CENTRAL UNIVERSITY OF PUNJAB, BATHINDA

M. Sc. Food Science and Technology

Batch 2024-2025

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
CST.501*	Computer Applications	Compulsory foundation	3	0	0	3
STA.503*	Bio-Statistics for Sciences	Compulsory foundation	3	0	0	3
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	
XXXX	Individualized Education Plan/tutorial Remedial class	Non-credit course	0	2	0	0
					Total credits	**22**

*Students can opt for this course on NPTEL, SWAYAM if 70% of the syllabus matches the MOOC course syllabus

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.530	Agripreneurship Development	Entrepreneurship course	2	0	0	2
XXX	Interdisciplinary Course	IDC	2	0	0	2
XXXX	Individualized Education Plan/tutorial Remedial class	Non credit course	0	2	0	0
IDC course to be offered by the Department						
FST.531	Technology of spices, plantation products and chocolate	IDC	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	**23**

Semester III						
Course Code	**Course Title**	**Type of course**	**Hours**			**Credits**
			L	**T**	**P**	
FST.517	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
XXX	Value added course	Value-added	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.XXX	Techniques in Food Analysis	Discipline elective	3	0	0	3
FST.600	Dissertation Part I	Skill-based	0	0	8	4
XXXX	Individualized Education Plan/tutorial Remedial class	Non-credit course	0	2	0	0
Value-added course to be offered by the Department						
FST.504	Nutrition and Specialty Foods	Value-added	2	0	0	2
FST.505	Food Product Development and Quality Evaluation	Value-added	0	2	0	
					Total	**22**

Semester IV						
Course Code	**Course Title**	**Type of course**	**Hours**			**Credits**
			L	**T**	**P**	
FST.601	Dissertation Part II	Skill-based	0	0	40	20
					Total	**20**

Total Credits = 22 + 23 + 22 + 20 = 85

Credit distribution

Semester	**Core courses**	**Elective Courses**			**Foundation Courses**	
		DE	**ID**	**SB**	**CF/ENT**	**EF/VB**
I	03 (9 Cr)	01 (3 Cr)		01 (2 Cr)	02 (6 Cr)	--
II	04 (12 Cr)	01 (3 Cr)	01 (2 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)
IV	--	--	--	01 (20 Cr: Dissertation)	--	--
Credits	**30**	**9**	**2**	**34**	**8**	**2**
					Total	**85**

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

MOOCs may be taken up to 40% of the total credits (excluding dissertation credits). MOOC may be taken in lieu of any course, but the content of that course should match a minimum of 70%. Mapping will be done by the department, and students will be informed accordingly.

Examination pattern and evaluation for Masters' students

Formative Evaluation: Internal assessment shall be 25 marks using any two or more of the given methods: tests, open book examination, assignments, term paper, etc. The Mid-semester test shall be descriptive type of 25 marks including short answer and essay type. The number of questions and distribution of marks shall be decided by the teachers.

Summative Evaluation: The End semester examination (50 marks) with 70% descriptive type and 30% objective type shall be conducted at the end of the semester. The objective type shall include one-word/sentence answers, fill-in the blanks, MCQs', and matching. The descriptive type shall include short answer and essay type questions. The number of questions and distribution of marks shall be decided by the teachers. Questions for exams and tests shall be designed to assess course learning outcomes along with focus on knowledge, understanding, application, analysis, synthesis, and evaluation.

The evaluation for IDC, VAC and entrepreneurship, innovation and skill development courses shall include MST (50 marks) and ESE (50 marks). The pattern of examination for both MST and ESE shall be same as ESE described above for other courses.

Evaluation of dissertation proposal in the third semester shall include 50% weightage by supervisor and 50% by HoD and senior-most faculty of the department. The evaluation of dissertation in the fourth semester shall include 50% weightage for continuous evaluation by the supervisor for regularity in work, mid-term evaluation, report of dissertation, presentation, and final viva-voce; 50% weightage based on average assessment scores by an external expert, HoD and senior-most faculty of the department. Distribution of marks is based on report of dissertation (30%), presentation (10%), and final viva-voce (10%). The external expert may attend final viva-voce through offline or online mode.

Examination pattern

Core, Discipline Elective, and Compulsory Foundation Courses			**IDC, VAC, and Entrepreneurship, Innovation and Skill Development Courses**	
	Marks	**Evaluation**	**Marks**	**Evaluation**
Internal Assessment	25	Various methods	-	-
Mid-semester test (MST)	25	Descriptive	50	Descriptive (70%) Objective (30%)
End-semester exam (ESE)	50	Descriptive (70%) Objective (30%)	50	Descriptive (70%) Objective (30%)

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

Marks for internship shall be given by the supervisor, HoD and senior-most faculty of the department.

Multiple-entry exit system

Department	Entry Programme	Exit Programme	Any of the Prerequisites
Applied Agriculture	M.Sc. FS&T	PG Diploma in FS&T	Industry Training-2 Months

L	T	P	Cr
3	0	0	3

Course Code: FST.506
Course Title: Food Chemistry
Total Hours - 45

Course Learning Outcome (CLO):
The completion of this course will enable learners to:

CLO 1: Explain physicochemical properties of major and minor components of foods.
CLO 2: Apply correct methods for estimating the moisture content of different foods.
CLO 3: Critically analyse chemical and nutritional properties of carbohydrates, proteins and lipids.
CLO 4: Critically evaluate the effect of processing on the properties of macro components of foods.
CLO 5: Give recommendations on sources, functions, stability and requirements of vitamins and minerals.

Unit/Hours	Content	Mapping with CLO
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.; Browning and related reactions. Case studies - acrylamide and furan formation in foods. **Learning Activities:** *Group discussions on role of water in food preservation*	**CLO1 and CLO2**
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; Sources and functions of food proteins; Protein quality and its evaluation.; Nitrite function, chemistry and nitrosamine formation. Effects of food processing: changes occurring in chemical, functional & nutritional properties of proteins **Learning Activities:** *Seminars on nutritive and functional properties of food proteins*	**CLO3**
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 **Learning Activities:** *Student seminars on rancidity and reversion of oils/fats*	**CLO3 and CLO4**
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, anthocyanins, etc.; Enzymatic and Non-enzymatic browning in foods. **Learning Activities:** *Group discussions on importance of vitamins, minerals and natural food colourants*	**CLO4 and CLO5**

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

Tools used:
PPT, YouTube Video, Google meet, NPTEL

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).
- HE Khoo, A Azlan, ST Tang and SM Lim, Anthocyanidins and anthocyanins: colored pigments as food, pharmaceutical ingredients, and the potential health benefits. Food and Nutrition Research, 2017, 61, 1361779.
- HK Chopra and PS Penesar, Food Chemistry. Narosa Publication (2010).
- J Cmolíka 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

Course Learning Outcome (CLO):
This course will enable learners:

CLO1: To explain how different foods are deteriorated and how they can be processed/preserved.
CLO2: To apply various processing/preservation techniques to different foods.
CLO3: To analyze the effect of various preservation techniques on processed foods.
CLO4: To develop novel techniques/methods of food preservation and to evaluate their effect on food properties.

Unit/hours	Content	Mapping with CLO
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 **Learning Activities:** *Group discussions on importance of food processing and preservation*	**CLO1**
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) **Learning Activities:** *Seminars on use of refrigeration, freezing and drying in food processing*	**CLO2**
Unit III/10 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 **Learning Activities:** *Group discussions on the advantages of non-thermal over thermal techniques*	**CLO3 and CLO4**
Unit IV/12 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; Technological challenges and limitations **Learning Activities:** *Seminars on irradiation preservation of foods*	**CLO3 and CLO4**

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

Tools used:
PPT, YouTube Video, Google meet, NPTEL

Suggested readings

- AK Haghi, Food Science: Research and Technology. Academic Press (2011).
- D Singh, Food Processing and Preservation. Shree Publisher (2015).
- DK Rosarioa et al. (2021). Principles and applications of non-thermal technologies and alternative chemical compounds in meat and fish. Critical Reviews in Food Science and Nutrition, 61, 1163-1183.
- 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).
- Liqing Qiu, Min Zhanga, Juming Tang, Benu Adhikari and Ping Cao (2019). Innovative technologies for producing and preserving intermediate moisture foods: A review. Food Research International, 116, 90-102
- 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 Varzakasand and C Tzia, Handbook of Food Processing. CRC Press (2016).

Course Code: FST.507
Course Title: Food Packaging
Total Hours - 45

L	T	P	Cr
3	0	0	3

Course Learning Outcome (CLO):
The course will make students:

CLO1: To explain functions, importance and laws of packaging.
CLO2: To classify different packaging material.
CLO3: To make use of appropriate packaging material in food industry.
CLO4: To give recommendation on the physical and chemical properties, advantages and limitations of different packages.
CLO5: To design packages for extending shelf life of different foods.

Unit I/Hours	Content	Mapping with CLO
Unit I/12 hours	**Introduction:** Definition; Package environment; Functions of packaging; Importance and scope of packaging; Classification of packages; Labelling laws; latest amendments in packaging and Labelling laws in India **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	**CLO1 and CLO2**

	Learning Activities: *Seminars on importance of packaging and advantages of glass as a package*	
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 **Learning Activities:** *Group discussions on application of metals and papers in food packaging*	**CLO2 and CLO3**
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 **Learning Activities:** *Group discussions on advantages and disadvantages of plastics in food packaging*	**CLO2 and CLO3**
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). **Learning Activities:** *Seminars on testing of packaging materials*	**CLO4 and CLO5**

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

Tools used:
PPT, YouTube Video, Google meet, NPTEL

Suggested readings

- Santosh Kumar, Avik Mukherjee, Joydeep Dutta (2022). Biopolymer- Based Food Packaging: Innovations and Technology Applications. Print ISBN:9781119702252 |Online ISBN:9781119702313, John Wiley & Sons, Inc.
- Annu, Tanima Bhattacharya, Shakeel Ahmed (2022). Nanotechnology in Intelligent Food Packaging. Print ISBN:9781119818953, Scrivener Publishing LLC
- Amrita Poonia, Tejpal Dhewa (2022). Edible Food Packaging (Applications, Innovations and Sustainability). ISBN: 978-981-16-2383-7
- Shakeel Ahmed (2022). Bionanocomposites for Food Packaging Applications (1st Edition) Paperback ISBN: 9780323885287; Woodhead Publishing Series
- 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).
- 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

Course Learning Outcome (CLO):
The course will enable students:

CLO1: To apply the laboratory practices important in basic and applied food chemistry in food analysis and quality improvement
CLO2: To estimate major components of foods
CLO3: To measure the quality and stability of oils/fats in foods
CLO4: To maximize quality of fresh cut fruits and vegetables by delaying/preventing browning

S No.	Practical	Mapping with CLO
1	Determination of moisture content of foods using different methods.	**CLO1 and CLO2**
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 sugar content of foods.	
7	Determination of ascorbic acid content of fruits using dye method.	
8	Determination of oil stability using Rancimat.	**CLO3**
9	Determination of acid value and saponification value of fat/oil.	
10	Determination of total phenolic content and antioxidant activities of plant foods.	**CLO4**
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
Course Title: Computer Applications
Total Hours: 45

L	T	P	Cr
3	0	0	3

Course Objectives:

- To understand the concept of computer fundamentals.
- To enable students to use the different basic computer applications and tools.
- To learn new skills in data processing and data mining.
- To understand the basic knowledge of AI and digital marketing

Course Outcomes:

Course Learning Outcome (CLO):
Upon successful completion of this course, the student will be able to:
CLO1:
Use different operating systems and their tools easily.
Use word processing software, presentation software, and spreadsheet software.
CLO2:
Understand networking and internet concepts.
Understanding of cyber security and the related threat to cyber security
CLO3:
Gain new skills in data processing and data mining
CLO4:
Use computers in every field, like teaching, industry, and research.
Knowledge of E-commerce, digital marketing, and AI

Units/Hours	Contents	Mapping with Course Learning Outcome
Unit I/ 8 hours	Computer Fundamentals: Introduction to Computer, Computer Architecture, Input/Output Devices, Memory (Primary & Secondary), Concept of Hardware and Software, Programming Languages (Low and High level), Compiler, Interpreter, Assembler. Application Software: Use of word processing software (MS Word) for creating reports and technical papers with the help of reference managers (Mendeley), Use of statistical packages (MS Excel) for analysis & visualization of data. **Learning Activities: Analysis of various tools and Case Studies**	**CLO1**
Unit II/ 8 hours	**Information Technology:** Overview of IT concepts, Internet Basics, Definition and importance of cybersecurity, Introduction to cybersecurity threats and vulnerabilities, Identifying & Protecting potential cyber threats in food technology systems. **Learning Activities:** Assignment-based learning	**CL02**

Unit III/ 8 hours	**Data Processing:** Importance and applications of data processing in food technology, Overview of data types and sources in the food industry, Introduction to software tools for data processing and analysis. **Data Mining:** Techniques for data collection in food technology, Data organization, storage, and retrieval, Data cleaning and preprocessing. **Learning Activities: Group discussion**	**CL03**
Unit IV/ 7 hours	**E-Commerce: Definition and scope of e-commerce,** Evolution of e-commerce in the food industry, Benefits and challenges of e-commerce. **Digital Marketing:** Search engine optimization (SEO) for food products, Social media marketing, Email marketing and newsletters, Online advertising and promotion strategies. **Artificial Intelligence:** Introduction to AI, Need for AI, Introduction to Approaches of AI (Machine & Deep Learning) Applications of AI in Food Technology. **Learning Activities:** Case Studies	**CL04**

Suggested Readings:

- A Goel and SK Ray, Computers: Basics and Applications. Pearson Education India(2012).
- PK Sinha, Computer Fundamentals. BPB Publications.
- Computer Organization & Architecture –Designing & Performance, William Stallings,
- Prentice Hall of India.
- Alfred Glkossbrenner- Internet 101 Computing MGH, 1996
- Lucas. 2004. lnformation Technology for Managemenf. McGraw Hill.
- Norton P. 1998. lntroduction to Computers. 2nd Ed. Tata McGraw Hill.
- Rajaraman V. 2006. lntroduction to lnformation Technology. Prentice Hall of India.

Web references

● Microsoft Office Professional 2013 Step by Step
https://ptgmedia.pearsoncmg.com/images/9780735669413/samplepages/97
807356694 13.pdf

Transactional Modes:

● PPT, Video, e-content, google drive

Course Code: STA.503
Course Title: Bio-Statistics for Sciences
Total hours - 45

L	T	P	Cr
3	0	0	3

Course Learning Outcome (CLO):

CLO1: The students will be able to apply statistical principles and procedures for solving food science problems.

CLO2: This course will enable students to decide which test to be used for data analysis

CLO3: The students will be able to give recommendations for parametric and non-parametric statistical analysis of data.

Unit /Hours	Content	Mapping with CLO
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. **Learning Activities:** *Application of statistical tools*	**CLO1**
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. **Learning Activities:** *Testing with experimental data*	**CLO1**
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. **Learning Activities:** *Testing with experimental data*	**CLO2**
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. **Learning Activities:** *Application of statistical tools*	**CLO3**

Suggested Readings:

- C. T Le, LE Eberly, Introductory biostatistics. John Wiley & Sons (2016).
- FE Croxton and D J Cowden, Applied General Statistics (1975).
- G Van Belle, LD Fisher, PJ Heagerty and T Lumley, Biostatistics: a methodology for the health sciences(Vol. 519). John Wiley & Sons (2004).
- H Motulsky, Intuitive biostatistics: a nonmathematical guide to statistical thinking. Oxford University Press (2014).
- PG Hoel, Introduction to Mathematical Statistics (1997).
- 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).

Transactional Modes:

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

L	T	P	Cr
3	0	0	3

Course Code: FST.573
Course Title: Technology of Spices, Sugar and Chocolate
Total hours - 45

Course Learning Outcome (CLO):
The course completion will make students:
CLO1: To identify spices forms and chocolate confectionary and understand how they are processed.
CLO2: To compare different spices for composition, health benefits, functions and applications.
CLO3: To critically analyze the effect of processing (milling, cryo-milling, fumigation and irradiation) on the properties of spices.
CLO4: To design/develop the processes for cane sugar manufacture.
CLO5: To recommend about the health effects of spices, sugar and chocolates.
CLO6: To maximize storage life and quality of spices, sugar and chocolate.

Unit /Hours	Content	Mapping with CLO
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 **Learning Activities:** *Seminars on major spices*	**CLO1 and CLO2**
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; FSSAI norms for spices and governing body **Learning Activities:** *Group discussions on applications of spice products*	**CLO3**
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 **Learning Activities:** *Group discussions sugars and their sources*	**CLO4**
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 **Learning Activities:** *Seminars on chocolate processing*	**CLO5 and CLO6**

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

Tools used:
PPT, YouTube Video, Google meet, NPTEL

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).
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- S Raghavan, Handbook of Spices, Seasonings and Flavorings. CRC Press (2007).
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- 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

Course Learning Outcome (CLO):
Upon completion of the course, the learner will be able:

CLO1: Identify the microbiology of food and dairy products.
CLO2: Explain the food spoilage and preservation methods.
CLO3: Propose the industrial aspect of dairy microbiology.
CLO4: Provide solution for pathogenic and spoilage microorganisms associated with different foods and their commercial importance.

Unit /Hours	Content	Mapping with CLO
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. Method for microbial examination of food: indicator organisms, direct examination, cultural techniques, Rapid methods in detection of microorganisms. Contamination during handling, processing and its control. **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. **Learning Activities:** *Seminars on advantages and disadvantages of microorganisms*	**CLO1 and CLO2**

Unit II/ 13hours	**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 intoxification, 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. **Learning Activities:** *Group discussions on factors affecting growth of microorganisms in foods*	**CLO2**
Unit III/11 hours	**Fermented and Dairy Food Products:** Microorganisms involved in food fermentations. Starter cultures for fermented dairy products (*Streptococcus thermophillus, 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. **Learning Activities:** *Group discussions on advantages of fermentation*	**CLO3**
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). **Learning Activities:** *Seminars on control of microorganisms in foods*	**CLO1 and CLO4**

Transactional Modes:

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

Tools used:

PPT, YouTube Video, Google meet, NPTEL

Suggested readings

- Liu, D. (Ed.). *Molecular Food Microbiology*. CRC Press. (2021).
- Doyle, M. P., Diez-Gonzalez, F., & Hill, C. (Eds.). (2020). *Food microbiology: fundamentals and frontiers*. John Wiley & Sons.
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- TJ Montville et al., Food Microbiology: An introduction. ASM press (2012).
- Batiha, G. E. S., Hussein, D. E., Algammal, A. M., George, T. T., Jeandet, P., Al-Snafi, A. E., & Cruz-Martins, N. Application of natural antimicrobials in food preservation: Recent views. *Food Control*, *126*, 108066. (2021).
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L	T	P	Cr
3	0	0	3

Course Code: FST.523
Course Title: Food Engineering and Unit Operations
Total Hours - 45

Course Learning Outcome (CLO):
The course will make students to:

CLO1: Elaborate various engineering properties of foods and how they are relevant to food processing.
CLO2: Explain principles of material balance, energy balance and fluid flow in food processing.
CLO3: Compare different types of filters, freezers, heat exchangers and leaching and distillation equipment.
CLO4: Develop processing methods of foods by applying unit operations like refrigeration, freezing, evaporation, drying, distillation and leaching.

Unit /Hours	Content	Mapping with CLO
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 **Learning Activities:** *Seminars on material/energy balance and fluid flow*	**CLO1 and CLO2**
Unit II/ 12hours	**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). **Learning Activities:** *Group discussions on various unit operations*	**CLO3**

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. **Learning Activities:** *Seminars on application of heating and cooling on food processing*	**CLO3**
Unit IV/ 12hours	**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). **Learning Activities:** *Group discussion on advantages of evaporation in food processing*	**CLO4**

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

Tools used:
PPT, YouTube Video, Google meet, NPTEL

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 (4^{th} 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).

Course Code: XXXX
Course Title: Individual Education Plan/Tutorial Remedial Class
Total Hours - 02

L	T	P	Cr
0	2	0	0

Individually each faculty clear the doubts of students on weekly basis.

Course Code: FST.522
Course Title: Processing of Cereals and Pseudocereals
Total Hours - 45

L	T	P	Cr
3	0	0	3

Course Learning Outcomes (CLO):
The completion of this course will enable learners:

CLO1: To relate chemical composition of cereals and pseudocereals with their structure.
CLO2: To compare different cereals and pseudocereals for their processing and applications in food industry.
CLO3: To effectively analyze functionality of cereals in traditional and novel foods.
CLO4: To develop / design technologies / processing methods for producing value - added cereal / pseudocereal-based products.

Unit /Hours	Content	Mapping with CLO
Unit I/11 hours	**Introduction:** Production, composition, structure and general usage of major cereals (wheat, rice, maize, barley, oats and millets) and pseudocereals **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 **Learning Activities:** *Group discussions on different cereals/pseudocereals, their production and general usages*	**CLO1 and CLO2**
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:** Chapatti making properties of wheat meal and quality analysis of chapatti **Learning Activities:** *Seminars on processing of wheat products*	**CLO2 and CLO3**
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	**CLO3**

	(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; Health benefits of millets **Learning Activities:** *Seminars on processing of rice, maize, oats and millets*	
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 benefits of pseudocereal intake **Learning Activities:** *Group discussions on nutritional and nutraceutical properties of pseudocereals*	**CLO3 and CLO4**

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

Tools used:
PPT, YouTube Video, Google meet, NPTEL

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).
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- 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).

Course Code: FST.524
Course Title: Processing of Fruits and Vegetables
Total Hours - 45

L	T	P	Cr
3	0	0	3

Course Learning Outcome (CLO):

The completion of this course will make students to:

CLO1: To relate the post-harvest handling of fruits and vegetables with the current status and methods of their processing.

CLO2: Compare different fruits and vegetables for composition, nutritional value, respiration rate and post-harvest biochemical changes.

CLO3: To apply canning in food industry and to evaluate its effect on nutritional value of fruits and vegetables.

CLO4: To develop/design the processes for manufacturing juices, jams, jellies, preserves and candied fruits.

CLO5: 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 /Hours	Content	Mapping with CLO
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) **Learning Activities:** *Group discussions on status and importance of fruit/vegetable processing*	**CLO1 and CLO2**
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) **Learning Activities:** *Seminars on canning of fruits and vegetables*	**CLO3**
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 **Learning Activities:** *Group discussions on importance of pectin in jam/jelly preparation*	**CLO4**
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 **Quality assurance in fruits and vegetable industry:** HACCP, VACCP and TACCP; AGMARK & CODEX specification on	**CLO5**

	maturity or grading of common fruits and vegetables; Latest government policy for fruits and vegetable processing sector **Learning Activities:** *Group discussions on different types of tomato products*	

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

Tools used:
PPT, YouTube Video, Google meet, NPTEL

Suggested readings

- Megh R. Goyal, Faizan Ahmad (2023). Quality Control in Fruit and Vegetable Processing: Methods and Strategies. Edition 1st Edition, First Published 2023 Apple Academic Press Pages 388. eBook ISBN9781003304999
- Nirmal K. Sinha, Jiwan S. Sidhu, József Barta, James S. B. Wu, M. Pilar Cano (2012). Handbook of Fruits and Fruit Processing. Print ISBN:9780813808949 Publisher: John Wiley & Sons, Ltd.
- 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).
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- 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).
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- NS Rathore, Post-harvest Management and Processing of Fruits and Vegetables. ICAR (2012).
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- SK Chattopadhyay, Handling Transportation and Storage of Fruits and Vegetable. Gene Tech Books (2015).
- WV Cruses, Commercial Fruit and Vegetables Processing. Agribios (2012).

L	T	P	Cr
3	0	0	3

Course Code: FST.552
Course Title: Application of Enzymes in Food Processing
Total Hours - 45

Course Learning Outcome (CLO):
The successful completion of this course will make students:

CLO1: To explain the importance of enzymes in food industry
CLO2: To explain effects of enzymes on the quality of raw and finished foods
CLO3: To give recommendations on the applications of enzymes in food industry
CLO4: To develop/design the processes for quality improvement of foods utilizing different enzymes
CLO5: To conclude the applications of the enzymes particularly in cereals, dairy, fruits, beer and protein foods

Unit /Hours	Content	Mapping with CLO
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.; Applications of Microbial Enzymes in Food Industry **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.). **Learning Activities:** *Seminar on types of enzymes most useful in food processing*	**CLO1 and CLO2**
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; Enzymatic production of Lipolyzed milk fat. **Learning Activities:** *Seminar on enzymes applications in milk and milk products*	**CLO2, CLO3 and CLO4**
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 **Learning Activities:** *Group discussions on enzymes roles in quality improvement of fruits and meat products*	**CLO3 and CLO4**
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 **Learning Activities:** *Group discussions on enzymes usages in brewing and protein modification*	**CLO4 and CLO5**

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

Tools used:
PPT, YouTube Video, Google meet, NPTEL

Suggested readings

- Fellows, P. J.. *Food processing technology: principles and practice*. Woodhead publishing. (2022).

- J Boudrant, JM Woodley and R Fernandez-Lafuente, Parameters necessary to define an immobilized enzyme preparation. Process Biochemistry (2019).
- Pitcher, W. H. Immobilized enzymes for food processing. In *Immobilized enzymes for food processing* (pp. 15-54). CRC Press. (2019).
- 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).
- Pati, S., & Samantaray, D. P. Enzymes in Brewing and Wine Industries. In *Novel Food Grade Enzymes: Applications in Food Processing and Preservation Industries* (pp. 165-181). Singapore: Springer Nature Singapore. (2022).
- Sá, A. G. A., Moreno, Y. M. F., & Carciofi, B. A. M. Food processing for the improvement of plant proteins digestibility. *Critical reviews in food science and nutrition*, *60*(20), 3367-3386. (2020).
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- Wu, S., Snajdrova, R., Moore, J. C., Baldenius, K., & Bornscheuer, U. T. Biocatalysis: enzymatic synthesis for industrial applications. *Angewandte Chemie International Edition*, *60*(1), 88-119. (2021).

L	T	P	Cr
3	0	0	3

Course Code: FST.511
Course Title: Nutrition, Nutraceuticals and Functional Foods
Total Hours - 45

Course Learning Outcome (CLO):

The completion of this course will make students:

CLO1: To explain the terms important in nutrition science and to explain what are nutraceuticals and functional foods

CLO2: To develop/design a diet fulfilling requirements of nutrients by people of different age group

CLO3: To compare various constituents of foods for their nutraceutical and bioactive properties

CLO4: To analyze the effects of processing on health benefits of food-based nutraceuticals

CLO5: To give recommendations on application of latest processing technologies for isolation of nutraceuticals

CLO6: To formulate the diets that can reduce the risk of chronic diseases

Unit /Hours	Content	Mapping with CLO
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. **Learning Activities:** *Seminars on nutrition and nutraceuticals and group discussions on functions of foods*	**CLO1 and CLO2**

Unit II/ 11 hours	**Neutraceuticals:** 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). **Learning Activities:** *Seminars on health benefits and usages of nutraceutical compounds from foods*	**CLO3**
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. **Learning Activities:** *Group discussions on processing and effect of processing on nutraceutical compounds of foods*	**CLO4 and CLO5**
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 **Learning Activities:** *Seminars on health benefits effects of antioxidants, fibre, resistant starch, omega 3 oils and probiotics*	**CLO6**

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

Tools used:
PPT, YouTube Video, Google meet, NPTEL

Suggested readings

- C Galanakis, Nutraceutical and Functional Food Components: Effects of Innovative Processing Techniques. Academic Press (2017).
- Egbuna, C., & Dable-Tupas, G. Functional foods and nutraceuticals. *Springer Nature Switzerland AG, 1*, 1-632. (2020).
- Cicero, A. F., & Rizzo, M. (Eds.). *Nutraceuticals and Cardiovascular Disease: An Evidence-based Approach for Clinical Practice*. Springer Nature. (2021).
- G Subbulakshmi, Functional Foods and Nutrition, Daya Publishing House (2014).
- Gulati, K., Thokchom, S. K., Joshi, J. C., & Ray, A. Regulatory guidelines for nutraceuticals in India: an overview. *Nutraceuticals*, 1273-1280. (2021).

- Grabacki, S. T., Pathak, Y. V., & Joshi, N. H. (Eds.). *Marine-based Bioactive Compounds: Applications in Nutraceuticals*. CRC Press. (2022).
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- M SharmaNutrition 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)
- Galanakis, C. M. (Ed.). *Nutraceutical and functional food components: Effects of innovative processing techniques*. Academic Press. (2021).
- 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

Course Learning Outcome (CLO):
The completion of this course will enable students:

CLO1: To compare cereals and pseudocereals for physicochemical and morphological properties by making experiments
CLO2: To estimate and isolate major components of cereals
CLO3: To prepare bakery foods using different methods
CLO4: To give recommendations on the suitability of different wheat flours for bread making

S. No	Practical	Mapping with CLO
1	Identification and physical properties of various cereals and pseudocereals.	CLO1 and CLO2
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.	**CLO3 and CLO4**
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.

L	T	P	Cr
0	0	4	2

Course Code: FST.527
Course Title: Fruits and Vegetable Processing - Practical
Total Hours - 60

Course Learning Outcome (CLO):
The completion of this course will enable students:

CLO1: To relate the present problems of fruits and vegetables with their handling
CLO1: To develop and evaluate new products based of fruits and vegetables
CLO1: To organize various techniques involved in the shelf life extension of fresh produce based products
CLO1: To conclude the effect of processing on properties of fruits and vegetable products

S. No	Practical	Mapping with CLO
1	Morphological characteristics of fruits	**CLO1**
2	Preparation and analysis of syrups	
3	Determination of PLW by the use of different packaging materials and temperature (Low, high).	
4	Determination of chilling injury in seasonal fruit.	
5	Cut out examination of fruit cans	
6	Preparation and quality evaluation of fruit juice concentrates	**CLO2**
7	Preparation and quality evaluation of jam and jellies	
8	Preparation and quality evaluation of tomato juice, puree, ketchup.	
9	Preparation and quality evaluation of RTS, Squash, Cordial	
10	Study of sorting and grading in given seasonal fruits and vegetables	
11	Dehydration of fruits and vegetables	**CLO3 and CLO4**

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.530
Agripreneurship Development
Total Hours: 15

Course Learning Outcomes (CLO): On the completion of this course, the students will

CLO1: Understand the basic concepts of entrepreneur, entrepreneurship and its importance
CLO2: Aware of the issues, challenges and opportunities in entrepreneurship
CLO3: Be able to develop capabilities of preparing proposals for starting small businesses
CLO4: Know the availability of various institutional supports for making a new start-up

Unit/ Hours	Contents	Mapping with CLO
I 4 Hours	Introduction to entrepreneur and entrepreneurship; Characteristics and functions of entrepreneurs; Classification of entrepreneurs; Entrepreneurial opportunities in Agriculture Sector. **Learning Activities:** *Case study, Exercise on profiling of entrepreneurs, Peer discussion.*	**CLO1**
II 3 Hours	Women entrepreneurship; Role of entrepreneurship in economic development; Barriers to entrepreneurship; Forms of Business Ownership. **Learning Activities:** Case study, *Exercise on profiling of successful women entrepreneurs, Group discussion.*	**CLO2**
III 4 Hours	Sources of innovative opportunities; Pre-feasibility study; Sources of finance; Business plan. **Learning Activities:** *Exercise on business plan, Case study, Group discussion, Assignments.*	**CLO3**
IV 4 Hours	Government programmes for development of agri-entrepreneurship; Micro, Small and Medium Enterprises (MSME); Agri clinic and Agribusiness Centers Programme (ACABC); Startup India; MUDRA Yojana. **Learning Activities:** *Student presentations.*	**CLO4**

Suggested Readings:

1. Dandekar, V. M. and Sharma, V. K., 2016, Agri-Business and Entrepreneurship Development. Manglam Publications, New Delhi.
2. Desai, V., 2006, Entrepreneurship Development, Project formulation, Appraisal & Financing for Small Industry. Himalaya Publications, New Delhi.
3. Hisrich, R. D. and Peters, M. P., 2002, Entrepreneurship, Tata McGraw Hill.

4. Kaplan, J. M. and Warren, A. C., 2013, Patterns of Entrepreneurship Management, John Wiley & Sons; 4th revised edition.
5. Nandan, H., 2007, Fundamentals of Entrepreneurship Management, Prentice Hall.

Modes of transaction:

- Classroom lecture
- Problem solving practices
- Group discussion
- Self-learning
- Peer learning
- Games and Role plays
- Lecture-cum-demonstration
- Brainstorming
- Case study discussion and analysis

Tools used:

MS Office- Word, Excel, PPT, Case Study, Google drive, Videos, Google meet, Google forms/docs, WhatsApp, e-content, e-learning open sources, Journals, Publications.

L	T	P	Cr
3	0	0	3

Course Code: FST.510
Course Title: Food Biotechnology
Total Hours - 45

Course Learning Outcome (CLO):

The course will enhance efficiency of students to:

CLO1: To explain what is food biotechnology and how is this relevant to food processing
CLO2: To explain the current and future prospects of food biotechnology and its applications in the food industry
CLO3: To apply the fermentation technology for production of compounds relevant in food industry
CLO4: To critically evaluate and recommend the applications of genetically modified foods

Unit /Hours	Content	Mapping with CLO
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.; Structure of DNA and RNA. Recombinant DNA Technology. **Learning Activities:** *Assignments on above topics*	**CLO1 and CLO2**
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 **Learning Activities:** *Term paper based discussions*	**CLO3**

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 **Learning Activities:** *Seminars on these topics*	**CLO3**
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. **Learning Activities:** *Group discussions on GM Foods*	**CLO4**

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

Tools used:
PPT, YouTube Video, Google meet, NPTEL

Suggested readings

- Perlmutter, B.A. (Ed.). Integration and Optimization of Unit Operations: Review of Unit Operations from R&D to Production: Impacts of Upstream and Downstream Process Decisions. (2022).
- Oyewole, O., Kareem, S., & Adeleye, T. Biotechnologies/fermentation technologies for large-scale industrial enzyme production for the food and beverage industry. *Fermentation and Algal Biotechnologies for the Food, Beverage and Other Bioproduct Industries*, 41-67. (2022).
- Chisti, Y., & Moo-Young, M. Fermentation technology, bioprocessing, scale-up and manufacture. In *Biotechnology* (pp. 177-222). CRC Press. (2020).
- PS Panesar and SS Marwaha, Biotechnology in Agriculture and Food Processing. CRC Press (2013).
- Díaz-Montes, E., & Castro-Muñoz, R. Separation of Bioactive Compounds from Fermentation Broths Using Membranes. In *Membrane Separation of Food Bioactive Ingredients* (pp. 281-307). Cham: Springer International Publishing. (2022).
- Singh, P., & Kumar, S. (2019). Microbial enzyme in food biotechnology. In *Enzymes in food biotechnology* (pp. 19-28). Academic Press.
- 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

Course Learning Outcome (CLO):

The course completion will enable students:

CLO1: To relate egg, poultry and meat composition with quality of products based on them
CLO2: To compare egg, poultry and meat for nutritive properties and stability
CLO3: To utilize eggs and egg products in formulated foods
CLO4: To analyse the relationship between pre and post-mortem changes in meats
CLO5: To justify the need of food safety management and hygiene in meat industry

Unit /Hours	Content	Mapping with CLO
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) **Learning Activities:** *Seminars on egg structure, compositions, nutritive value and components responsible for functionality in food formulation*	**CLO1 and CLO2**
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. **Learning Activities:** *Group discussion on nutritive value and processing of muscle foods*	**CLO2 and CLO3**
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. **Learning Activities:** *Group discussion on processing of muscle foods*	**CLO2 and CLO3**
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. **Learning Activities:** *Seminars and assignments on hazards, sanitation and hygiene in meat processing industry*	**CLO4 and CLO5**

Transactional Modes:

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

Suggested readings

- 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
Course Title: Food Additive and Toxins
Total Hours - 45

L	T	P	Cr
3	0	0	3

Course Learning Outcomes (CLO):
The course will enhance efficiency of learners:

CLO1: To explain what is food toxicology and how is this relevant to food processing
CLO2: To explain various food additives and to recommend their applications in different foods
CLO3: To critically evaluate foods for the presence of natural and derived various toxins
CLO4: To recommend the processing for eliminating the natural and derived toxins in foods

Unit /Hours	Content	Mapping with CLO
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 **Learning Activities:** *Assignments on above topics*	**CLO1**
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 **Learning Activities:** *Term paper based discussions on the topics*	**CLO2**
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 **Learning Activities:** *Group discussions and seminars on food additives*	**CLO2**
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. **Learning Activities:** *Group discussions and seminars on toxins in foods*	**CLO3 and CLO4**

Transactional Modes:

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

Tools used:
PPT, YouTube Video, Google meet, NPTEL

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).

Course Code: FST.531
Course Title: Technology of spices, plantation products and chocolate
Total hours - 30

L	T	P	Cr
2	0	0	2

Course Learning Outcome (CLO):
The course completion will make students:
CLO1: To identify spices forms and chocolate confectionary and understand how they are processed.
CLO2: To compare different spices for composition, health benefits, functions and applications.
CLO3: To critically analyze the effect of processing (milling, cryo-milling, fumigation and irradiation) on the properties of spices.
CLO4:. To study the technology in of tea and coffee manufacturing
CLO5: To recommend about the health effects of spices,Plantations and chocolates.
CLO6: To maximize storage life and quality of spices, Plantations, and chocolate.

Unit /Hours	Content	Mapping with CLO
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 **Learning Activities:** *Seminars on major spices*	**CLO1 and CLO2**
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; FSSAI norms for spices and governing body **Learning Activities:** *Group discussions on applications of spice products*	**CLO3**
Unit III/11 hours	**Tea:** Occurrence, chemistry of constituents; harvesting; types of tea - green, oolong and CTC; chemistry and technology of CTC	**CLO4**

	tea; manufacturing process for green tea and black tea manufacture; instant tea manufacture; quality evaluation and grading of tea. Coffee: Occurrence, chemical constituents; harvesting, fermentation of coffee beans; changes taking place during fermentation; drying; roasting; process flow sheet for the manufacture of coffee powder; instant coffee technology; chicory chemistry; quality grading of coffee **Learning Activities:** *Group discussions on tea and coffee health effects*	
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 **Learning Activities:** *Seminars on chocolate processing*	**CLO5 and CLO6**

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

Tools used:
PPT, YouTube Video, Google meet, NPTEL

Suggested readings

- Banerjee B. 2002. Tea Production and Processing. Oxford Univ. Press.
- Minifie BW. 1999. Chocolate, Cocoa and Confectionery Technology. 3rd Ed. Aspen Publ.
- NIIR. 2004. Handbook on Spices. National Institute of Industrial Research Board, Asia Pacific Business Press Inc.
- 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).

Course Code: FST.517
Course Title: Processing of Legumes and Oilseeds
Total Hours - 45

L	T	P	Cr
3	0	0	3

Course Learning Outcome (CLO):
The completion of this course will enable learners:

CLO1: To relate chemical composition of legumes and oilseeds with their structure
CLO2: To compare different legumes and oilseeds for their processing and applications in food industry
CLO3: To effectively utilize legumes and oilseeds in the production of edible oil, protein and starch-rich products
CLO4: To develop/ design technologies /processing methods for improving the nutritional properties of pulses and oilseeds

Unit /Hours	Content	Mapping with CLO
Unit I/11 hours	**Legumes:** Legumes vs pulses; Production, Classification; Composition, Anatomical structure; Traditional and novel applications; Anti-nutritional/Bioactive constituents in legumes/pules 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. Digestibility of legume proteins and methods to improve it. **Learning Activities:** *Group discussions and seminars on the legumes and their constituents*	**CLO1**
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. **Learning Activities:** *Group discussions and seminars on the legumes processing*	**CLO2 and CLO3**
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. **Learning Activities:** *Group discussions on major sources of edible oils and their composition and processing*	**CLO2 and CLO3**

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 **Learning Activities:** *Term paper based discussions on refining of oil/fats and by-product utilization*	**CLO4**

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

Tools used:
PPT, YouTube Video, Google meet, NPTEL

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).
- RY Yada, Proteins in Food Processing (Second Edition). Woodhead Publishing, Elsevire, Oxford, UK (2018).

Course Code: FST.551
Course Title: Processing of Milk and Milk Products
Total Hours - 45

L	T	P	Cr
3	0	0	3

Course Learning Outcome (CLO):
The course will make students able:

CLO1: To relate composition with physicochemical and nutritional properties of milk
CLO2: To explain processing technologies, regulations, standards, specifications of milk and milk products
CLO3: To develop indigenous and western dairy products
CLO4: To analyse and compare the dairy practices in India and developed world
CLO5: To critically evaluate and summarize dairy sector problems in India

Unit /Hours	Content	Mapping with CLO

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 **Learning Activities:** *Seminars on the above topics*	**CLO1**
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) **Learning Activities:** *Term paper based discussion on milk and milk products processing*	**CLO2**
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 **Learning Activities:** *Term paper based discussion on products processing*	**CLO2 and CLO3**
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. FSSAI norms for Adulteration in milk **Learning Activities:** *Assignments and Term paper based discussion on products processing*	**CLO4 and CLO5**

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

Tools used:
PPT, YouTube Video, Google meet, NPTEL

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
Total hours - 45

L	T	P	Cr
3	0	0	3

Course Learning Outcome (CLO):

The course will enable students:

CLO1: To relate quality control with food safety in food industry

CLO2: To explain various sensory characteristics and quality attributes of foods of animal and plant origin

CLO3: To make use of sensory analysis principles, cleaning and sanitation in food processing

CLO4: To justify the need of laws applicable in food industry in India to ensure manufacture of safe of food products

CLO5: To organize food safety management and quality control systems for audit and certification

Unit /Hours	Content	Mapping with CLO
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 **Learning Activities:** *Seminars on food safety and quality control*	**CLO1**
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 **Learning Activities:** *Seminars and group discussions on assessment of chemical and sensory quality attributes of foods*	**CLO2 and CLO3**
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	**CLO4**

	Regulation/Authorities (WTO, SPS, TBT Bilateral agreement, Codex Alimentarius, ISO) **Learning Activities:** *Term paper based discussions on the topics*	
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.; Latest five years amendments in FSSAI. Food Safety Modernization Act; Food Safety Index **Learning Activities:** *Group discussions on the topics*	**CLO5**

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

Tools used:
PPT, YouTube Video, Google meet, NPTEL

Suggested readings

- A Kramer and BA Twigg, Quality Control for the Food Industry. AVI Publishing Company (1990).
- A Vasconcellos, Quality Assurance for the Food Industry: A Practical Approach. CRC Press (2003).
- CW Wrigley Cereal Grains: Assessing and Managing Quality Woodhead Publishing (2015).
- H Lawless, Quantitative Sensory Analysis: Psychophysics Models and Intelligent Design. Wiley Blackwell (2013).
- K Kapiris, Food Quality. Intech Publisher (2014).
- 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 Otles, 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).

Course Code: FST.553
Course Title: Milk and Milk Processing - Practical
Total Hours - 60

L	T	P	Cr
0	0	4	2

Course Learning Outcome (CLO):
The completion of the course will enable learners:

CLO1: To conduct qualitative tests on milk
CLO2: To check adulteration of milk and milk products
CLO3: To prepare indigenous and western dairy products
CLO4: To practically evaluate important quality characteristics of dairy products

S.No	Practical	Mapping with CLO
1	Platform tests of milk (Acidity, Clot on boiling, Alcohol test, MBR test).	**CLO1**
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.	**CLO1**
6	Preparation and quality evaluation of butter.	**CLO3 and CLO4**
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

Course Learning Outcome (CLO):
The course completion will make students to:

CLO1: List various tests for quality analysis of milk, cereals, pulses, fats, egg, etc.
CLO2: Determine physicochemical properties of different food products
CLO3: Make use of sensory tests for quality evaluation of foods
CLO4: Analyse and evaluate different foods for adulterations
CLO5: Effectively plan quality analysis/testing system in a food industry

S.No	Practical	Mapping with CLO
1	Test for assessment of quality of milk - estimation and fat and SNF	**CLO1 and CLO2**
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	

L	T	P	Cr
3	0	0	3

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	**CLO3 and CLO4**
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.528
Course Title: Fermented Foods
Total Hours - 45

Course Learning Outcome (CLO):
The course will make students:

CLO1: To explain importance of microorganisms in food industry
CLO2: To compare different types of fermentations and their applications in food industry
CLO3: To discuss the beneficial role of fermentation technology in food preparation
CLO4: To develop/design different types of dairy, fruits, vegetables, meat-based indigenous and western fermented products
CLO5: To adapt the skill of introducing indigenous fermented food products into the market

Unit /Hours	Content	Mapping with CLO
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) **Learning Activities:** *Seminars and group discussions on the topics*	**CLO1**
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.	**CLO2 and CL03**

	Soy-based fermented foods: miso, natto, temph, soy sauce, sofu, etc. **Learning Activities:** *Seminars and group discussions on the topics*	
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 **Learning Activities:** *Term paper based discussions on application of fermentation in food processing*	**CLO3 and CL04**
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 **Learning Activities:** *Term paper based discussions on application of fermentation in food processing*	**CLO4 and CL05**

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

Tools used:
PPT, YouTube Video, Google meet, NPTEL

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).

Course Code: FST.529
Course Title: Beverages Technology
Total Hours - 45

L	T	P	Cr
3	0	0	3

Course Learning Outcome (CLO):
The completion of this course will make students:

CLO1: To have knowledge of processing of different beverages
CLO2: To explain the ingredients and production steps in manufacturing of beverages
CLO3: To make efficient use of raw materials and technologies in beverage industry

CLO4: To give recommendations about nutritional properties of different alcoholic and non-alcoholic beverages

CLO5: To design/develop technologies for quality improvement of beverages

Unit /Hours	Content	Mapping with CLO
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 **Learning Activities:** *Seminars and group discussions on the topics*	**CLO1 and CLO2**
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 evaluation **Learning Activities:** *Seminars and group discussions on processing of tea and coffee*	**CLO2 and CLO3**
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 **Learning Activities:** *Term paper based discussions on processing of cocoa and beer*	**CLO2 and CLO3**
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 **Learning Activities:** *Seminars and term paper based discussions on processing of alcoholic beverages*	**CLO4 and CLO5**

Transactional Modes:

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

Tools used:

PPT, YouTube Video, Google meet, NPTEL

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).

Course Code: FST.554
Course Title: Food Hygiene, By-Products and Waste Management
Total Hours - 45

L	T	P	Cr
3	0	0	3

Course Learning Outcome (CLO):

The course will enable learners:

CLO1: To understand importance of hygiene and sanitation differentiate between food by-products and waste

CLO2: To recommend methods for efficient by-product utilization from grain, fruit, vegetable, sugar, meat processing industry, etc.

CLO3: To critically evaluate the effect of proper and incomplete treatment of food wastes

CLO4: To recommend and develop systems for wastes from different food industries

Unit /Hours	Content	Mapping with CLO
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 **Learning Activities:** *Seminars on the topics*	**CLO1**
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 **Learning Activities:** *Group discussions on by-product utilization*	**CLO2 and CLO3**
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 **Learning Activities:** *Term paper based discussions on by-product utilization*	**CLO2 and CLO3**
Unit IV/ 12 hours	**Food Waste management:** Types of food processing wastes (oil, fruit juice, cereal, meat waste, dairy and food packaging);	**CLO4**

	Methods for waste treatment (physical, chemical and biological methods); Biomethanation and biocomposting; Incineration; Efficient combustion technology **Learning Activities:** *Assignments and term paper based discussions on waste management*	

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

Tools used:
PPT, YouTube Video, Google meet, NPTEL

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).

Course Code: FST.XXX
Course Title: Techniques in Food Analysis
Total Hours - 45

L	T	P	Cr
3	0	0	3

Course Learning Outcome (CLO):
The completion of this course will enable learners to:

CLO1: Students will have a thorough understanding on the working principle and instrumentation of various techniques used in food analysis.
CLO2: The students will know the importance of various methods to identify any malfunction aspect of food.
CLO3: To develop the skills on the quantification technique of various components, allergens present in food products.
CLO4: students can critically appreciate the importance of point of care devices in food analysis and critically analyse the HACCP protocol.

Unit/Hours	Content	Mapping with CLO
I/11 hours	Nature and Concept of Food analysis, Basic instrumentation: Principle for pH meter, Dialysis, ultra filtration, Reverse osmosis. Centrifugation: Principle, Theory (RCF, Sedimentation coefficient) and types of Rotors, Ultracentrifugation, Calorimetry: Bomb calorimeter, Principle of Rheological Analysis- Rheological parameters, rheological methods, instruments and application, Texture profile analysis, Densimetry, Refractometry, *food preservation* **Learning Activities:** *Seminars on Principle of Rheological Analysis*	**CLO1 and CLO2**
II/11 hours	Spectroscopic analysis of food components, Principle, instrumentation & application of Colorimetric (colorimeter,colourflex), UV-Vis spectrophotometer,	**CLO2 and CLO3**

	Spetroflurometer, IR, Atomic Absorption Spectroscopy, Mass spectroscopy, NMR and ESR. **Learning Activities:** *Seminars on Spectroscopic analysis of food components*	
III/11 hours	Chromatography: Theory & Principle, chromatographic parameter (partition coefficient, capacity factor, retention & dead time, Resolution& their calculation),components of chromatography & types (paper, thin layer, partition) Advance chromatography: GC,HPLC,HPTLC(principle, instrumentation &application). Separation technique & analysis: Electrophoresis: Paper & gel electrophoresis, PAGE, iso-electric focusing, 2D electrophoresis, Immuno electrophoresis. **Learning Activities:** *Student seminars on components of chromatography & types*	**CLO3 and CLO4**
IV/12 hours	Immuno-techniques: Principle, antigen-antibody interaction, enzymatic immune assay- ELISA and its types. Different immuno techniques of antigen detection in food sample. **Learning Activities:** *Group discussions on importance of* Different immuno techniques of antigen detection in food sample.	**CLO4**

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

Tools used:
PPT, YouTube Video, Google meet, NPTEL

Suggested readings

- Bioinstrumentation by Veerakumari,MJP Publisher, 06-Jun-2019
- Biochemical & Molecular biology techniques. byWilson& Walker, Cambridge University Press Publication date: 19 April 2018
- Food Chemistry, Aurand, L.W. and Woods, A.E. 1973.AVI, Westport.Guo, X., Lin, H., Xu, S., & He, L. Recent advances in spectroscopic techniques for the analysis of microplastics in food. Journal of Agricultural and Food Chemistry, 70(5), 1410-1422.(2022)
- Nollet, L. M., & Munjanja, B. K. (Eds.). Ambient mass spectroscopy techniques in food and the environment. CRC Press.(2019).
- Wu, L., Li, G., Xu, X., Zhu, L., Huang, R., & Chen, X. . Application of nano-ELISA in food analysis: Recent advances and challenges. TrAC Trends in Analytical Chemistry, 113, 140-156.(2019)
- Wang, S., Chen, H., & Sun, B. Recent progress in food flavor analysis using gas chromatography–ion mobility spectrometry (GC–IMS). Food Chemistry, 315, 126158.(2020).
- Sontag, G., Pinto, M. I., Noronha, J. P., & Burrows, H. D. Analysis of food by high performance liquid chromatography coupled with coulometric detection and related techniques: A review. *Journal of agricultural and food chemistry*, *67*(15), 4113-4144.(2019).
- An Introduction to Practical Biochemistry. Plummer, D.T. 1971Mc-Graw Hill Pub.Co., New York.
- A Manualof Laboratory Techniques. Raghuramulu, N., Madhavan Nair, K., and Kalyanasundaram, S. Ed.1983.National Institute of Nutrition, ICMR, Hyderabad

Course Code: FST.504
Course Title: Nutrition and Specialty Foods (Value-added)

L	T	P	Cr
2	0	0	2

Total Hours - 30

Course Learning Outcome (CLO):

The course completion will make students:

CLO1: To explain terms important in nutrition science.

CLO2: To compare various constituents of foods for nutritional properties.

CLO3: To compare therapeutic and speciality foods.

CLO4: To formulate and recommend diets for reducing the risk of chronic diseases.

Unit /Hours	Content	Mapping with CLO
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 **Learning Activities:** *Group discussion on differences between nutrients and nutraceuticals*	**CLO1**
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. **Learning Activities:** *Seminars on nutritive value of foods*	**CLO2**
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 **Learning Activities:** *Discussions on therapeutic properties of nutrients*	**CLO3**
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 **Learning Activities:** *Seminars on disease-preventing roles of food constituents*	**CLO4**

Transactional Modes:

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

Tools used:

PPT, YouTube Video, Google meet, NPTEL

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
2	0	0	2

Course Code: FST.XXX
Course Title: FOOD PRODUCT DEVELOPMENT AND QULAITY EVALUATION
Total Hours - 30
Course Learning Outcome (CLO):

The completion of this course will enable learners to:

CLO1: Students who complete this course will be able to understand and comprehend the basics of Market survey and its importance
CLO2: This course will help them in Recipe Development; use of traditional recipe and modification
CLO3: The course will also enable them to learn selection of materials/ingredients for specific purposes; modifications for production on large scale, cost effectiveness
CLO4: The Students will develop skills in different techniques and tests in product development and comparison of market samples.
CLO5: Students will be able to demonstrate the ability to develop packaging systems for maximum stability and cost effectiveness;

Unit/Hours	Content	Mapping with CLO
I/11 hours	**FOOD NEEDS & CONSUMER PREFERENCE -** Market survey and its importance in; designing a questionnaire to find consumer needs for a product or a concept. Developing a product to meet the requirements. Product life cycle. Creating brand value for the product. The SWOT analysis. **Learning Activities:** *Seminars on Methods of designing a questionnaire*	**CLO1 and CLO2**
II/11 hours	**DESIGNING NEW PRODUCTS -** New Food Product Development (NPD) process and activities, The Stage-Gate model NPD success factors, new product design, food innovation case studies, market-oriented NPD methodologies, organization for successful NPD; Recipe Development; use of traditional recipe and modification; involvement of consumers, chefs and recipe experts;	**CLO2 and CLO3**

	selection of materials/ingredients for specific purposes; modifications for production on large scale, cost effectiveness and return on investment, nutritional needs or uniqueness; use of novel food ingredients and novel processing technologies. **Learning Activities:** *Seminars on Recipe Development; use of traditional recipe and modification*	
III/11 hours	**STANDARDIZATION & LARGE SCALE PRODUCTION -** Process design, equipment needed; establishing process parameters for optimum quality; Sensory Evaluation; Lab requirements; different techniques and tests; statistical analysis; application in product development and comparison of market samples; stages of the integration of market and sensory analysis. **Learning Activities:** *Student seminars on different techniques and tests in product development and comparison of market samples*	**CLO3 and CLO4**
IV/12 hours	**QUALITY, SAFETY & REGULATORY ASPECTS -** Product Stability; evaluation of shelf life; changes in sensory attributes and effects of environmental conditions; accelerated shelf life determination; developing packaging systems for maximum stability and cost effectiveness; interaction of package with food; Regulatory Aspects; whether standard product and conformation to standards; Approval for Proprietary Product. Outcomes and activities in product commercialization, Pre-launch trial, Steps in product launch, Evaluation of the Launch, product performance testing, developing test market strategies, Case Studies of some successes and failures, food choice models and new product trends. **Learning Activities:** *Group discussions on importance of Written communication*	**CLO4 and CLO5**

Transactional Modes:

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

Tools used:

PPT, YouTube Video, Google meet, NPTEL

Suggested readings

- Firouz, M. S., Mohi-Alden, K., & Omid, M. A critical review on intelligent and active packaging in the food industry: Research and development. *Food Research International, 141,* 110113. (2021).
- Granato, D., Barba, F. J., Bursać Kovačević, D., Lorenzo, J. M., Cruz, A. G., & Putnik, P. Functional foods: Product development, technological trends, efficacy testing, and safety. *Annual review of food science and technology*, *11*, 93-118. (2020).

- Methods for developing new food products An Instructional Guide. Methods-for-Developing-New-Food-Products-preview.pdf (destechpub.com)
- Introduction To Food Product Development Introduction to Food Product Development – Food Product Development Lab Manual (pressbooks.pub)
- The consumer in product development, Food Product Development - Chapter 5 - The consumer in product development (nzifst.org.nz)

L	T	P	Cr
0	0	4	8

Course Code: FST.600
Course Title: Dissertation Part I
Course Learning Outcome (CLO):
The course completion will develop higher cognitive skills:

CLO1: To apply the scientific method of research for solving food science or industrial problems with quantitative reasoning skills
CLO2: 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.
Mapping with course learning outcome: CLO1 and CLO2

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

Course Code: XXXX
Course Title: Individual Education Plan/Tutorial Remedial Class
Total Hours - 02

L	T	P	Cr
0	2	0	0

Individually each faculty clear the doubts of students on weekly basis.

L	T	P	Cr
0	0	40	20

Course Code: FST.601
Course Title: Dissertation Part II
Course Learning Outcome (CLO):
The course completion will develop higher cognitive skills:

CLO1: To apply the scientific method of research for solving food science or industrial problems with quantitative reasoning skills
CLO2: 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.

Mapping with course learning outcome: CLO1 and CLO2

Transactional Modes:

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