

CENTRAL UNIVERSITY OF PUNJAB, BATHINDA



M. Sc. Food Science and Technology

Session 2020-22

**Department of Applied Agriculture
School of Basic and Applied Sciences**

Programme Outcome

M.Sc. Food Science and Technology programme focusses on :

- Developing new food products using traditional and novel methodologies for the participation in community service and research and targets on enabling the students to perform professional and leadership roles in the field of food science and technology.

Semester I

Course Code	Course Title	Type of course	Hours			Credits
			L	T	P	
FST.506	Food Chemistry	C	4	0	0	4
FST.521	Food Processing and Preservation	C	4	0	0	4
FST.513	Food Microbiology	C	4	0	0	4
FST.508	Food Chemistry Lab	C	0	0	4	2
IDC	Interdisciplinary Course (from other departments)	IDC	2	0	0	2
CST.501	Computer Applications	CF	2	0	0	2
CST.502	Computer Applications-Lab	CF	0	0	4	2
Students will opt any one of DE courses/MOOCs						
FST.510	Food Biotechnology	DE	4	0	0	4
FST.511	Nutrition, Nutraceutical and Functional Foods	DE				
Total						24
Interdisciplinary course to be offered to students of other departments						
FST.515	Principles of Food Processing and Preservation	IDC	2	0	0	2

Semester II

Course Code	Course Title	Type of course	Hours			Credits
			L	T	P	
FST.522	Processing of Cereals, Pulses and Oilseeds	C	4	0	0	4
FST.523	Food Engineering and Unit Operations	C	4	0	0	4
FST.524	Processing of Fruits and Vegetables	C	4	0	0	4
FST.525	Cereals, Pulses and Oilseeds-Lab	C	0	0	2	1
FST.526	Food Engineering-Lab	C	0	0	2	1
FST.527	Fruits and Vegetable Processing-Lab	C	0	0	2	1
FST.572	Poultry, Meat and Fish Processing	C	4	0	0	4
FST.573	Technology of Spices, Sugar and Chocolate	C	4	0	0	4
IDC	Interdisciplinary Course (from other departments)	IDC	2	0	0	2
Total						25
Interdisciplinary course to be offered to students of other departments						
FST.529	Introduction to Nutrition and Specialty Foods	IDC	2	0	0	2

Semester III

Course Code	Course Title	Type of course	Hours			Credits
			L	T	P	
FST.551	Processing of Milk and Milk Products	C	4	0	0	4
FST.552	Application of Enzymes in Food Processing	C	4	0	0	4
FST.553	Milk and Milk Processing-Lab	C	0	0	4	2
FST.543	Seminar-I	SBE	0	0	0	1
FST.599	Project	SBE	0	0	0	6
STA.503	Statistics for Sciences	CF	2	0	0	2
VAC	Value Added Course (from other departments)	EF	1	0	0	1
Students need to opt for any one of DE courses/MOOCs						
FST.528	Fermented Foods	DE	4	0	0	4
FST.529	Beverage Technology	DE				
Total						24
Value added course to be offered to students of other departments						
VAC	Nutrition and Specialty Foods	EF	1	0	0	1

Semester IV

Course Code	Course Title	Type of course	Hours			Credits
			L	T	P	
FST.571	Food Safety, Regulation and Policy	C	4	0	0	4
FST.507	Food Packaging	C	4	0	0	4
FST.509	Food Packaging-Lab	C	-	0	2	1
FST.574	Food Quality-Lab	C	0	0	4	2
FST.577	Competitive Exam Preparatory Course	DEC	0	2	0	2
FST.576	Analytical Techniques - Principles and Application	DEC	0	0	4	2
FST.544	Seminar-II	SBE	0	0	0	1
FST.599	Project	SBE	0	0	0	6
VAC	Value Added Course (from other departments)	EF	1	0	0	1
Total						23
Value added course to be offered to students of other departments						
VAC	Nutrition and Specialty Foods	EF	1	0	0	1

C = Core; CF = Compulsory Foundation; DE = Discipline Elective; IDC = Interdisciplinary; EF = Elective Foundation/ Value Added; SBE = Skill-Based Elective; DEC = Discipline Enrichment Course

Total Credits = 24 + 25 + 24 + 23 = 96

Evaluation for Theory courses:

The theory courses shall be evaluated by Continuous Assessment, Mid Semester Test and End Semester Exams as detailed below

Continuous Assessment

Surprize tests (Average of two best)	: 10 marks
Assignment	: 05 marks
Term paper	: 10 marks
Mid Semester Test	: 25 marks
End Semester Exam (Subjective)	: 25 marks
End Semester Exam (Objective)	: 25 marks

Course Code: FST.506**Course Title: Food Chemistry****Total Hours-60**

L	T	P	Cr
4	0	0	4

Learning Outcomes:

The completion of this course will enable learners to:

- Explain physicochemical properties of major and minor components of foods.
- Apply correct methods for estimating the moisture content of different foods.
- Critically analyse chemical and nutritional properties of carbohydrates, proteins and lipids.
- Give recommendations on sources, functions, stability and requirements of vitamins and minerals.
- Critically evaluate the effect of processing on the properties of macro components of foods.

Unit I**14 Hours**

Water: Function; Types; Methods for measurement of total and available water in foods

Carbohydrate: Classification; Occurrence; Properties and applications of important polysaccharides such as starch, cellulose, guar gum, xanthan gum, pectin, etc.; Starch digestibility and Glycaemic Index; MCC, CMC, MC and HPMC

Unit II**14 Hours**

Proteins: Classification; Physicochemical properties of proteins; Protein structure; Forces involved in stability of protein structure; Denaturation; Functional properties; Methods of protein analysis; Nutritional properties; Chemical and biological methods for evaluation of protein quality; Processing induced changes

Unit III**16 Hours**

Lipids: Classification; Physicochemical properties of lipids; Functions of lipids in foods; Rancidity and flavour reversion; Measurement of lipid oxidation; Role of fats in body; Health problems associated with fats; Trans fats; Recommendations for fat intake; Fat replacement strategies; Tests for evaluation of oils and fats

(melting point, smoke point, saponification value, acid value, iodine value, acetyl value, Reichart-Meissl number, tests for stability of oils and fats, etc.); Non-food uses of oils and fats

Unit IV

16 Hours

Vitamins: Sources, requirements, functions stability and toxicity of different vitamins.

Minerals: General functions of minerals; Specific functions and requirements of Ca, P, Mg, Fe, Cu, Zn, Se, etc.

Plant pigments: Chlorophylls, curcumin, betalains, carotenoids, anthocyanins, anthoxanthins, tannins, etc.

Browning Reactions in foods: Enzymatic; Non-enzymatic; Control of food

Transactional Modes:

Mode of transaction shall be Lecture, presentation, Dialogue, Lecture-cum-demonstration, Seminar, discussion, etc.

Suggested readings

1. Chakraborty MM (2003). *Chemistry and Technology of Oils and Fats*. Prentice Hall.
2. Cheung P (2015). *Handbook of Food Chemistry*. Springer Science.
3. Chopra HK and Penesor PS (2010). *Food Chemistry*. Narosa Publication.
4. Damodaran S (2008). *Fennema's Food Chemistry*. CRC Press.
5. Hettiarachchy (2012). *Food Proteins and Peptides*. CRC Press.
6. Kumari S (2012). *Basics of Food Biochemistry and Microbiology*. Koros Press.
7. *Manuals* published by Food Safety and Standard Authority, GOI.
8. Msagati TAM (2013). *Chemistry of Food Additives and Preservatives*. John Wiley and Sons.
9. Owusu K et al. (2015). *Introduction to Food Chemistry*. CRC Press.
10. Ustunol Z (2015). *Applied Food Protein Chemistry*. John Wiley and Sons.
11. Velisek J et al. (2014). *The Chemistry of Food*. Wiley Blackwell.
12. H.K. Chopra and P.S. Panesar (2015), *Food Chemistry*, Published by Narosa Publishing.
13. Bemiller (2019) *Carbohydrate Chemistry for Food Scientists*, Woodhead Publications
14. Teresa SCM (2019) *Starches For Food Application: Chemical Technological And Health Properties*, Academic Press
15. Cmolika J & Pokorny J (2000) Physical refining of edible oils. *European Journal of Lipid Science and Technology*, 102, 472-486

Course Code: FST.521

Course Title: Food Processing and Preservation

Total Hours-60

L	T	P	Cr
4	0	0	4

Learning Outcome:

This course will enable learners:

- To explain how different foods are deteriorated and how they can be processed/preserved.
- To apply various processing/preservation techniques to different foods.
- To analyse the effect of various preservation techniques on processed foods
- To develop novel techniques/methods of food preservation and to evaluate their effect on food properties

Unit I

16 Hours

Introduction: Scope of food processing; Principles of food processing and preservation; Water activity and its relation with the chemical and microbial spoilage of foods; Causes of food deterioration

Processing and preservation by heat: Heat resistance of microorganisms; Protective effect of food constituents; Blanching; Pasteurization; Sterilization and UHT processing; Ohmic heating; Microwave heating, etc.

Unit II

15 Hours

Processing and preservation by low temperature: Refrigeration; Freezing; Differences between refrigeration and freezing; Freezing curve; Factors affecting freezing rate; Freezing methods and equipment; Changes in foods during refrigeration and frozen storage

Processing and preservation by drying and dehydration: Drying curve; Drying methods and equipment; Changes in food due to drying; Intermediate moisture foods (IMF)

Unit III

17 Hours

Novel/emerging technologies for food preservation: High pressure processing; Pulsed electric field; Hurdle technology; Nanotechnology; Ozone application; Technologies for sous-vide ready meals

Application of membrane technology in food processing: RO, NF, UF, MF and Electrodialysis; Membrane materials; Configuration and modules

Unit IV

12 Hours

Concentration: Applications/purposes; Concentration methods and equipment; Changes in Food during concentration

Irradiation in food preservation: Source; Direct and indirect effects responsible for death/inactivation of microorganisms; Dose determination; Effect on foods

Transactional Modes:

Mode of transaction shall be Lecture, presentation, Lecture-cum-demonstration, Seminar, discussion etc.

Suggested readings

1. AK Haghi, *Food Science: Research and Technology*. Academic Press (2011).
2. D Singh, *Food Processing and Preservation*. Shree Publisher (2015).
3. G Saravakos and AK Kostaropoulos, *Handbook of Food Process Equipment*. Springer (2016).
4. GV Barbosa-canovas and GW Gould, *Innovation in Food Processing*. CRC Press (2017).
5. H W Xiao et al., Recent developments and trends in thermal blanching - A comprehensive review. *Information Processing in Agriculture*. Volume 4, 2017, 101-127
6. HS Ramaswamy and M Marcotte, *Food Processing Principle and Application*. Taylor and Francis (2006).
7. JS Smith and YH Hui, *Food Processing*. Wiley (2014).
8. K Kai, *Innovative Food Processing Technologies*. WP Publisher (2016).
9. M Regier, *The Microwave Processing of Foods*. Academic Press, (2017).
10. MC Knirsch et al., Ohmic heating—a review. *Trends in Food Science & Technology*, 21, 2010, 436-441.
11. NN Potter, *Food Science*. CBS Publishers (2007).
12. P Fellows, *Food Processing Technology Principles and Practice*. CRC Press (2005).
13. RL Shewfelt, *Introducing Food Science*. CRC (2013).
14. T Varzakas and C Tzia, *Handbook of Food Processing*. CRC Press (2016).
15. Edelstein S (2018) *Food Science*, Jones & Bartlett Learning
16. Baisya (2019) *Changing Face of Processed Food Industry in India*, Ane Books
17. Mehta (2020) *Fermentation effects on food properties*, CRC Press
18. Ahmed J (2018) *Novel Food Processing*, CRC Press
19. Sun DW (2020) *Thermal food processing new technology and quality issues*, CRC Press
20. Boye J (2012) *Green Technology in food Production*
21. Chemat F (2019) *Green Food Processing Techniques: Preservation Transformation and Extraction*, Academic Press
22. Boye J (2012) *Green Technology in Food Production*
23. James et al. (2002) *Ozone: A Potential Disinfectant for Food Industry*. *Journal of Scientific and Industrial Research*, 61, 504-509.

Course Code: FST.513

Course Title: Food Microbiology

Total Hours-60

L	T	P	Cr
4	0	0	4

Learning Outcome:

Upon completion of the course, the learner will be able:

- To explain occurrence of microorganisms in foods.
- To distinguish between structure and morphology of bacteria, fungi and algae important in foods.
- To make use of the method of microbial destruction/control in the food industry.
- To compare different foods with respect to their microbial spoilage.

- To conclude the effect of pathogens and spoilage microorganisms in foods and the conditions under which they grow.

Unit I

15 Hours

Introduction: History of microbiology; Classification/groups of microorganism; Distribution of microorganisms in nature; Morphology and structure of bacteria, fungi and algae; Normal growth curve of bacteria; Nutritional and physical requirements for growth of bacteria; Bacterial spores and their significance in food microbiology

Unit II

15 Hours

Microorganism in Foods: Sources of microorganism in food (contamination from plants, animals, sewage, soil, water, air, etc). Food as substrate for microbial growth; Heat resistance of microorganisms and their spores; Factors affecting heat resistance of microorganisms; Thermal death time, Z, F and D values; Physical, chemical and biological method of microbial destruction; Methods of microbial examination of foods, Beneficial uses of microorganism in foods- Probiotics

Unit III

15 Hours

Microbiological spoilage & Preservation of foods: Chemical changes caused by microorganisms; Spoilage of milk and milk products, cereals and cereal products; meat and meat products, fish and fish products, poultry and eggs, sugars, spices and salt, canned foods; Indicators of microbial food spoilage

Unit IV

15 Hours

Food borne illnesses: Food borne infections, Food borne intoxications, Mycotoxins (sources and prevention); Food sanitation and public health; Control of Food Borne Pathogen by natural antimicrobials; Toxins produced by Staphylococcus, Clostridium, Aspergillus; Bacterial pathogens like Salmonella, Bacillus, Listeria, Shigella, Compylobacter

Transactional Modes:

Mode of transaction shall be Lecture, presentation, Lecture-cum-demonstration, Seminar, discussion etc.

Suggested readings

1. *Microbiology* by MJ Pelczar, J Michael. McGraw-Hill (1999).
2. *Modern Food Microbiology* (7th edition) by JM Jay Golden Food Science Text Series (2005).
3. *Food Microbiology* (5th edition) by WC Frazier and DC Weshoff. Mcgraw-Hill (2015).
4. *Basics of Food Biochemistry and Microbiology* by S Kumari. Koros Press (2012).
5. *Food Microbiology: An introduction* by TJ Montville et al. ASM press (2012).
6. *Food Microbiology: Fundamentals and Frontiers* by MP Doyle and RL Buchanan. ASM press (2007).
7. *Food Microbiology* by MR Adams et al. RSC (2016).
8. *Food Microbiology* by WM Foster. CBS Publishers (2016).

9. *Laboratory Manual of Food Microbiology* by N Garg. I.K. International Publishing House (2013).

Course Code: FST.508

Course Title: Food Chemistry-Lab

Total Hours-60

L	T	P	Cr
0	0	4	2

Learning Outcome:

The course will enable students:

- To perform the laboratory practices important in basic and applied food chemistry and to make use of these tests in food analysis and quality improvement
- To estimate major components of foods.
- To measure the quality and stability of oils/fats in foods.
- To maximize quality of fresh cut fruits and vegetables by delaying/preventing browning.

S.No Practical

1. Determination of moisture content of foods using different methods.
2. Determination of total, soluble and insoluble ash content of different foods.
3. Determination of chlorophyll content.
4. Determination of crude proteins using Kjeldhal method.
5. Determination of crude fat content of different foods.
6. Determination of acid value and saponification value of fat/oil.
7. Determination of ascorbic acid content using dye method.
8. Determination of sugar content.
9. Determination of total phenolic content and antioxidant activities of plant foods.
10. Determination of oil stability by using rancimat.
11. Study methods for eliminating enzymatic browning of fruits and vegetables

Lab practical may be modified depending on the availability of materials and facilities as well as latest advancements.

Evaluation criteria for practical courses:

The course shall be evaluated by Continuous Assessment and End Term Assessment as detailed below

Continuous Assessment

Attendance	: 10 marks
Performance	: 20 marks
Good Laboratory Practices	: 20 marks

End Term Assessment

Report	: 10 marks
Oral viva-voce	: 20 marks
Performance (practical)	: 10 marks
Performance (report/write-up)	: 10 marks

Transactional Modes:

Mode of transaction shall be Lecture-cum-demonstration, Experimentation, Problem solving, etc.

Course Code: CST.501

Course Title: Computer Applications

Total Hours: 30

L	T	P	Cr
2	0	0	2

Learning outcome:

Upon successful completion of this course, the student will be able to:

- Use different operating system and their tools easily.
- Use word processing software, presentation software, spreadsheet software and latex.
- Understand networking and internet concepts.
- Use computers in every field like teaching, industry and research.

UNIT I

Computer Fundamentals: Introduction to Computer, Input devices, Output Devices, Memory (Primary and Secondary), Concept of Hardware and Software, C.P.U., System bus, Motherboard, Ports and Interfaces, Expansion Cards, Ribbon Cables, Memory Chips, Processors, Software: Types of Software, Operating System, User Interface of popular Operating System, Introduction to programming language, Types of Computer.

UNIT II

Computer Network: Introduction to Computer Network, Types of Network: LAN, WAN and MAN, Topologies of Network, Internet concept, WWW.

Word Processing: Text creation and Manipulation; Table handling; Spell check, Hyper-linking, Creating Table of Contents and table of figures, Creating and tracking comments, language setting and thesaurus, Header and Footer, Mail Merge, Different views, Creating equations, Page setting, Printing, Shortcut keys.

UNIT III

Presentation Tool: Creating Presentations, Presentation views, working on Slide Transition, Making Notes Pages and Handouts, Drawing and Working with Objects, Using Animations, Running and Controlling a Slide Show, Printing Presentations, and Shortcut keys.

Spread Sheet: Entering and editing data in cell, Basic formulas and functions, deleting or inserting cells, deleting or inserting rows and columns, printing of Spread Sheet, Shortcut keys.

UNIT IV

Use of Computers in Education and Research: Data analysis tools, e-Library, Search engines related to research, Research paper editing tools like Latex.

Transactional Modes:

PPT, Video, e-content, google drive

Suggested Readings:

1. Sinha, P.K. Computer Fundamentals. BPB Publications.
2. Goel, A., Ray, S. K. 2012. Computers: Basics and Applications. Pearson Education India.
3. Microsoft Office Professional 2013 Step by Step
<https://ptgmedia.pearsoncmg.com/images/9780735669413/samplepages/9780735669413.pdf>

Course Code: CST.502**Course Title: Computer Applications - Lab**

L	T	P	Cr
0	0	4	2

The lab assignments will be based on theory paper CST.501.

Lab Evaluation:

The evaluation of lab criteria will be based on following parameters:

Evaluation Parameters**Marks**

Practical File	5
Implementation	15
Viva-voce	30
Total	50

Course Code: FST.510**Course Title: Food Biotechnology****Total Hours-60**

L	T	P	Cr
4	0	0	4

Learning Outcome:

The course will enhance efficiency of students to:

- To explain what is food biotechnology and how is this relevant to food processing
- To explain the current and future prospects of food biotechnology and its applications in the food industry
- To apply the fermentation technology for production of compounds relevant in food industry.
- To critically evaluate and recommend the applications of genetically modified foods.

Unit I**15 Hours**

Overview of Food biotechnology: Present scenario and future prospects of food biotechnology; Applications of biotechnology in the food industry; Biotechnology and food safety

Unit II**15 Hours**

Fermenter: Fermenter design; Parts of fermenter and their functions; Types of fermentation processes, aeration and agitation

Media for industrial fermentation; Downstream processing (centrifugation, filtration, precipitation, extraction, drying, cell disruption); Membrane technology and its application in fermentation industry

Unit III**15 Hours**

Application of Food Biotechnology: in the production of bio-colours, flavours, vitamins, bio-preservatives, antibiotics and industrial alcohol

Single cell proteins: Definition; Advantages; Nutritional value; Microorganisms used as SCP; Production of SCP; Fungi and algae as food

Probiotics and prebiotics: Definition; Composition; Health effects; Safety consideration; Future trends

Unit IV**15 Hours**

Genetically modified foods: Definitions; Advantages; Indian and global market and value; Effect on environment, farming structure, biodiversity and soil ecosystem; Safety; Future prospects. Golden rice: Need, history and production.

Transactional Modes:

Mode of transaction shall be Lecture, presentation, Lecture-cum-demonstration, Seminar, discussion etc.

Suggested readings

1. K Shetty, *Functional Foods and Biotechnology*. CRC Press Taylor & Francis (2015).
2. KL Benson, *Industrial Microbiology*. CBS Publishers (2016).
3. PS Panesar and SS Marwaha, *Biotechnology in Agriculture and Food Processing*. CRC Press (2013).
4. S Skariyachan et al., *Introduction to Food Biotechnology*. CBS Publisher (2012).
5. SS Kariyachan, *Food Biotechnology*. CBS Publisher (2012).
6. SS Marwaha and JK Arora, *Biotech Strategies in Agro processing*. Asiatech (2003).
7. VK Gupta et al. *Biotechnology of Bioactive Compounds*. Wiley-Blackwell (2015).
8. VK Joshi and RS Singh, *Food Biotechnology: Principles and Practices*. IK International Publishing House (2012)
9. W Clarke, *Biotechnology of Industrial Microbiology*. CBS Publishers (2016).
10. YH Hui, *Food Biotechnology*. Wiley-Blackwell (2014).
11. Paredes-López et al. Food biotechnology review: Traditional solid-state fermentations of plant raw materials—application, nutritional significance, and future prospects. *Critical Reviews in Food Science & Nutrition*, 1988, 27, 159-18

Course Code: FST.511**Course Title: Nutrition, Nutraceuticals and Functional Foods****Total Hours-60**

L	T	P	Cr
4	0	0	4

Learning Outcome:

The completion of this course will make students:

- To explain the terms important in nutrition science and to explain what are nutraceuticals and functional foods
- To compare various constituents of foods for their nutraceutical and bioactive properties.

- To develop/design a diet fulfilling requirements of nutrients by people of different age group
- To analyze the effects of processing on health benefits of food-based nutraceuticals.
- To give recommendations on application of latest processing technologies for isolation of nutraceuticals.
- To formulate the diets which can reduce the risk of chronic diseases.

Unit I

15 Hours

Introduction to Nutrition and Nutraceuticals: Definitions (food, diet, nutrients, nutrition, adequate/good nutrition, nutritional status, malnutrition, nutritional care, health, nutraceuticals, functional foods and dietary supplements); Energy balance; Functions of food; Food types and groups; Concept of balanced diet
Nutritional requirements during life cycle: Nutritional requirements and RDA for infants, school children, adolescents, pregnant and lactating mother and elderly people; Alcoholism and nutrition: Nutritional problem among alcoholics; Health problems from alcohol abuse; Benefits of moderate alcohol use.

Unit II

15 Hours

Nutraceuticals: Classification; Reasons for taking supplements; Sources and health benefits of nutraceuticals like phytosterols, polyphenols, phyto-oestrogens, lycopene, dietary fibre, non-digestible oligosaccharides, etc.; Probiotics and prebiotics (Definitions, Characteristics, Possible probiotics and prebiotics, health benefits); Omega-3 fatty acids and oils (Sources; Applications; Health benefits); Conjugated linoleic acids (biological actions and health benefits); Chitin and chitosan (Production and application of bioactive chitosan oligosaccharides as nutraceuticals); Glucosamine (Production and Health Benefits); Bioactive peptides (examples, productions and functions)

Unit III

15 Hours

Processing technologies: Application of supercritical fluid and membrane technology in the production of nutraceuticals; Impact of processing on the bioactivity of functional and nutraceutical ingredients in foods
Incorporation of nutraceutical ingredients in baked foods; Regulation of nutraceuticals and functional foods; Food label claim guidelines and marketing issues for nutraceuticals and functional foods and product positioning.

Unit IV

15 Hours

Nutraceuticals in disease prevention: prevalence and risk factors for coronary heart diseases, Diet and coronary heart diseases relationship, probiotics, prebiotics and omega 3 fatty acids for prevention of coronary heart diseases; Prevalence and causes of obesity; measurement of obesity (body mass index), dietary and non-dietary approaches for treatment of severe obesity (VLCD and Gastroplasty); Foods and cancers: anti-tumour action of phytochemicals, antioxidants and dietary fibres

Transactional Modes:

Mode of transaction shall be Lecture, Dialogue, presentation, Lecture-cum-demonstration, Seminar, discussion, etc.

Suggested readings

1. C Galanakis, *Nutraceutical and Functional Food Components: Effects of Innovative Processing Techniques*. Academic Press (2017).
2. EC Robert, *Handbook of Nutraceuticals and Functional Foods*. CRC Press (2006).
3. G Subbulakshmi, *Functional Foods and Nutrition*, Daya Publishing House (2014).
4. GR Gibson and CM Williams, *Functional Foods: Concept to Product*. Woodhead Publishing (2000).
5. H Dominguez *Functional Ingredients from Algae for Foods and Nutraceuticals*. Woodhead Publishing (2013).
6. J Boye, *Nutraceutical and Functional Food Processing Technology*. Wiley Blackwell (2015).
7. J Gilbert, *Bioactive Compounds in Foods*. Wiley India (2014).
8. J Shi, *Functional Food Ingredients and Nutraceuticals: Processing Technologies*. CRC Press (2006).
9. M Saarela, *Functional Foods: Concept to Product*. Woodhead Publishing (2014).
10. M. Swaminathan, *Essentials of Food and Nutrition*, Volumes 1-2. Ganesh Publisher (1974).
11. NN Potter, *Food Science*. CBS Publishers (2007).
12. RR Watson, *Fruits Vegetables and Herbs: Bioactive Foods in Health Promotion*. Academic Press, (2016).
13. S Riar et al., *Functional Foods and Nutraceuticals: Sources and Their Developmental Techniques*. New India publishing agency (2015).
14. Subbulakshmi S and Subhadra M, *Nutrition in Traditional Therapeutic Foods*. Daya Publishing House (2015).
15. V Vaclavik and CW Elizabeth, *Essentials of Food Science*. Springer (2014).
16. Y Zhao, *Specialty Foods: Processing Technology, Quality and Safety*. CRC Press (2012).
17. Edelstein S (2018) *Food Science*, Jones & Bartlett Learning
18. Trust Beta (2019) *Cereal Grain-Based Functional Foods*, Royal Society Of Chemistry
19. Rao (2018) *Lycopene And Tomatoes In Human Nutrition And Health*, CRC Press
20. Shiomi (2018) *Superfood & Functional of food The Development of Superfood and their roles*
21. Neelam Singh (2018) *Food Nutrition, Science and Technology*, Woodhead Publication
22. Sonkar (2018) *Food and Nutrition Security*, Chandralok Prakashan
23. Sharma, M (2018) *Nutrition for the Family*, Sports Educational Tech
24. Chemat F (2019) *Green Food Processing Techniques: Preservation Transformation and Extraction*, Academic Press
25. Choksi PM and Joshi VY (2007) *A Review on Lycopene-Extraction, Purification, Stability and Applications*. *International Journal of Food Properties*, 10, 289-298
26. Story et al. (2010) *An Update on the Health Effects of Tomato Lycopene*. *Annual Reviews in Food Science and Technology*, 2010, 1-24

27. Gogus U & Smith C (2010) n-3 Omega fatty acids: a review of current knowledge. International Journal of Food Science and Technology, 45, 417-436

Course Code: FST.522

Course Title: Processing of Cereals, Pulses and Oilseeds

Total Hours-60

L	T	P	Cr
4	0	0	4

Learning Outcome:

The completion of this course will enable learners:

- To relate chemical composition of cereals, pulses and oilseeds with their structure.
- To compare different cereals, pulses and oilseeds for their processing and applications in food industry.
- To effectively utilize cereals, pulses and oilseeds in production of value-added traditional and novel foods.
- To conclude about the nutritionally important constituents and antinutritional factors in pulses
- To develop/design technologies/processing methods for improving nutritional properties of pulses and oilseeds.

Unit I

17 Hours

Introduction: Production, composition, structure and usage of major cereals like wheat, rice, maize, barley and oats; Pseudocereals

Wheat: Classification; Cleaning; Conditioning; Milling; Air fractionation of flours; Flour treatment; Quality tests for analysis of flour: physicochemical and rheological tests (farinograph, mixograph, extensiograph, alveograph, pasting profile, etc.) for wheat flour analysis; Yeast fermentation tests (fermentograph, rheofermentometer, maturograph, etc); Bakery ingredients and their roles in bakery products; Manufacturing and evaluation of bakery products; Biochemical changes during bread making; Durum wheat processing(milling and manufacturing of pasta products); Production of wheat starch and vital wheat gluten; Manufacturing of chapatti.

Unit II

15 Hours

Rice: Rice quality and grading; Aging - Changes during aging, methods for accelerated aging; Milling; Parboiling - Methods, changes during parboiling, advantages and disadvantages; Technology of quick cooking rice and sake; Stabilization of rice bran.

Maize: Dry and wet milling; Processing of by-products from dry and wet milling; Production of starch-based syrups and sweeteners (HFCS, Dextrose, high maltose syrups, maltodextrins, etc.); Alkaline cooked products; Processing of maize germ oil and flakes.

Oats: Composition and processing of rolled oats; Health benefits of oats and beta glucan.

Unit III

15 Hours

Legumes/pulses: Legumes *vs.* pulses; Production, structure, constituents and classification of pulses; Anti-nutritional factors in legumes and methods of elimination; Milling; Technology of legume/pulse flours, proteins (concentrates and isolates) and starches; Cooking properties of pulses and Hard-to-cook defect; Technology of soy milk, tofu, proteins (soy flour, concentrates and isolates) and TVP; Application of soy proteins.

Unit IV

13 Hours

Oilseeds: Production and trade of oils and oilseeds; Components of vegetable oils; Oilseed processing: drying, storage, cleaning, grading, dehulling, flaking, heat treatment/ extrusion, oil extraction (mechanical and solvent extraction); Physical and chemical refining of crude vegetable oils; Modification of vegetable oils (hydrogenation, winterization/fractionation and interesterification); Utilization of de-oiled cake/meal

Transactional Modes:

Mode of transaction shall be Lecture, presentation, Lecture-cum-demonstration, Seminar, discussion etc.

Suggested readings

1. A Chakraverty and RP Singh, *Postharvest Technology and Food Process Engineering*. CRC Press (2014)
2. A Chakraverty et al. *Handbook of Postharvest Technology*. Marcel Dekker (2003).
3. B Richards, *Oils Fats and Fatty Foods*. Biotech Books (2014).
4. BK Tiwari and N Singh, *Pulse Chemistry and Technology*. RSC (2012).
5. BK Tiwari et al., *Pulse Foods*. Wiley Publication (2011).
6. BK Tiwari, *Pulse Foods: Processing Quality and Nutraceutical Applications*. Academic Press (2014).
7. BO Juliano, *Rice: Chemistry and Technology*. AACC (1985).
8. Bolton, Richards ER, *Oils, Fats and Fatty Foods: Their Practical Examination*. Biotech Books (2014).
9. CW Wrigley, *Cereal Grains: Assessing and Managing Quality*. Woodhead Publishing (2015).
10. K Liu, *Soybeans: Chemistry, Technology, and Utilization*. Springer (1997).
11. KK Rajah, *Fats in Food Technology*. John Wiley & Sons (2014).
12. MM Chakrabarty, *Chemistry and Technology of Oils and Fats*. Allied Publishers (2012).
13. N Khetarpal et al., *Fats and Oils in Health and Nutrition*. Astral Publishing House (2014).
14. NL Kent, *Technology of Cereals*. Pergamon Press (1984).
15. PS Belton, *Physical chemistry of Foods*. (2005).
16. SA Watsan and PE Ramsat, *Corn: Chemistry and Technology*, AACC (1987).
17. Y Pomeranz, *Wheat: Chemistry and Technology*. AACC (1990).
18. Maria Angeles (2019) Legumes, Royal Society of Chemistry
19. Trust Beta (2019) Cereal Grain-Based Functional Foods, Royal Society of Chemistry

20. Bemiller (2019) Carbohydrate Chemistry for Food Scientists, Woodhead Publications
21. Silva Clerici Maria Teresa (2019) Starches For Food Application: Chemical Technological and Health Properties, Academic Press
22. Shevkani, K. et al. (2017). Wheat Starch production, structure, functionality, and applications-a review. International Journal of Food Science and Technology, 52, 38-58
23. Singh, B. et al. (2017) Bioactive constituents in pulses and their health benefits, Journal of Food Science and Technology, 54, 858-870.

Course Code: FST.523

Course Title: Food Engineering and Unit Operations

Total Hours-60

L	T	P	Cr
4	0	0	4

Learning Outcome:

The course will make students to:

- Elaborate various engineering properties of foods and how they are relevant to food processing
- Explain principles of material balance, energy balance and fluid flow in food processing.
- Compare different types of filters, freezers, heat exchangers and leaching and distillation equipment.
- Develop processing methods of foods by applying unit operations like refrigeration, freezing, evaporation, drying, distillation and leaching.

Unit I

15 Hours

Introduction: Engineering properties of foods and their applications in food processing

Material and energy balance: Basic principles, total mass balance and component mass balance. Material balance calculations involved in dilution, concentration and dehydration. Heat balance calculations

Fluid flow: Nature and classification of fluids; Newtonian and Non-Newtonian fluids, streamline and turbulent flow; Viscosity and its measurement; Flow measurement devices (Pitot tube, Orifice meter, Venturimeter). Pressure and its measurement (Simple and Differential manometers)

Raw material preparation: Cleaning; Sorting; Grading; Peeling

Unit II

15 Hours

Size reduction: Size reduction in food processing; Forces applied for size reduction; Equipment. Mixing: Theory; Mixers for liquids of low or moderate viscosity (Paddle agitators, turbine agitators and propeller agitators); Mixers for high viscosity pastes (Pan Mixer, horizontal mixer and dough mixer); Mixers for dry solids (tumbler mixer and vertical screw mixer). Screening: Definitions; Types of screens; Factors affecting screening.

Filtration and centrifugation: Filtration theory; Types of filtration (pressure filtration, vacuum filtration and centrifugal filtration); Filtration methods (bed filters, plate and frame filters, leaf filters, continuous rotary filters); Centrifuge

equipment (Liquid-liquid centrifuges, centrifugal clarifiers, desludging and dewatering centrifuges).

Unit III

15 Hours

Heat transfer in food processing: Thermal properties of foods; Modes of heat transfer; Systems for heating and cooling (steam injection and steam infusion, tubular, scrapped surface, plate heat, shell and tube heat exchangers).

Refrigeration and freezing: Refrigeration system and its components; Refrigeration cycle and refrigeration load; Freezing curve; Food Freezing systems (Indirect and direct contact freezers e.g. Plate freezers, Air blast freezers, and immersion freezing); Freezing time calculation.

Unit IV

15 Hours

Evaporation and dehydration: Parts of an evaporator; Types of evaporators (Batch type pan evaporator, Natural circulation evaporator, Rising film evaporator, Falling film evaporator, Rising/Falling film evaporator, Forced circulation type evaporator, Agitated thin film evaporator). Vapour recompression systems; Free moisture content; Bound moisture content; Critical moisture content; Equilibrium moisture content; Constant and falling rate drying period; Types of dryers (tray drier, tunnel drier, roller or drum drier, fluidized bed drier, spray drier, pneumatic drier, rotary drier, trough drier, bin drier, vacuum drier and freeze drier).

Distillation: Classification of distillation; Equilibrium or Flash distillation; Simple batch or Differential distillation; Simple steam distillation; Distillation with reflux

Leaching: Rates of leaching; Leaching equipment (fixed bed leaching, moving bed leaching, agitated solid leaching).

Transactional Modes:

Mode of transaction shall be Lecture, presentation, Lecture-cum-demonstration, Seminar, discussion etc.

Suggested readings

1. A Chakraverty and RP Singh, *Postharvest Technology and Food Process Engineering*. CRC Press (2014)
2. DR Heldman and DB Lund, *Handbook of Food Engineering*. CRC (2017).
3. G Saravakos and AK Kostaropoulos, *Hand Book of Food Process Equipment*. Springer (2002).
4. J Brennan, *Food Processing Handbook*. Wiley (2006)
5. K Marwaha, *Food Process Engineering: Theory and Laboratory Experiments*. Genetech Books (2015).
6. L Mathur, *Food Science Engineering and Technology*. SBS Publisher (2016).
7. LJ Callisto, *Essentials in Food and Control Engineering*. Reference New York (2015).
8. McCabe et al, *Unit Operations of Chemical Engineering*. McGraw-Hill (2014).
9. RP Singh and DR Heldmann, *Introduction to Food Engineering*. Academic Press (1993).

10. RT Toledo, *Fundamentals of Food Process Engineering*. CBS Publisher (1993).
11. Z Berk, *Food Process Engineering and Technology*. Elsevier (2013).
12. Nehra, M (2019) *Dictionary of Terms in Food Science and Technology*, The Readers Paradise

Course Code: FST.524

Course Title: Processing of Fruits and Vegetables

Total Hours-60

L	T	P	Cr
4	0	0	4

Learning Outcome:

The completion of this course will make students to:

- To relate the post-harvest handling of fruits and vegetables with the current status and methods of their processing.
- Compare different fruits and vegetables for composition, nutritional value, respiration rate and post harvest biochemical changes.
- To apply canning in food industry and to evaluate its effect on nutritional value of fruits and vegetables.
- To develop/design the processes for manufacturing juices, jams, jellies, preserves and candied fruits
- To maximise the shelf life of fruits and vegetables by reducing post harvest losses to the minimum by applying appropriate methods of handling, processing and storage.

Unit I

15 Hours

Introduction: Current status of fruits and vegetable processing in India. Post-harvest handling of fruits and vegetables: Classification and composition of fruits and vegetables and their nutritional value; Respiration (RQ, climacteric and Non climacteric fruits), Assessment of maturity indices; Biochemical changes during ripening; Post-harvest handling operation of common fruits and vegetables; Edible coatings; Methods of storage (refrigerated, CAS, MAS, ZECC and hypobaric storage)

Unit II

15 Hours

Canning: Canning of fruits and vegetables; Impact of canning on nutritional value of fruits and vegetables; Aseptic canning of fruits and vegetables: Operation; Equipment; Specifications. Spoilage of canned fruits and vegetable; Minimal processing of fruits and vegetables; Fresh cut fruits and vegetables (produce for the fresh-cut processing, treatments to ensure safety, additives to preserve quality)

Unit III

15 Hours

Juice Processing: Method of juice extraction; Equipment; Preservation; Enzymatic maceration; Juice concentration (methods, processing and flavour retention); Specifications; Preparations of jams, jellies, preserves and candied fruits: Pectin and related compounds; Role of pectin and theories of gel formation; Preparation of dietetic jellies

Unit IV**15 Hours**

Fruits & Vegetable Product Processing: Manufacturing of preserves and candied fruits; Specifications;

Processing of tomato products: Puree; Paste; Ketchup; Soup; Specifications

Processing of potato products: Flour; Chips; Fries; Nutritive value of potato products; Acrylamide in potato products

Transactional Modes:

Mode of transaction shall be Lecture, presentation, Lecture-cum-demonstration, Seminar, discussion etc.

Suggested readings

1. AK Jaiswal, *Food Processing Technology: Impact on Product Attributes*. CRC Press (2017)
2. G Lal, *Preservation of Fruits and Vegetables*. ICAR (2015).
3. J Jethro, *Tropical Fruit Processing*. AP Publisher (2014).
4. LR Verma and VK Joshi, *Post-harvest Technology of Fruit and Vegetables*. Indus Publishing Company (2016).
5. NS Rathore, *Post-harvest Management and Processing of Fruits and Vegetables*. ICAR (2012).
6. S Thaper, *Home Presentation of Fruits and Vegetables*. Punjab Agricultural University (2007).
7. SK Chattopadhyay, *Handling Transportation and Storage of Fruits and Vegetable*. Gene Tech Books (2015).
8. WV Cruses, *Commercial Fruit and Vegetables Processing*. Agribios (2012).
9. Li et al. (2020) *Vegetables and Fruits*, CRC Press
10. Seymour (2020) *Biochemistry of Food Ripening*, Springer
11. Marriott (2018) *Principles of Food Sanitation*, Springer
12. Arthey (2020) *Fruit Processing*, CRC Press
13. Rao (2018) *Lycopene and Tomatoes In Human Nutrition And Health*, CRC Press.

Course Code: FST.572**Course Title: Poultry, Meat and Fish Processing****Total hours - 60**

L	T	P	Cr
4	0	0	4

Learning Outcome:

The course completion will enable students:

- To relate egg, poultry and meat composition with quality of products based on them.
- To compare egg, poultry, fish and meat for nutritive properties and stability.
- To utilize eggs and egg products in formulated foods
- To analyse the relationship between pre and post-mortem changes in meats.
- To justify the need of food safety management and inspection in meat industry.

Unit I**15 Hours**

Eggs: Structure; Composition; Nutritive value; Grading; Internal quality (evaluation and factors affecting egg quality); Preservation of whole eggs; Packaging of whole eggs; Functional properties; Microbial spoilage; Freezing and pasteurization of liquid eggs; Mechanism and factors affecting gelation and foaming properties of eggs; Technology of egg products (egg powders and frozen egg products)

Unit II**15 Hours**

Poultry: Status of poultry and meat industry in India; Types; Composition; Nutritive value; Factors affecting quality of poultry meat; Poultry slaughtering and dressing (operation and equipment); Changes during freezing and thawing of poultry meat

Meat: Chemical composition and nutritive value of meat; Structure of meat tissue; Pre-mortem condition and their effect on post mortem quality; Post-mortem biochemical changes; Factors affecting post-mortem changes; Muscle concentration and relaxation; Eating properties of meat; Cooking quality of meat; Pre-slaughter operations and slaughtering operations.

Unit III**15 Hours**

Processing and preservation: Principles, equipment and applications of mechanical deboning; Preservation of meats by chilling, freezing, freeze drying, pickling, curing, cooking and smoking, dehydration, irradiation, chemical and biological preservatives; Tenderization; Equipment for manufacture of meat Comminuted/minced meat product; Quality evaluation of sausages

Fish: Type and Classification; Quality; Storage; Products (fish pickle, dried fish & fish protein hydrolysate, surimi, etc.)

Unit IV**15 Hours**

Sanitation and safety in meat industry: Food safety management in meat industry; Inspection and safety standards in meat industry; Pesticide and drug residue in poultry meat; Pathogenic microorganisms on processed poultry; Factors affecting microbial growth in poultry; Effects of processing on pathogen load.

Transactional Modes:

Mode of transaction shall be Lecture, presentation, Lecture-cum-demonstration, Seminar, discussion, etc.

Suggested readings

1. AM Pearson and TA Gillett, *Processed Meats*. CBS Publishers (1996).
2. GC Mead, *Poultry Meat Processing and Quality*. Woodhead Publishing Ltd. (2004).
3. I Guerrero-Legarreta, *Handbook of Poultry Science and Technology*. Wiley (2010).
4. *Lawrie's Meat Science* Woodhead Publishing (2017).
5. LS Bozaris, *Seafood Processing: Technology, Quality and Safety*. John Wiley and Sons Ltd. (2014).
6. NN Potter, *Food Science*. CBS Publishers (2007).

7. R Fernandes, *Microbiology Handbook of Meat products*. Medtech (2017).
8. SC Ricke, *Organic Meat Production and Processing*. Wiley-Blackwell (2012).
9. Sohrab, *A Practical Guide for Implementation of Integrated ISO-9001 HACCP System for the Food Processing Industry*. Allied Publishers Ltd. (2001).
10. YH Hui, *Handbook of Meat and Meat Processing*. CRC Press (2012).
11. YH Hui, *Meat Science and Applications*. Marcel Dekker (2001).
12. Benjamin M. Bohrer (2019). An investigation of the formulation and nutritional composition of modern meat analogue products. *Food Science and Human Wellness*, Volume 8, Issue 4, Pages 320-329.
13. Paula A. Gonzalez-Rivas, Surinder S. Chauhan, Minh Ha, Narelle Fegan, Robyn D. Warner (2020). Effects of heat stress on animal physiology, metabolism, and meat quality: A review. *Meat Science*, Volume 162, Article 108025.

Course Code: FST.573

Course Title: Technology of Spices, Sugar and Chocolate

Total hours - 60

L	T	P	Cr
4	0	0	4

Learning Outcome:

The course completion will make students:

- To identify spices forms and chocolate confectionary and understand how they are processed
- To compare different spices for composition, health benefits, functions and applications
- To design/develop the processes for cane sugar manufacture.
- To critically analysing the effect of processing (milling, cryo-milling, fumigation and irradiation) on the properties of spices.
- To recommend about the health effects of spices, sugar and chocolates.
- To maximize storage life and quality of spices, sugar and chocolate.

Unit I

15 Hours

Introduction: Classification; Composition; Health benefits; Forms, functions and applications of spices;

Processing: Major spices (black pepper, small cardamom, ginger, chilli and turmeric); Processing of white pepper; Technology of onion, ginger and garlic pastes and powders; Other spices: Fennel, celery, dill, onion, clove, nutmeg, saffron, cumin, coriander, cinnamon, fenugreek, garlic, mace, clove, mint and vanilla;

Organic spices: Concept, standard and quality

Unit II

15 Hours

Oleoresins and Spice emulsions (method of manufacture, chemistry of the volatiles); Cryo-milling of spices; Microbial contamination and insect infestation in spices and its control; Fumigation and irradiation of spices

Essential oils: Sources; Production; Adulteration; Analysis; Biological activities; Therapeutic and industrial uses

Unit III

15 Hours

Cane sugar technology: Composition of cane and cane juice; Manufacturing of sugar (process and equipment); Cane preparation and juice extraction; Screening, Clarification; Evaporation; Sugar boiling; Crystallization; Centrifugal separation; Drying and storage; Deterioration of sugar during storage and its prevention; By-products of sugar industry and their utilization

Unit IV

15 Hours

Chocolate: History of chocolate; Cocoa beans and production; Ingredients in chocolate (crystalline and amorphous sugar; lactose, glucose and fructose; milk and other dairy ingredients); Cocoa butter properties; Processing of cocoa beans (cleaning, roasting and winnowing; grinding of nib, production of cocoa butter and cocoa powder); Refining; Conching; Chocolate; Tempering; Moulding; Enrobing and panning; Packaging requirements and material used for packaging of chocolate; Health effects of chocolate confectionary

Transactional Modes:

Mode of transaction shall be Lecture, presentation, Lecture-cum-demonstration, Seminar, discussion etc.

Suggested readings

1. A Chakraverty et al., *Handbook of Postharvest Technology*, Marcel Dekker (2003).
2. DA Patil, *Spices and Condiments: Origin, History and Applications*. Astral Publishing House (2013).
3. JG Woodroof et al., *Hand Book of Sugars for Processors, Chemists and Technologists*. AVI Publication (1973).
4. K Husnu Can Baser and G Buchbauer, *Handbook of Essential Oils: Science, Technology, and Applications*. CRC Press (2016).
5. KV Peter, *Handbook of Herbs and Spices*, CRC Press (2000).
6. NN Potter, *Food Science*. CBS Publishers (2007).
7. R Lees and B Jackson, *Sugar Confectionery and Chocolate Manufacture*. Blackie Academic and Professional (1992).
8. S Raghavan, *Handbook of Spices, Seasonings and Flavorings*. CRC Press (2007).
9. V Vaclavik and CW Elizabeth, *Essentials of Food Science*. Springer (2014).
10. VB Singh, *Spices*. New Age International (2008).
11. Xiuxiu Teng, Min Zhang, Sakamon Devahastin (2019). New developments on ultrasound-assisted processing and flavor detection of spices: A review. *Ultrasonics Sonochemistry*, Volume 55, Pages 297-307.

Course Code: FST.525

Course Title: Cereals, Pulses and Oilseed Analysis-Lab

Total Hours-30

L	T	P	Cr
0	0	2	1

Learning Outcome:

The completion of this course will enable students:

- To compare cereals, pulses and oilseeds for physicochemical and morphological properties by making experiments.
- To estimate and isolate major components of cereals, pulses and oil seeds
- To prepare bakery foods using different methods.
- To give recommendations on the suitability of different wheat flours for bread making.

S.N. Practical

1. Determination of physicochemical properties of cereals, legumes and oilseeds.
2. Determination of husk content of covered cereals.
3. Determination of physicochemical properties of wheat flour and whole wheat meal.
4. Determination of cooking properties of rice.
5. Isolation of wheat starch and gluten.
6. Determination of amylose content of starches.
7. Morphological properties of different cereal starches.
8. Determination of germination capacity of barley.
9. Laboratory milling of wheat and rice.
10. Manufacturing of different baked products and their quality evaluation.
11. Stabilization of oats and tetrazolium test for germ viability.
12. Preparation and evaluation of legume protein concentrates/isolates.
13. Parboiling of paddy and quality evaluation of parboiled rice.
14. Rheological properties of wheat flour dough.
15. Determination of viability of barley using tetrazolium test
16. Extraction and evaluation of oil from oilseeds

Lab practical may be modified depending on the availability of materials and facilities as well as latest advancements.

Transactional Modes:

Mode of transaction shall be Lecture-cum-demonstration, discussion, Experimentation, Problem solving etc.

Evaluation criteria for practical courses:

The course shall be evaluated by Continuous Assessment and End Term Assessment as detailed below

Continuous Assessment

Attendance	: 10 marks
Performance	: 20 marks
Good Laboratory Practices	: 20 marks

End Term Assessment

Report	: 10 marks
Oral viva-voce	: 20 marks
Performance (practical)	: 10 marks
Performance (report/write-up)	: 10 marks

Course Code: FST.526
Course Title: Food Engineering-Lab
Total hours - 30

L	T	P	Cr
0	0	2	1

Learning Outcome:

The completion of this course will make students to:

- Relate construction/design of processing machines with their applications in the food industry.
- Demonstrate the scientific methodology during food engineering laboratory investigations.
- Build the skills in terms of designing processes employing latest processing parameters.
- Elaborate the design and working principles of equipments relevant in food industry.
- Designing the process for quick freezing of foods.

S.N. Practical

1. Determination of viscosity of liquid foods.
2. Study the working principle and operation of various types of grinders.
3. Study the working principle and operation of various types of crushers.
4. Study components and working principle of domestic refrigerator.
5. Determination of particle size distribution and average particle size (sieve analysis).
6. Working principle and operation of belt conveyor, screw conveyor, bucket elevator
7. Determination of freezing time of selected foods.
8. Study the working principles and operation of an evaporator.
9. Study the working principle and operation of a spray freeze drier
10. Determination of drying time of various foods

Lab practical may be modified depending on the availability of materials and facilities as well as latest advancements.

Transactional Modes:

Mode of transaction shall be Lecture-cum-demonstration, discussion, Experimentation, Problem solving etc.

Evaluation criteria for practical courses:

The course shall be evaluated by Continuous Assessment and End Term Assessment as detailed below

Continuous Assessment

Attendance	: 10 marks
Performance	: 20 marks
Good Laboratory Practices	: 20 marks

End Term Assessment

Report	: 10 marks
Oral viva-voce	: 20 marks
Performance (practical)	: 10 marks
Performance (report/write-up)	: 10 marks

Course Code: FST.527**Course Title: Fruits and Vegetable Processing-Lab****Total Hours - 30**

L	T	P	Cr
0	0	2	1

Learning Outcome:

The completion of this course will enable students:

- To relate the present problems of fruits and vegetables with their handling.
- To explain the processing techniques
- To develop and evaluate new products based of fruits and vegetables.
- To organize various techniques involved in the shelf life extension of fresh produce based products.
- To conclude the effect of processing on properties of fruits and vegetable products.

S.N. Practical

1. Morphological characteristics of fruits
2. Preparation and analysis of syrups
3. Determination of PLW by the use of different packaging materials and temperature.
4. Cut out examination of fruit cans
5. Preparation and quality evaluation of fruit juice concentrates
6. Preparation and quality evaluation of jam and jellies
7. Dehydration of fruits and vegetables
8. Freezing of fruits and vegetables
9. To determine change in characteristics of fruit during storage at low temperature.

Lab practical may be modified depending on the availability of materials and facilities as well as latest advancements.

Transactional Modes:

Mode of transaction shall be Lecture-cum-demonstration, discussion, Experimentation, Problem solving etc.

Evaluation criteria for practical courses:

The course shall be evaluated by Continuous Assessment and End Term Assessment as detailed below

Continuous Assessment

Attendance	: 10 marks
Performance	: 20 marks
Good Laboratory Practices	: 20 marks

End Term Assessment

Report	: 10 marks
Oral viva-voce	: 20 marks
Performance (practical)	: 10 marks
Performance (report/write-up)	: 10 marks

Course Code: FST.551**Course Title: Processing of Milk and Milk Products****Total Hours - 60**

L	T	P	Cr
4	0	0	4

Learning Outcome:

The course will make students able:

- To relate composition with physicochemical and nutritional properties of milk.
- To explain processing technologies, regulations, standards, specifications of milk and milk products.
- To develop indigenous and western dairy products.
- To analyse and compare the dairy practices in India and developed world.
- To critically evaluate and summarize dairy sector problems in India.

Unit I**15 Hours**

Introduction: Definition of milk; Composition of milk of various milk animals; Factors affecting composition of milk; Physicochemical and nutritional properties of milk; Factors affecting quality and quantity of milk produced by milk animals; Sources of milk contamination; Quality evaluation and testing of milk; Procurement and transportation of market milk

Unit II**15 Hours**

Processing of fluid milk: Processing technology and regulations agencies, standards/specifications for full-cream, standardized, toned, skim, reconstituted, recombined, toned, double-toned, standardized; flavoured, filled-milk, etc.

Cream: Types of creams; Composition of cream; Production methods; Neutralization of cream; Ripening of cream for butter making (natural ripening, ripening with starter cultures)

Unit III**15 Hours**

Butter: Types; Composition; Preparation of butter; Churning theories; Defects (causes and prevention)

Condensed and evaporated milk: Standards; Composition; Nutritive Value; Manufacture; Defects (causes and prevention)

Milk powders: Standards; Composition; Nutritive value; Process of manufacture; Defects (causes and prevention); Instantiation

Unit IV

15 Hours

Cheese: Classification, Composition; Nutritive value; Process of manufacture of cheddar, mozzarella and processed cheese

Ice cream: Standards; Composition; Nutritive value, Process of manufacture, Ingredients and their roles; Defects (causes and prevention)

Indigenous milk products: Ghee, Dahi, Desi Butter, Chhanna, Khoa, Srikhand, rabri, etc

Transactional Modes:

Mode of transaction shall be Lecture, presentation, Lecture-cum-demonstration, Seminar, discussion etc.

Suggested readings

1. *Analysis of Milk and Milk Products* by Milk Industry Foundation (2014).
2. BK Mishra, *Dairy and Food Product Technology*. Biotech Books (2016).
3. C Shortt, *Handbook of Functional Dairy Products*. CRC Press (2014).
4. D Ward, *Dairy Science and Technology*. Larsen & Keller (2017).
5. H Subrota, *Dairy Product Technology*. Astral (2015).
6. J Coimbra, *Engineering Aspects of Milk and Dairy Products*. CRC Press (2010).
7. M Sararela and TM Sandholm, *Functional Dairy Products*. Woodhead Publishing Ltd. (2014).
8. P Gangasagare, *A Textbook of Traditional Dairy Products*. Oxford Book Company (2018).
9. R Early, *The Technology of Dairy Products*. Springer Science (2010)
10. R Sharma, *Production Processing & Quality of Milk Products*. International Book Distributing Co. (2006).
11. RC Chnadan and A Kilara, *Dairy Ingredients for Food Processing*. Wiley (2011).
12. RD Boer, *From Milk By Products to Milk Ingredients*. John Wiley & Sons (2014).
13. RK Robinson, *Modern Dairy Technology Volume 1, 2 Advances in Milk Processing*. Springer (1994).
14. S De, *Outlines of Dairy Technology*. Oxford University Press (2015).
15. Getachew Osei (2017). *Handbook of Milk and Dairy Product* Publisher: Agri-Horti Press. ISBN-10: 938328563X, ISBN-13: 978-9383285631
16. Alan H. Varnam (2013). *Milk and Milk Products: "Technology, Chemistry And Microbiology"* (Food Products Series) 1994th Edition. Publisher: Springer; 1994 edition (March 22, 2013), ISBN-13: 978-1461357322, ISBN-10: 1461357322

Course Code: FST.552

Course Title: Application of Enzymes in Food Processing

Total Hours - 60

L	T	P	Cr
4	0	0	4

Learning Outcome:

The successful completion of this course will make students:

- To explain the importance of enzymes in food industry.
- To explain effects of enzymes on the quality of raw and finished foods.
- To give recommendations on the applications of enzymes in food industry
- To develop/design the processes for quality improvement of foods utilizing different enzymes.
- To conclude the applications of the enzymes particularly in cereals, dairy, fruits, beer and protein foods.

Unit I

15 Hours

Introduction: Nomenclature; General properties; Classification; Sources of enzymes; Production and purification of enzymes; Factors affecting enzymatic activity; Mechanism of enzyme inhibition; Immobilization of enzymes

Enzymes in cereal processing: Enzymatic production of modified starches, corn syrups containing glucose, maltose, glucose, fructose, etc.; Significance of enzymes in baking industry (amylases, protease, gluco-oxidases, lipase, xylanases and transglutaminase)

Unit II

15 Hours

Enzymes in dairy industry: Indigenous enzymes involved in antimicrobial and antiviral activity of milk; Exogenous enzymes in dairy industry (proteinases, lipase, beta-galactosidase, lysozyme, glucose-oxidase, superoxide dismutase, sulfhydryl oxidase, catalyse, lacto-peroxidase and transglutaminase); Hydrolysis of lactose in milk and whey; Use of enzymes for determining milk quality; Production and use of microbial enzymes for dairy processing; Enzymes in cheese production (coagulant technology, rennin and its formation, enzymes in cheese preservation)

Unit III

15 Hours

Importance and application of enzymes in fruits processing: Distribution of pectic substances and pectin enzymes in fruits; Commercial pectinases; Specific applications of enzymes in juice technology like clarification, debittering, etc.

Enzymes in meat industry: Enzymes used for meat processing (proteases and peptidases, lipases, transglutaminase, oxidative enzymes and glutaminase); Enzymatic tenderization of meat; Enzymatic generation of flavours in meat products

Unit IV

15 Hours

Enzymes in brewing: Brewing with high and very high levels of adjuncts; Improving filtration; Chill-proofing; Making new and special beers; Extending shelf life of packaged beer

Enzymatic modification of proteins and lipids: production, isolation, purification, hydrolysis, esterification, application of lipase in fats and oils;

Transactional Modes:

Mode of transaction shall be Lecture, presentation, Lecture-cum-demonstration, Seminar, discussion etc.

Suggested readings

1. AN Shukla, *Industrial Enzymology*. Discovery Publishing House (2009).
2. JR Whitaker *Handbook of Food Enzymology*. CRC press (2016).
3. PS Panesar et al., *Enzymes in Food Processing: Fundamentals and Potential Applications*. I.K. International Publishing House (2013).
4. RJ Whitehurst and MV Oort, *Enzymes in Food Technology*. Wiley-Blackwell (2010).
5. S Shanmugam and K Kumar, *Enzyme Technology*. I.K. International Publishing (2009).
6. T Nagodawithana and G Reed, *Enzymes in Food Processing*. Academic Press (1993).
7. Majid Sharifi, Mohammad Javad Sohrabi, Sara Haji Hosseinali, Anwarul Hasan, Mojtaba Falahati (2020). Enzyme immobilization onto the nanomaterials: Application in enzyme stability and prodrug-activated cancer therapy, *International Journal of Biological Macromolecules*, 143, 2020, 665-676.
8. Joseph Boudrant, John M. Woodley, Roberto Fernandez-Lafuente (2019). Parameters necessary to define an immobilized enzyme preparation. *Process Biochemistry*, In press, corrected proof, Available online 23 November 2019.

Course Code: FST.553

Course Title: Milk and Milk Processing-Lab

Total Hours - 60

L	T	P	Cr
0	0	4	2

Learning Outcome:

The completion of the course will enable learners:

- To conduct qualitative tests on milk.
- To prepare indigenous and western dairy products.
- To check adulteration of milk and milk products.
- To practically evaluate important quality characteristics of dairy products.

S.N. Practical

1. Platform tests of milk (Acidity, Clot on boiling, Alcohol test, MBR test).
2. Determination of milk fat content.
3. Determination of specific gravity using lactometer.
4. Determination of SNF and TS content of milk using lactometer.
5. Detection of common adulterants and preservatives of milk.
6. Preparation and quality evaluation of butter.
7. Preparation of and quality evaluation of ghee from cream and butter.
8. Preparation of flavoured milk.

9. Preparation and quality evaluation of Khoa.
10. Preparation and quality evaluation of chhanna/paneer.
11. Preparation and quality evaluation of curd and yoghurt.

Lab practical may be modified depending on the availability of materials and facilities as well as latest advancements.

Transactional Modes:

Mode of transaction shall be Lecture-cum-demonstration, discussion, Experimentation, Problem solving etc.

Evaluation criteria for practical courses:

The course shall be evaluated by Continuous Assessment and End Term Assessment as detailed below

Continuous Assessment

- Attendance : 10 marks
- Performance : 20 marks
- Good Laboratory Practices : 20 marks

End Term Assessment

- Report : 10 marks
- Oral viva-voce : 20 marks
- Performance (practical) : 10 marks
- Performance (report/write-up) : 10 marks

Course Code: FST.528

Course Title: Fermented Foods

Total Hours - 60

L	T	P	Cr
4	0	0	4

Learning Outcome:

The course will make students:

- To explain importance of microorganisms in food industry
- To compare different types of fermentations and their applications in food industry.
- To discuss the beneficial role of fermentation technology in food preparation.
- To develop/design different types of dairy, fruits, vegetables, meat-based indigenous and western fermented products.
- To adapt the skill of introducing indigenous fermented food products into the market.

Unit I

15 Hours

Microorganisms used in food fermentation: Beneficial uses of microorganisms in foods; Fermentation; Classification of food fermentations (alcoholic, lactic and acetic acid fermentations); Advantages of fermentation; General methods of fermentation (aerobic fermentation, anaerobic fermentation, solid state fermentation and submerged fermentation)

Unit II

15 Hours

Starter cultures: Introduction, history, concentrated cultures, starter culture problems, yeast and mould cultures

Fermented milk and milk products: (cheese, cultured cream, curd/dahi, kefir; kumis; yogurt, bulgarian milk, acidophilus milk, etc.); Health benefits of fermented milk products

Fermented fruits and vegetables: pickles; kimchi; sauerkraut, etc.

Soy-based fermented foods: miso, natto, temph, soy sauce, sofu, etc.

Unit III

15 Hours

Fermentation for food processing: Fermented indigenous products (dosa; idli; dhokla, wari, bhatura, utppam, jabeli, wada, etc.)

Alcoholic beverages based on fruit juices (wine, vinegar, etc), cereals (whisky, beer, vodka, etc.) and sugar cane (rum)

Fermented meat and fish products (sausage, pickle, fish paste, sauce, etc.);

Bioactive compounds in fermented foods

Unit IV

15 Hours

Fermentative production: Baker's yeast; Aminoacids (glutamic acid, lysine); Organic acids (citric and lactic acid); Enzymes; Polysaccharides (dextran, xanthan, pullulan, alginate, etc.); Single cell proteins

Transactional Modes:

Mode of transaction shall be Lecture, dialogue, presentation, Lecture-cum-demonstration, Seminar, discussion etc.

Suggested readings

1. B Ray and A Bhunia, *Fundamental Food Microbiology*. CRC Press (2018)
2. D Montet, *Fermented Foods: Biochemistry and Biotechnology*. CRC Press (2016).
3. DJ Owens, *Indigenous Fermented Foods of Southeast Asia*. CRC Press (2015)
4. J Frias, *Fermented Foods in Health and Disease Prevention*. Academic Press (2017).
5. PF Stanbury, *Principles of Fermentation Technology*. Elsevier (2017).
6. PS Panesar and SS Marwaha, *Biotech in Agriculture and Food Processing*. Taylor and Francis (2014).
7. SC Prescott and CG Dunn, *Industrial Microbiology*. Agrobios (2011).
8. SS Marwaha and JK Arora, *Biotech Strategies in Agro-processing*. Asiatech (2003).
9. SS Marwaha and JK Arora, *Food Processing Biotech: Application*. Asia Tech Publication (2000).
10. Mehta (2020) *Fermentation Effects on Food Properties*, CRC Press
11. Edelstein S (2018) *Food Science*, Jones & Bartlett Learning
12. Santini (2019) *Case Studies in the Wine Industry*, Elsevier

Course Code: FST.529
Course Title: Beverages Technology
Total Hours - 60

L	T	P	Cr
4	0	0	4

Learning Outcome:

The completion of this course will make students:

- To have knowledge of processing of different beverages.
- To explain the ingredients and production steps in manufacturing of beverages.
- To make efficient use of raw materials and technologies in beverage industry
- To give recommendations about nutritional properties of different alcoholic and non-alcoholic beverages.
- To design/develop technologies for quality improvement of beverages.

Unit I

15 Hours

Introduction: Types of beverages and their importance; Status of beverage industry in India

Packaged drinking water: Definition; Technology; Quality evaluation; Methods of water treatment, BIS quality standards of bottled water;

Soft drinks: Types; Role of various ingredients of soft drinks; Technology of carbonated soft drinks, synthetic beverages and sports drinks; Microbial stability of carbonated beverages

Tea: Types; Technology of black tea, green tea, pickled tea, instant tea and decaffeinated tea; Quality evaluation and grading

Unit II

15 Hours

Coffee: Cultivation; Technology; Fermentation of coffee beans; Changes during fermentation; Drying; Roasting; Process flow sheet for the manufacture of coffee powder, instant coffee; Decaffeination; Quality grading

Cocoa and chocolate-based beverages: Fermentation; Drying; Storage and transport; Cleaning and roasting of beans; Nibs, alkalizing, roasting and sterilizing (NARS) process; Kibbling and winnowing; Grinding; Deodorization; Alkalization; Pressing; Packaging; Cocoa-based beverages; Changes during procession of cocoa.

Unit III

15 Hours

Beer: Ingredients of beer; Characteristics of barley for malting and brewing; Problem of dormancy and water sensibility; Steeping techniques; Germination of barley; Kilning techniques; Changes during malting; Quality evaluation of malt; Mashing; Beer adjuncts; Filtration and boiling of wort; Changes during wort boiling; Hops; Fermentation; Lagering (objectives and techniques); Spoilage of beer; Chill haze

Unit IV

15 Hours

Wine: Types; Production of the must and pressing; Fermentation; Maturation; Filtration, clarification and bottling; Special wines; Colouring and flavouring compounds in wine; Quality evaluation and control

Distilled alcoholic beverages: Types; Principle of distillation; Manufacturing of distilled alcoholic beverages like whisky, brandy, rum, gin, vodka, etc.; Flavour and aroma compounds in whisky, rum, brandy, gin and vodka

Transactional Modes:

Mode of transaction shall be Lecture, presentation, Lecture-cum-demonstration, Seminar, discussion etc.

Suggested readings

- B Escher, *Bioanalytical Tools in Water Quality Assessment*. Iwa Publishing (2012).
- JG Woodroof and GF Phillips, *Beverages: Carbonated and Non-Carbonated*. AVI Publication (1974).
- MJ Lewis and TW Young, *Malting and Brewing Science* (1981).
- NN Potter, *Food Science*. CBS Publishers (2007).
- P Quevauviller, *Analytical Methods for Drinking Water*. John Wiley (2006).
- PS Panesar and SS Marwaha, *Biotech in Agriculture and Food Processing*. Taylor and Francis (2013).
- V Vaclavik and CW Elizabeth, *Essentials of Food Science*. Springer (2014).
- Varnam and S Sutherland, *Beverages: Technology, Chemistry and Microbiology*. Chapman and Hall (1994).
- Santini (2019) Case Studies in the Wine Industry, Elsevier
- Mussatto et al. (2011) Production, Composition, and Application of Coffee and Its Industrial Residues. *Food and Bioprocess Technology*, 4, 661-672.

Course Code: FST.543

Course Title: Seminar-I

Total Hours - 15

L	T	P	Cr
0	0	0	1

Learning Outcome:

After the completion of the course students will be able to survey literature, write clear and concise technical reports and communicate concise technical presentation based on constructive criticism effectively.

Transactional Modes:

Mode of transaction shall be Seminar.

Evaluation:

Seminars shall be evaluated as detailed below:

Continuous Assessment

Innovation in idea : 20

Interaction with Supervisor : 20

Attendance : 10

Assessment of end term evaluation

Report : 15 marks

Content : 10 marks

Presentation skills : 15 marks
Responses to queries : 10 marks

Course Code: FST.599
Course Title: Project

L	T	P	Cr
0	0	0	6

Learning Outcome:

- The course completion will develop higher cognitive skills to apply the scientific method to food science problems with quantitative reasoning skills.

Evaluation: Students are required to carry out one project work of 12 credits in III and IV semesters (6 credits in each) as per the course structure.

In the III semester, students shall search the research problem/idea and finalize the tentative outline of the same which shall be evaluated through a presentation to departmental committee

In the IV semester, the project work shall be completed as outlined/planned in the III semester and the project report shall be submitted to the Department before the start of the end semester examination. The report shall be evaluated as per the University rules.

Transactional Modes:

Mode of transaction shall be Demonstration, Dialogue and Discussion, Lecture-cum-demonstration, Experimentation etc.

Criteria of Evaluation:

Continuous Assessment

Continuous reporting : 10 marks
Interaction with Supervisor : 20 marks
Good Laboratory Practices : 20 marks

Assessment of end term evaluation

Report write-up : 30 marks
Report presentation : 20 marks

Course Code: STA.503
Course Title: Statistics for Sciences
Total hours - 30

L	T	P	Cr
2	0	0	2

Learning Outcome:

- The students will be able to apply statistical principles and procedures for solving food science problems.

Unit I

8 Hours

Descriptive Statistics: Meaning, need and importance of statistics. Attributes and variables. Measurement and measurement scales. Collection and tabulation

of data. Diagrammatic representation of frequency distribution: histogram, frequency polygon, frequency curve, ogives, stem and leaf plot, pie chart.

Unit II

8 Hours

Measures: Measures of central tendency, dispersion (including box and whisker plot), skewness and kurtosis. Linear regression and correlation (Karl Pearson's and Spearman's) and residual plots.

Unit III

8 Hours

Random variables and Distributions: Discrete and continuous random variables. Discrete Probability distributions like Binomial, Poisson and continuous distributions like Normal, F and student-t distribution.

Unit IV

8 Hours

Differences between parametric and non-parametric statistics. Confidence interval, Errors, Levels of significance, Hypothesis testing. **Parametric tests:** Test for parameters of Normal population (one sample and two sample problems) z-test, student's t-test, F and chi-square test and Analysis of Variance (ANOVA). **Non-Parametric tests: One sample:** Sign test, signed rank test, Kolmogorov-Smirnov test, run test. Critical difference (CD), Least Significant Difference (LSD), Kruskal-Wallis one-way ANOVA by ranks, Friedman two-way ANOVA by ranks.

Recommended Books:

1. P. L. Meyer, *Introductory Probability and Statistical Applications*, Oxford & IBH Pub, 1975.
2. R. V. Hogg, J. Mckean and A. Craig, *Introduction to Mathematical Statistics*, Macmillan Pub. Co. Inc., 1978.

Suggested Readings:

1. F. E. Croxton and D. J. Cowden, *Applied General Statistics*, 1975.
2. P. G. Hoel, *Introduction to Mathematical Statistics*, 1997.

Transactional Modes:

Mode of transaction shall be Lecture, presentation, Lecture-cum-demonstration, Seminar, discussion etc.

Course Code: FST.571

Course Title: Food Safety, Regulation and Policy

Total hours - 60

L	T	P	Cr
4	0	0	4

Learning Outcome:

The course will enable students:

- To relate quality control with food safety in food industry
- To explain various sensory characteristics and quality attributes of foods of animal and plant origin.
- To make use of sensory analysis principles, cleaning and sanitation in food processing.

- To justify the need of laws applicable in food industry in India to ensure manufacture of safe of food products.
- To organize food safety management and quality control systems for audit and certification.

Unit I

15 Hours

Food safety: Definition; Need; Factors affecting food safety

Concept of quality control: Objectives, importance and functions of quality control; Quality attributes of foods: Size and shape; Colour and gloss; Viscosity and consistency; Texture; Taste; Objective methods for measurement of colour, texture and consistency

Unit II

15 Hours

Methods of quality assessment: fruits and vegetables, cereals and cereal products, dairy product, fats and oils, meat and meat products, poultry and eggs, oils and fats, spices, etc.

Sensory characteristics of food: colour, taste, aroma, texture, Panellist (Types, ideal panellist requirement),

sensory test: Types of sensory test-difference, rating, sensitivity, testing time, design of sensory experiment-evaluation card, testing laboratory, sample preparation,

Unit III

15 Hours

Food laws and regulations: Importance and application of food regulatory system; Food Safety and Standards Act, 2006 (transition from PFA, FPO, MMPO, MFPO); AGMARK; BIS; QCI; Export promotion bodies and inspection council; International Food Regulation/Authorities (WTO, SPS, TBT Bilateral agreement, Codex Alimentarius, ISO)

Unit IV

15 Hours

Food safety management and quality control systems: Total Quality Management; ISO 22000; Quality assurance; GMP; GLP; Sanitary and hygienic practices; HACCP

Food Policy: Corporate Social Responsibility in India; Public Distribution System in India; Policy initiatives by the Government in food processing sector; Agricultural Export Zone of India; Mega Food Park scheme, etc.

Transactional Modes:

Mode of transaction shall be Lecture, Presentation, Lecture-cum-demonstration, Seminar, discussion, etc.

Suggested readings

- A Kramer and BA Twigg, *Quality Control for the Food Industry*. AVI Publishing Company (1990).
- A Vasconcellos, *Quality Assurance for the Food Industry: A Practical Approach*. CRC Press (2003).
- CW Wrigley, *Cereal Grains: Assessing and Managing Quality*. Woodhead Publishing (2015).
- H Lawless, *Quantitative Sensory Analysis: Psychophysics Models and Intelligent Design*. Wiley Blackwell (2013).

- K Kapiris, *Food Quality*. Intech Publisher (2014).
- L Nollet, *Handbook of Food Analysis*. CRC Press (2015).
- M Clute, *Food Industry Quality Control Systems*. CRC Press (2017).
- N Khetarpaul, *Food Analysis*. Daya Publishing House (2016).
- R Marsili, *Flavour Fragrance and Odour Analysis*. CRC Press (2012).
- RC Beier, *Pre-harvest and Postharvest Food Safety*. Wiley India (2016).
- RMS Cruz et al., *Methods in Food Analysis*. CRC Press (2014).
- S Otles, *Methods of Analysis of Food Components and Additives*. CRC Press (2012).
- S Sehgal, *A Laboratory Manual of Food Analysis*. Panima Educational Book (2016).
- Sohrab, *A Practical Guide for Implementation of Integrated ISO-9001 HACCP System for the Food Processing Industry*. Allied Publishers Ltd. (2001).
- Y Motarjemi, *Food Safety Management: A practical Guide for the Food Industry*. Academic Press (2014).
- YC Daniel, *Instruments Methods for Quality Assurance in Foods*. Marcel Dekker Inc (2017).
- Gordon (2016) *Food Safety and Quality Systems in Developing Countries*
- Kiron Prabhakar (2016) *A Practical Guide to Food Laws and Regulations*, Bloombury

Course Code: FST.507

Course Title: Food Packaging

Total Hours-60

L	T	P	Cr
4	0	0	4

Learning Outcome:

The course will make students:

- To explain functions, importance and laws of packaging.
- To classify different packaging material.
- To make use of appropriate packaging material in food industry.
- To give recommendation on the physical and chemical properties, advantages and limitations of different packages.
- To design packages for extending shelf life of different foods.

Unit I

15 Hours

Introduction: Definition; Package environment; Functions of packaging; Importance and scope of packaging; Classification of packages; Labelling laws

Glass as packaging material: Composition; Physical properties of glass; Advantages and disadvantages of glass packaging materials; Types of glass containers; Parts of glass container; Manufacture, annealing and surface treatments

Unit II

15 Hours

Metal packaging materials: Tin plate; Chromium coated steel; Aluminium containers and foil; Corrosion of metal containers; Corrosiveness of foods; Effect of processing on corrosion of cans; External corrosion of cans

Paper and paper-based packaging materials: Manufacture (pulping, digestion, bleaching, beating, refining, paper making and converting); Types of paper; Physical properties of papers; Paper bags; Cartons; CFB boxes, Advantages and disadvantages of paper and paper-based packaging materials

Plastic and plastic-based packaging materials: Classification of polymers; Properties and application of different plastics; Laminates: Types and properties. Coating on paper and films; Types and methods of coating

Unit III

15 Hours

Aseptic packaging: Definition; Reasons of aseptic packaging; Sterilization of packages and food contact surfaces; System of aseptic packaging
Packaging of microwavable foods; Retortable pouch technology

Mechanical and functional tests on packages: Measurement of thickness, weight, water absorption, bursting strength, tear resistance, puncture resistance, OTR, WVTR and tensile strength of packaging materials. Measurement of grease resistance of paper.

Unit IV

15 Hours

Packaging of specific foods: Fruits and vegetables; Dairy products; Cereal products; Snacks; Whole eggs; Meat and meat products; Water; Fruit juices; Beer; Wine; Carbonated beverages

Novel Packaging (antimicrobial food packaging, non-migratory bioactive polymers, active and intelligent packaging).

Transactional Modes:

Mode of transaction shall be Lecture, presentation, Lecture-cum-demonstration, Seminar, discussion etc.

Suggested readings

- Brody A (2017). *Active Packaging for Food Applications*. CRC Press.
- Cha DS & Chinnan M S (2004). *Biopolymer-based antimicrobial packaging: a review. Critical reviews in food science and nutrition*, 44, 223-237.
- Han JH (2014). *Innovations in Food Packaging*. Academic Press.
- *Handbook of Frozen Food Processing and Packaging* Oxford Book Company (2018).
- Kadoya T. (2014). *Food Packaging*. Academic Press.
- Lee DS and Yam KL (2008). *Food Packaging Science and Technology* by. CRC Press Taylor & Francis.
- Omre PK (2016). *Food packaging systems*. Biotech Books.
- Robertson GL (2005). *Food Packaging Principles and Practice*. CRC Press.
- Sanches-Silva A, Costa D, Albuquerque TG et al. (2014). *Trends in the use of natural antioxidants in active food packaging: a review. Food Additives & Contaminants: Part A*, 31, 374-395.
- Yam KL and Lee DS (2015). *Emerging Food Packaging Technologies: Principles and Practice*. Woodhead Publishing.
- Davis G & Song JH (2005) *Biodegradable Packaging Based on Raw materials from crops and Their Impact on Waste Management*. Industrial Crops and Products

Course Code: FST.509
Course Title: Food Packaging-Lab
Total Hours - 30

L	T	P	Cr
0	0	2	1

Learning Outcome:

The completion of this course will make students to:

- Identify packaging materials used commercially in food industry.
- Evaluate different packaging material for physicochemical properties
- Predict the latest trend of packaging system.
- Critically evaluate packaging related problems in food industry.
- Design packages for storage of different types of foods

S. N. Practical

1. Identification of different types of packaging material.
2. Spotting-Packaging symbols.
3. Determination of WVTR in different packaging materials.
4. Determination of Grammage weight of paper.
5. Determination of uniformity and amount of wax coating.
6. Determination of grease resistance of packaging material.
7. Determination of water absorption of paperboard and CFB.
8. To conduct drop test of different packaging material.
9. Determination of tin coating weight and porosity.

Lab practical may be modified depending on the availability of materials and facilities as well as latest advancements.

Transactional Modes:

Mode of transaction shall be Lecture-cum-demonstration, discussion, Experimentation, Problem solving etc.

Evaluation criteria for practical courses:

The course shall be evaluated by Continuous Assessment and End Term Assessment as detailed below

Continuous Assessment

Attendance	: 10 marks
Performance	: 20 marks
Good Laboratory Practices	: 20 marks

End Term Assessment

Report	: 10 marks
Oral viva-voce	: 20 marks
Performance (practical)	: 10 marks
Performance (report/write-up)	: 10 marks

Course code: FST.574
Course Title: Food Quality-Lab
Total hours - 30

L	T	P	Cr
0	0	2	1

Learning Outcome:

The course completion will make students to:

- List various tests for quality analysis of milk, cereals, pulses, fats, egg, etc.
- determine physicochemical properties of different food products.
- Make use of sensory tests for quality evaluation of foods.
- Analyse and evaluate different foods for adulterations.
- Effectively plan quality analysis/testing system in a food industry.

S.N. Practical

1. Test for assessment of quality of milk -estimation and fat and SNF
2. Test for assessment of quality of cereals
 - a) Estimation of Amylose content in rice
 - b) Estimation of gluten content in dough
 - c) Estimation of 1000kernel weight, porosity, bulk density, density, Angle of repose
 - d) Quality and safety of rice-mycotoxins determination
3. Test for assessment of quality of pulses
 - a) Evaluation of cooking quality of legume
 - b) Estimation of 1000-grain weight, porosity, bulk density, density, Angle of repose
4. Test for assessment of quality of fats and oils-physical and chemical parameters.
5. Determination of different components of egg (albumin content, yolk content and shell content)
6. Sensory test - difference test (paired comparison test, duo trio test, triangle test); Rating test -Ranking test, Hedonic test, Single sample difference test, Two sample difference test.

Lab practical may be modified depending on the availability of materials and facilities as well as latest advancements.

Transactional Modes:

Mode of transaction shall be Lecture-cum-demonstration, Dialogue, Discussion, Experimentation, Problem solving etc.

Evaluation criteria for practical courses:

The course shall be evaluated by Continuous Assessment and End Term Assessment as detailed below

Continuous Assessment

Attendance	: 10 marks
Performance	: 20 marks
Good Laboratory Practices	: 20 marks

End Term Assessment

Report	: 10 marks
Oral viva-voce	: 20 marks

Performance (practical) : 10 marks
Performance (report/write-up) : 10 marks

Course Code: FST.577

Course Title: Competitive Exam Preparatory Course

Total hours - 30

L	T	P	Cr
0	2	0	2

Learning Outcome:

- The course will enable students to succeed in various competitive exam by providing information about various tests of national levels.
- The syllabus of various national competitive examinations (e.g. ICAR, FSSAI, FCI, etc) would be discussed with the students.

Transactional Modes:

Mode of transaction shall be Self-learning, Discussion, Brain storming, etc.

Evaluation:

The courses shall be evaluated by Continuous Assessment, Mid Semester Test and End Semester Exams as detailed below

Continuous Assessment

Surprise tests : 25 marks

Mid Semester Test (Objective) : 25 marks

End Semester Exam (Objective) : 50 marks

Course Code: FST.576

Course Title: Analytical Techniques-Principles and Applications

Hours-60

L	T	P	Cr
0	0	4	2

Learning Outcome:

- The completion of this course will develop an expertise in analytical skills on different hi-end equipment utilized in food sector.
- Basics and analytical applications of UV/Vis Spectrophotometer, Atomic Absorption Spectrometer and FTIR in food industry
- Basics and analytical application of chromatographic techniques in food analysis/fractionation
- Principles and applications of viscometers for the determination of viscosity of different foods
- Basics and analytical separation/purification applications of centrifugal equipment in food processing
- Morphological characterization of different food samples

Lab practical may be modified depending on the availability of materials and facilities as well as latest advancements.

Transactional Modes:

Mode of transaction shall be Lecture-cum-demonstration, discussion, Experimentation, Problem solving etc.

Evaluation criteria for practical courses:

The course shall be evaluated by Continuous Assessment and End Term Assessment as detailed below

Continuous Assessment

Attendance : 10 marks

Performance : 20 marks

Good Laboratory Practices : 20 marks

End Term Assessment

Report : 10 marks

Oral viva-voce : 20 marks

Performance (practical) : 10 marks

Performance (report/write-up) : 10 marks

Course Code: FST.544

Course Title: Seminar-II

Total hours - 15

L	T	P	Cr
1	0	0	1

Learning Outcome:

After the completion of the course, students will be able to survey literature, write clear and concise technical reports and communicate concise technical presentation based on constructive criticism effectively.

Transactional Modes:

Mode of transaction shall be Seminar.

Evaluation:

Seminars shall be evaluated as detailed below:

Continuous Assessment

Innovation in idea : 20

Interaction with Supervisor : 20

Attendance : 10

Assessment of end term evaluation

Report : 15 marks

Content : 10 marks

Presentation skills : 15 marks

Responses to queries : 10 marks

Course Code: FST.599
Course Title: Project

L	T	P	Cr
0	0	0	6

Learning Outcome:

- The course completion will develop higher cognitive skills to apply the scientific method to food science problems with quantitative reasoning skills.

Evaluation criteria: Students are required to carry out one project work of 12 credits in III and IV semesters (6 credits in each) as per the course structure. In the III semester, students shall search the research problem/idea and finalize the tentative outline of the same which shall be evaluated through a presentation to committee constituted as per the University rules applicable from time to time. In the IV semester, the project work shall be completed as outlined/planned in the III semester and the project report shall be submitted to the Department before the start of the end semester examination.

Transactional Modes:

Mode of transaction shall be Experimentation, Self-learning, Brain storming.

Criteria of Evaluation:

Continuous Assessment

Continuous reporting : 10 marks

Interaction with Supervisor : 20 marks

Good Laboratory Practices : 20 marks

Assessment of end term evaluation

Report write-up : 30 marks

Report presentation : 20 marks

Course No. FST.515

Course Title: Principles of Food Processing and Preservation

Total hours - 30

L	T	P	Cr
2	0	0	2

Learning Outcome:

The course completion will enable students:

- To explain how different foods are deteriorated and how they can be processed/preserved.
- To apply various processing/preservation techniques to different foods.
- To analyse the effect of various preservation techniques on processed foods
- To develop novel techniques/methods of food preservation and to evaluate their effect on food properties

Unit I

8 Hours

Introduction to Food Processing: Scope of food processing; Classifications of Foods; Causes of Food Deterioration/ Spoilage; Principles of food Preservation

Unit II**7 Hours**

Prevention of Food Deterioration: Processing and preservation by heat: Microwave heating, etc. Processing and preservation by low temperature (refrigeration/freezing); Processing and preservation by drying and dehydration

Unit III**7 Hours**

Concept of quality control: Objectives, importance and functions of quality control

Quality attributes of foods: Size and shape; Colour and gloss; Viscosity and consistency; Texture; Taste; Objective methods for measurement of colour, texture and consistency

Unit IV**8 Hours**

Food safety and management: Hazards in Foods; Total Quality Management; Quality assurance; GMP; GLP; Sanitary and hygienic practices; HACCP; Export import policy

Transactional Modes:

Mode of transaction shall be Lecture, Presentation, Lecture-cum-demonstration, Seminar, Discussion, Dialogue, etc.

Suggested readings

- A Kramer and BA Twigg, *Quality Control for the Food Industry*. AVI Publishing Company (1990).
- A Vasconcellos, *Quality Assurance for the Food Industry: A Practical Approach*. CRC Press.
- K Kapisris, *Food Quality*. Intech Publisher (2014).
- NN Potter, *Food Science*. CBS Publishers (2007).
- M Clute, *Food Industry Quality Control Systems*. CRC Press (2017).
- RC Beier, *Pre-harvest and Postharvest Food Safety*. Wiley India (2016).
- Sohrab, *A Practical Guide for Implementation of Integrated ISO-9001 HACCP System for the Food Processing Industry*. Allied Publishers Ltd. (2001).
- Y Motarjemi, *Food Safety Management: A practical Guide for the Food Industry*. Academic Press (2014).

Course No. FST.529**Course Title: Introduction to Nutrition and Specialty Foods****Total hours - 30**

L	T	P	Cr
2	0	0	2

Learning Outcome:

The course completion will make students enable to:

- To explain the terms important in nutrition science and to explain what are nutraceuticals and functional foods
- To compare various constituents of foods for their nutraceutical and bioactive properties.
- To compare therapeutic and speciality foods.

- To formulate and recommend diets for reducing the risk of chronic diseases.

Unit I

8 Hours

Introduction: Definitions (food, diet, nutrients, nutrition, adequate/good nutrition, nutritional status, malnutrition, nutritional care, health); Functions of food; Food types and groups; Concept of balanced diet; Nutraceutical components in foods

Nutrition values of food constituents - Carbohydrates, proteins, lipids, minerals and vitamins

Unit II

7 Hours

Therapeutic nutrition; Foods and diets recommended and restricted in blood, circulatory and cardiac diseases, coeliac disease, diabetes and obesity

Introduction to speciality foods: Specialty foods for gluten and lactose intolerants, heart patients and obese people and their potential in India viz a viz developed world

Unit III

7 Hours

Disorders & Diseases: Types of lactose intolerance; Symptoms; Causes; Prevalence; Approaches for preparation of low lactose and lactose-free milk products- Probiotic and non-probiotic techniques

Types, symptoms, causes and prevalence of gluten intolerance and coeliac disease; Approaches for preparation of gluten-free baked foods; Allowed and restricted ingredients; Gluten-free labelling

Unit IV

8 Hours

Prevalence and risk factors: Coronary heart diseases; Diet and coronary heart diseases relationship; Probiotics, prebiotics and role of omega 3 fatty acids in their prevention. Prevalence and causes of obesity; measurement of obesity - body mass index (BMI); Dietary and non-dietary approaches for treatment of severe obesity (VLCD and Gastroplasty); Natural and synthetic non-nutritive sweeteners

Transactional Modes:

Mode of transaction shall be Lecture, presentation, Lecture-cum-demonstration, Seminar, discussion etc.

Suggested readings

- G Subbulakshmi, *Functional Foods and Nutrition*, Daya Publishing House (2014).
- GR. Gibson and CM. Williams, *Functional Foods: Concept to Product*. Woodhead Publishing (2000).
- M. Swaminathan, *Essentials of Food and Nutrition*, Volumes 1-2. Ganesh Publisher (1974).
- NN Potter, *Food Science*. CBS Publishers (2007).
- S Riar et al., *Functional Foods and Nutraceuticals: Sources and Their Developmental Techniques*. New India Publishing Agency (2015).
- Y Zhao, *Specialty Foods: Processing Technology, Quality and Safety*. CRC Press (2012).

Course Code: VAC
Course Title: Nutrition and Specialty Foods
Total Hours - 15

L	T	P	Cr
1	0	0	1

Learning Outcome:

The course completion will make students:

- To explain terms important in nutrition science
- To compare various constituents of foods for nutritional properties.
- To compare therapeutic and speciality foods.
- To formulate and recommend diets for reducing the risk of chronic diseases.

Unit I **4 Hours**

Introduction: Definitions (food, diet, nutrients, nutrition, adequate/good nutrition, nutritional status, malnutrition, nutritional care, health, nutraceuticals, functional foods and dietary supplements); Functions of food; Food types and groups; Concept of balanced diet

Unit II **4 Hours**

Nutrition: Nutritional requirements during life cycle: Nutritional requirements and RDA for infants, school children, adolescents, pregnant and lactating mother and elderly people;

Alcoholism and nutrition: Nutritional problem among alcoholics.

Unit III **3 Hours**

Therapeutic nutrition: Foods and diets recommended and restricted in blood, circulatory and cardiac diseases, diabetes and obesity.

Introduction to speciality foods: Specialty foods for gluten and lactose intolerants, heart patients and obese people and their potential in India viz a viz developed world

Unit IV **4 Hours**

Disorders & Diseases: Types of lactose intolerance; Symptoms; Causes; Prevalence; Approaches for preparation of low lactose and lactose-free milk products-Probiotic and non-probiotic techniques; coeliac disease

Transactional Modes:

Mode of transaction shall be Lecture, presentation, Lecture-cum-demonstration, Seminar, discussion etc.

Suggested readings

- C Galanakis, *Nutraceutical and Functional Food Components: Effects of Innovative Processing Techniques*. Academic Press (2017).
- EC Robert, *Handbook of Nutraceuticals and Functional Foods*. CRC Press (2006).
- G Subbulakshmi, *Functional Foods and Nutrition*, Daya Publishing House (2014).
- GR Gibson and CM Williams, *Functional Foods: Concept to Product*.

- Woodhead Publishing (2000).
- H Dominguez *Functional Ingredients from Algae for Foods and Nutraceuticals*. Woodhead Publishing (2013).
 - J Boye, *Nutraceutical and Functional Food Processing Technology*. Wiley Blackwell (2015).
 - J Gilbert, *Bioactive Compounds in Foods*. Wiley India (2014).
 - J Shi, *Functional Food Ingredients and Nutraceuticals: Processing Technologies*. CRC Press (2006).
 - M Saarela, *Functional Foods: Concept to Product*. Woodhead Publishing (2014).
 - M. Swaminathan, *Essentials of Food and Nutrition*, Volumes 1-2. Ganesh Publisher (1974).
 - NN Potter, *Food Science*. CBS Publishers (2007).
 - RR Watson, *Fruits Vegetables and Herbs: Bioactive Foods in Health Promotion*. Academic Press, (2016).
 - S Riar et al., *Functional Foods and Nutraceuticals: Sources and Their Developmental Techniques*. New India publishing agency (2015).
 - Subbulakshmi S and Subhadra M, *Nutrition in Traditional Therapeutic Foods*. Daya Publishing House (2015).
 - V Vaclavik and CW Elizabeth, *Essentials of Food Science*. Springer (2014).
 - Y Zhao, *Specialty Foods: Processing Technology, Quality and Safety*. CRC Press (2012).

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