

CENTRAL UNIVERSITY OF PUNJAB, BATHINDA



M. Sc. Food Science and Technology

Session 2021-23

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

Graduate attributes

The graduates of the Master of Science in Food Science and Technology will acquire the following:

Context of Society

The students of this course will understand the significant role of food science, processing, preservation, nutrition and quality in the broader societal context. There will be an understanding of the basics of professional ethics, research ethics and food-safety related issues.

Enterprising

The course content will train learners and develop skills of processing of cereals, legumes, fruits and vegetables, milk products, etc. This will enhance employability in the field of food processing and preservation. The programme will enable students to get adopted in the area of food science as technical personals (e.g. production officers/executives, quality assurance executives, technical officers, analysts, etc.).

Research Aptitude

The learners will be able to study and learn the effective use of research tools to support academic writing, reference management and independent study using digital resources and learning materials. This will help them to learn solving food science and industrial research problems and explore relevant research areas.

Course Structure

Semester I						
Course Code	Course Title	Type of course	Hours			Credits
			L	T	P	
FST.506	Food Chemistry	Core	3	0	0	3
FST.521	Food Processing and Preservation	Core	3	0	0	3
FST.507	Food Packaging	Core	3	0	0	3
FST.508	Food Chemistry - Practical	Skill-based	0	0	4	2
XXX	Interdisciplinary Course	IDC	2	0	0	2
CST.501	Computer Applications	Compulsory foundation	2	0	0	2
CST.502	Computer Applications - Practical	Skill-based (CF)	0	0	4	2
STA.503	Statistics for Sciences	Compulsory foundation	2	0	0	2
Students to opt for any one of following discipline elective courses						
FST.573	Technology of Spices, Sugar and Chocolate	Discipline elective	3	0	0	3
FST.513	Food Microbiology	Discipline elective	3	0	0	
FST.523	Food Engineering and Unit Operations	Discipline elective	3	0	0	
Total credits						22

Semester II						
Course Code	Course Title	Type of course	Hours			Credits
			L	T	P	
FST.522	Processing of Cereals and Pseudocereals	Core	3	0	0	3
FST.524	Processing of Fruits and Vegetables	Core	3	0	0	3

FST.552	Application of Enzymes in Food Processing	Core	3	0	0	3
FST.511	Nutrition, Nutraceutical and Functional Foods	Core	3	0	0	3
FST.525	Cereals and Pseudocereals Processing - Practical	Skill-based	0	0	4	2
FST.527	Fruits and Vegetable Processing - Practical	Skill-based	0	0	4	2
ABM.529	Agripreneurship Development	Entrepreneurship course	1	0	0	1
XXX	Value added course	Value-added	2	0	0	2
Students to opt for any one of following discipline elective courses						
FST.510	Food Biotechnology	Discipline elective	3	0	0	3
FST.572	Poultry and Meat Processing	Discipline elective	3	0	0	
FST.530	Food Additives and Toxins	Discipline elective	3	0	0	
Total						22
Value-added course to be offered by the Department						
FST.504	Nutrition and Specialty Foods	Value-added	2	0	0	2

Semester III						
Course Code	Course Title	Type of course	Hours			Credits
			L	T	P	
FST.555	Processing of Legumes and Oilseeds	Core	3	0	0	3
FST.551	Processing of Milk and Milk Products	Core	3	0	0	3
FST.571	Food Safety, Regulation and Policy	Core	3	0	0	3
FST.553	Milk and Milk Processing-Practical	Skill-based	0	0	4	2
FST.574	Food Quality-Practical	Skill-based	0	0	4	2
FST.577	Competitive Exam Preparatory Course	Discipline enrichment	2	0	0	2
Students to opt for any one of following discipline elective courses						
FST.528	Fermented Foods	Discipline elective	3	0	0	3
FST.529	Beverage Technology	Discipline elective	3	0	0	
FST.554	Food Hygiene, By-Products and Waste Management	Discipline elective	3	0	0	
FST.600	Research Proposal	Skill-based	0	0	8	4
Total						22

Semester IV						
Course Code	Course Title	Type of course	Hours			Credits
			L	T	P	
FST.600	Dissertation	Skill-based	0	0	40	20
Total						20

Total Credits = 22 + 22 + 22 + 20 = 86

Credit distribution

Semester	Core courses	Elective Courses			Foundation Courses	
		DE	ID	SB	CF	EF/VB
I	03 (9 Cr)	01 (3 Cr)	01 (2 Cr)	01 (2 Cr)	03 (6 Cr)	--
II	04 (12 Cr)	01 (3 Cr)	--	02 (4 Cr)	--	01 (2 Cr)
III	03 (9 Cr)	01 (3 Cr)	--	02 (4 Cr) 01 (4 Cr: Research Proposal)	01 (2 Cr) 01 (1 Cr)	--
IV	--	--	--	01 (20 Cr: Dissertation)	--	
Credits	30	9	2	34	9	2
Total						86

DE: Discipline Elective; **ID:** Interdisciplinary; **SB:** Skill-based; **CF:** Compulsory foundation (DEC-Discipline Enrichment; ENT-Entrepreneurship); **EF:** Elective foundation; **VB:** Value-based

Evaluation criteria

	Core, Discipline Elective, Compulsory Foundation, Value Added and Interdisciplinary Courses		Discipline Enrichment Course		Entrepreneurship Course	
	Marks	Evaluation	Marks	Evaluation	Marks	Evaluation
Internal Assessment	25	Various	-	-	-	-
Mid-semester test (MST)	25	Subjective	50	Objective	25	Objective
End-semester test (EST)	50	Subjective (70%) Objective (30%)	50	Objective	25	Subjective

Dissertation (Fourth Semester)		
	Marks	Evaluation
Supervisor	50	Continuous assessment (regularity in work, mid-term evaluation) dissertation report, presentation, final viva-voce
External expert, HoD and senior-most faculty of the department	50	Dissertation report (30), presentation (10), final viva-voce (10)

Evaluation pattern similar to fourth semester dissertation will apply for internship where supervisor will award 50% marks and external co-supervisor, HoD and senior-most faculty will award 50% marks.

Skill-based (practical) courses shall be evaluated by Continuous Assessment and End Term Assessment as detailed below:

- Continuous Assessment (Attendance: 10 marks; Day to day performance: 40 marks)
- End Term Assessment (Report: 10 marks; Oral viva-voce: 20 marks; Performance: 20 marks)

L	T	P	Cr
3	0	0	3

Course Code: FST.506

Course Title: Food Chemistry

Total Hours - 45

Learning Outcome:

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

11 Hours

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

Carbohydrates: Classification; Occurrence; Properties and application of important polysaccharides such as starch, cellulose, guar gum, xanthan gum, pectin, etc.; Cellulose and derivatives (MCC, CMC, MC and HPMC); Starch digestibility and Glycaemic Index

Unit II

11 Hours

Proteins: Classification; Physicochemical properties of proteins; Protein structure; Forces involved in stability of protein structure; Denaturation; Functional properties; Methods of protein analysis; Protein quality and its evaluation

Unit III

11 Hours

Lipids: Classification; Functions of lipids (fat/oils) in foods; Flavour defects in lipids; Role of fats in human nutrition; Health problems associated with fats; Trans fats; Recommendations for fat intake; Non-food applications of oils and fats

Unit IV

12 Hours

Vitamins and minerals: Sources, requirements, functions stability and toxicity of vitamins; General functions of minerals; Specific functions and requirements of Ca, P, Mg, Fe, Cu, Zn, Se, etc.

Colour of foods: Chlorophylls, curcumin, betalains, carotenoids, phenolic pigments etc.; Enzymatic and Non-enzymatic browning in foods.

Transactional Modes:

Mode of transaction shall be Lecture, presentation, Dialogue, google forms/docs, Lecture-cum-demonstration, Seminar, discussion, e-content, etc.

Internal assessment shall be through any of the following:

Surprise Tests, one sentence summary, case analysis, simulated problem solving, open book techniques, classroom assignments, homework assignments, term paper, presentations, Kahoot, Padlet, one sentence summary, student generated questions and discussions.

Suggested readings

- FA Aladedunye and R Przybylski, Degradation and nutritional quality changes of oil during frying. Journal of the American Oil Chemists' Society, 86, 149-156 (2009).
- FSSAI, Manuals published by Food Safety and Standard Authority, GOI (2016).

- HK Chopra and PS Penesar, Food Chemistry. Narosa Publication (2010).
- J Cmolika and J Pokorny, Physical refining of edible oils. European Journal of Lipid Science and Technology, 102, 472-486 (2000).
- J Hettiarachchy, Food Proteins and Peptides. CRC Press (2012).
- J Velisek, The Chemistry of Food. Wiley Blackwell (2014).
- K Owusu, Introduction to Food Chemistry. CRC Press (2015).
- MM Chakraborty, Chemistry and Technology of Oils and Fats. Prentice Hall (2003).
- P Cheung, Handbook of Food Chemistry. Springer Science (2015).
- S Bemiller, Carbohydrate Chemistry for Food Scientists, Woodhead Publications (2019).
- S Damodaran and KL Parkin, Fennema's Food Chemistry. CRC Press (2017).
- S Kumari, Basics of Food Biochemistry and Microbiology. Koros Press (2012).
- SCM Teresa, Starches for Food Application: Chemical Technological and Health Properties, Academic Press (2019).
- TAM Msagati, Chemistry of Food Additives and Preservatives. John Wiley and Sons (2013).
- Z Ustunol, Applied Food Protein Chemistry. John Wiley and Sons (2015).

L	T	P	Cr
3	0	0	3

Course Code: FST.521

Course Title: Food Processing and Preservation

Total Hours - 45

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 analyze 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

12 Hours

Introduction: Status of food processing - India *vs* developed world; Principles of food preservation; Causes of food deterioration; Water activity and its relation with food spoilage

Processing and preservation by heat: Heat resistance of microorganisms; Protective effect of food constituents; Blanching; Pasteurization; Sterilization and UHT processing; Effect on foods

Unit II

11 Hours

Processing and preservation by low temperature: Refrigeration vs Freezing; Refrigeration system; Freezing curve; Factors affecting freezing rate; Freezing methods and equipment; Effects on foods

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

Unit III

12 Hours

Novel and emerging technologies for food preservation: High pressure processing; Pulsed electric field; Hurdle technology; Ozone application; Ohmic heating; Microwave

heating; Technologies for sous-vide ready meals; Membrane technology - RO, NF, UF, MF and Electrodialysis; Membrane materials, Configuration and modules

Unit IV

10 Hours

Concentration: Methods; Equipment; Changes in Food during concentration

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

Transactional Modes:

Mode of transaction shall be Lecture, presentation, Dialogue, google forms/docs, Lecture-cum-demonstration, Seminar, discussion, e-content, etc.

Internal assessment shall be through any of the following:

Surprise Tests, one sentence summary, case analysis, simulated problem solving, open book techniques, classroom assignments, homework assignments, term paper, presentations, Kahoot, Padlet, one sentence summary, student generated questions and discussions.

Suggested readings

- AK Haghi, Food Science: Research and Technology. Academic Press (2011).
- D Singh, Food Processing and Preservation. Shree Publisher (2015).
- DW Sun (2020) Thermal food processing new technology and quality issues, CRC Press.
- F Chemat, Green Food Processing Techniques: Preservation Transformation and Extraction, Academic Press (2019).
- G Saravakos and AK Kostaropoulos, Handbook of Food Process Equipment. Springer (2016).
- GV Barbosa-canovas and Gould GW, Innovation in Food Processing. CRC Press (2017).
- HS Ramaswamy and M Marcotte, Food Processing Principle and Application. Taylor and Francis (2006).
- HW Xiao et al., Recent developments and trends in thermal blanching - A comprehensive review. Information Processing in Agriculture. Volume 4, 101-127 (2017).
- J Boye, Green Technology in Food Production, CRC Press (2012).
- J. Ahmed, Novel Food Processing, CRC Press (2018).
- JS Smith and YH Hui, Food Processing. Wiley (2014).
- K Kai, Innovative Food Processing Technologies. WP Publisher (2016).
- M Regier, The Microwave Processing of Foods. Academic Press, (2017).
- MC Knirsch (2010) Ohmic heating—a review. Trends in Food Science & Technology, 21, 436-441.
- NN Potter, Food Science. CBS Publishers (2007).
- P Fellows, Food Processing Technology Principles and Practice. CRC Press (2005).
- P Putnik, JM Lorenzo, FJ Barba et al., Novel food processing and extraction technologies of high-added value compounds from plant materials. Foods, 7(7), 106 (2018).
- RL Shewfelt, Introducing Food Science. CRC (2013).
- S Edelstein, Food Science, Jones & Bartlett Learning (2018).
- T Varzakas and C Tzia, Handbook of Food Processing. CRC Press (2016).

Course Code: FST.507

Course Title: Food Packaging

L	T	P	Cr
3	0	0	3

Total Hours - 45

Learning Outcome:

The course will make students:

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

Unit I

12 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

11 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

Unit III

11 Hours

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

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

Unit IV

11 Hours

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.

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, Dialogue, google forms/docs, Lecture-cum-demonstration, Seminar, discussion, e-content, etc.

Internal assessment shall be through any of the following:

Surprise Tests, one sentence summary, case analysis, simulated problem solving, open book techniques, classroom assignments, homework assignments, term paper, presentations, Kahoot, Padlet, one sentence summary, student generated questions and discussions.

Suggested readings

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

L	T	P	Cr
0	0	4	2

Course Code: FST.508

Course Title: Food Chemistry - Practical

Total Hours-60

Learning Outcome:

The course will enable students:

- To apply the laboratory practices important in basic and applied food chemistry 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.N. 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 of leafy vegetables.
4. Determination of protein content using Kjeldahl, direct absorption and Lowry's/Bradford's 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 of fruits using dye method.
8. Determination of sugar content of foods.
9. Determination of total phenolic content and antioxidant activities of plant foods.
10. Determination of oil stability using Rancimat.
11. Study methods for eliminating enzymatic browning of fruits and vegetables
12. Determination of refractive index of liquid foods.

Transactional Modes:

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

Course Code: CST.501

L	T	P	Cr
2	0	0	2

Course Title: Computer Applications

Total Hours - 30

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.

Unit IV

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

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

Suggested Readings:

- A Goel and SK Ray, Computers: Basics and Applications. Pearson Education India (2012).
- PK Sinha, Computer Fundamentals. BPB Publications.

Web references

- Microsoft Office Professional 2013 Step by Step
<https://ptgmedia.pearsoncmg.com/images/9780735669413/samplepages/9780735669413.pdf>

Transactional Modes:

- PPT, Video, e-content, google drive

Internal assessment shall be through any of the following:

Surprise Tests, one sentence summary, case analysis, simulated problem solving, open book techniques, classroom assignments, homework assignments, term paper, presentations, Kahoot, Padlet, one sentence summary, student generated questions and discussions.

L	T	P	Cr
0	0	4	2

Course Code: CST.502

Course Title: Computer Applications - Lab

Total hours: 60

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

Course Code: STA.503

L	T	P	Cr
2	0	0	2

Course Title: Statistics for Sciences

Total hours - 32

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, Kolmogrov- 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:

- PL Meyer, Introductory Probability and Statistical Applications, Oxford & IBH Pub (1975).
- RV Hogg, J. Mckean and A. Craig, Introduction to Mathematical Statistics, Macmillan Pub. Co. Inc. (1978).

Suggested Readings:

- FE Croxton and D J Cowden, Applied General Statistics (1975).
- PG Hoel, Introduction to Mathematical Statistics (1997).

Transactional Modes:

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

Internal assessment shall be through any of the following:

Surprise Tests, one sentence summary, case analysis, simulated problem solving, open book techniques, classroom assignments, homework assignments, term paper, presentations, Kahoot, Padlet, one sentence summary, student generated questions and discussions.

Course Code: FST.573

Course Title: Technology of Spices, Sugar and Chocolate

L	T	P	Cr
3	0	0	3

Total hours - 45

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 analyze 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

12 Hours

Introduction to spice processing: Classification; Composition; Health benefits; Forms, functions and applications of spices; Processing of major spices (black pepper, small cardamom, ginger, chilli, turmeric, etc.); Processing of white pepper; Technology of onion, ginger and garlic pastes and powders

Unit II**11 Hours**

Spice products: 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

Unit III**11 Hours**

Cane sugar technology: Production; Trade; Composition of cane and cane juice; Manufacturing of sugar (process and equipment); Deterioration of sugar during storage and its prevention; By-products of sugar industry and their utilization

Unit IV**11 Hours**

Chocolate processing: History; Cocoa beans and production; Ingredients in chocolate; 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, Dialogue, google forms/docs, Lecture-cum-demonstration, Seminar, discussion, e-content, etc.

Internal assessment shall be through any of the following:

Surprise Tests, one sentence summary, case analysis, simulated problem solving, open book techniques, classroom assignments, homework assignments, term paper, presentations, Kahoot, Padlet, one sentence summary, student generated questions and discussions.

Suggested readings

- A Chakraverty et al., Handbook of Postharvest Technology, Marcel Dekker (2003).
- DA Patil, Spices and Condiments: Origin, History and Applications. Astral Publishing House (2013).
- JG Woodroof et al., Hand Book of Sugars for Processors, Chemists and Technologists. AVI Publication (1973).
- K Husnu Can Baser and G Buchbauer, Handbook of Essential Oils: Science, Technology, and Applications. CRC Press (2016).
- KV Peter, Handbook of Herbs and Spices, CRC Press (2000).
- NN Potter, Food Science. CBS Publishers (2007).
- R Lees and B Jackson, Sugar Confectionery and Chocolate Manufacture. Blackie Academic and Professional (1992).
- S Raghavan, Handbook of Spices, Seasonings and Flavorings. CRC Press (2007).
- S. Balasubramanian, Roselin, P., Singh, K. K., Zachariah, J., & Saxena, S. N. (2016). Postharvest processing and benefits of black pepper, coriander, cinnamon, fenugreek, and turmeric spices. Critical reviews in food science and nutrition, 56(10), 1585-1607.
- V Vaclavik and CW Elizabeth, Essentials of Food Science. Springer (2014).
- VB Singh, Spices. New Age International (2008).
- X Teng, M Zhang and S Devahastin, New developments on ultrasound-assisted processing and flavor detection of spices: A review. Ultrasonics Sonochemistry, Volume 55, Pages 297-307 (2019).

L	T	P	Cr
3	0	0	3

Course Code: FST.513
Course Title: Food Microbiology
Total Hours - 45

Learning Outcome:

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

- Identify the microbiology of food and dairy products
- Explain the food spoilage and preservation methods.
- Propose the industrial aspect of dairy microbiology.
- Provide solution for pathogenic and spoilage microorganisms associated with different foods and their commercial importance.

Unit I

11 Hours

Microbiology of Food: Microbial habitat of specific food materials, adaptations and changes in microbiome of vegetables, fruits, milk, fermented and non-fermented milk products, fresh meats, poultry and non-dairy fermented foods.

Microbial spoilage of foods: Types and causes of spoilage of cereals and cereals products, spoilage of vegetables and fruits, spoilage of meat and meat products, spoilage of fish and other sea foods, spoilage of eggs and other poultry products, spoilage of milk and milk products.

Unit II

13 Hours

Microbial Growth in Food: Intrinsic, extrinsic and implicit factors, Microbial interactions, Inorganic, organic and antibiotic additives. Physical and chemical factors influencing the destruction of microorganisms including thermal death time, Z, F and D values. Food Borne Diseases: Importance and significance of microorganisms in food. Food borne diseases- Bacterial food borne diseases-(*Staphylococcal intoxication, Botulism, Salmonellosis, Shigellosis, EHEC E. coli infection, Listeria monocytogens infection, Clostridium perfringens gastroenteritis, Bacillus cereus gastroenteritis*; Food-borne fungi-*Mycotoxins* in foods and its implication on crops.

Unit III

11 Hours

Fermented and Dairy Food Products: Microorganisms involved in food fermentations. Starter cultures for fermented dairy products (*Streptococcus thermophilus, Lactobacillus bulgaricus*). Fermented milk products- Acidophilus and Bulgarian milk, yoghurt, cheese, Kefir, Koumiss; Fermented grains and vegetable products - Sauerkraut, Soy sauce, Tempeh, Miso, and Kimchi; Single cell protein, Role of microorganisms in beverages - tea and coffee fermentations. Vinegar Fermentation. Prebiotic and Probiotics in foods and its benefits.

Unit IV

10 Hours

Food Preservation and Safety: Use of High and low temperature, Control of water activity, Use of Radiations in preservation, Modified atmosphere packaging, High pressure processing, chemical preservatives and naturally occurring antimicrobials; Bacteriocins and their applications. Microbial testing of food, Microbiological quality standards of food and regulatory bodies: FDA (Food and Drug Administration), HACCP (Hazard Analysis and critical control points), FSSAI (Food Safety and Standards Authority of India).

Transactional Modes:

Mode of transaction shall be Lecture, presentation, Dialogue, google forms/docs, Lecture-cum-demonstration, Seminar, discussion, e-content, etc.

Internal assessment shall be through any of the following:

Surprise Tests, one sentence summary, case analysis, simulated problem solving, open book techniques, classroom assignments, homework assignments, term paper,

presentations, Kahoot, Padlet, one sentence summary, student generated questions and discussions.

Suggested readings

- JM Jay, Modern Food Microbiology (7th edition). Golden Food Science Text Series (2005).
- MJ Pelczar and J Michael, Microbiology. McGraw-Hill (1999).
- MP Doyle and RL Buchanan, Food Microbiology: Fundamentals and Frontiers. ASM press (2007).
- MR Adams et al., Food Microbiology. RSC (2016).
- N Garg, Laboratory Manual of Food Microbiology. I.K. International Publishing House (2013).
- S Kumari, Basics of Food Biochemistry and Microbiology. Koros Press (2012).
- TJ Montville et al., Food Microbiology: An introduction. ASM press (2012).
- WC Frazier and DC Weshoff, Food Microbiology (5th edition). Mcgraw-Hill (2015).
- WM Foster, Food Microbiology. CBS Publishers (2016).

L	T	P	Cr
3	0	0	3

Course Code: FST.523

Course Title: Food Engineering and Unit Operations

Total Hours - 45

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

11 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; 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

Unit II

12 hours

Raw material preparation: Cleaning; Sorting; Grading; Peeling

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 and filtration: Definitions; Types of screens; Factors affecting screening; Types

of filtration (pressure filtration, vacuum filtration and centrifugal filtration); Filtration methods (bed filters, plate and frame filters, leaf filters, continuous rotary filters).

Unit III

10 hours

Heat transfer in food processing: 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

12 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).

Transactional Modes:

Mode of transaction shall be Lecture, presentation, Dialogue, google forms/docs, Lecture-cum-demonstration, Seminar, discussion, e-content, etc.

Internal assessment shall be through any of the following:

Surprise Tests, one sentence summary, case analysis, simulated problem solving, open book techniques, classroom assignments, homework assignments, term paper, presentations, Kahoot, Padlet, one sentence summary, student generated questions and discussions.

Suggested readings

- A Chakraverty and RP Singh, Postharvest Technology and Food Process Engineering. CRC Press (2014)
- DR Heldman and DB Lund, Handbook of Food Engineering. CRC (2017).
- G Saravakos and AK Kostaropoulos, Hand Book of Food Process Equipment. Springer (2002).
- J Brennan, Food Processing Handbook. Wiley (2006)
- K Marwaha, Food Process Engineering: Theory and Laboratory Experiments. Genetech Books (2015).
- L Mathur, Food Science Engineering and Technology. SBS Publisher (2016).
- LJ Callisto, Essentials in Food and Control Engineering. Reference New York (2015).
- McCabe et al, Unit Operations of Chemical Engineering. McGraw-Hill (2014).
- RP Singh and DR Heldmann, Introduction to Food Engineering (4th edition). Academic Press (2009).
- RT Toledo, Fundamentals of Food Process Engineering. CBS Publisher (1993).
- Z Berk, Food Process Engineering and Technology. Elsevier (2013).
- M Nehra, Dictionary of Terms in Food Science and Technology, The Readers Paradise (2019).

2	0	0	2
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Course Code: FST.504

Course Title: Nutrition and Specialty Foods (Value-added)

Total Hours - 30

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

7 Hours

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

Unit II

7 Hours

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

Unit III

8 Hours

Therapeutic nutrition: Foods and diets recommended and restricted in cancers, coronary artery diseases, diabetes and obesity.

Introduction to specialty 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

8 Hours

Disorders and 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, Dialogue, google forms/docs, Lecture-cum-demonstration, Seminar, discussion, e-content, etc.

Internal assessment shall be through any of the following:

Surprise Tests, one sentence summary, case analysis, simulated problem solving, open book techniques, classroom assignments, homework assignments, term paper, presentations, Kahoot, Padlet, one sentence summary, student generated questions and discussions.

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 echnologies. 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).
- 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).
- S Subbulakshmi and M Subhadra, 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).

L	T	P	Cr
3	0	0	3

Course Code: FST.522

Course Title: Processing of Cereals and Pseudocereals

Total Hours - 45

Learning Outcome:

The completion of this course will enable learners:

- To relate chemical composition of cereals and pseudocereals with their structure.
- To compare different cereals and pseudocereals for their processing and applications in food industry.
- To effectively analyze functionality of cereals in traditional and novel foods.
- To develop / design technologies / processing methods for producing value-added cereal/pseudocereal-based products.

Unit I

11 Hours

Introduction: Production, composition, structure and general usage of major cereals (wheat, rice, maize, barley, oats and millets)

Wheat milling: Classification of wheat; Cleaning; Conditioning; Roller milling; Air fractionation of flours; Flour treatment; Quality tests for analysis of wheat flour.

Durum wheat and pasta processing: Milling of durum wheat; Processing of fresh and dry pasta (Ingredients and production); Composition and nutritive value of pasta products

Unit II

12 Hours

Technology of bakery products: Bakery ingredients and their roles in bakery products; Rheological analysis of flour and dough (farinograph, mixograph, extensiograph, alveograph, pasting profile, etc.); Yeast fermentation tests (fermentograph, rheofermentometer, maturograph, etc.); Manufacturing of bakery products; Biochemical changes during bread making.

Chapatti-making properties: Milling; Chapatti making properties of wheat meal and quality analysis of chapatti

Unit III

11 Hours

Rice: Rice quality and grading; Changes during aging of rice; Accelerated aging; Milling; Parboiling (Methods, advantages and disadvantages and changes during parboiling); Technology of quick cooking rice and sake.

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; Processing of rolled oats; Health benefits of oats and beta glucan

Millets: Types; Nutritive value and processing

Unit IV

11 Hours

Pseudocereals: Origin, production, utilization, structure and composition of common pseudocereals (buckwheat, quinoa and amaranth); Carbohydrates, proteins and lipids of pseudocereals; Food usages of whole pseudocereals; Milling; Nutritional and health implications of pseudocereal intake.

Transactional Modes:

Mode of transaction shall be Lecture, presentation, Dialogue, google forms/docs, Lecture-cum-demonstration, Seminar, discussion, e-content, etc.

Internal assessment shall be through any of the following:

Surprise Tests, one sentence summary, case analysis, simulated problem solving, open book techniques, classroom assignments, homework assignments, term paper, presentations, Kahoot, Padlet, one sentence summary, student generated questions and discussions.

Suggested readings

- A Chakraverty and RP Singh, Postharvest Technology and Food Process Engineering. CRC Press (2014)
- A Chakraverty et al., Handbook of Postharvest Technology. Marcel Dekker (2003).
- BO Juliano, Rice: Chemistry and Technology. AACC (1985).
- CM Haros and R Schoenlechner, Pseudocereals: chemistry and technology. John Wiley & Sons (2017).
- CW Wrigley, Cereal Grains: Assessing and Managing Quality. Woodhead Publishing (2015).
- H Cornell and AW Hoveling, Wheat: chemistry and utilization. CRC press (2020).
- K Khan, Wheat: Chemistry and Technology. Elsevier (2016).
- KA Rosentrater and AD Evers, Kent's technology of cereals: An introduction for students of food science and agriculture. Woodhead Publishing. PS Belton, Physical chemistry of Foods. (2017).
- M. Sissons. Durum wheat chemistry and technology. Academic Press (2016).
- S Bemiller (2019) Carbohydrate Chemistry for Food Scientists, Woodhead Publications
- S Clerici and M Teresa, Starches for Food Application: Chemical Technological and Health Properties, Academic Press (2019).
- SA Watsan and PE Ramsat, Corn: Chemistry and Technology, AACC (1987).
- Shevkani, K. et al., Wheat Starch production, structure, functionality, and applications-a review. International Journal of Food Science and Technology, 52, 38-58 (2017).
- T BetaCereal Grain-Based Functional Foods, Royal Society of Chemistry (2019).

L	T	P	Cr
3	0	0	3

Course Code: FST.524

Course Title: Processing of Fruits and Vegetables

Total Hours - 45

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**12 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**11 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**11 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**11 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, Dialogue, google forms/docs, Lecture-cum-demonstration, Seminar, discussion, e-content, etc.

Internal assessment shall be through any of the following:

Surprise Tests, one sentence summary, case analysis, simulated problem solving, open book techniques, classroom assignments, homework assignments, term paper, presentations, Kahoot, Padlet, one sentence summary, student generated questions and discussions.

Suggested readings

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

Course Code: FST.552

L	T	P	Cr
3	0	0	3

Course Title: Application of Enzymes in Food Processing

Total Hours - 45

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

12 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, etc.)

Unit II

11 Hours

Enzymes in milk and dairy products: 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; Enzymes for determining milk quality; Enzymes in cheese production

Unit III

11 Hours

Enzymes in fruits processing: 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

11 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

Enzymes in protein modification: Proteases for producing protein hydrolysates; Functional properties; Allergenicity

Transactional Modes:

Mode of transaction shall be Lecture, presentation, Dialogue, google forms/docs, Lecture-cum-demonstration, Seminar, discussion, e-content, etc.

Internal assessment shall be through any of the following:

Surprise Tests, one sentence summary, case analysis, simulated problem solving, open book techniques, classroom assignments, homework assignments, term paper, presentations, Kahoot, Padlet, one sentence summary, student generated questions and discussions.

Suggested readings

- AN Shukla, Industrial Enzymology. Discovery Publishing House (2009).
- J Boudrant, JM Woodley and R Fernandez-Lafuente, Parameters necessary to define an immobilized enzyme preparation. Process Biochemistry (2019).
- JR Whitaker Handbook of Food Enzymology. CRC press (2016).
- M Sharifi et al., Enzyme immobilization onto the nanomaterials: Application in enzyme stability and prodrug-activated cancer therapy, International Journal of Biological Macromolecules, 143, 665-676 (2020).
- PS Panesar et al., Enzymes in Food Processing: Fundamentals and Potential Applications. I.K. International Publishing House (2013).
- RJ Whitehurst and MV Oort, Enzymes in Food Technology. Wiley-Blackwell (2010).
- S Shanmugam and K Kumar, Enzyme Technology. I.K. International Publishing (2009).
- T Nagodawithana and G Reed, Enzymes in Food Processing. Academic Press (1993).

Course Code: FST.511

L	T	P	Cr
3	0	0	3

Course Title: Nutrition, Nutraceuticals and Functional Foods

Total Hours - 45

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

12 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; 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.

Unit II

11 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

11 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

Food applications: 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

11 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 fibers

Transactional Modes:

Mode of transaction shall be Lecture, presentation, Dialogue, google forms/docs, Lecture-cum-demonstration, Seminar, discussion, e-content, etc.

Internal assessment shall be through any of the following:

Surprise Tests, one sentence summary, case analysis, simulated problem solving, open book techniques, classroom assignments, homework assignments, term paper, presentations, Kahoot, Padlet, one sentence summary, student generated questions and discussions.

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).

- F Chemat, Green Food Processing Techniques: Preservation Transformation and Extraction, Academic Press (2019)
- 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).
- M Saarela, Functional Foods: Concept to Product. Woodhead Publishing (2014).
- M Sharma Nutrition for the Family, Sports Educational Tech (2018)
- M. Swaminathan, Essentials of Food and Nutrition, Volumes 1-2. Ganesh Publisher (1974).
- N Singh, Food Nutrition, Science and Technology, Woodhead Publication (2018)
- NN Potter, Food Science. CBS Publishers (2007).
- PM Choksi and VY Joshi, A Review on Lycopene-Extraction, Purification, Stability and Applications. International Journal of Food Properties, 10, 289-298 (2007).
- R Rao, Lycopene and Tomatoes In Human Nutrition And Health, CRC Press (2018)
- RR Watson Fruits Vegetables and Herbs: Bioactive Foods in Health Promotion. Academic Press, (2016).
- S Edelstein, Food Science, Jones & Bartlett Learning (2018)
- S Riar et al., Functional Foods and Nutraceuticals: Sources and Their Developmental Techniques. New India publishing agency (2015).
- S Story et al., An Update on the Health Effects of Tomato Lycopene. Annual Reviews in Food Science and Technology, 2010, 1-24 (2010)
- S Subbulakshmi and M Subhadra, Nutrition in Traditional Therapeutic Foods. Daya Publishing House (2015).
- U Gogus and C Smith (2010) n-3 Omega fatty acids: a review of current knowledge. International Journal of Food Science and Technology, 45, 417- 436 (2010)
- V Vaclavik and CW Elizabeth, Essentials of Food Science. Springer (2014).
- Y Zhao, Specialty Foods: Processing Technology, Quality and Safety. CRC Press (2012).

L	T	P	Cr
0	0	4	2

Course Code: FST.525

Course Title: Cereals and Pseudocereals Processing - Practical

Total Hours - 60

Learning Outcome:

The completion of this course will enable students:

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

S.N. Practical

1. Identification and physical properties of various cereals and pseudocereals.
2. Determination of husk content of covered cereals.
3. Determination of sedimentation value and solvent retention capacity 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 cereal starches and flours.
7. Evaluation of the microstructure of cereals/pseudocereals.
8. Laboratory wet milling of maize.
9. Manufacturing of different baked products and their quality evaluation.
10. Determination of germination capacity and germ viability (tetrazolium test) of barley.
11. Experimental malting of barley.
12. Pasting properties of different cereals and pseudocereal flours.
13. Laboratory parboiling of paddy and quality evaluation of parboiled rice.
14. Comparison of wheat flour and semolina for physicochemical properties.
15. Cooking and sensory evaluation of noodles and pasta products.

Transactional Modes:

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

Course Code: FST.527

L	T	P	Cr
0	0	4	2

Course Title: Fruits and Vegetable Processing - Practical**Total Hours - 60****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.

Transactional Modes:

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

L	T	P	Cr
1	0	0	1

Course Code: ABM.529

Agripreneurship Development

Total Hours: 15

Learning Outcomes: On the completion of this course, the students will

- Understand the basic concepts of entrepreneur, entrepreneurship and its importance.
- Aware of the issues, challenges and opportunities in entrepreneurship.
- Be able to develop capabilities of preparing proposals for starting small businesses.
- Know the availability of various institutional supports for making a new start-up.

Unit I**4 hours**

Introduction to entrepreneur and entrepreneurship; Characteristics and functions of entrepreneurs; Classification of entrepreneurs; Entrepreneurial opportunities in Agriculture Sector;

Unit II**3 hours**

Women entrepreneurship; Role of entrepreneurship in economic development; Barriers to entrepreneurship; Forms of Business Ownership;

Unit III**4 hours**

Sources of innovative opportunities; Pre-feasibility study; Sources of finance; Business plan;

Unit IV**4 hours**

Government programmes for development of agri-entrepreneurship; Micro, Small and Medium Enterprises (MSME); Agriclinic and Agribusiness Centres Programme (ACABC); Startup India; MUDRA Yojana;

Transactional Modes:

Lecture, Seminar, Case study, Case analysis, Brain storming.

Internal assessment shall be through any of the following:

Surprise Tests, one sentence summary, case analysis, simulated problem solving, open book techniques, classroom assignments, homework assignments, term paper, presentations, Kahoot, Padlet, one sentence summary, student generated questions and discussions.

Suggested Readings:

- VM Dandekar and VK Sharma, Agri-Business and Entrepreneurship Development. Manglam Publications, New Delhi (2016).
- V Desai, Entrepreneurship Development, Project formulation, Appraisal & Financing for Small Industry. Himalaya Publications, New Delhi (2006).
- RD Hisrich and MP Peters, Entrepreneurship, Tata McGraw Hill (2002).

- JM Kaplan and AC Warren, Patterns of Entrepreneurship Management, John Wiley & Sons; 4th revised edition (2013).
- H Nandan, Fundamentals of Entrepreneurship Management, Prentice Hall (2007).

L	T	P	Cr
3	0	0	3

Course Code: FST.510

Course Title: Food Biotechnology

Total Hours - 45

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

12 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

11 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

11 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

11 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, Dialogue, google forms/docs, Lecture-cum-demonstration, Seminar, discussion, e-content, etc.

Internal assessment shall be through any of the following:

Surprise Tests, one sentence summary, case analysis, simulated problem solving, open book techniques, classroom assignments, homework assignments, term paper,

presentations, Kahoot, Padlet, one sentence summary, student generated questions and discussions.

Suggested readings

- K Shetty, Functional Foods and Biotechnology. CRC Press Taylor & Francis (2015).
- KL Benson, Industrial Microbiology. CBS Publishers (2016).
- P 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 and Nutrition, 27, 159-18 (1988).
- PS Panesar and SS Marwaha, Biotechnology in Agriculture and Food Processing. CRC Press (2013).
- S Skariyachan et al., Introduction to Food Biotechnology. CBS Publisher (2012).
- SS Kariyachan, Food Biotechnology. CBS Publisher (2012).
- SS Marwaha and JK Arora, Biotech Strategies in Agro processing. Asiatech (2003).
- VK Gupta et al. Biotechnology of Bioactive Compounds. Wiley-Blackwell (2015).
- VK Joshi and RS Singh, Food Biotechnology: Principles and Practices. IK International Publishing House (2012)
- W Clarke, Biotechnology of Industrial Microbiology. CBS Publishers (2016).
- YH Hui, Food Biotechnology. Wiley-Blackwell (2014).

L	T	P	Cr
3	0	0	3

Course Code: FST.572

Course Title: Poultry and Meat Processing

Total hours - 45

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 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 hygiene in meat industry.

Unit I

12 Hours

Eggs: Structure; Composition; Nutritive value; Grading; External and Internal quality; Preservation and Packaging of whole eggs; Functional properties of yolk and albumen; Microbiology; 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

12 Hours

Poultry: Status of poultry and meat industry in India; Types; Composition; Nutritive value; Poultry slaughtering and dressing (operation and equipment).

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; Eating quality of meat; Tenderization of meats.

Unit III

10 Hours

Processing and preservation: Principles, equipment and applications of mechanical deboning; Restructured meat products processing; Preservation of meats by chilling,

freezing, pickling/salting/curing, smoking, dehydration, irradiation, chemical and biological preservatives; Intermediate moisture and shelf stable meat products;

Unit IV

11 Hours

Comminuted meat product: Technology of manufacture of Comminuted/minced meat product; Quality evaluation of sausages; Comminuted meats vs meat emulsions

Safety in meat industry: Meat plant sanitation and hygiene; Pesticide and drug residue in poultry meat; Pathogenic microorganisms on processed poultry.

Transactional Modes:

Mode of transaction shall be Lecture, presentation, Dialogue, google forms/docs, Lecture-cum-demonstration, Seminar, discussion, e-content, etc.

Internal assessment shall be through any of the following:

Surprise Tests, one sentence summary, case analysis, simulated problem solving, open book techniques, classroom assignments, homework assignments, term paper, presentations, Kahoot, Padlet, one sentence summary, student generated questions and discussions.

Suggested readings

- AM Pearson and TA Gillett, Processed Meats. CBS Publishers (1996).
- BM Bohrer, 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 (2019)
- GC Mead, Poultry Meat Processing and Quality. Woodhead Publishing Ltd. (2004).
- I Guerrero-Legarreta, Handbook of Poultry Science and Technology. Wiley (2010).
- Lawrie's Meat Science Woodhead Publishing (2017).
- LS Boziaris, Seafood Processing: Technology, Quality and Safety. John Wiley and Sons Ltd. (2014).
- NN Potter, Food Science. CBS Publishers (2007).
- PA Gonzalez-Rivas et al. Effects of heat stress on animal physiology, metabolism, and meat quality: A review. Meat Science, Volume 162, Article 108025 (2020).
- R Fernandes, Microbiology Handbook of Meat products. Medtech (2017).
- SC Ricke, Organic Meat Production and Processing. Wiley-Blackwell (2012).
- Sohrab, A Practical Guide for Implementation of Integrated ISO-900 HACCP System for the Food Processing Industry. Allied Publishers Ltd. (2001).
- YH Hui, Handbook of Meat and Meat Processing. CRC Press (2012).
- YH Hui, Meat Science and Applications. Marcel Dekker (2001).

Course Code: FST.530

L	T	P	Cr
3	0	0	3

Course Title: Food Additive and Toxins

Total Hours - 45

Learning Outcome:

The course will enhance efficiency of learners:

- To explain what is food toxicology and how is this relevant to food processing
- To explain various food additives and to recommend their applications in different foods
- To critically evaluate foods for the presence of natural and derived various toxins

- To recommend the processing for eliminating the natural and derived toxins in foods.

Unit I **10 Hours**

Overview of Food Additives and Toxins: Definitions; General classification and principles; Nutritional and non-nutritional additives and natural vs synthetic additives; Uses/applications; Functions; Risks and benefits

Unit II **11 Hours**

Common food additives I: Anti-microbial agents (Class I and Class II preservatives) permissible limits; Anti-caking agents; Humectants; Flour bleaching agents and bread improvers; Acidulates and pH control agents; Chelating agents and sequestrants; Thickeners and binders

Unit III **11 Hours**

Common food additives II: Nutritional additives; Fat substitutes and replacers; Nutritive and non-nutritive sweeteners; Antioxidants; Natural colour additives; Antibrowning agents; Emulsifiers and stabilizers

Unit IV **11 Hours**

Toxins in foods: Natural toxicants in animal and plant foods; Microbial toxins; Toxicants generated during food processing such as nitrosamines, acrylamide, benzene, dioxins and furans; Methods for elimination of natural and derived toxins in foods.

Transactional Modes:

Mode of transaction shall be Lecture, presentation, Dialogue, google forms/docs, Lecture-cum-demonstration, Seminar, discussion, e-content, etc.

Internal assessment shall be through any of the following:

Surprise Tests, one sentence summary, case analysis, simulated problem solving, open book techniques, classroom assignments, homework assignments, term paper, presentations, Kahoot, Padlet, one sentence summary, student generated questions and discussions.

Suggested readings

- AL Branen, Food Additives, Marcel Dekker (2002).
- K Shetty, Functional Foods and Biotechnology. CRC Press Taylor & Francis (2015).
- KL Benson, Industrial Microbiology. CBS Publishers (2016).
- PS Panesar and SS Marwaha, Biotechnology in Agriculture and Food Processing. CRC Press (2013).
- T Pussa Principles of Food Toxicology, CRC Press (2007).
- T Shibamoto and L Bjeldanes, Introduction to Food Toxicology, Academic Press (2012).
- V Vaclavik and CW Elizabeth, Essentials of Food Science, Springer (2014).

L	T	P	Cr
3	0	0	3

Course Code: FST.517

Course Title: Processing of Legumes and Oilseeds

Total Hours - 45

Learning Outcome:

The completion of this course will enable learners:

- To relate chemical composition of legumes and oilseeds with their structure.
- To compare different legumes and oilseeds for their processing and applications in food industry.
- To effectively utilize legumes and oilseeds in production of protein and starch-rich products.
- 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**11 Hours**

Legumes: Legumes vs pulses; Production, Classification; Composition, Anatomical structure; Traditional and novel applications; Anti-nutritional/Bioactive constituents in legumes/pulses and methods of elimination; Pulse starch (extraction, properties and applications); Pulse proteins (structure, PPC/PPI extraction and properties); Cooking properties of pulses and hard-to-cook defect

Unit II**12 Hours**

Processing of legumes/pulses: Traditional and modern methods of legumes/pulse processing; Milling of pulses and pre-milling treatments; Technology of legume/pulse flours, proteins (concentrates and isolates); Soy milk vs bovine milk; Technology of soy milk and tofu manufacture, Processing of soy-flour, concentrate and isolate; Soy-based textured vegetable proteins.

Unit III**11 Hours**

Oilseeds: Major oilseeds and oils; Composition; Production; Trade of oils and oilseeds; Components of vegetable oils; Oilseed processing for oil extraction: drying, storage, cleaning, grading, dehulling, flaking, heat treatment/ extrusion, oil extraction (mechanical and solvent extraction)

Rice bran as a source of edible oil: Rice bran stabilization; Extraction of oil.

Unit IV**11 Hours**

Processing and refining of Oil and oil cake/meal: Physical and chemical refining of crude oils from oil seeds; Modification of vegetable oils (hydrogenation, winterization/fractionation and interesterification); Utilization of de-oiled cake/meal; Application and functionality of oilseed protein products

Transactional Modes:

Mode of transaction shall be Lecture, presentation, Dialogue, google forms/docs, Lecture-cum-demonstration, Seminar, discussion, e-content, etc.

Internal assessment shall be through any of the following:

Surprise Tests, one sentence summary, case analysis, simulated problem solving, open book techniques, classroom assignments, homework assignments, term paper, presentations, Kahoot, Padlet, one sentence summary, student generated questions and discussions.

Suggested readings

- A Chakraverty and RP Singh, Postharvest Technology and Food Process Engineering. CRC Press (2014)
- A Chakraverty et al. Handbook of Postharvest Technology. Marcel Dekker (2003).
- B Richards, Oils Fats and Fatty Foods. Biotech Books (2014).

- BK Tiwari and N Singh, Pulse Chemistry and Technology. RSC (2012).
- BK Tiwari, Pulse Foods: Processing Quality and Nutraceutical Applications. Academic Press (2014).
- Bolton, Richards ER, Oils, Fats and Fatty Foods: Their Practical Examination. Biotech Books (2014).
- K Liu, Soybeans: Chemistry, Technology, and Utilization. Springer (1997).
- KK Rajah, Fats in Food Technology. John Wiley & Sons (2014).
- M Angeles, Legumes, Royal Society of Chemistry (2019).
- MM Chakrabarty, Chemistry and Technology of Oils and Fats. Allied Publishers (2012).
- N Khetarpal et al., Fats and Oils in Health and Nutrition. Astral Publishing House (2014).
- N Sozer et al., Traditional and New Food Uses of Pulses. Cereal Chemistry, 94, 66-73 (2017).

Course Code: FST.551

Course Title: Processing of Milk and Milk Products

L	T	P	Cr
3	0	0	3

Total Hours - 45

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

12 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

11 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

11 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**11 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**Suggested readings**

- AH Varnam, Milk and Milk Products: "Technology, Chemistry and Microbiology" (Food Products Series). Springer (2013)
- Analysis of Milk and Milk Products by Milk Industry Foundation (2014).
- BK Mishra, Dairy and Food Product Technology. Biotech Books (2016).
- C Shortt, Handbook of Functional Dairy Products. CRC Press (2014).
- D Ward, Dairy Science and Technology. Larsen & Keller (2017).
- G Osei, Handbook of Milk and Dairy Product Publisher: Agri-Horti Press (2017)
- H Subrota, Dairy Product Technology. Astral (2015).
- J Coimbra, Engineering Aspects of Milk and Dairy Products. CRC Press (2010).
- M Sararela and TM Sandholm, Functional Dairy Products. Woodhead Publishing Ltd. (2014).
- P Gangasagare, A Textbook of Traditional Dairy Products. Oxford Book Company (2018).
- R Early, The Technology of Dairy Products. Springer Science (2010)
- R Sharma, Production Processing & Quality of Milk Products. International Book Distributing Co. (2006).
- RC Chnadan and A Kilara, Dairy Ingredients for Food Processing. Wiley (2011).
- RD Boer, From Milk By-Products to Milk Ingredients. John Wiley & Sons (2014).
- RK Robinson, Modern Dairy Technology Volume 1, 2 Advances in Milk Processing. Springer (1994).
- S De, Outlines of Dairy Technology. Oxford University Press (2015).

Course Code: FST.571**Course Title: Food Safety, Regulation and Policy**

L	T	P	Cr
3	0	0	3

Total hours - 45**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**12 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

11 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 panelist requirement),

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

Unit III

11 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

11 Hours

Food safety management and quality control systems: Total Quality Management; ISO 22000; Quality assurance; GMP; GLP; Sanitary and hygienic practices; HACCP, VACCP, TACCP; 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, Dialogue, google forms/docs, Lecture-cum-demonstration, Seminar, discussion, e-content, etc.

Internal assessment shall be through any of the following:

Surprise Tests, one sentence summary, case analysis, simulated problem solving, open book techniques, classroom assignments, homework assignments, term paper, presentations, Kahoot, Padlet, one sentence summary, student generated questions and discussions.

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 Kapisiris, Food Quality. Intech Publisher (2014).
- K Prabhakar, A Practical Guide to Food Laws and Regulations, Bloombury (2016).
- L Nollet, Handbook of Food Analysis. CRC Press (2015).
- M Clute, Food Industry Quality Control Systems. CRC Press (2017).
- M Gordon, Food Safety and Quality Systems in Developing Countries (2016)
- N Khetarpaul, Food Analysis. Daya Publicing 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 Otlés, Methods of Analysis of Food Components and Additives. CRC Press (2012).

- S Sehgal, A Laboratory Manual of Food Analysis. Panima Educational Book (2016).
- S 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).

L	T	P	Cr
0	0	4	2

Course Code: FST.553

Course Title: Milk and Milk Processing - Practical

Total Hours - 60

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.

Transactional Modes:

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

L	T	P	Cr
0	0	4	2

Course code: FST.574

Course Title: Food Quality - Practical

Total hours - 60

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.

Transactional Modes:

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

Course Code: FST.577

L	T	P	Cr
2	0	0	2

Course Title: Competitive Exam Preparatory Course**Total hours - 30****Learning Outcome:**

- The course will enable students to succeed in various competitive exam by providing information about various tests of national levels.

The course shall be based on the syllabus of various national-level competitive examinations (e.g. ICAR, UGC, FSSAI, FCI, etc).

Transactional Modes:

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

Course Code: FST.528

L	T	P	Cr
3	0	0	3

Course Title: Fermented Foods**Total Hours - 45****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

12 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

11 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

11 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

11 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, presentation, Dialogue, google forms/docs, Lecture-cum-demonstration, Seminar, discussion, e-content, etc.

Internal assessment shall be through any of the following:

Surprise Tests, one sentence summary, case analysis, simulated problem solving, open book techniques, classroom assignments, homework assignments, term paper, presentations, Kahoot, Padlet, one sentence summary, student generated questions and discussions.

Suggested readings

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

L	T	P	Cr
3	0	0	3

Course Code: FST.529

Course Title: Beverages Technology

Total Hours - 45

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

12 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;

Synthetic/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

Unit II

11 Hours

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

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

Unit III

11 Hours

Cocoa and chocolate-based beverages: Processing of cocoa beans and nibs; Technology of cocoa-based beverages

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; 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

11 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

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, Dialogue, google forms/docs, Lecture-cum-demonstration, Seminar, discussion, e-content, etc.

Internal assessment shall be through any of the following:

Surprise Tests, one sentence summary, case analysis, simulated problem solving, open book techniques, classroom assignments, homework assignments, term paper, presentations, Kahoot, Padlet, one sentence summary, student generated questions and discussions.

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).
- S Santini, Case Studies in the Wine Industry, Elsevier (2019)
- V Vaclavik and CW Elizabeth, Essentials of Food Science. Springer (2014).
- Varnam and S Sutherland, Beverages: Technology, Chemistry and Microbiology. Chapman and Hall (1994).

L	T	P	Cr
3	0	0	3

Course Code: FST.554

Course Title: Food Hygiene, By-Products and Waste Management

Total Hours - 45

Learning Outcome:

The course will enable learners:

- To differentiate between food by-products and waste
- To recommend methods for efficient by-product utilization from grain, fruit, vegetable, sugar, meat processing industry, etc.
- To critically evaluate the effect of proper and incomplete treatment of food wastes.
- To recommend and develop systems for wastes from different food industries.

Unit I

10 Hours

Introduction: General principles of food hygiene; Personal hygiene; Hygienic food handling; Sanitation facilities and procedures in food plant operation; Method of cleaning and disinfection; Detergents and sanitizers

Unit II

11 Hours

By-product utilization I: Types, availability and utilization of by-products of cereals, legumes and oilseeds; Utilization of by-products from fruits and vegetables processing, sugar industries, brewery and distillery

Unit III

11 Hours

Status of waste from food industry: Current utilization of dairy by-products i.e. whey, buttermilk and ghee residue; Availability and utilization of by-products of meat, poultry and fish processing industry

Unit IV

12 Hours

Food Waste management: Types of food processing wastes (oil, fruit juice, cereal, meat waste, dairy and food packaging); Methods for waste treatment (physical, chemical and biological methods); Biomethanation and biocomposting; Incineration; Efficient combustion technology

Transactional Modes:

Mode of transaction shall be Lecture, presentation, Dialogue, google forms/docs, Lecture-cum-demonstration, Seminar, discussion, e-content, etc.

Internal assessment shall be through any of the following:

Surprise Tests, one sentence summary, case analysis, simulated problem solving, open book techniques, classroom assignments, homework assignments, term paper, presentations, Kahoot, Padlet, one sentence summary, student generated questions and discussions.

Suggested readings

- NN Potter, Food Science. CBS Publishers (2007).
- S Ioannis, Waste Management for Food Industries. Elsevier (2008).
- V Vaclavik and CW Elizabeth, Essentials of Food Science. Springer (2014).

L	T	P	Cr
0	0	4	8

Course Code: FST.600

Course Title: Research proposal

Learning Outcome:

The course completion will develop higher cognitive skills:

- To apply the scientific method of research for solving food science or industrial problems with quantitative reasoning skills.
- To construct study design

Students shall prepare a proposal for research work or industrial projects under supervisor/guide from the Department. They shall submit the proposal to the Department for evaluation. Synopsis will be evaluated as per the University policy.

Transactional Modes:

Mode of transaction shall be Demonstration, Dialogue and Discussion, Lecture-cum-demonstration, Experimentation, industrial training, e-contents, google drive, etc

L	T	P	Cr
0	0	40	20

Course Code: FST.600

Course Title: Dissertation

Learning Outcome:

The course completion will develop higher cognitive skills:

- To apply the scientific method of research for solving food science or industrial problems with quantitative reasoning skills.
- To construct study design and presenting the same orally and in writing

Students shall carry out research work / dissertation in the IV semesters under supervisor/guide from the Department. Group dissertation may be opted, with a group consisting of a maximum of four students. Dissertations can be taken up in collaboration with industry or in a group from within the discipline or across the discipline. Dissertation will be evaluated by the Department, as per the University policy.

Transactional Modes:

Mode of transaction shall be Demonstration, Dialogue and Discussion, Lecture- cum- demonstration, Experimentation, industrial training, e-contents, google drive, etc.