

**Department of Food Technology**  
**Guru Jambheshwar University of Science and Technology, Hisar, Haryana**  
**CBCS Scheme and Syllabus Effective from 2018 onwards**  
**M.Tech. (Food Technology)**

Program Core	Program Elective	Open Elective	Research Project	Audit Course	Research Methodology and IPR	Mini project	Total Credit
16	19	3	26	NC	2	2	68

**Semester I**

Sr. No.	Course code	Course Nomenclature	Course Type	Teaching Scheme (hrs/weeks)			Credit	Marks
				L	T	P		
1	1MFT01	Advances in Food Engineering	Program Core I	3	0	0	3	100
2	1MFT02	Advances in Food Analysis	Program Core II	3	0	0	3	100
3	1MFT03	Elective I	Program Elective I	3	0	0	3	100
4	1MFT04	Elective II	Program Elective II	3	0	0	3	100
5	1MFT05	Program Core Lab I	Lab I	0	0	4	2	100
6	1MFT06	Program Elective Lab II	Lab II	0	0	4	2	100
7	1MFT07	Research Methodology and IPR		2	0	0	2	100
8	Audit Course	One from the list	Audit Course I	2	0	0	NC	100
			<b>Total credits</b>	<b>16</b>	<b>0</b>	<b>8</b>	<b>18</b>	

**Semester II**

Sr. No.	Course code	Course Nomenclature	Course Type	Teaching Scheme (hrs/weeks)			Credit	Marks
				L	T	P		
9	2MFT11	Advances in Post-harvest Technology of Fruits and Vegetable	Program Core III	3	0	0	3	100
10	2MFT12	Advances in Cereal Science and Technology	Program Core IV	3	0	0	3	100
11	2MFT13	Program Elective III	Program Elective III	3	0	0	3	100
12	2MFT14	Program Elective IV	Program Elective IV	3	0	0	3	100
13	2MFT15	Program Core Lab III	Lab III	0	0	4	2	100
14	2MFT16	Program Elective Lab IV	Lab IV	0	0	4	2	100

15	2MFT18	Mini Project		0	0	4	2	100
16	Audit Course	One from the list	Audit Course II	2	0	0	NC	100
			<b>Total Credits</b>	<b>14</b>	<b>0</b>	<b>12</b>	<b>18</b>	

### Semester III

Sr. No.	Course code	Course Nomenclature	Course Type	Teaching Scheme (hrs/weeks)			Credit	Marks
				L	T	P		
17	3MFT21	Program Elective V	Program Elective V	3	0	0	3	100
18	3MFT-801A	Dissertation Phase-I	Dissertation	0	0	20	10	100
19	Open Elective	One from the list	Open Elective	3	0	0	3	100
			<b>Total Credits</b>	<b>6</b>	<b>0</b>	<b>20</b>	<b>16</b>	

### Semester IV

Sr. No.	Course code	Course Nomenclature	Course Type	Teaching Scheme (hrs/weeks)			Credit	Marks
				L	T	P		
20	4MFT-801B	Dissertation Phase-II/Thesis	Dissertation/Thesis	0	0	32	16	100
			<b>Total Credits</b>	<b>0</b>	<b>0</b>	<b>32</b>	<b>16</b>	

**Total Credits**

**68**

#### List of Program Elective:

##### Program Elective-I

- 1MFT03 (i) Food Safety and Quality Assurance  
(ii) Food Additives, Contaminants and Toxicology

##### Program Elective-II

- 1MFT04 (i) Novel Food Packaging  
(ii) Technology of Frozen Foods

##### Program Elective-III

- 2MFT13 (i) Advances in Dairy Technology  
(ii) Beverage Technology

##### Program Elective-IV

- 2MFT14 (i) Advances in Meat, Fish, Poultry and Egg Processing  
(ii) Snack Food Technology

##### Program Elective-V

- 3MFT 21 (i) Bioprocess engineering  
(ii) Nutraceuticals & Functional foods

#### Important Notes:

- The credit requirement for the M. Tech (Food Technology) degree is 68credits inclusive of the 19 elective course credits.
- Each theory paper examination will be of 3 hours duration and practical examination will be of 4 hours duration.
- The students shall be encouraged to undergo industrial/institute/organization training during semester breaks.
- A student is required to undertake a Dissertation/Thesis of 26 credits on a topic approved by the supervisor and the Departmental Research Committee (DRC). The student is required to prepare his/her

research project synopsis and should make a presentation to the DRC after the commencement of the final examination of second semester.

5. The research project shall be evaluated by the internal & external examiner at the end of the Semester IV.
6. Audit Course (Non Credit, 2+0+0) will be offered in semester I & II. Every student has to opt for one course in each semester as per the list. It is mandatory to qualify in this course.
7. Student has to opt for any one open elective course as per the list attached other than that offered by one's own department.
8. A Supervisor will be allotted by the Chairperson for every student in the beginning of first semester.

**Program outcome:**

1. Ability to apply principles of food engineering in industry.
2. Understand, identify and analyze a problem related to food industry and ability to find an appropriate solution for the same.
3. Design, implement and evaluate a research based project to meet demands of the society.
4. Use appropriate techniques, skills, and modern tools in the food industry and in academic profession.

## Audit Courses/Open Electives for M.Tech. (2018 batch onwards)

### List of Audit Courses 1 (1st Semester-Non Credit):

Sr. No.	Course	Code	To be Taught by Department	Time table schedule
1	English for Research Paper Writing	AC01	CMT	1 <sup>st</sup> Lecture Thursday & Friday
2	Disaster Management	AC02	ESE (Env. Sc. and Engg.)	
3	Value Education	AC04	Religious Studies	
4	Stress Management by Yoga	AC07	Physiotherapy	

### List of Audit Courses 2 (2nd Semester-Non Credit):

Sr. No.	Course	Code	To be Taught by Department	Time table schedule
1	Sanskrit for Technical Knowledge	AC03	Religious Studies	1 <sup>st</sup> Lecture Thursday & Friday
2	Constitution of India	AC05	Faculty of Law	
3	Pedagogy Studies	AC06	HRDC	
4	Personality Development through Life Enlightenment Skills	AC08	Applied Psychology	

### \*List of Open Electives (3<sup>rd</sup> Semester-3 Credits):

Sr. No.	Course	Code	To be Taught by Department	Time table schedule
1	Business Analytics	3OE01	MBA/HSB	1 <sup>st</sup> Lecture Wednesday, Thursday & Friday
2	Industrial Safety	3OE02	Mechanical Engineering	
3	Operations Research	3OE03	MBA/HSB	
4	Cost Management of Engineering Projects	3OE04	MBA/HSB	
5	Composite Materials	3OE05	Mechanical Engineering	
6	Waste to Energy	3OE06	ESE (Env. Sc. and Engg.)	
7	Advancements in Communication System	3OE07	ECE	
8	Introduction to Soft Computing Techniques	3OE08	CSE	
9	Advanced Printing Technology	3OE09	Printing Technology	
10	Computer Aided Design & Manufacturing	3OE10	Mechanical Engineering	
11	Food Safety and Quality Assurance	3OE11	Food Technology	
12	Basic Nanotechnology	3OE12	Bio and Nano Technology	
13	MEMS & NEMS – Sensors & Devices	3OE13	Bio and Nano Technology	

\***Note:** Student has to choose any one Open Elective out of above list other than offered by his/her own department.

**Choice Based Credit System**

**COURSE CURRICULUM**

**M.Tech. (FOOD TECHNOLOGY)**

## **Program Core I 1MFT01 : ADVANCES IN FOOD ENGINEERING**

**3+0+0**

### **Objectives:**

- To illustrate various aspects of food engineering.
- To develop understanding about fluid flow and its applications.
- To understand mechanism of heat transfer in food processing
- To explain method of freezing process.

### **UNIT-I**

Engineering properties of foods, their significance in equipment design. Constraints and need of innovation. Challenges for food engineering. Tools and concepts in process design microbial survivor curves, general method for process calculation. Sterilization of continuous flowing fluid.

### **UNIT-II**

Fluid flow handling systems for Newtonian liquids, force balance on a fluid element flowing in a pipe, derivation of Bernoulli equation. Measurement of viscosity, capillary tube viscometer. Flow characteristics of non Newtonian fluids. Properties of non-Newtonian fluids. Velocity profile of a power law. Pumps-characteristics, types and selection.

### **UNIT-III**

Thermal properties of foods. Steady state and unsteady state heat transfer: Conduction in multilayered systems. Estimation of convective heat-transfer coefficient. Forced and free convection. Estimation of overall heat-transfer coefficient. NTU method for designing heat changers. Design of a plate heat exchanger, Design of a tubular heat exchanger.

### **UNIT-IV**

Pressure-enthalpy charts. Frozen-food properties. Freezing point curves, phase diagrams, methods of freeze concentration, design problems. Freezing of foods, freeze concentration and drying, freezing time: plank's equation and Pham's method, theory of ultra-filtration and reverse osmosis, selection and types of membranes and properties, Properties of steam. Steam traps Methods of estimating steam consumption.

### **Recommended Readings:**

- Rao, M. A., Rizvi, S. S. H. and Datta A.K. (2005). *Engineering Properties of Foods*: CRC Press.
- Heldman, D. R. (2007). *Food Process Engineering*: AVI Publications.
- Toledo, R. T. (1997). *Fundamentals of Food Process Engineering* (2 ed.): CBS Publications, New Delhi.
- Rizvi, S. S. H. and Mittal, G. S. (1992). *Experimental Methods in Food Engineering*: Van Nostrand Reinhold.
- Chanes J.W., Gustavo (2002) *Engineering and Food for the 21<sup>st</sup> Century* CRC Press.
- Theodoros V.C., *Food Engineering Handbook* (2011) CRC Press

**Objectives:**

- To develop an understanding about the advanced analytical and instrumental techniques.
- To illustrate the principle and mechanism of analytical instruments.
- To describe bio-chemical analysis of food components.

**UNIT-I**

Spectroscopy: UV-Visible spectroscopy, Atomic absorption spectroscopy, Flame photometry, Fluorescence spectroscopy, Emission spectroscopy, Mass-spectroscopy, Fourier Transform Infra-Red.

**UNIT-II**

Methods of separation and analysis of biochemical compounds and macromolecules: Principles and applications of Gas Chromatography, High Performance Liquid Chromatography, Thin layer chromatography.

**UNIT-III**

Microscopic techniques: Light microscopy, Scanning electron microscopy, Transmission electron microscopy, particle size analysis, Thermal techniques in food analysis: Differential scanning calorimetry and Thermo gravimetric analysis.

**UNIT-IV**

Electrophoresis: Different kinds of electrophoresis, western blotting, gel documentation, DNA analysis: DNA purification, PCR-based analysis, DNA fingerprinting.

**Recommended Readings:**

- Pare, J. R. J. and Bélanger, J. M. R. (2015). *Instrumental Methods of Food Analysis*: Elsevier
  - Pomeranz, Y. and Meloan, C. E. (1996). *Food Analysis: Theory and Practice* (3 ed.): CBS Publications, New Delhi.
  - Winton, A. L. (2001). *Techniques of Food Analysis*: Agrobios, Jodhpur.
  - Sharma, B. K. (1994). *Instrumental Methods of Chemical Analysis*: Krishna, Meerut.
  - Skoog, D. A., Holler, F. J. and Nieman, T. A. (1998). *Principles of Instrumental Analysis* (5 ed.): Harcourt, Singapore.
- Gopalan, R., Subramanian, P. S. and Rangarajan, K. (2008). *Elements of Analytical Chemistry*: Sultan Chand & Sons

## Program Elective –I

### 1MFT03 :FOOD SAFETY AND QUALITY ASURANCE 3+0+0

#### Objectives:

- To illustrate the importance of food safety, food quality, food laws and regulations in Food industry.
- To describe the food quality management systems.
- To explain the national and international food laws and regulations.
- To exemplify different food adulterants.

#### UNIT-I

Sampling, specification, labeling, safety and quality assessment of fruits and vegetable, cereals, dairy products, meat, fish, poultry and processed food products, Sensory evaluation: Introduction, panel screening, selection methods, interaction and thresholds

#### UNIT-II

Developments, objective and functions of food safety and quality assurance, Quality enhancement models, Statistical Quality Control for food industry, Food Quality Management Systems, implementation of quality control programmes, Quality control tools, Quality control charts for food plant sanitation, Food Safety Management Systems, Causes of failure of Food Safety Programs

#### UNIT-III

Indian food laws and regulations, Food safety acts, Regulations for waste disposals, Codex alimentarius, ISO series, World Trade Organization, Food and Agricultural Organization, World Health Organization, Food safety and legislation in USA and Europe, Technical Barriers in Trade, Enforcers of food laws approval process for food additives, additives food labeling, Intellectual Property Right, HACCP and its application.

#### UNIT-IV

Food adulteration: Types of adulterants, Common adulterants for foods like milk and milk products, honey, wheat flours, edible oils, cereals, condiments (whole and ground) pulses, coffee, tea, confectionery, baking powder, non-alcoholic beverages, vinegar, besan and curry powder

#### **Recommended Readings:**

- Lawless, H. T. and Heymann, H. (2013). *Sensory Evaluation of Food: Principles and Practices*: Springer, New Delhi.
- Shapton, D. A. and Shapton, N. F. (1993). *Principles and Practice for the Safe Processing of Foods*: Heinemann, Oxford.
- Schmidt, R. H. and Rodrick, G. E. (2003). *Food Safety Handbook*: John Wiley, New Jersey.
- Rees, N. and Watson, D. (2000). *International Standards for Food Safety*: Aspen, America.
- Anjaneyulu, Y. and Marayya, R. (2009). *Quality Assurance and Quality Management in Pharmaceutical Industry*: Pharma, Hyderabad.
- Ho, S. K. M. (1999). *Operations and Quality Management*: ITP, London.

## Program Elective –I

### 1MFT03: FOOD ADDITIVES, CONTAMINANTS AND TOXICOLOGY

3+0+0

#### Objective:

- To describe various food additives and contaminants.
- To illustrate the functionality of food additives.
- To exemplify the limits of permissible additives in processed foods.

#### UNIT-I

Additives in food processing and preservation: Classification, need, properties, functions and safety, quality evaluation of additives, Food labeling, Laws and regulations for food additives

#### UNIT-II

Chemistry, uses and functions: Chemical preservative, bio-preservatives, fortification, antioxidants, emulsifiers, humectants, stabilizers, chelating agents, pH control agents and acidulants, texturizing agents, plasticizers, flavor enhancers, enzymes, coloring agents, sweeteners, flavoring agents

#### UNIT-III

Food contaminants: biological, chemical, physical and environmental contaminants, Inorganic and organometallic food contaminants, Sources and their impact on human health

#### UNIT-IV

Food contaminants from industrial wastes: Heavy metals, polychlorinated polyphenyls, dioxins, Toxicants formed during food processing polycyclic aromatic hydrocarbons, nitrosamines, veterinary drug residues and melamine contaminations, Pesticide residues in food

#### **Recommended Readings:**

- Branen, A. L., Davidson, P. M. and Salminen, S. (2002). *Food Additives*: Marcel Dekker, New York.
- Wood, R., Foster, L., Damant, A. and Pauline, K. (2004). *Analytical Methods for Food Additives*: Boca Raton, New York.
- Watson, D. H. (2014). *Food Chemical Safety*: Additives: WP, New Delhi.
- Steinhart, E., Doyle, M. E. and Cochrane, B. A. (1995). *Food Microbiology and Toxicology*: Marcel Dekker, New York.

**Objective:**

- The purpose of this course is to explain the various recent techniques of food packaging, applications, principles and requirements of these techniques.
- Identify the purpose, principle and advance knowledge related to the various packaging technology systems.
- Awareness of students about the recycling of packaging materials, biodegradable packaging materials and safety and legislative aspects.

**UNIT-I**

Active and intelligent packaging techniques, oxygen, ethylene and other scavengers: Oxygen scavenging technology, selection of right type of oxygen scavengers, ethylene scavenging technology, carbon dioxide and other scavengers, antimicrobial food packaging, antimicrobial packaging system, effectiveness of antimicrobial packaging.

**UNIT-II**

Advantages of non-migratory bioactive polymers, Inherently bioactive synthetic polymers: types and application, Polymers with immobilized bioactive compounds, defining and classifying time temperature indicators (TTIs), requirements for TTIs, development of TTIs, maximizing the effectiveness of TTIs to monitor shelf-life during distribution, use of freshness indicator in packaging: Compounds indicating the quality of packaged food products, pathogen indicators.

**UNIT-III**

Developments in modified atmosphere packaging (MAP): Novel MAP applications for fresh-prepared produce, novel MAP gases, testing novel MAP applications, Applying high O<sub>2</sub> MAP. Combining MAP with other preservation techniques, packaging-flavour interactions: Factors affecting flavour absorption, role of the food matrix, role of differing packaging materials.

**UNIT-IV**

Modern packaging systems: Green plastics for food packaging, problem of plastic packaging waste, range of biopolymers, developing novel biodegradable materials, traceability: radio frequency identification, recycling packaging materials: recyclability of packaging plastics, improving the recyclability of plastics packaging, Testing the safety and quality of recycled material, using recycled plastics in packaging, methods for testing consumer responses to new packaging concepts.

**Recommended Readings:**

- Jung, H. H. (2014). *Innovations in Food Packaging*: Oxford, London.
- Ahvenainen. R. (2003). *Novel Food Packaging Techniques*: CRC Publications.
- Robertson, G. L. (2010). *Food Packaging and Shelf Life*: CRC Publications, New York.
- Robertson, G. L. (2006). *Food Packaging: Principles and Practice* (2 ed.): CRC Publications, Boca Raton.

**Objectives:**

- To understand important aspects of freezing such as thermo physical properties, glass transition temperature, microbiology of frozen food, freezing loads and freezing time calculations.
- To acquire in depth knowledge on cold chain facility for the frozen foods and innovations in the freezing processes.
- To study on quality and safety of frozen foods and learn about various techniques to measure and control the quality of frozen foods.
- To understand suitability of different packaging materials for frozen foods.

**UNIT-I**

Food freezing :importance and potentialities, nutritive values of frozen foods, Microbiology of frozen foods , Freezing methods and equipment, sharp freezers the Quick freezing systems – Freezing cabinets and walk in freezers, Frozen food locker plants, Glass transitions in frozen foods and biomaterials, Thermo-physical properties of frozen foods, Freezing loads and Freezing time calculation, Innovations in freezing process.

**UNIT-II**

Cold Chain: Cold store design and maintenance, Packaging and machineries, Transportation, Retail display equipments and management, Household refrigerators and freezers, Monitoring and control of the cold chain, Cold storage and thawing of foods – Adaptability of vegetables to freezing, preparation and freezing of meat, poultry and fish, freezing of Dairy products, precooked frozen foods, storage of frozen food.

**UNIT-III**

Quality and Safety of Frozen Foods: Importance of quality control and standards in the frozen food industries, Quality and safety of frozen meat and meat products, frozen fish, Shellfish, and related products, frozen vegetables, frozen fruits, frozen dairy products, frozen ready meals, frozen bakery products, frozen eggs and egg products, Sensory analysis of frozen foods, Monitoring and Measuring Techniques for Quality and Safety, Chemical Measurements, Food borne illnesses and detection of pathogenic microorganisms, Shelf-life prediction of frozen foods.

**UNIT-IV**

Packaging of Frozen Foods:Introduction to frozen food packaging, Plastic packaging of frozen foods, Paper and card packaging of frozen foods, Packaging of frozen foods with other materials, Packaging machinery.

**Recommended readings:**

- Sun, Da-Wen (2012). *Handbook of Frozen Food Processing and Packaging*: Taylor & Francis, United State of America.
- Kennedy, C. J. (2000). *Managing Frozen Foods*: CRC Press, New York.
- Potter, S. (2006). *Food Science*: Sage, New Delhi.

**Program core Lab I 1MFT05: Advances in Food Analysis 0+0+4**

Preparation of solutions and buffers, Determination of titratable acidity in foods using a potentiometric titration, Diastatic activity of honey, UV-Visible Spectro-photometric analysis of a carotenoid, determination of hydroxymethylfurfural in honey, Atomic absorption spectroscopic analysis of heavy metals in foods, Secondary structure analysis of starch and proteins using Fourier Transform Infra-Red (FTIR), Gas chromatography (GC) quantification of alcohol content in beverages using the internal standard method, High performance liquid chromatography (HPLC) quantification of sugars in foods and beverages, Separation and identification of food constituents using HPLC, thin layer chromatography (TLC) of food colors, Microstructural and partical size analysis of starch, Determination of thermal properties of food samples, Extraction of different types of proteins and identification using electrophoresis, DNA isolation and fingerprinting of plant tissues.

**Program elective Lab II 1MFT06: Additives, Contaminants and Food Safety 0+0+4**

Techniques of sampling and quality assessment of fruits, vegetable, cereals, dairy products, meat, poultry, milk and other processed products, Performance of the sensitivity tests for four basic tests (Sweet, salty, sour and bitter), Identification and ranking of food product attributes using Sensory evaluation scales (Hedonic rating, Ranking difference, Triangle test), Sensory evaluation of milk and detection of flavor defects in milk, Qualitative tests for fats and oils, spices and condiments, Detection of adulteration in food products viz. honey, other sweetening agents, spices (whole and powder), pulses, oils, cereals, sweets, tea, coffee,

Detection of non-permitted food additives in market food samples, sweets, ice-creams and beverages products, estimation of antioxidants, Estimation of residual sulphur dioxide in beverages, Estimation of benzoic acid in tomato sauce and fruit beverage, Analysis of edible common salt for moisture content and total chlorides, Estimation of contaminants, chemical residues and aflatoxins, pesticides and heavy metals contaminants in foods, Visits to the testing laboratories of the food industry, educational institutions and testing centers.

**1MFT07: RESEARCH METHODOLOGY AND IPR 2+0+0**

- **Course Outcomes:**
- At the end of this course, students will be able to
- Understand research problem formulation.
- Analyze research related information
- Follow research ethics
- Understand relevance and significance of IPR
  
- **Unit 1:** Defining research methodology and a research problem. Importance of research methodology. Objectives of research and types of research. Criteria of good research. Research process – formulating the research problem, literature survey, development of working hypothesis, preparation of research design, implementation of research hypothesis, collection of data and analysis.
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- **Unit 2:** Writing a research thesis and paper: Characteristics of good thesis, outline of a thesis, effective technical writing. Scientific paper writing. Effective literature studies approaches, plagiarism, and research ethics.
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- **Unit 3:** What is IPR? Patent: Concept of Patent, Product / Process Patents & Terminology, Preparation of Patent Documents, Process for Examination of Patent Application, Procedure for Filing of Patent Application and types of Applications, Assignment and licensing of Patents, Patent Infringement.
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- **Unit 4:** Definition and concept of Trademarks, Different kinds of marks (brand names, logos, signatures, symbols, well known marks, certification marks and service marks), Non registrable Trademarks, Procedure for Registration of Trademarks, Assignment/Transmission / Licensing of Trademarks, Infringement of Trademarks. Nature of Copyright, Works in which Copyrights subsist, Rights Conferred by Copyright, Assignment, Transmission, Licensing of Copyrights, Infringement of Copyrights.

### **Program Core III**

## **2MFT11: ADVANCES IN POST-HARVEST TECHNOLOGY OF FRUITS AND VEGETABLES**

**3+0+0**

### **Objectives:**

- To illustrate the relationship of Indian economy with respect to the fresh and processed fruits and vegetables and their spoilages.
- To acquaint with the post-harvest handling technologies of fruits and vegetables to reduce post-harvest losses and their value addition.

### **UNIT-I**

Fruit and vegetable production, classification, structure and composition; Importance and scope of post-harvest management of fruits and vegetables in Indian economy, Pre-harvest factors affecting post-harvest quality, post-harvest losses, Maturity indices and standards for selected fruits and vegetables, instrumental methods of maturity determination, standards and specifications for fresh fruits and vegetable, Assessment of Fruit Quality, advances in non-destructive quality measurement of fruits and vegetables.

### **UNIT-II**

Advanced harvesting tools and their design aspects, advances in Post-Harvest Handling operations; Cleaning, washing of fruits and vegetables, types of cleaners, screens, types of screens, rotary screens, vibrating screens, machinery for cleaning of fruits and vegetables (air cleaners, washers), cleaning efficiency, care and maintenance; Sorting and grading: Sorting, grading, methods of grading, Size grading, color grading, specific gravity grading, screening, equipment for grading of fruits and vegetables, grading efficiency, care and maintenance, Separation: Magnetic separator, de stoners, electrostatic separators, pneumatic separators.

### **UNIT-III**

Post-harvest physiological and biochemical changes in fruits and vegetables; ripening of climacteric and non-climacteric fruits; changes during ripening; Role of ethylene in fruit ripening, ripening chambers, Field heat of fruits and vegetables and primary processing operations Post harvest treatments, advances in pre-cooling, equipment Commodity pretreatments-chemicals, types of coating, pre-packaging, irradiation, blanching, peeling and other pre-processing operations; transportation and storage operations, Mechanism and Advances in CA and MA, hypobaric storage, cold storage design, Zero energy cool chamber

### **UNIT-IV**

Post-harvest disorders chilling injury and diseases, Biological, Physical and Chemical Control of postharvest Diseases, advances in drying and packaging of fruits and vegetables, cushioning materials used in packaging of fresh fruits, Minimal processing.

### **Recommended readings:**

- Haard, N.F. and Salunkhe, D.K. (1975). *Postharvest Biology and Handling of Fruits and Vegetable*: AVI, Westport.
- Kader, A. A. (1992). *Post-harvest Technology of Horticultural Crops*, (2ed.): University of California, Division of Agriculture and National Resources, California.
- Salunkhe, D.K. and Kadam, S.S. (2005). *Handbook of Fruit Science and technology, Production, Composition, Storage, and Processing*: Marcel Dekker, USA.
- Thompson, A.K. 1995. *Post-Harvest Technology of Fruits and Vegetables*: Blackwell publication.
- Wills-Ron B.H. and Golding, J.B. (2015). *Advances in Postharvest Fruit and Vegetable Technology*: Taylor and Francis, CRC Press.
- Siddiqui, M. W., (2015). *Post-Harvest Biology and Technology of Horticultural Crops: Principles and Practices for Quality Maintenance*: Apple Academic Press Inc.

## Program Core IV 2MFT12: ADVANCES IN CEREAL SCIENCE AND TECHNOLOGY

3+0+0

### Objective:

- To illustrate the recent developments in the cereals science and technology.
- To explain modern processing techniques of cereals in food industries.
- To impart knowledge regarding various processed product lines in food industries.

### UNIT-I

Present status and future prospects of cereal grains in India, food grain production and consumption trends. Coarse grain processing. Wheat kernel structure, wheat grading, roller flour milling, influence of wheat type and grain quality on flour yield, grain hardness and its relevance to end product quality, advances in wheat cleaning, conditioning and milling, wheat flour component interactions (protein-starch, protein-lipid and starch-lipid) and their influence on end product quality, advances in isolation, biochemical characterization, micro-structural and functionality of wheat gluten proteins.

### UNIT-II

Advances in role of wheat proteins in dough and gluten visco-elasticity, micro-structure of dough, conversion of dough foam structure to bread sponge structure during bread baking, concept of gas retention in wheat dough during fermentation and baking, advances in bread making processes, effect of wheat components and ingredients on the growth of yeast during fermentation operation, bread staling and its prevention, production of variety biscuits, breads and pasta products.

### UNIT-III

Paddy varieties, their composition and quality characteristics, advances in methods of paddy parboiling, advantages and limitation of parboiling, paddy dehusking processes, Rice ageing, accelerated ageing, modern rice milling, factors affecting head rice yields and losses at different stages of milling, rice mill machinery, Rice based products and their quality. Methods of rice bran oil extraction and refining.

### UNIT-IV

Dry and wet milling of maize, modern methods of maize processing, gluten and starch separation, maize starch conversion into value added products, acid hydrolysis, enzyme hydrolysis, processing for dextrose, malto-dextrin and other products, Barley varieties, composition and quality characteristics, malting process and industrial applications of barley malt and malt products.

### Recommended Readings:

- Kulp K. & Ponte J. G. (2014). *Handbook of Cereal Science & Technology*, 2<sup>nd</sup> edition: CRC press.
- Wrigley C.W. & Batey I. L. (2010). *Cereal grains, assessing and managing quality*, CRC press.
- Dendy D. A. V. & Dobsasoczyk B. J. (2001). *Cereal and Cereal Products, Chemistry and Technology*: An ASPEN publication.
- Owens G. (2000). *Cereal Processing Technology*: CRC Press.
- Faridi H. & Faubin J. M. (1997). *Dough Rheology & Baked product Texture*: CBS Publishers.

**Objective:**

- To illustrate the technologies of processing of milk and milk products.
- To describe the different physico-thermal properties and their applications.
- To elucidate the thermal processing of milk and quality changes therein.
- To explain the hygiene and sanitation practices in milk plant.

**UNIT-I**

Technology of Market Milk: Dairy Industry in India: present status and scope; Milk: definition, composition and nutritive value; grading of milk; factors affecting composition of milk; physico-chemical properties of milk; FSSAI standards and legislations for market milk. Liquid milk processing: filtration/clarification; bacto-fugation; standardization; homogenization; pasteurization (LTLT, HTST); sterilization; UHT processing; aseptic packaging; storage and distribution. Technology of special milks: Technology of sterilized/ flavored milk, acidophilus milk, bulgarian milk, kumis, kefir; reconstituted & recombined milk, toned, double toned milk.

**UNIT-II**

Technology of fat rich dairy products: Cream: definition and legal standards, consumer cream products, standardization & production of cream, processing of cream (neutralization & pasteurization), butter: definition, butter-making process, overrun, yield, theories of churning, quality of butter, fat losses in cream & butter, defects in cream & butter. Ice-cream: definition, classification and composition of ice-cream, technological aspects of ice cream preparation, packaging, hardening, storage and shipping of ice cream.

**UNIT-III**

Technology of condensed and dried milk: Definition and legal standards for evaporated and condensed milks, methods of manufacture and physico-chemical properties of evaporated and condensed milk, concept of heat stability & its control, defects in condensed and evaporated milks, Quality of raw milk for dried milks, definition and legal standards for dried milks, milk drying system (film, roller, drum, spray, foam spray drying), method of manufacture of dried milks (WMP & SMP), defects in dried milk, Technology of yoghurt and cheese: Yoghurt - Definition and technology of yoghurt manufacturing, technology of different varieties of cheese manufacturing (cheddar & mozzarella), changes during ripening of cheese, yield of cheese; manufacture of processed cheese, defects in cheese, accelerated ripening of cheese.

**UNIT-IV**

Technology of indigenous dairy products: Introduction to traditional dairy products, khoa, channa, paneer, dahi, shrikhand, ghee, khoa and channa based sweets, miscellaneous traditional dairy foods, Dairy industry by-products and sanitation: By-products: introduction, definition, composition, Importance and food applications, whey protein concentrates & isolates, Dairy plant sanitation: hygiene in dairy industry, different types of cleansing/sanitizing agents and their applications, cleaning systems in dairy industry.

**Recommended Readings:**

- Winton, A. L. and Winton, K. B. (2000). *Milk and Milk Products*: Agrobios, India.
- Kuttu, C. I. and Khamer, S. (2004). *Milk Production and Processing*: Daya, Delhi.
- Fox, P. F. and McSweeney, P. L. H. (1998). *Dairy Chemistry and Biochemistry*: Kluwer Academic, New York.
- Kurmann, J. A., Rasic, J. L. and Kroger, M. (1992). *Encyclopedia of Fermented Fresh Milk Products: An International Inventory of Fermented Milk, Cream, Buttermilk, Whey and Related Products*: CBS Publications, New Delhi.
- Davis, J. G. (1994). *Milk Testing: The Laboratory Control of Milk*: Agro Botanical, Bikaner.

**Objective :**

To provide an understanding of the science and technology for processing different types of beverages.

**Outcome:**

Students shall have thorough knowledge of processing of fruit juice beverages, carbonated beverages, citrus beverages, tea and coffee.

**UNIT-I**

Beverages, importance of beverages in our diet, treatment of water for food industry. Technology of alcoholic and non-alcoholic beverages- wine, cider, brandy, perry, toddy. Fruit juice beverages methods of production, preservation and packaging, physiological aspects of fruit juice production and methods of fruit juice clarification.

**UNIT-II**

Technology of soft drinks, mineral water, ingredients, and additives used in production of soft drinks. Manufacturing of carbonated and non-carbonated beverages, technology of carbonation, and application of CO<sub>2</sub> in juice preservation.

**UNIT-III**

Citrus beverages, whey beverages and utilization of whey in development of fortified drinks, use of low calorie sweeteners in beverages. Equipments and machineries for juice pressing, methods of bottling, enzymatic clarification and debittering of juices. Fruit juice beverages, squash, cordial, crush, RTS, nectar, syrups, their types and production, blending of juices.

**UNIT-IV**

Production, processing and chemistry of tea manufacturing, tea products such as soluble tea, tea concentrate, de-caffeinated and flavoured tea. Production, processing, roasting and brewing of coffee, soluble coffee manufacture, standards and specifications of coffee products, de-caffeinated coffee, and coffee brew concentrate and chicory. Cocoa processing and cocoa beverages.

**Recommended Readings:**

1. Rao, L. J. M. & Ramalakshmi, K. (2011). Recent trends in soft beverages: AFST, India.
2. Priest, F. G. & Campbell, I. (1996). Brewing Microbiology (2nd ed.): Chapman and Hall, London.
3. Hui, Y. H. (2004). Handbook of Food and Beverage Fermentation Technology: Marcel Dekker, New York.
4. Varnam, A. H. & Sutherland, J. P. (1994). Beverages: Technology, Chemistry and Microbiology: Chapman, London.
5. Varnam, A. H. & Sutherland, J. P. (2009). Beverages Technology, Chemistry and Microbiology: Springer, UK.

## **Program Elective IV**

### **2MFT14: ADVANCES IN MEAT, FISH, POULTRY AND EGG PROCESSING 3+0+0**

#### **Objective:**

- To understand the importance of livestock, egg and poultry industry.
- To describe structure, composition and nutritional quality of animal products.
- To comprehend the various post-mortem changes related to muscle and various other tissues.
- To illustrate the processing technology of meat, poultry, fish and eggs.
- To explain value addition and packaging of meat, fish and poultry products.

#### **UNIT-I**

Production, Processing and consumption trends, Prospects of meat industry, Meat spoilage, Endogenous and exogenous infections, Hygiene and sanitation, Meat composition from different sources, Post-mortem muscle chemistry and composition, Intramuscular fat, Rigor mortis, The conversion of muscle into meat: Animals' stunning methods, ante-mortem and post-mortem examination, Design of handling facilities: Slaughtering and dressing, Consequences of circulatory failure, Proteolytic and other chemical changes, Operational factors affecting meat quality, Effects of processing on meat tenderization, Chilling, freezing and preservation, prepared meat products, intermediate moisture and dried meat products, The eating quality of meat: color, flavors and retention, water holding capacity, juiciness, texture and taste, meat eating and health, Inedible by-products

#### **UNIT-II**

Quality characteristics of poultry products, Lay-out and design of poultry processing plants, Plant sanitation, Poultry meat processing operations and equipment for de-feathering, bleeding, scalding etc., Poultry meat products, Refrigerated storage of poultry meat, by-products

#### **UNIT-III**

Egg structure, structural abnormalities, functions of egg in food system, egg products, whole egg powder, egg yolk products, by-products, their packaging and storage, eating quality of eggs, Inspection and grading, preservation and safe handling

#### **UNIT-IV**

Commercially important marine products from India, Product export and its sustenance, Processing operations, Basic biochemistry, Preservation of postharvest fish freshness, Transportation in refrigerated vehicles, Deodorization of transport systems, Design of refrigerated and insulated trucks, Grading and preservation of shell fish, pickling and preparation of fish protein concentrate, fish oil and other by-products

#### **Recommended Readings:**

- Lawrie, R. A. (1998). *Lawrie's Meat Science* (6 ed.): Woodhead Publications, Cambridge.
- Alan, H. V. and Jane, P. S. (1995). *Meat and Meat Products: Technology, Chemistry and Microbiology*: Chapman & Hill, London.
- Carmen, R. O. and George, J. M. (1997). *Poultry Meat and Egg Production*: CBS Publications, New Delhi.
- Winton, A. L. and Barberwinton, K. (1999). *Fish and Fish Products*: Agrobios, Bikaner.
- Winton, A. L. and Winton, K. B. (1993). *The Structure and Composition of Animal Product*: Agro Botanical, Bikaner.

**Objective:**

To impart knowledge related to various snack foods and their manufacturing techniques.

**Outcome:**

Students shall be able to understand various technological aspects of traditional and modern snack foods.

**UNIT-I**

Extrusion: Introduction to extruders and their principles, types of extruders. Extruders in the food industry: History and uses. Single screw extruder: principle of working, factors affecting extrusion process, co-kneaders. Twin screw extruder: Feeding, screw design, screw speed, screw configurations. Pre-conditioning of raw materials used in extrusion process: operations and benefits and devolatilization. Chemical and nutritional changes in food during extrusion. Addition and subtraction of materials, shaping and forming at the die. Post-extrusion processes- colouring, flavouring and packaging of extruded snack foods.

**UNIT-II**

Breakfast cereals: Introduction and classification (flaked cereals, oven puffed cereals, gun puffed cereals, shredded products). Breakfast cereal-manufacturing processes (traditional and modern methods), High shear cooking process and steam cookers. Texturized vegetable protein: definition, processing techniques. Direct expanded (DX) and third generation (3G) snacks: types. Concept of junk & fried foods and their impact on human health.

**UNIT-III**

Technology for grain-based snacks: Whole grains- roasted, toasted, puffed, popped, flaked. Coated grains- salted, spiced and sweetened. Formulation, processing and quality assessment of chips and wafers, papads, instant premixes of traditional Indian snack foods.

**UNIT-IV**

Technology for fruit and vegetable-based snacks- chips, wafers; Technology for coated nuts- salted, spiced and sweetened chikkies. Equipments for frying, baking, drying, toasting, roasting, flaking, popping, blending, coating and chipping.

**Recommended Readings:**

1. Booth, R. G. (1997). Snack Food: CBS, New Delhi.
2. Raymond, W. L. & Rooney, L. W. (2001). Snack Foods Processing: CRC. London.
3. Lusas, E. W. & Rooney, L. W. (2015). Snack Foods Processing: CRC. London.
4. Guy, R. (2001). Extrusion Cooking: Technologies and Applications: Woodhead, USA.
5. Riaz, M. N. (2000). Extruders in Food Applications: Technomic, Lanchester.

**Program core Lab III 2MFT15: Cereal & Post Harvest technology****0+0+4**

Post harvest quality evaluation of different fresh fruits and vegetables. Effects of storage on post-harvest quality of fruits and vegetables. Studies of regulations of ripening of banana, mango, papaya etc. Minimal processing of the cut fruits and vegetables. Shelf-life studies of different fruits. Preparation and quality evaluation of different products of fruits. Dehydration of fruits and their quality evaluation.

Grading of wheat varieties, milling quality of hard and soft wheat varieties, effect of grains parameters on the flour yield and quality, quality assessment of wheat gluten, damaged starch and bread flour quality, effect of damaged starch of flour on biscuit quality, factors affecting water absorption of wheat flour, effect of ingredients and processing parameters of yeast growth, assessment of dough rheology using doughLab and mixolab, bread, biscuits, noodles making potential of different wheat flours, quality assessment of bakery products.

**Program elective Lab IV 2MFT16: Advances in Dairy Technology****0+0+4**

Sampling of milk and milk products, Platform tests of milk: Organoleptic test, Sediment test, COB test, Alcohol test, Alcohol-Alizarin test, Titratable acidity and pH milk. Determination of specific gravity of milk, total solids and solid-not-fat using lactometer, Detection of milk adulterant- added water, starch, cane sugar, neutralizers and preservatives (formalin and hydrogen peroxide), synthetic milk (urea test, detergent test, common salt), Alkaline phosphatase test to determine adequacy of pasteurization. Estimation of casein in milk, lactose, chlorides, Reichert-Meissel number and Polensky value, Moisture in butter (Dean and Stark distillation), Colouring matter in butter, Curd and salt in butter, Peroxide value, Iodine value of ghee, Acid value of ghee, Saponification value of ghee, Fat and total solids in cream. Development of some indigenous dairy products- Standardization and preparation of khoa/ice cream/ rasogulla.

**Program elective Lab IV 2MFT16: Beverage Technology****0+0+4**

Determination of water quality parameters for beverages, preservation and packaging of alcoholic and non-alcoholic beverages, determination of quality parameters for alcoholic and non-alcoholic beverages, preparation of fruit juice products, Squash, Nectar/cordial, tomato puree, paste, sauce. standardization of method for fruit juice extraction and clarification, enzymatic clarification, effect of carbonation on shelf life of fruit beverages, extraction and debittering of citrus juice, evaluation of quality testing parameters of wines, chemical and sensory quality analysis of soft drink, preparation of whey based beverages. Decaffeination and sensory evaluation of coffee beverages. Determination of brewing quality parameters of tea and coffee.

**Objective:**

- To acquaint the students with recent concepts of Bioprocess Engineering.
- To illustrate the functioning of various devices involved in formation and recovery of bio-processed products.

**UNIT-I**

Introduction to bioprocessing, historical developments, bioenergetics, enzyme kinetics-Michaelis-Menten model, effect of temperature on reaction rate, microbial growth kinetics- batch culture, continuous culture, fed batch culture and application of fed batch culture, Sterilization and sanitation: thermal death kinetics, medium sterilization (batch and continuous design), sterilization of fermenter, feed and wastes; filter sterilization of media, air and exhaust air; theory of depth filters, isolation, preservation (storage on reduced temp, storage under liquid nitrogen, storage on agar slopes, storage in dehydrated form) and improvement of industrially important micro-organisms.

**UNIT-II**

Fermenter design- basic functions of fermenters, types of fermenter, construction material, pipes and tubes, valves and steam traps, agitator and impeller, stirrer and bearing (seals and drives), sparger, baffles, achievement and maintenance of aseptic conditions (sterilization of air, exhaust gas and fermenter), sampling port, controlling devices.

**UNIT-III**

Product recovery- foam separation, precipitation, filtration (batch, continuous, cross flow filtration), filter aids, filtration equipment, filtration theory, centrifugation, centrifuge equipment, centrifugation theory, liquid- liquid extraction– solvent recovery, two phase aqueous extraction, supercritical fluid extraction, chromatography, (adsorption chromatography, gel permeation, ion exchange chromatography, HPLC, RPC, continuous chromatography), membrane processes (ultrafiltration, reverse osmosis, liquid membranes), drying, crystallization, whole broth processing.

**UNIT-IV**

Bioprocess instrumentation- Offline analytical methods, physical, chemical and biosensors, online sensors.

**Recommended readings:**

- Doran, P. M. (1995). *Bioprocess Engineering Principles*: Academic press, New Delhi.
- Shuler, M. L. (2002). *Bioprocess Engineering Basic Concepts* (2 ed.): PHI, New Delhi.
- Sablani, S. S., Rahman, M. S., Datta, A. K. and Mujumdar, A. S. (2007). *Handbook of Food and Bioprocess Modeling Techniques*: CRC Publications, New York.

## **Program Elective V**

### **3MFT21 : NUTRACEUTICALS AND FUNCTIONAL FOODS 3+0+0**

#### **Objectives:**

- To impart the concept of nutraceuticals and functional ingredients in foods, and to determine their role in health and disease prevention.
- To learn about various phytochemicals-their sources, functions and usefulness.
- To understand basics of Extraction methods of Phyto-chemicals and development of functional foods.
- To study the usefulness and effects of Probiotics & Prebiotics in gastrointestinal health.

#### **UNIT-I**

Nutraceuticals and functional foods: definition, types and scope, need, food applications and their health benefits, Nutraceutical compounds and their classification, Nutraceuticals for specific situations such as cancer, heart disease, stress, osteoarthritis, hypertension etc.

#### **UNIT-II**

Extraction of Phyto-chemicals and development of functional foods: Extraction methods for maximum recovery, Stability studies. Cereal products as functional foods – oats, wheat bran, rice bran etc, Functional vegetable products, oil seeds, sea foods and sea weeds, antimicrobial compounds, Coffee, tea and other beverages as functional foods/drinks and their protective effect.

#### **UNIT-III**

Development of functional foods. Development of biomarkers to indicate efficacy of functional ingredients Effects of processing conditions and storage. Marketing and regulatory issues for functional foods and nutraceuticals.

#### **UNIT-IV**

Prebiotics and Probiotics: Usefulness of Probiotics & Prebiotics in gastrointestinal health and other benefit. Examples of useful microbes and their benefits, Prebiotic ingredients in foods, types of prebiotics and their effects on gut microbes, Probiotic foods and their functional role,

#### ***Recommended readings:***

- Mine, Y and Fereidoon, S. (2006). *Nutraceutical Proteins and Peptides in Health and Disease*: TF, Boca Raton.
- Bagchi, D. (2008). *Nutraceutical and Functional Food Regulations in United States and Around the World*: Elsevier, London.
- Shi, J. (2007). *Functional Food Ingredients and Nutraceuticals: Processing Technologies*: CRC Press, London.
- Guo, M. (2009). *Functional Food: Principles and Technology*: WP, New Delhi.