2. Da-Wen Sun. 2005. Emerging technologies for food processing. Elsevier Academic Press, California.
3. Fellows P. J. 2000. Food processing technology principles and practice. Published by Woodhead Publishing Limited, Cambridge, England.
4. Da-wen Sun: Emerging Technologies for Food Processing, Elsevier Academic Press Marcel Dekker Inc. NY (1995)
5. G.W. Gould. 1995. New Methods of Food Preservation. Published by Blackie Academic and Professional, UK.

14FP2042 COMPUTATIONAL FLUID DYNAMICS LAB

Credits: 0:0:2

Co Requisite : 14CE2003- Mechanics of Fluids & 14FP2021-Food Process Equipment Design

Course Objectives

- To make students to understand the flow and heat transfer analysis in engineering problems of practical interest.
- To enable students to study different fluid flows and developing a better intuition of fluid mechanics.
- To enable students to understand the process of developing a geometrical model of the flow, applying appropriate boundary conditions, specifying solution parameters, and visualizing the results.

Course Outcomes

- The students get technical knowledge in the actual implementation of CFD methods The emphasis on the use of CFD as a virtual fluid laboratory.
- The students understand the process of developing a geometrical model of the flow, applying appropriate boundary conditions, specifying solution parameters, and visualizing the results.
- The students have an appreciation for the factors limiting the accuracy of CFD solutions.

The faculty conducting the laboratory will prepare a list of 12 experiments and get the approval of HoD/Director and notify it at the beginning of each semester.

14FP3001 SEPARATION PROCESSES IN FOOD ENGIINEERING

Credits: 3:0:0

Course Objectives:

- To enable the students understand the concepts of separation of solids and liquids in food engineering application.
- To understand the principle behind various separation process equipments.
- To provide knowledge to the students about the working and application of various separation equipments.

Course Outcomes:

- Students will be able to apply their knowledge on separation techniques.
- Students will be able to select suitable separation equipments needed for food industries.
- Students will be able to operate various separation equipments.

Basic principles of fluid flow-devices to measure pressures-types of flow-simple mass balance - continuity equation-pressure drop due to friction-flow in packed beds; Mechanical separation-screens – sedimentation- Filtration-equipments for filtration and sedimentation; Centrifugal separation- Basic equations. Different types of centrifuges - advantages and applications; Filtration by membrane systems- Reverse Osmosis (RO), Nano filtration (NF), Diafiltration, Ultra filtration (UF) and Micro filtration (MF), Membrane Configuration -, membrane materials-Adsorption and Diffusion-Basics of absorption- Diffusion of gases in liquid and solid foods, Moisture transfer in foods, Diffusion in porous foods, Inter-phase moisture transport. Diffusion of aroma components

Reference Books

1. Geankoplis C.J., "Transport process and separation process principles", PHI learning private limited, New Delhi, 4th edition, ISBN-978-81-203-2614-9, 2008.
2. McCabe, W.L., Smith, J.C., and Harriott, P., "Unit operations of chemical engineering". McGrawhill Intl. Edition, Singapore, 7th edn. ISBN-007-424740-6, 2005.
3. Coulson J.M., Richardson J.F., Bachurst J.R., and J.H. Harker – "Coulson & Richardson's Chemical Engineering – Vol. 2 Particle Technology and Separation Processes", Butterworth & Heinemann - Elsevier science Ltd., Fifth Edition, ISBN 0750644451, 2002.
4. Ramaswamy H.S. and Markotte M., "Food Processing Principles and Applications", CRC Press Ltd. ISBN-1-58716-008-0, 2006.

14FP3002 MASS TRANSFER PROCESSES IN FOOD ENGINEERING

Credit 3:0:0

Course Objectives:

- To understand the need of mass transfer process in food industries
- To understand the principle behind various mass transfer process
- To know the operation of various mass transfer equipments

Course Outcomes:

- The students can understand the application of various mass transfer processes in food industries
- The student can select suitable mass transfer operation for a specific need
- The students can design various mass transfer equipments for food processing equipments

Energy balance and material balance for various mass transfer processes. Vapour liquid equilibrium, simple batch and steam distillation. Single and multiple effect evaporator - mode of operation and methods of feeding. Thermo and mechanical systems in evaporators. Solid liquid and liquid liquid extraction. Super critical fluid extraction. Super critical fluid state, Properties of Super critical CO_2, Density, Viscosity, Volatility. Applications; extraction of Fatty acids, oleoresins and essential oils; Relative advantages, limitations and economics.

Text Books:

1. Geankoplis C.J., "Transport process and separation process principles", PHI learning private limited, New Delhi, 4th edition, ISBN-978:81-203-2614-9, 2008.
2. Ramaswamy H.S. and Markotte M., "Food Processing Principles and Applications", CRC Press Ltd. ISBN-1-58716-008-0, 2006.
3. McCabe, W.L., Smith, J.C., and Harriott, P., "Unit operations of chemical engineering". McGrawhill Intl. Edition, Singapore, 7th edn. ISBN-007-424740-6, 2005.
4. Coulson J.M., Richardson J.F., Bachurst J.R., and J.H. Harker – "Coulson & Richardson's Chemical Engineering – Vol. 2 Particle Technology and Separation Processes", Butterworth & Heinemann - Elsevier science Ltd., Fifth Edition, ISBN 0750644451, 2002.

14FP3003 TECHNOLOGY OF FOOD FLAVOURANTS AND COLOURANTS

Credits: 3:0:0

Course Objectives:

- To enable the student to understand the basics of foods flavours and colours
- To enable the student to learn the Chemistry & technology of natural flavours, pigments

Course Outcomes:

- To develop methods for stabilization of natural colorants
- To develop aroma chemicals
- To develop techniques for analysis of colorants and aroma chemicals

Basics of flavours and colours: Olfactory perception of flavour and taste – Theories of olfaction - Molecular structure and activity relationships of taste-Chemicals causing pungency, astringency, cooling effect - Regulations, Toxicology and Safety aspects. Technology of natural flavours: Classification – Alliaceous flavours - Bittering agents, Coffee and Cocoa, Fruit flavours. Evolution of flavours during processing – Essential oils and oleoresins - Chemistry and Technology of Chlorophyll and carotenoids - Haems and bilins, annatto, saffron, turmeric- - Anthocyanins and betalains - Microbial and cell suspensions in the synthesis of colours and flavours- Technology for the production of dried colourants and flavorants - Analysis of flavours and colours: Total component analysis - Head space analysis –Solid phase micro extraction - E-Nose technology - Tristimulus colorimetry.

Reference Books

1. Socaciu C., "Food Colorants - Chemical and Functional Properties", CRC Press, Taylor and Francis group, LLC, ISBN No. 9780849393570, 2008.
2. Reineccius G. and Heath H.B., "Flavor Chemistry and Technology" , Taylor and Francis group, CRC Press, II Edition, 2006.
3. Rowe D.J., "Chemistry and Technology of Flavors and Fragrances", Blackwell Publishing Ltd., U.K., ISBN No. 1405114509, 2005.
4. Marsili R., "Techniques for Analyzing Food Aroma", Marcel Dekker Inc., 1997
5. Francisco D-V and Octavio P-L., "Natural Colorants for Food and Nutraceutical Uses", CRC Press LLC, 2003.
6. Lauro G.J., "Natural Food Colorants", Marcel Dekker Inc., 2000.

14FP3004 FOOD PLANT LAYOUT AND DESIGN

Credits: 3:0:0

Course Objectives:

- To enable the student to understand the various factors involved in the site selection and design of food plant layout.
- To enable the students learn the concept of preparing cost estimate and economics.
- To understand the importance HACCP and food safety laws governing food industries.

Course Outcomes:
On completion of the course, and exposed to

- The student will gain knowledge to design and setting up of new food processing plant as Entrepreneur and/or consultant.
- The student can prepare cost estimate and economic analysis of food industry.
- The student can implement the food safety standards in food industries.

Consideration for location of food processing plants- Site selection-Product Capacity– Storage of Raw materials and Product - Waste Disposal, Utilities – other requirements - water, electricity, labor, transportation facilities, refrigeration, boiler- laboratory - Plans for Future Expansion. Plant layout- different types. Flow process charts. Machine flow diagrams. Selection of processing and handling machines. Plant utilities - Raw material requirements. Application of system design and principles. Layout plans for different machines and utilities. Plant specifications and cost estimates, plant profile. Process plant sanitation and hygiene. Economics-Cost of Producing a Product-Capital - Elementary Profitability Measures.

Reference Books:

1. Dennis R. Heldman and Daryl B. Lund. "Hand Book of Food Engineering", Second edition, CRC Press, Taylor and Francis Group, 2007.
2. R.K. Sinnot. "Coulson and Richardsons Chemical Engineering" Vo. 6., 4th Edition, Elsevier Publication. 2005.
3. Max S. Peters and Klaus D. Timmerhaus and Ronald West. "Plant Design and Economics For Chemical Engineers", 5th Edition, Tata Mc-Graw Hill Education. 2003.
4. T.C. Robberts. "Food Plant Engineering Systems". CRC Press. 2002.

14FP3005 INSTRUMENTAL TECHNIQUES FOR FOOD QUALITY AND SAFETY

Credit: 3:0:0

Course Objectives

- To understand the importance of analytical techniques for quality control
- To know the appropriate analytical method for specific purpose
- To apply the principles of instrumentation in food processing industries

Course Outcomes

- The students can understand the working principle of various instruments
- The students can do various qualitative and quantitative analyses
- The knowledge gained can be used for food quality control

Chromatography principles. High performance liquid chromatography, Gas chromatograph - column efficiency, types of detectors – FID, TCD, ECD, MSD. FTIR Spectroscopy. Atomic Absorption Spectroscopy and Atomic Emission Spectrometry (AES). ICP – Mass spectrometry - Atomic Fluorescence Spectrometry (AFS). The NMR Phenomenon – Types of information provided by NMR spectra – Instrumental and Experimental Considerations – Solid state NMR – application of NMR to Food analysis. Application of GC/MS, LC/MS / FAB/MS / MS/MS and linked scan techniques for food analyze.

Reference Books:

1. Semioh ötles. Methods of analysis of food components and additives, 2012 second edition. CRC Press, Taylor and Francis group
2. Yolando Pico, Chemical analysis of food techniques and applications, 2012 Elsevier publications
3. Rouessac F. and Rouessac A. Chemical Analysis: Modern Instrumentation Methods and Techniques, 2007, 2nd Edition, John Wiley and Sons. Ltd. England. ISBN: 978-0-470-85903-2

14FP3006 STORAGE ENGINEERING OF GRAINS

Credits : 3:0:0

Course Objectives

- To enable the students to understand the various concepts of food storage, post harvest loss and prevention of such losses.
- To impart knowledge on the design aspects of storage structures
- To provide knowledge on modern storage methods

Course Outcomes

- The students will be able to know all the operation in food storage and post harvest handling.
- The food loss prevention can help to meet the food demand.
- The quality of the products can be maintained and make available during off season.

Storage of grains, Biochemical changes during storage, Storage Capacity estimate models-Storage factors affecting losses, Bag & bulk storage, Pressure distribution theories, Rodent control, method of stacking - preventive method, bio-engineering properties of stored products, Structural and thermal design of storage structures. Air distribution systems, CA & MA storage, Storage of dehydrated products, Food spoilage and prevention.

Reference Books

1. K.M. Sahay and K.K. Singh; Unit operations of Agricultural Processing, Vikash Publishing house, 2008.
2. Judith A. Evans, Frozen Food Science and Technology, Blackwell Publishing Ltd, 2008.
3. Y. H. Hui and others, Handbook of Frozen Foods, Marcel Dekker, Inc, 2004.
4. Jelle Hayma, The storage of tropical agricultural products, Agromisa Foundation, Wageningen, 2003.
5. David J. Walker and Graham Farrell, Food Storage Manual, Natural Resources Institute, 2003.
6. T.P.Ojha & A.M.Michael, Principles of Agricultural Engineering Vol-I, 2003, Jain Brothers, New Delhi.
7. P.Fellows, Food processing Technology: Principles and Practice, 2000, CRC, Wood Head Publishing Ltd.

14FP3007 FOOD LAWS AND SAFETY REGULATIONS

Credit: 3:0:0

Course Objectives

- To enable the students to understand the basics of food safety and regulations governing the same, the world over.
- To make the students to understand the role of individual personnel of the regulatory authority
- To enable to understand food safety management systems

Course Outcomes

- Students will be able to develop Protocols based on GMP for Food Processing Industries
- Develop new innovative norms and Ensure implementation of adequate safety regulations and control.
- Students will be able to run risk analysis based upon data and statistics obtained from production lines.

Structure, organization and practical operation of international intergovernmental food regulation bodies such as World Trade order - Codex Alimentarius -World Health Organization. Regulatory affairs - International Food Regulatory Affairs - Risk Analysis- Food and Health- Farm to Fork Regulation of the Food Chain- Regulating authority for food safety in India and its role - Food labelling –Standards at the world level for processed food, irradiated foods, genetically modified foods – EU & US approach to nutritional labelling and Health claims. General concepts of HACCP and ISO 22000. Safety aspects of drinking water and Indian regulations for bottled water.

Reference Books

1. The History and Future of the World Trade Organization, WTO Publications 2013, Craig Van Grasstek, ISBN-13: 978-9287038715
2. Guide to the Food Safety and Standards Act. Tax-mann allied Services Pvt. Ltd., ISBN – 10 – 8174968288. 2006.

3. Rajesh Mehta and J. George - Food Safety Regulation Concerns and Trade- The Developing Country Perspective. Published by Macmillan India Ltd., New Delhi. 2005
4. Enhancing participation in Codex Activities : FAO/WHO training package, 2005, ISBN 92 5 1052778

14FP3008 LOGISTICS AND DISTRIBUTION MANAGEMENT IN FOOD INDUSTRY

Credits 3:0:0

Course objectives

- To understand the fundamentals of supply chain management
- To learn the importance of supply chain management in Food preservation
- To learn about the opportunities available in the country

Course outcomes

- Will able to develop skills on methods to improve supply chain management
- Will be able to develop newer and cost-effective strategies for logistics
- Will be able to help the consumer to get quality food.

Supply chain management – Basic concepts – Global supply chain operation - Planning and sourcing – Lean supply management and Six sigma quality– Agile supply management - Making and delivering – Coordination and use of Technology – Supply chain metrics – Opportunities – Developing a supply chain system – Relationship and integration – Third Party logistics in Supply chain – Sustainable supply chain management – Outsourcing – Internationalisation of the supply chain and retailing - Temperature controlled supply chains – Future perspectives

Reference Books

1. Sanders N.R., Supply chain management: A global perspective, Wiley Publications, 2012.
2. Scott C., H Lundgren, and P Thompson. Guide to Supply Chain Management, Springer Verlag, 2011.ISBN: 978-3-642-17675-3
3. Bourlakis, M.A., and P W. H. Weightman, Food Supply Chain Management, Blackwell Publishing Ltd. 2004. ISBN: 1-4051- 0168-7.
4. Michael H. Hugos, "Essentials of Supply chain management", John Wiley and Sons, 2003. ISBN 0-471-23517-2
5. Eastham J., L Sharples and S D Ball, Food Supply chain Management – Issues for the Hospitality and retail sector, Reed Elsevier PLC group. 2001. ISBN: 0 7506 4762 0.

14FP3009 FOOD ANALYSIS LAB

Credits: 0:0:2

Course Objectives

- To train the student to analyse food components
- To make the students aware of the standards of food quality

Course Outcomes

- Students would be able to assess the quality of the food
- Students would be able to develop newer methods of food analysis

The faculty conducting the laboratory will prepare a list of 12 experiments and get the approval of HoD/Director and notify it at the beginning of each semester.

14FP3010 FOOD ENGINEERING AND TRANSPORT PROCESSES LAB

Credits: 0:0:2

Course Objectives

- To enable the students to understand the principle and operation of food machinery.
- To enable the students to understand the means of pressure loss in fluid dynamics
- To enable the students to understand the means of heat losses in food systems

Course Outcomes

- Students would be able to apply the fundamental knowledge of operation of machinery and evaluate the performance.
- Students would be able to develop systems that minimize pressure losses in flow systems
- Students would be able to judge the efficiency of a system and develop suitable technologies

The faculty conducting the laboratory will prepare a list of 12 experiments and get the approval of HoD/Director and notify it at the beginning of each semester.

14FP3011 FOOD PRODUCT TECHNOLOGY LAB

Credits: 0:0:2

Course Objectives

- To understand the ingredients needed for preparations of food products.
- To calculate the quantity of ingredients for preparations of food products.

Course Outcomes

- The students are able to list the various ingredients needed for preparations of food products.
- The students are able to calculate the quantity of ingredients for preparations of food products.

The faculty conducting the laboratory will prepare a list of 12 experiments and get the approval of HoD/Director and notify it at the beginning of each semester.

14FP3012 ADVANCES IN DAIRY, MEAT AND FISH PROCESSING

Credits: 3:0:0

Course Objectives

- To understand about the composition, nutritive value of meat, poultry and fish
- To know about processing technology of meat, poultry and fish
- To learn the value addition and packaging of meat, fish and poultry products

Course Outcomes

- The student will be able to understand to process meat, poultry and fish.
- The students will be able to learn hygienic and mechanised processing.
- The students will be able to prepare various value added products.

Introduction, Basic dairy terminology- Dairy Products technology- Quality aspects - Dairy Processing Equipments- Plant piping, Pumps. Energy use in Dairy plant.
Meat composition - Explanation of muscle structure and compositions - Description of animal fat and its modifiers. Description of bone and its modifiers. Post mortem muscle chemistry. Meat color, flavors of meat products, meat microbiology and safety. Slaughtering and carcass processing. Meat Products. Good manufacturing practice and HACCP. Poultry Processing - Fish and other marine products processing.

Reference Books

1. Leo M. L. Nollet, "Handbook of Meat, Poultry and Seafood Quality", Blackwell Publishing, 2007.
2. Garret Smit. G., Dairy Processing. Woodhead Publishing Limited, England. 2005.
3. Mead G, "Poultry meat processing and quality", Woodhead Publishing Limited, 2004.
4. National Institute of Industrial Research, Modern Technology of Milk processing and Dairy products, II Edition, NIIR Publications, India, 2004
5. Joseph Kerry, John Kerry and David Ledwood, "Meat Processing", Woodhead Publishing Limited, CRC Press, 2002.
6. Sukumar De. Outlines of Dairy Technology, Oxford University Press. 2001. ISBN: 9780195611946
7. Hui, Y.H., Nip, W.K., Rogers, R.W, "Meat Science and Applications". Marcel Dekkar Inc. New York,2001.
8. Balachandran, K.K, "Post Harvest Technology of Fish and Fish Products", Daya Publishing House, New Delhi, 2001.

14FP3013 ADVANCES IN FOOD MICROBIOLOGY

Credits: 3:0:0

Course Objectives

To enable the student to understand:

- The interaction between food and microbes
- The uses of microbes in the development of food products
- Importance of microbiology in relation to sanitation.

Course Outcomes

On completion of the course, the student will gain knowledge and exposed to

- Various microorganisms involved in food and food product spoilage
- The multifarious role in different types of food fermentations
- Preservation techniques and control measures employed in the promotion and production of microbiologically safe food

Food and microorganisms: factors affecting growth of microorganisms - food preservation and spoilage food – thermal and non thermal mode of preservation – Microbiology of various types of foods – Meat, fish, poultry, dairy products, fruits and vegetables, cereals and pulses, enteral nutrient solution – Indicators of food quality and safety– HACCP and food safety- food and enzyme produced by microorganism -Food borne diseases – Gastroenteritis, Staphylococcal infections, Botulism, Listeriosis, Salmonellosis, Shigellosis – Mycotoxins

Text Books

1. William C Frazier and Dennis C. Westoff, "Food Microbiology", Special Edition, Springer, The Mc Graw-Hill Companies, ISBN-9780070667181, 2008.
2. Adams M.R and Moss M.O, "Food Microbiology", Panima Publishing corporation, New Delhi, 2nd Edition, Third reprint, ISBN-13:9788122410143,978-8122410143, 2007.

14FP3014 ADVANCES IN PROCESSING OF CEREALS, PULSES AND OIL SEEDS

Credits: 3:0:0

Course Objectives

- To understand the structure and composition of cereals and pulses.
- To know the techniques involved in milling of cereals and pulses.
- To understand the extraction and refining of oil from oil seeds.

Course Outcomes

On completion of the course, the student will gain knowledge.

- Various techniques and equipments used to process cereals and pulses.
- Value added products developed from cereals and pulses.
- Different storage structures and protection of stored grains.

Structure, composition and quality characteristics of cereals and pulses- Machinery used for milling cereals and pulses-Parboiling of rice – Processing of maize - Nixtamalisation – Processing of Pulses - Products and by products of cereals and pulses-Extraction and refining of oil from oil seed-Techniques involved in milling and drying of cereals and pulses- Quality gradation in rice, corn, and pulses.

Reference Books

1. P. S. Kendurkar, Post-Harvest Technology and Value Addition in Cereals, Pulses and Oilseeds Indian Society of Agricultural Biochemists,Indian Society of Agricultural Biochemists, 2008
2. Amalendu Chakraverty, Post Harvest Technology of Cereals, Pulses and Oilseeds, 3rd Edn., Oxford and IBH Publishing Company Pvt. Limited, 2006
3. Amalendu Chakraverty, Arun S. Mujumdar, Hosahalli S. Ramaswamy Handbook of Postharvest Technology: Cereals, Fruits, Vegetables, Tea, and Spices CRC Press, 22-Jan-2003
4. Amalendu Chakraverty, R. Paul Singh: Postharvest technology: cereals, pulses, fruits and vegetables Science Publishers, 2001
5. Karel Kulp and Joseph P Pante, "Handbook of Cereal Science and Technology",Mercel Dekkar, USA, 2000.

14FP3015 ADVANCES IN PROCESSING OF HORTICULTURE, SPICES AND PLANTATION PRODUCTS

Credit: 3:0:0

Course Objectives

- To enable the student to know about post harvest technology of fruits and vegetables.
- To provide knowledge on processing & preservation techniques of fruits and vegetables
- To provide knowledge on processing plantation and spice crops.

Course Outcomes

- The students acquire knowledge on fruit and vegetable processing.
- The students apply their knowledge of processing methods in food industries
- Students will be able to understand the processing steps involved for different plantation products and spices.

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Importance of post harvest technology of fruits and vegetables -post harvest handling- Physiology -Spoilage - Principles and methods of preservation - Canning -Minimal processing -Hurdle technology - Quick freezing preservation- Drying and dehydration methods -Osmotic dehydration- Foam mat drying –Freeze drying - Intermediate moisture foods –Sensory evaluation of fruits, vegetables and their products.

Chemistry and Technology of Coffee– Production of coffee powder-Chicory chemistry - Quality grading. Tea - types of tea -Technology of Cocoa and Cocoa Products- Major Spices– Oleoresins and essential oils –Chemistry of the volatiles –Enzymatic synthesis of flavor identicals - Quality control. Processing of Minor Spices.

Reference Books

1. Chakraverty, A., Mujumdar, A.S., Raghavan, G.S.V., Ramaswamy, H.S. Handbook of post harvest technology – cereals, fruits, vegetables, tea and spices. Marcel Dekker Inc., New York (Special Indian Reprint). 2010.
2. Srivastava, R.P. and Sanjeev kumar. Fruit and vegetable preservation. Principles and practices. International book Distributing Co., Lucknow. 2002. ISBN:8185860742
3. Peter, K.V. Hand book of herbs and spices. Volume 2. Woodhead publishing Ltd., 2004Tainter, D.R. Grenis, A.T. Spices and Seasonings – A food technology hand book. 2nd edition. John Wiley and Sons, Inc., Canada. 2001.
4. Shafiur Rahman. Handbook of Food Preservation. Replika Press Pvt. Ltd. India.2006.

5. Verma, L.R and Joshi, V.K. Post harvest technology of fruits & vegetables (Vol I & II). Indus publishing company, New Delhi.2000.

14FP3016 MILLING AND BAKERY TECHNOLOGY

Credit: 3:0:0

Course objectives

To enable the students to understand

- Quality tests for wheat
- Importance of wheat quality on the quality of the products
- Milling and its importance in product manufacture

Course outcomes

- The students would be able to use the knowledge in developing new products
- The students would be able to use suitable machinery for minimising / altering the quality of wheat during milling
- The students would be able to develop newer standards for baked products

Laboratory testing of Wheat grain Quality – Testing of dough - Viscoamylograph, Farinograph - Wheat milling Flow sheet and Machinery involved - wheat products and wheat by-products - Bakery Equipment and Engineering - Bulk handling of ingredients, Weighing equipment, Dough mixers, Dividers, rounders, Proofing, moulding, Ovens, Slicers, Packaging materials and equipment, Sanitation and safety -Bread manufacturing processes – Biscuit- Types of biscuit doughs –importance of the consistency of the dough- Cake – Flour specification – ingredients – manufacturing process – types of chemically aerated goods - Types of Confectionery - raw materials and processing of toffee, chocolates, fruit drops, hard boiled candies

Reference Books

1. Sumnu S.G. and Sahin S. Food Engineering aspects of baking sweet goods, CRC Press, Taylor and Francis Group, 2008.
2. Hui Y.H., Bakery Products: Science and Technology, Blackwell Publishing, 2006. ISBN 13:978-0-8138-0187-2.
3. Cauvain S.P. and Young L.S., Baked Products: Science, Technology and Practice, Blackwell Publishing, 2006.ISBN-13: 978-1-4051-2702-8
4. Kulp K. and Ponte Jr. Joseph G, Handbook of Cereal Science and Technology, Second Edition, Revised and Expanded, Marcel Dekker Inc. 2000. ISBN 0-8247-8297-1.

14FP3017 FOOD INDUSTRY WASTE MANAGEMENT

Credits : 3:0:0

Course Objectives

- To enable the student understand the extent of wastes produced in a food industry and its environmental effects
- To enable the student understand the nature of food wastes and methods of treatment
- To enable the student know the importance of waste utilization in Food industries

Course Outcomes

- Students will attain knowledge about the methods of managing food wastes
- Students will gain knowledge on the methods for utilization of food wastes.
- Students will gain knowledge on getting value-added products from wastes

Legislations pertaining to Food waste disposal - Key drivers for waste management and co-product recovery in Food Processing – Strategies to be followed for optimizing manufacturing to minimize wastes – Key issues and technologies for Food waste separation and Co-product recovery – Methods of solid and liquid waste treatment –

Impact of water footprint and rehabilitation of Food industry waste water - Waste management in specific food industries – Methods to obtain value-added products from wastes.

Reference Books

1. Kosseva M and C Webb, Food Industry Wastes, Assessment and Recuperation of Commodities, Academic Press, 2013. ISBN: 978-0-12-391921-2
2. Panda H. The Complete Book on Managing Food Processing Industry Waste, Asia Pacific Business Press Inc, 2011. ISBN: 9788178331454.
3. Waldron K.W., Handbook of waste management and co-product recovery in food processing (Volume 1), Woodhead Publishing Ltd., 2007. ISBN - 1 84569 025 7
4. Arvanitoyannis I., Waste Management for the Food Industries, Academic Press, 2007.ISBN: 978-0-12-373654-3.
5. Wang L.K. , Y-T Hung, H H. Lo and C Yapijakis, Waste Treatment in the Food Processing Industry, CRC Press, 2005. ISBN 9781420037128

14FP3018 REFRIGERATION AND COLD STORAGE ENGINEERING

Credits : 3:0:0

Course Objectives

- To enable the students to understand the various concepts behind refrigeration and storage construction.
- To study the various refrigeration systems.
- To understand the shelf life enhancement under refrigerated condition.

Course Outcomes

- The students will be able to apply their knowledge on cold storage of perishable products.
- The students will be able to design refrigeration and cold storage systems.
- The students will be able to understand the controlling of microbial activity and maintain freshness of the products.

Refrigeration cycles, Refrigerants and Equipments- COP -Atmospheric air and its properties, Psychometrics, Cold Storage- construction, design, prefabricated systems. Freezer storage, pre-cooling and pre freezing. Cold storage practice, stacking and handling of materials, optimum temperatures for foods. Storages- operation and maintenance. Chilled foods- equipment, Secondary refrigerants, direct expansion, transport and display cabinets - microbiology, packaging - Hygienic design considerations for chillers and chilled Storages- Evaporative cooling and its applications. Freezing equipment, Freezing rates, ice crystals, quick freezing, cryogenic Freezing, freezing of different foods.

Reference Books

1. Da-Wen Sun, Hand book of Frozen Food Processing and Packaging, Second Edition, CRC Press, Taylor and Francis Group, 2012. ISBN 978 – 1 – 4398- 3604 – 0
2. C.P. Mallet, Frozen Food Technology, Springer London, Limited, 2012. ISBN 1461365767, 9781461365761
3. William C. Whitman, William M. Johnson, John A. Tomczyk, and Eugene Silberstein Refrigeration and Air Conditioning Technology, Sixth Edition, Delmar, Cengage Learning, 2009.
4. Judith A. Evans, Frozen Food Science and Technology, Blackwell Publishing Ltd, 2008.

14FP3019 ADVANCES IN FOOD PROCESS ENGINEERING

Credits: 3:0:0

Course Objectives

- To enable the students to study & understand the various preservation methods foods.
- To enable the student to understand the emerging technologies applied to food processing.
- To strategize the applications in a wide range of food systems.

Course Outcomes

- The students will be able to conserve and minimize the losses in food produce.
- The students will be able to apply the know how in maintaining food security.
- The students will be able to develop newer technologies for food preservation.

Thermo bacteriology of foods – Understanding freeze concentration - membrane process -ultra filtration and Reverse osmosis. Minimal Processing of Foods with thermal methods- Spray drying – Ohmic heating - Microwave processing – Equipment. Application of Biosensors and Biocatalysts in Food. Non thermal methods- its applications - Application of light pulses in sterilization of foods and packaging materials – High pressure processing- Insight on technologies like osmotic dehydration - freeze drying - Food irradiation - advantages and applications. - Super critical fluid extraction – Aseptic processing in foods - extrusion cooking – equipment.

Reference Books

1. James G.Brennen., " Food Processing Hand Book", Wiley – VCH Verlog GmbH, 2006.
2. Sun D-W, "Emerging Technologies for Food Processing", Published by Academic Press, 2005.
3. Ohlsson T. and Bengtsson N., "Minimal Processing Technologies in the Food Industry", Published by Woodhead Publishing Ltd.,ISBN No. 0849312078, England, 2002.
4. P Richardson, Campden and Chorleywood., "Thermal Technologies in Food Processing" Food Research Association, UK, Woodhead Publishing Limited, Abington Hall, Abington, Cambridge, CB1 6AH, England, 2001.
5. Guy R. "Extrusion cooking – Technologies and Applications" Woodhead Publishing Ltd., CRC Press LLC, England, 2000.
6. Gould G.W., "New Methods Of Food Preservation", Aspen Publishers, Great Britain, ISBN No. 0834213419, 1999.

14FP3020 ENGINEERING PROPERTIES OF FOOD

Credits: 3:0:0

Course Objectives

- To learn the Engineering properties food and related biomaterials
- To understand the importance in developing new products
- To understand the significance of engineering properties in deciding the sequence of unit operations during processing, handling and storage.

Course Outcomes

- The students will understand the science and engineering concepts for characterizing the thermo-physical behaviour of foods and related biomaterials.
- The students will know the basic principles needed to select and operate instruments and equipments.
- The students will know to design and develop newer and cost effective technologies.

Mechanical properties of foods: compression and shear, deformation testing ,non-destructive methods. Mechanical damage to fruits and vegetables, grains and seeds: failure criteria, external force during handling, detection and evaluation damage. Rheological properties of liquid foods - measurement and applications. Textural Properties: Instruments for measurement of consistency, hardness, firmness, brittleness - Dielectric properties- loss factor, dielectric constant - Gas exchange properties of fruits and vegetables: respiration and fermentation, gas diffusion and applications. Electromagnetic properties- Non destructive methods of testing - optical instruments, colour and colour spaces, NIR spectroscopy.

Reference Books

1. Ludger Figura and Arthur Teixeira. Food Physics-Physical Properties-Measurement and Applications, Springer 2007 .ISBN : 0-12-119062-5
2. Rao MA, Rizvi SSH and Datta AK, Engineering Properties of Foods .Taylor & Francis/CRC press 2005

3. Malcolm Bourne .Food Texture and Viscosity Concept and Measurement .API -2002 ISBN : 978-3-540-34191-8

14FP3021 DESIGN OF FOOD PROCESSING EQUIPMENTS

Credit 3:0:0

Course Objectives

- To know the importance of process equipment design in processing industries.
- To know the factors influencing the process equipment design
- To have knowledge about the materials of construction of the process equipments

Course Outcomes

- The students can design the process equipment for food processing
- The students can calculate the capital cost for food process plant
- The students can calculate the cost of production of the product

Materials of construction, design of pressure vessels, cylindrical shell, internal and external pressure. Design of storage vessels. Rectangular tank without stiffeners and with stiffeners. Design of reaction vessels and its classification. Design of vessel shell with half coil, design of vessel shell with jacket. Design of Heat exchangers - design pressure and design temperature- shell design and tube heat exchanger design. Design of evaporators – types and design consideration. Design of driers - design of tray dryer, rotary dryer.

Reference Books

1. James R. Couper, W. Roy Penney, James R Fair, Stanley M. Wales. Chemical Process Equipment Selection and Design, third edition 2012, Elsevier publications.
2. Maroulis Z.B. and Saravacos G.D. Food Process Design, Marcel Dekker Inc. ISBN-0824743113, 2003.
3. Coulson ,J.M. and Richardson,J.F. "Chemical Engineering " Butterworth-Heinemnn Elsevier, ISBN-0750644451, 2002.

14FP3022 ADVANCES IN PACKAGING AND HANDLING OF FOODS

Credit 3:0:0

Course Objectives

- To study about the functions of packaging along with the influence of various factors on food.
- To know about the different packaging materials like cans, bottles, flexible films etc.
- To study about the various methods of packaging and the equipments used for packaging.

Course Outcomes

- Students will attain knowledge about the testing of various packaging materials and also suitability of packaging materials with respect to the products.
- Students understand the designing of various storage structures and theories related to it.
- Students are updated of the recent technological advancements in the field of Food Packaging.

Importance of packaging - Fundamentals of packaging - Packaging materials and their properties, suitability and costs. Manufacture of packaging materials- Metals, Glass, Plastic- Flexible, semi-rigid, rigid - Paper and paperboard. Filling and sealing in food packaging - Types of Packaging – Active, MAP, CA, Intelligent, Retort pouch, vacuum, inert gas - Labelling and Printing. Tests for Packaging materials. Importance of material handling, electro-mechanical material handling-bulk conveying equipment (belt/chain/drag, screw/auger conveyors, pneumatic conveyors, bucket elevators etc) - Handling of wet products.

Reference Books

1. K.M. Sahay and K.K. Singh; Unit operations of Agricultural Processing, Vikash Publishing house, 2008.

2. K. L. Yam, D.S. Lee and L. Piergiovanni, Hand Book of Food Packaging, CRC Press, 2006
3. G. L. Robertson, Food Packaging: Principles and Practices, 2nd ed, CRC, 2005
4. R.Coles, D.McDowell and M. J. Kirwan, Food Packaging Technology, CRC Press, 2003
5. R. Ahvenainen, Novel Food Packaging Techniques, Woodhead Publishing, 2003
6. T.C.Robberts: Food Plant Engineering Systems, CRC Press Ltd. Washington, USA, 2002.
7. R.Paul Singh, Dennis R.Heldman; "Introduction to Food Engineering" (3rd edition), Academic press, Elsevier, 2001.

14FP3023 FOOD MATERIAL SCIENCE

Credits: 3:0:0

Course Objectives

- To enable students understand the importance of food polymers
- To make the students understand the interaction of food constituents in maintaining the texture and structure of a food
- To enable the students understand the effect of various methods of processing on the structure and texture of food materials

Course Outcomes

Students would be able

- To develop new products which are nutritional and cost effective
- To predict their behaviour during storage
- To develop cheaper sources of raw materials for a product

Basics of theory of glass transitions –Key elements of the food polymer science approach –Models – the dynamics map –water as a plasticizer - Crystallisation – gelation mechanism –Mechanism of gel formation in food systems– Basic Theories of gelation – mechanical properties of cured gels –Foods as composite materials –solid foams and sponges – Fibrous structures – Reinforcement by solid particles and fibers –Cellular structures of fruits and vegetables - Emulsions – Types of food emulsions –Measurement of particle size and size distributions in emulsions - Factors affecting stability of emulsions – Structures of adsorbed layers on the surfaces of emulsion droplets - Protein stabilized emulsions and foams -Mechanism of Maillard Reaction – Factors influencing Maillard reaction – Type of amino acid, pH, type of sugar, solvent state, sugar – amine ratio, Advanced glycosylation products - – Kinetics of Maillard browning

Reference Books

1. Aguilera J.M. and Lillford P.J., "Food Materials Science – Principles and Practice, Springer, ISBL 978-0-387-71946-7, 2008.
2. Schwartzberg H.G., and Hartel R.W., "Physical Chemistry of Foods", Marcel Dekker Inc., New York, ISBN No. 0824786939, 1992.
3. Friberg S., Larsson K. and Sjoblom S. "Food Emulsions" Marcel Dekker Inc., Fourth Edition, ISBN No. 0824746961, 2004.
4. Damodaran S., Parkin K. and Fennema O.R.,"Fennema's Food Chemistry", CRC Press, ISBN No. 0849392721, 9780849392726, 2008.
5. Belitz H-D., Grosch W.and Schieberle P., "Food Chemistry"- Springer Verlag, Berlin Heidelberg, Germany, III Revised Edition, ISBN No. 3540408177, 2004.

14FP3024 FOOD PROCESSING AND BIOTECHNOLOGY

Credit 3:0:0

Course Objectives

- To provide knowledge about the chemistry and microbial aspects of food.
- To teach the various processing methods of foods.

- To equip knowledge with the various equipments for processing of foods.

Course Outcomes

- The student will gain knowledge about the chemistry and microbial aspects of food.
- The student will have the know-how of various processing methods of foods and the related equipments for processing of foods.

Food Chemistry-Constituent of food – contribution to texture, flavour and organoleptic properties of food; food additives – intentional and non-intentional and their functions; enzymes in food processing. Food Microbiology - Sources and activity of microorganisms associated with food; food fermentation; food chemicals; food borne diseases – infections and intoxications, food spoilage – causes. Food Processing-Raw material characteristics; cleaning, sorting and grading of foods; physical conversion operations – mixing, emulsification, extraction, filtration, centrifugation, membrane separation, crystallization, heat processing. Food Preservation- Use of high temperatures – sterilization, pasteurization, blanching, aseptic canning; frozen storage – freezing curve characteristics. Factors affecting quality of frozen foods; irradiation preservation of foods. Manufacture of Food Products- Bread and baked goods, dairy products – milk processing, cheese, butter, ice-cream, vegetable and fruit products; edible oils and fats; meat, poultry and fish products; confectionery, beverages.

Reference Books

1. Saravacos GD and Maroulis ZB, Food Process Engineering Operations, Taylor and Francis group, 2011. ISBN 9781420083538.
2. Campbell-Platt, G. Food Science and Technology, Wiley-Blackwell, 2009. ISBN: 978-0-632-06421-2.
3. Damodaran S, Parkin KL, Fennema OR, Fennema's Food Chemistry, CRC Press/Taylor & Francis, 2008
4. Adams MR and Moss MO, Food Microbiology, 3rd ed. RSC Publishing, 2008. ISBN 978-0- 854042845.

14FP3025 ADVANCES IN PROCESSING OF HORTICULTURE PRODUCTS

Credit: 3:0:0

Course Objectives:

- To enable the student to know about post harvest technology of fruits and vegetables.
- To provide knowledge on processing & preservation techniques of fruits and vegetables
- To make the students acquire knowledge on fruit and vegetable processing

Course Outcomes:

- The students would be able to develop skills on various preservation techniques.
- The students would apply their knowledge in developing newer and cost-effective strategies of food preservation
- The students would be able to develop foods that are wholesome and safe

Importance of post harvest technology of fruits and vegetables -post harvest handling- Physiology -Fruit ripening - Spoilage -Deteriorative factors and their control - Principles and methods of preservation -Pre-treatments - Commercial canning -Minimal processing -Hurdle technology -Thermal and non-thermal preservation - Quick freezing preservation- Drying and dehydration methods- Different types of dryers- components and working- Osmotic dehydration- Foam mat drying –Freeze drying - Emerging preservation techniques- Microwave heating – Radiation preservation - Intermediate moisture foods –Ohmic heating -High pressure processing -Sensory evaluation of fruits, vegetables and their products - Packaging and storage- packaging materials-Aseptic packaging -Storage systems of fruits and vegetables and their products -Cold storage - Modified and Control Atmosphere Storage.

Reference Books

1. Rodrigues FS and Fernandes AN. Advances in Fruit Processing Technologies, CRC Press, Taylor and Francis group, 2012. ISBN 978 – 1 – 4398- 5152 – 4.
2. Hui Y.H. Handbook of Fruits and Fruit Processing. Blackwell Publishing, 2006. ISBN 13: 978 – 0 – 8138-1981-5.

3. W Jongen. Fruit and Vegetable Processing: Improving Quality, Woodhead Publishing Ltd., England. 2002. ISBN 185573548.
4. Shafiur Rahman. Handbook of Food Preservation. Replika Press Pvt. Ltd. India.2006.

14FP3026 FOOD ANALYSIS AND AGRO BIOTECHNOLOGY LAB

Credits : 0:0:4

Course Objectives

- To understand about the analysis of food products
- To know about the standards of analysis.
- To learn the biotechnology aspects of foods

Course Outcomes

- The student will be able to understand the analysis methods of food products.
- The students will be able to apply their knowledge in research centres.
- The students will be able to prepare standards for analytical methods.

The faculty conducting the laboratory will prepare a list of 12 experiments and get the approval of HoD/Director and notify it at the beginning of each semester.