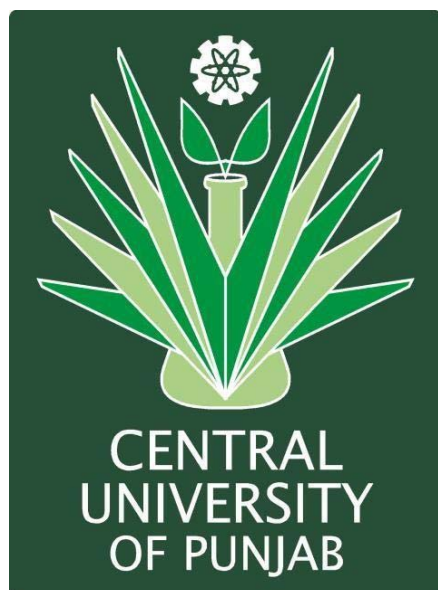


**CENTRAL UNIVERSITY OF PUNJAB, BATHINDA**



**M. Sc. Food Science and Technology**

**Batch 2022**

**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

| <b>Semester I</b>   |   |                       |       |   |   |           |
|---|---|-----------------------|-------|---|---|-----------|
| Course Code   | Course Title                              | Type of course        | Hours |   |   | Credits   |
|   |   |                       | L     | T | P |           |
| FST.506   | Food Chemistry                            | Core                  | 3     | 0 | 0 | 3         |
| FST.521   | Food Processing and Preservation          | Core                  | 3     | 0 | 0 | 3         |
| FST.507   | Food Packaging                            | Core                  | 3     | 0 | 0 | 3         |
| FST.508   | Food Chemistry - Practical                | Skill-based           | 0     | 0 | 4 | 2         |
| XXX   | Interdisciplinary Course                  | IDC                   | 2     | 0 | 0 | 2         |
| CST.501   | Computer Applications                     | Compulsory foundation | 2     | 0 | 0 | 2         |
| CST.502   | Computer Applications - Practical         | Skill-based (CF)      | 0     | 0 | 4 | 2         |
| STA.503   | Statistics for Sciences                   | Compulsory foundation | 2     | 0 | 0 | 2         |
| <b>Students to opt for any one of following discipline elective courses</b> |   |                       |       |   |   |           |
| 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 |           |
| <b>Total credits</b>  |   |                       |       |   |   | <b>22</b> |

| <b>Semester II</b>  |  |                         |       |   |   |           |
|---|--|-------------------------|-------|---|---|-----------|
| 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 | 1     | 0 | 0 | 1         |
| XXX   | Value added course                               | Value-added             | 2     | 0 | 0 | 2         |
| <b>Students to opt for any one of following discipline elective courses</b> |  |                         |       |   |   |           |
| 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 |           |
| <b>Total</b>  |  |                         |       |   |   | <b>22</b> |
| <b>Value-added course to be offered by the Department</b>                   |  |                         |       |   |   |           |
| FST.504   | Nutrition and Specialty Foods                    | Value-added             | 2     | 0 | 0 | 2         |

| Semester III  |  |                       |       |   |   |           |
|---|--|-----------------------|-------|---|---|-----------|
| Course Code   | Course Title                                   | Type of course        | Hours |   |   | Credits   |
|   |  |                       | L     | T | P |           |
| FST.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         |
| FST.577   | Competitive Exam Preparatory Course            | Discipline enrichment | 2     | 0 | 0 | 2         |
| <b>Students to opt for any one of following discipline elective courses</b> |  |                       |       |   |   |           |
| FST.528   | Fermented Foods                                | Discipline elective   | 3     | 0 | 0 | 3         |
| FST.529   | Beverage Technology                            | Discipline elective   | 3     | 0 | 0 |           |
| FST.554   | Food Hygiene, By-Products and Waste Management | Discipline elective   | 3     | 0 | 0 |           |
| FST.600   | Dissertation Part I                            | Skill-based           | 0     | 0 | 8 | 4         |
| <b>Total</b>  |  |                       |       |   |   | <b>22</b> |

| 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        |
| <b>Total</b> |                      |                |       |   |    | <b>20</b> |

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

### Credit distribution

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

**DE:** Discipline Elective; **ID:** Interdisciplinary; **SB:** Skill-based; **CF:** Compulsory foundation (DEC-Discipline Enrichment; 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 content of that course should match a minimum 70%. Mapping will be done by the department and students will be informed accordingly.

### Evaluation criteria

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

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

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

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

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

**A. Continuous Assessment (Course-wise): [25 Marks]**

Two or more of the given methods (Surprise Tests, in-depth interview, unstructured interview, Jigsaw method, Think-Pair Share, Students Teams Achievement Division (STAD), Rubrics, portfolios, case based evaluation, video based evaluation, Kahoot, Padlet, Directed paraphrasing, Approximate analogies, one sentence summary, Pro and con grid, student generated questions, case analysis, simulated problem solving, media assisted evaluation, Application cards, Minute paper, open book techniques, classroom assignments, homework assignments, term paper).

**B. Mid Semester Test: Based on Subjective Type Test [25 Marks]**

**C. End-Term Exam: 70% subjective type and 30% objective type [50 Marks].**

The objective type will include one word answers, fill-in the blank, sentence completion, true/false, MCQs', and matching, analogies. The subjective type will include a very short answer (1-2 lines), short answer (one paragraph), essay type with restricted response, and essay type with extended response.

| 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   | <p><b>Water:</b> Function; Types; Methods for measurement of total and available water in foods.</p> <p><b>Carbohydrates:</b> 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</p> <p><b>Learning Activities:</b> <i>Group discussions on role of water in food preservation</i></p>           | <b>CLO1 and CLO2</b> |
| II/11 hours  | <p><b>Proteins:</b> 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</p> <p><b>Learning Activities:</b> <i>Seminars on nutritive and functional properties of food proteins</i></p>   | <b>CLO3</b>          |
| III/11 hours | <p><b>Lipids:</b> 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</p> <p><b>Learning Activities:</b> <i>Student seminars on rancidity and reversion of oils/fats</i></p>  | <b>CLO3 and CLO4</b> |
| IV/12 hours  | <p><b>Vitamins and minerals:</b> 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.</p> <p><b>Colour of foods:</b> Chlorophylls, curcumin, betalains, carotenoids, anthocyanins, etc.; Enzymatic and Non-enzymatic browning in foods.</p> <p><b>Learning Activities:</b> <i>Group discussions on importance of vitamins, minerals and natural food colourants</i></p> | <b>CLO4 and CLO5</b> |

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

| L | T | P | Cr |
|---|---|---|----|
| 3 | 0 | 0 | 3  |

**Course Code: FST.521**

**Course Title: Food Processing and Preservation**

**Total Hours - 45**

**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 |
|------------------------|---|------------------|
| <b>Unit I/12 hours</b> | <p><b>Introduction:</b> Status of food processing - India <i>vs</i> developed world; Principles of food preservation; Causes of food deterioration; Water activity and its relation with food spoilage</p> <p><b>Processing and preservation by heat:</b> Heat resistance of microorganisms; Protective effect of</p> | <b>CLO1</b>      |

|                          |   |                      |
|--------------------------|---|----------------------|
|                          | food constituents; Blanching; Pasteurization; Sterilization and UHT processing; Effect on foods<br><b>Learning Activities:</b> <i>Group discussions on importance of food processing and preservation</i>   |                      |
| <b>Unit II/11 hours</b>  | <b>Processing and preservation by low temperature:</b> Refrigeration vs Freezing; Refrigeration system; Freezing curve; Factors affecting freezing rate; Freezing methods and equipment; Effects on foods<br><b>Processing and preservation by dehydration:</b> Drying curve; Drying methods and equipment; Changes in food due to drying; Intermediate moisture foods (IMF)<br><b>Learning Activities:</b> <i>Seminars on use of refrigeration, freezing and drying in food processing</i> | <b>CLO2</b>          |
| <b>Unit III/10 hours</b> | <b>Novel and emerging technologies for food preservation:</b> 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<br><b>Learning Activities:</b> <i>Group discussions on advantages of non-thermal over thermal techniques</i>   | <b>CLO3 and CLO4</b> |
| <b>Unit IV/12 hours</b>  | <b>Concentration:</b> Methods; Equipment; Changes in Food during concentration<br><b>Irradiation in food preservation:</b> Source; Dose; Direct and indirect effects responsible for death/inactivation of microorganisms; Effect on foods<br><b>Learning Activities:</b> <i>Seminars on irradiation preservation of foods</i>  | <b>CLO3 and CLO4</b> |

**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).
- DW Sun (2020) Thermal food processing new technology and quality issues, CRC Press.
- F Chemat, Green Food Processing Techniques: Preservation Transformation and Extraction, Academic Press (2019).
- G Saravakos and AK Kostaropoulos, Handbook of Food Process Equipment. Springer (2016).
- GV Barbosa-canovas and Gould GW, Innovation in Food Processing. CRC Press (2017).
- HS Ramaswamy and M Marcotte, Food Processing Principle and Application. Taylor and Francis (2006).
- HW Xiao et al., Recent developments and trends in thermal blanching - A comprehensive review. Information Processing in Agriculture. Volume 4, 101-127 (2017).
- J Boye, Green Technology in Food Production, CRC Press (2012).



- J. Ahmed, Novel Food Processing, CRC Press (2018).
- JS Smith and YH Hui, Food Processing. Wiley (2014).
- K Kai, Innovative Food Processing Technologies. WP Publisher (2016).
- M Regier, The Microwave Processing of Foods. Academic Press, (2017).
- MC Knirsch (2010) Ohmic heating—a review. Trends in Food Science & Technology, 21, 436-441.
- NN Potter, Food Science. CBS Publishers (2007).
- P Fellows, Food Processing Technology Principles and Practice. CRC Press (2005).
- P Putnik, JM Lorenzo, FJ Barba et al., Novel food processing and extraction technologies of high-added value compounds from plant materials. Foods, 7(7), 106 (2018).
- RL Shewfelt, Introducing Food Science. CRC (2013).
- S Edelstein, Food Science, Jones & Bartlett Learning (2018).
- T Varzakas and C Tzia, Handbook of Food Processing. CRC Press (2016).

**Course Code: FST.507**

**Course Title: Food Packaging**

| L | T | P | Cr |
|---|---|---|----|
| 3 | 0 | 0 | 3  |

**Total Hours - 45**

**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  | <p><b>Introduction:</b> Definition; Package environment; Functions of packaging; Importance and scope of packaging; Classification of packages; Labelling laws</p> <p><b>Glass as packaging material:</b> 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</p> <p><b>Learning Activities:</b> <i>Seminars on importance of packaging and advantages of glass as a package</i></p>   | <b>CLO1 and CLO2</b> |
| Unit II/11 hours | <p><b>Metal packaging materials:</b> 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</p> <p><b>Paper and paper-based packaging materials:</b> 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</p> <p><b>Learning Activities:</b> <i>Group discussions on application of metals and papers in food packaging</i></p> | <b>CLO2 and CLO3</b> |

|                          |  |                      |
|--------------------------|--|----------------------|
| <b>Unit III/11 hours</b> | <b>Plastic and plastic-based packaging materials:</b><br>Classification of polymers; Properties and application of different plastics; Laminates: Types and properties. Coating on paper and films; Types and methods of coating<br><b>Aseptic packaging:</b> Definition; Reasons of aseptic packaging; Sterilization of packages and food contact surfaces; System of aseptic packaging; Packaging of microwavable foods; Retortable pouch technology<br><b>Learning Activities:</b> <i>Group discussions on advantages and disadvantages of plastics in food packaging</i>   | <b>CLO2 and CLO3</b> |
| <b>Unit IV/11 hours</b>  | <b>Mechanical and functional tests on packages:</b><br>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.<br><b>Packaging of specific foods:</b> 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).<br><b>Learning Activities:</b> <i>Seminars on testing of packaging materials</i> | <b>CLO4 and CLO5</b> |

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

|          |          |          |           |
|----------|----------|----------|-----------|
| <b>L</b> | <b>T</b> | <b>P</b> | <b>Cr</b> |
| 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.                               | <b>CLO1 and CLO2</b> |
| 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.  | <b>CLO3</b>          |
| 9     | Determination of acid value and saponification value of fat/oil.                                  | <b>CLO4</b>          |
| 10    | Determination of total phenolic content and antioxidant activities of plant foods.                |                      |
| 11    | Study methods for eliminating enzymatic browning of fruits and vegetables                         |                      |
| 12    | Determination of refractive index of liquid foods.  |                      |

**Transactional Modes:**

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

**Course Code: CST.501**

| L | T | P | Cr |
|---|---|---|----|
| 2 | 0 | 0 | 2  |

**Course Title: Computer Applications**

**Total Hours - 30**

**Course Learning outcome (CLO):**

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

**CLO1:** Use different operating system and their tools easily.

**CLO2:** Understand networking and internet concepts.

**CLO3:** Use word processing software, presentation software, spreadsheet software and latex.

**CLO4:** Use computers in every field like teaching, industry and research.

| Unit /Hours          | Content  | Mapping with CLO     |
|----------------------|--|----------------------|
| Unit I/<br>8 hours   | <b>Computer Fundamentals:</b> Introduction to Computer, Input devices, Output Devices, Memory (Primary and Secondary), Concept of Hardware and Software, C.P.U., System bus, Motherboard, Ports and Interfaces, Expansion Cards, Ribbon Cables, Memory Chips, Processors, Software: Types of Software, Operating System, User Interface of popular Operating System, Introduction to programming language, Types of Computer.<br><b>Learning Activities:</b> <i>Exercise on various components of computers</i>  | <b>CLO1</b>          |
| Unit II/<br>8 hours  | <b>Computer Network:</b> Introduction to Computer Network, Types of Network: LAN, WAN and MAN, Topologies of Network, Internet concept, WWW.<br><b>Word Processing:</b> Text creation and Manipulation; Table handling; Spell check, Hyper-linking, Creating Table of Contents and table of figures, Creating and tracking comments, language setting and thesaurus, Header and Footer, Mail Merge, Different views, Creating equations, Page setting, Printing, Shortcut keys.<br><b>Learning Activities:</b> <i>Exercise on word software and discussions on computer networking</i> | <b>CLO2 and CLO3</b> |
| Unit III/<br>8 hours | <b>Presentation Tool:</b> Creating Presentations, Presentation views, working on Slide Transition, Making Notes Pages and Handouts, Drawing and Working with Objects, Using Animations, Running and Controlling a Slide Show, Printing Presentations, and Shortcut keys.<br><b>Learning Activities:</b> <i>Exercise on presentation software</i>   | <b>CLO3 and CLO4</b> |
| Unit IV/<br>7 hours  | <b>Spread Sheet:</b> Entering and editing data in cell, Basic formulas and functions, deleting or inserting cells, deleting or inserting rows and columns, printing of Spread Sheet, Shortcut keys.<br><b>Use of Computers in Education and Research:</b> Data analysis tools, e-Library, Search engines related to research, Research paper editing tools like Latex.<br><b>Learning Activities:</b> <i>Exercise and discussions on application of computers in education and research</i>  | <b>CLO3 and CLO4</b> |

#### Suggested Readings:

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

#### Web references

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

#### Transactional Modes:

- PPT, Video, e-content, google drive

| L | T | P | Cr |
|---|---|---|----|
| 0 | 0 | 4 | 2  |

**Course Code: CST.502**

**Course Title: Computer Applications - Lab**

**Total hours: 60**

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

**Course Code: STA.503**

| L | T | P | Cr |
|---|---|---|----|
| 2 | 0 | 0 | 2  |

**Course Title: Statistics for Sciences**

**Total hours - 32**

**Course Learning Outcome (CLO):**

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

| Unit /Hours             | Content   | Mapping with CLO |
|-------------------------|---|------------------|
| <b>Unit I/8 hours</b>   | <b>Descriptive Statistics:</b> 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.<br><b>Learning Activities:</b> <i>Application of statistical tools</i>   | <b>CLO1</b>      |
| <b>Unit II/ 8 hours</b> | 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.<br><b>Learning Activities:</b> <i>Testing with experimental data</i>  | <b>CLO1</b>      |
| <b>Unit III/8 hours</b> | 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.<br><b>Learning Activities:</b> <i>Testing with experimental data</i>  | <b>CLO1</b>      |
| <b>Unit IV/ 8 hours</b> | Differences between parametric and non-parametric statistics. Confidence interval, Errors, Levels of significance, Hypothesis testing. Parametric tests: Test for parameters of Normal population (one sample and two sample problems) z- test, student's t-test, F and chi-square test and Analysis of Variance (ANOVA). Non-Parametric tests: One sample: Sign test, signed rank test, Kolmogorov- Smirnov test, run test. Critical difference (CD), Least Significant Difference (LSD), Kruskal-Wallis one-way ANOVA by ranks, Friedman two-way ANOVA by ranks.<br><b>Learning Activities:</b> <i>Application of statistical tools</i> | <b>CLO1</b>      |

**Recommended Books:**

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

**Suggested Readings:**

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

**Transactional Modes:**

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

**Course Code: FST.573****Course Title: Technology of Spices, Sugar and Chocolate**

| L | T | P | Cr |
|---|---|---|----|
| 3 | 0 | 0 | 3  |

**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   | <b>Introduction to spice processing:</b> 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<br><b>Learning Activities:</b> <i>Seminars on major spices</i>   | <b>CLO1 and CLO2</b> |
| Unit II/ 11 hours | <b>Spice products:</b> 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<br><b>Learning Activities:</b> <i>Group discussions on applications of spice products</i>  | <b>CLO3</b>          |
| Unit III/11 hours | <b>Cane sugar technology:</b> 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<br><b>Learning Activities:</b> <i>Group discussions sugars and their sources</i>   | <b>CLO4</b>          |
| Unit IV/ 11 hours | <b>Chocolate processing:</b> 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<br><b>Learning Activities:</b> <i>Seminars on chocolate processing</i> | <b>CLO5 and CLO6</b> |

**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).
- 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).

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|----------|----------|----------|-----------|
| <b>L</b> | <b>T</b> | <b>P</b> | <b>Cr</b> |
| 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.

| <b>Unit /Hours</b>     | <b>Content</b>   | <b>Mapping with CLO</b> |
|------------------------|--|-------------------------|
| <b>Unit I/11 hours</b> | <p><b>Microbiology of Food:</b> 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.</p> <p><b>Microbial spoilage of foods:</b> Types and causes of spoilage of cereals and cereals products, spoilage of vegetables and fruits, spoilage of meat and meat products, spoilage of fish</p> | <b>CLO1 and CLO2</b>    |

|                              |   |                      |
|------------------------------|---|----------------------|
|                              | and other sea foods, spoilage of eggs and other poultry products, spoilage of milk and milk products.<br><b>Learning Activities:</b> <i>Seminars on advantages and disadvantages of microorganisms</i>  |                      |
| <b>Unit II/<br/>13hours</b>  | <b>Microbial Growth in Food:</b> 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- ( <i>Staphylococcal intoxicification, Botulism, Salmonellosis, Shigellosis, EHEC E. coli infection, Listeria monocytogens infection, Clostridium perfringens gastroenteritis, Bacillus cereus gastroenteritis</i> ; Food-borne fungi- <i>Mycotoxins</i> in foods and its implication on crops.<br><b>Learning Activities:</b> <i>Group discussions on factors affecting growth of microorganisms in foods</i> | <b>CLO2</b>          |
| <b>Unit III/11 hours</b>     | <b>Fermented and Dairy Food Products:</b> Microorganisms involved in food fermentations. Starter cultures for fermented dairy products ( <i>Streptococcus thermophilus, Lactobacillus bulgaricus</i> ). 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.<br><b>Learning Activities:</b> <i>Group discussions on advantages of fermentation</i>   | <b>CLO3</b>          |
| <b>Unit IV/<br/>10 hours</b> | <b>Food Preservation and Safety:</b> 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).<br><b>Learning Activities:</b> <i>Seminars on control of microorganisms in foods</i>  | <b>CLO1 and CLO4</b> |

**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**

- JM Jay, Modern Food Microbiology (7th edition). Golden Food Science Text Series (2005).
- MJ Pelczar and J Michael, Microbiology. McGraw-Hill (1999).
- MP Doyle and RL Buchanan, Food Microbiology: Fundamentals and Frontiers. ASM press (2007).
- MR Adams et al., Food Microbiology. RSC (2016).



- N Garg, Laboratory Manual of Food Microbiology. I.K. International Publishing House (2013).
- S Kumari, Basics of Food Biochemistry and Microbiology. Koros Press (2012).
- TJ Montville et al., Food Microbiology: An introduction. ASM press (2012).
- WC Frazier and DC Weshoff, Food Microbiology (5th edition). Mcgraw-Hill (2015).
- WM Foster, Food Microbiology. CBS Publishers (2016).

| L | T | P | Cr |
|---|---|---|----|
| 3 | 0 | 0 | 3  |

**Course Code: FST.523**

**Course Title: Food Engineering and Unit Operations**

**Total Hours - 45**

**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     |
|-------------------------|---|----------------------|
| <b>Unit I/11 hours</b>  | <p><b>Introduction:</b> Engineering properties of foods and their applications in food processing</p> <p><b>Material and energy balance:</b> Basic principles, total mass balance and component mass balance; Heat balance calculations</p> <p><b>Fluid flow:</b> 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</p> <p><b>Learning Activities:</b> <i>Seminars on material/energy balance and fluid flow</i></p>  | <b>CLO1 and CLO2</b> |
| <b>Unit II/ 12hours</b> | <p><b>Raw material preparation:</b> Cleaning; Sorting; Grading; Peeling</p> <p><b>Size reduction:</b> Size reduction in food processing; Forces applied for size reduction; Equipment.</p> <p><b>Mixing:</b> 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). <b>Screening and filtration:</b> 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).</p> | <b>CLO3</b>          |

|                          |   |             |
|--------------------------|---|-------------|
|                          | <b>Learning Activities:</b> <i>Group discussions on various unit operations</i>   |             |
| <b>Unit III/10 hours</b> | <p><b>Heat transfer in food processing:</b> Modes of heat transfer; Systems for heating and cooling (steam injection and steam infusion, tubular, scrapped surface, plate heat, shell and tube heat exchangers).</p> <p><b>Refrigeration and freezing:</b> 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.</p> <p><b>Learning Activities:</b> <i>Seminars on application of heating and cooling on food processing</i></p>  | <b>CLO3</b> |
| <b>Unit IV/12hours</b>   | <p><b>Evaporation and dehydration:</b> 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).</p> <p><b>Learning Activities:</b> <i>Group discussion on advantages of evaporation in food processing</i></p> | <b>CLO4</b> |

**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<sup>th</sup> 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).

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| <b>L</b> | <b>T</b> | <b>P</b> | <b>Cr</b> |
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**Course Code: FST.504**

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

**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.

| <b>Unit /Hours</b>      | <b>Content</b>  | <b>Mapping with CLO</b> |
|-------------------------|---|-------------------------|
| <b>Unit I/7 hours</b>   | <b>Introduction:</b> 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<br><b>Learning Activities:</b> <i>Group discussion on differences between nutrients and nutraceuticals</i>                                     | <b>CLO1</b>             |
| <b>Unit II/7 hours</b>  | <b>Nutrition:</b> 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.<br><b>Learning Activities:</b> <i>Seminars on nutritive value of foods</i>  | <b>CLO2</b>             |
| <b>Unit III/8 hours</b> | <b>Therapeutic nutrition:</b> Foods and diets recommended and restricted in cancers, coronary artery diseases, diabetes and obesity.<br><b>Introduction to specialty foods:</b> Specialty foods for gluten and lactose intolerants, heart patients and obese people and their potential in India viz a viz developed world<br><b>Learning Activities:</b> <i>Discussions on therapeutic properties of nutrients</i> | <b>CLO3</b>             |
| <b>Unit IV/8 hours</b>  | <b>Disorders and Diseases:</b> 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<br><b>Learning Activities:</b> <i>Seminars on disease-preventing roles of food constituents</i>   | <b>CLO4</b>             |

**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 |
|---|---|---|----|
| 3 | 0 | 0 | 3  |

**Course Code: FST.522**

**Course Title: Processing of Cereals and Pseudocereals**

**Total Hours - 45**

**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     |
|------------------------|---|----------------------|
| <b>Unit I/11 hours</b> | <p><b>Introduction:</b> Production, composition, structure and general usage of major cereals (wheat, rice, maize, barley, oats and millets) and pseudocereals</p> <p><b>Wheat milling:</b> Classification of wheat; Cleaning; Conditioning; Roller milling; Air fractionation of flours; Flour treatment; Quality tests for analysis of wheat flour.</p> <p><b>Durum wheat and pasta processing:</b> Milling of durum wheat; Processing of fresh and dry pasta (Ingredients and production); Composition and nutritive value of pasta products</p> <p><b>Learning Activities:</b> <i>Group discussions on different cereals/pseudocereals, their production and general usages</i></p> | <b>CLO1 and CLO2</b> |

|                                  |  |                              |
|----------------------------------|--|------------------------------|
| <b>Unit II/<br/>12<br/>hours</b> | <b>Technology of bakery products:</b> 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.<br><b>Chapatti-making properties:</b> Milling; Chapatti making properties of wheat meal and quality analysis of chapatti<br><b>Learning Activities:</b> <i>Seminars on processing of wheat products</i>  | <b>CLO2<br/>and<br/>CLO3</b> |
| <b>Unit<br/>III/11<br/>hours</b> | <b>Rice:</b> 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.<br><b>Maize:</b> Dry and wet milling; Processing of by-products from dry and wet milling; Production of starch-based syrups and sweeteners (HFCS, Dextrose, high maltose syrups, maltodextrins, etc.); Alkaline cooked products; Processing of maize germ oil and flakes.<br><b>Oats:</b> Composition; Processing of rolled oats; Health benefits of oats and beta glucan<br><b>Millets:</b> Types; Nutritive value and processing; Health benefits of millets<br><b>Learning Activities:</b> <i>Seminars on processing of rice, maize, oats and millets</i> | <b>CLO3</b>                  |
| <b>Unit IV/<br/>11 hours</b>     | <b>Pseudocereals:</b> 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.<br><b>Learning Activities:</b> <i>Group discussions on nutritional and nutraceutical properties of pseudocereals</i>  | <b>CLO3<br/>and<br/>CLO4</b> |

#### 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).

- KA Rosentrater and AD Evers, Kent's technology of cereals: An introduction for students of food science and agriculture. Woodhead Publishing. PS Belton, Physical chemistry of Foods. (2017).
- M Sissons, Durum wheat chemistry and technology. Academic Press (2016).
- NA Mir, CS Riar and S Singh, Nutritional constituents of pseudo-cereals and their potential use in food systems: A review. Trends in Food Science and Technology, 2018, 75, 170-180.
- S Bemiller (2019) Carbohydrate Chemistry for Food Scientists, Woodhead Publications
- S Clerici and M Teresa, Starches for Food Application: Chemical Technological and Health Properties, Academic Press (2019).
- SA Watsan and PE Ramsat, Corn: Chemistry and Technology, AACC (1987).
- Shevkani, K. et al., Wheat Starch production, structure, functionality, and applications-a review. International Journal of Food Science and Technology, 52, 38-58 (2017).
- T BetaCereal Grain-Based Functional Foods, Royal Society of Chemistry (2019).

| L | T | P | Cr |
|---|---|---|----|
| 3 | 0 | 0 | 3  |

**Course Code: FST.524**

**Course Title: Processing of Fruits and Vegetables**

**Total Hours - 45**

**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     |
|--------------------------|--|----------------------|
| <b>Unit I/12 hours</b>   | <b>Introduction:</b> 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)<br><b>Learning Activities:</b> <i>Group discussions on status and importance of fruit/vegetable processing</i> | <b>CLO1 and CLO2</b> |
| <b>Unit II/ 11 hours</b> | <b>Canning:</b> 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  | <b>CLO3</b>          |

|                          |  |             |
|--------------------------|--|-------------|
|                          | and vegetables (produce for the fresh-cut processing, treatments to ensure safety, additives to preserve quality)<br><b>Learning Activities:</b> <i>Seminars on canning of fruits and vegetables</i>   |             |
| <b>Unit III/11 hours</b> | <b>Juice Processing:</b> 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<br><b>Learning Activities:</b> <i>Group discussions on importance of pectin in jam/jelly preparation</i>   | <b>CLO4</b> |
| <b>Unit IV/ 11 hours</b> | <b>Fruits &amp; Vegetable Product Processing:</b> Manufacturing of preserves and candied fruits; Specifications;<br><b>Processing of tomato products:</b> Puree; Paste; Ketchup; Soup; Specifications Processing of potato products: Flour; Chips; Fries; Nutritive value of potato products; Acrylamide in potato products<br><b>Quality assurance in fruits and vegetable industry:</b> HACCP, VACCP and TACCP<br><b>Learning Activities:</b> <i>Group discussions on different types of tomato products</i> | <b>CLO5</b> |

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

**Course Code: FST.552**

| L | T | P | Cr |
|---|---|---|----|
| 3 | 0 | 0 | 3  |

**Course Title: Application of Enzymes in Food Processing****Total Hours - 45****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

| <b>Unit /Hours</b>       | <b>Content</b>   | <b>Mapping with CLO</b>    |
|--------------------------|--|----------------------------|
| <b>Unit I/12 hours</b>   | <b>Introduction:</b> Nomenclature; General properties; Classification; Sources of enzymes; Production and purification of enzymes; Factors affecting enzymatic activity; Mechanism of enzyme inhibition; Immobilization of enzymes<br><b>Enzymes in cereal processing:</b> 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.).<br><b>Learning Activities:</b> <i>Seminar on types of enzymes most useful in food processing</i> | <b>CLO1 and CLO2</b>       |
| <b>Unit II/ 11 hours</b> | <b>Enzymes in milk and dairy products:</b> 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.<br><b>Learning Activities:</b> <i>Seminar on enzymes applications in milk and milk products</i>               | <b>CLO2, CLO3 and CLO4</b> |
| <b>Unit III/11 hours</b> | <b>Enzymes in fruits processing:</b> Commercial pectinases; Specific applications of enzymes in juice technology like clarification, debittering, etc.<br><b>Enzymes in meat industry:</b> 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<br><b>Learning Activities:</b> <i>Group discussions on enzymes roles in quality improvement of fruits and meat products</i>   | <b>CLO3 and CLO4</b>       |
| <b>Unit IV/ 11 hours</b> | <b>Enzymes in brewing:</b> Brewing with high and very high levels of adjuncts; Improving filtration; Chill-proofing; Making new and special beers; Extending shelf life of packaged beer<br><b>Enzymes in protein modification:</b> Proteases for producing protein hydrolysates; Functional properties; Allergenicity   | <b>CLO4 and CLO5</b>       |



|  |  |  |
|--|--|--|
|  | <b>Learning Activities:</b> <i>Group discussions on enzymes usages in brewing and protein modification</i> |  |
|--|--|--|

**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**

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

**Course Code: FST.511**

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|----------|----------|----------|-----------|
| <b>L</b> | <b>T</b> | <b>P</b> | <b>Cr</b> |
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**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

| <b>Unit /Hours</b>     | <b>Content</b>  | <b>Mapping with CLO</b> |
|------------------------|---|-------------------------|
| <b>Unit I/12 hours</b> | <b>Introduction to Nutrition and Nutraceuticals:</b> Definitions (food, diet, nutrients, nutrition, adequate/good nutrition, nutritional status, malnutrition, nutritional care, health, nutraceuticals, functional foods and dietary supplements); | <b>CLO1 and CLO2</b>    |

|                           |   |                      |
|---------------------------|---|----------------------|
|                           | <p>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.</p> <p><b>Learning Activities:</b> <i>Seminars on nutrition and nutraceuticals and group discussions on functions of foods</i></p>   |                      |
| <b>Unit II/ 11 hours</b>  | <p><b>Nutraceuticals:</b> 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).</p> <p><b>Learning Activities:</b> <i>Seminars on health benefits and usages of nutraceutical compounds from foods</i></p> | <b>CLO3</b>          |
| <b>Unit III/ 11 hours</b> | <p><b>Processing technologies:</b> 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</p> <p><b>Food applications:</b> 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.</p> <p><b>Learning Activities:</b> <i>Group discussions on processing and effect of processing on nutraceutical compounds of foods</i></p>   | <b>CLO4 and CLO5</b> |
| <b>Unit IV/ 11 hours</b>  | <p><b>Nutraceuticals in disease prevention:</b> 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</p> <p><b>Learning Activities:</b> <i>Seminars on health benefits effects of antioxidants, fibre, resistant starch, omega 3 oils and probiotics</i></p>  | <b>CLO6</b>          |

**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).

- F Chemat, Green Food Processing Techniques: Preservation Transformation and Extraction, Academic Press (2019)
- G Subbulakshmi, Functional Foods and Nutrition, Daya Publishing House (2014).
- GRGibson and CM Williams, Functional Foods: Concept to Product. Woodhead Publishing (2000).
- H Dominguez Functional Ingredients from Algae for Foods and Nutraceuticals. Woodhead Publishing (2013).
- J Boye, Nutraceutical and Functional Food Processing Technology. Wiley Blackwell (2015).
- J Gilbert, Bioactive Compounds in Foods. Wiley India (2014).
- M Saarela, Functional Foods: Concept to Product. Woodhead Publishing (2014).
- M Sharma Nutrition for the Family, Sports Educational Tech (2018)
- M. Swaminathan, Essentials of Food and Nutrition, Volumes 1-2. Ganesh Publisher (1974).
- N Singh, Food Nutrition, Science and Technology, Woodhead Publication (2018)
- NN Potter, Food Science. CBS Publishers (2007).
- PM Choksi and VY Joshi, A Review on Lycopene-Extraction, Purification, Stability and Applications. International Journal of Food Properties, 10, 289-298 (2007).
- R Rao, Lycopene and Tomatoes In Human Nutrition And Health, CRC Press (2018)
- RR Watson Fruits Vegetables and Herbs: Bioactive Foods in Health Promotion. Academic Press, (2016).
- S Edelstein, Food Science, Jones & Bartlett Learning (2018)
- S Riar et al., Functional Foods and Nutraceuticals: Sources and Their Developmental Techniques. New India publishing agency (2015).
- S Story et al., An Update on the Health Effects of Tomato Lycopene. Annual Reviews in Food Science and Technology, 2010, 1-24 (2010)
- S Subbulakshmi and M Subhadra, Nutrition in Traditional Therapeutic Foods. Daya Publishing House (2015).
- U Gogus and C Smith (2010) n-3 Omega fatty acids: a review of current knowledge. International Journal of Food Science and Technology, 45, 417- 436 (2010)
- V Vaclavik and CW Elizabeth, Essentials of Food Science. Springer (2014).
- Y Zhao, Specialty Foods: Processing Technology, Quality and Safety. CRC Press (2012).

| L | T | P | Cr |
|---|---|---|----|
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**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.                             | <b>CLO1 and CLO2</b> |
| 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.                                  | <b>CLO3 and CLO4</b> |
| 10 | Determination of germination capacity and germ viability (tetrazolium test) of barley.                   |                      |
| 11 | Experimental malting of barley.  |                      |
| 12 | Pasting properties of different cereals and pseudocereal flours.   |                      |
| 13 | Laboratory parboiling of paddy and quality evaluation of parboiled rice.                                 |                      |
| 14 | Comparison of wheat flour and semolina for physicochemical properties.                                   |                      |
| 15 | Cooking and sensory evaluation of noodles and pasta products.  |                      |

**Transactional Modes:**

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

**Course Code: FST.527**

| L | T | P | Cr |
|---|---|---|----|
| 0 | 0 | 4 | 2  |

**Course Title: Fruits and Vegetable Processing - Practical**

**Total Hours - 60**

**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   | <b>CLO1</b>      |
| 2     | Preparation and analysis of syrups  |                  |
| 3     | Determination of PLW by the use of different packaging materials and temperature. |                  |
| 4     | Cut out examination of fruit cans   | <b>CLO2</b>      |
| 5     | Preparation and quality evaluation of fruit juice concentrates                    |                  |
| 6     | Preparation and quality evaluation of jam and jellies                             |                  |
| 7     | Dehydration of fruits and vegetables  |                  |

|          |   |                      |
|----------|---|----------------------|
| <b>8</b> | Freezing of fruits and vegetables                                     | <b>CLO3 and CLO4</b> |
| <b>9</b> | To determine change in characteristics of fruit during storage at low |                      |

**Transactional Modes:**

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

|          |          |          |          |
|----------|----------|----------|----------|
| <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| 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

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

|  |   |  |
|--|---|--|
|  | <b>Learning Activities:</b> <i>Student presentations.</i> |  |
|--|---|--|

**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.

|          |          |          |           |
|----------|----------|----------|-----------|
| <b>L</b> | <b>T</b> | <b>P</b> | <b>Cr</b> |
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**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     |
|------------------------|---|----------------------|
| <b>Unit I/12 hours</b> | <b>Overview of Food biotechnology:</b> Present scenario and future prospects of food biotechnology; Applications of biotechnology in the food industry; Biotechnology and food safety | <b>CLO1 and CLO2</b> |

|                              |   |             |
|------------------------------|---|-------------|
|                              | <b>Learning Activities:</b> <i>Assignments on above topics</i>  |             |
| <b>Unit II/<br/>11 hours</b> | <b>Fermenter:</b> Fermenter design; Parts of fermenter and their functions; Types of fermentation processes, aeration and agitation<br>Media for industrial fermentation; Downstream processing (centrifugation, filtration, precipitation, extraction, drying, cell disruption); Membrane technology and its application in fermentation industry<br><b>Learning Activities:</b> <i>Term paper based discussions</i>   | <b>CLO3</b> |
| <b>Unit III/11 hours</b>     | <b>Application of Food Biotechnology:</b> in the production of bio-colours, flavours, vitamins, bio-preservatives, antibiotics and industrial alcohol<br><b>Single cell proteins:</b> Definition; Advantages; Nutritional value; Microorganisms used as SCP; Production of SCP; Fungi and algae as food<br>Probiotics and prebiotics: Definition; Composition; Health effects; Safety consideration; Future trends<br><b>Learning Activities:</b> <i>Seminars on these topics</i> | <b>CLO3</b> |
| <b>Unit IV/<br/>11 hours</b> | <b>Genetically modified foods:</b> 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.<br><b>Learning Activities:</b> <i>Group discussions on GM Foods</i>   | <b>CLO4</b> |

#### 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

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

| L | T | P | Cr |
|---|---|---|----|
| 3 | 0 | 0 | 3  |

**Course Code: FST.572**

**Course Title: Poultry and Meat Processing**

**Total hours - 45**

**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   | <p><b>Eggs:</b> 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)</p> <p><b>Learning Activities:</b> <i>Seminars on egg structure, compositions, nutritive value and components responsible for functionality in food formulation</i></p> | CLO1 and CLO2    |
| Unit II/12 hours  | <p><b>Poultry:</b> Status of poultry and meat industry in India; Types; Composition; Nutritive value; Poultry slaughtering and dressing (operation and equipment).</p> <p><b>Meat:</b> 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.</p> <p><b>Learning Activities:</b> <i>Group discussion on nutritive value and processing of muscle foods</i></p>                                | CLO2 and CLO3    |
| Unit III/10 hours | <p><b>Processing and preservation:</b> 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.</p> <p><b>Learning Activities:</b> <i>Group discussion on processing of muscle foods</i></p>   | CLO2 and CLO3    |
| Unit IV/11 hours  | <p><b>Comminuted meat product:</b> Technology of manufacture of Comminuted/minced meat product; Quality evaluation of sausages; Comminuted meats vs meat emulsions</p> <p><b>Safety in meat industry:</b> Meat plant sanitation and hygiene; Pesticide and drug residue in poultry meat; Pathogenic microorganisms on processed poultry.</p> <p><b>Learning Activities:</b> <i>Seminars and assignments on hazards, sanitation and hygiene in meat processing industry</i></p>  | 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**

- AM Pearson and TA Gillett, Processed Meats. CBS Publishers (1996).



- BM Bohrer, An investigation of the formulation and nutritional composition of modern meat analogue products. Food Science and Human Wellness, Volume 8, Issue 4, Pages 320-329 (2019)
- GC Mead, Poultry Meat Processing and Quality. Woodhead Publishing Ltd. (2004).
- I Guerrero-Legarreta, Handbook of Poultry Science and Technology. Wiley (2010).
- Lawrie's Meat Science Woodhead Publishing (2017).
- LS Boziaris, Seafood Processing: Technology, Quality and Safety. John Wiley and Sons Ltd. (2014).
- NN Potter, Food Science. CBS Publishers (2007).
- PA Gonzalez-Rivas et al. Effects of heat stress on animal physiology, metabolism, and meat quality: A review. Meat Science, Volume 162, Article 108025 (2020).
- R Fernandes, Microbiology Handbook of Meat products. Medtech (2017).
- SC Ricke, Organic Meat Production and Processing. Wiley-Blackwell (2012).
- Sohrab, A Practical Guide for Implementation of Integrated ISO-900 HACCP System for the Food Processing Industry. Allied Publishers Ltd. (2001).
- YH Hui, Handbook of Meat and Meat Processing. CRC Press (2012).
- YH Hui, Meat Science and Applications. Marcel Dekker (2001).

**Course Code: FST.530**

| L | T | P | Cr |
|---|---|---|----|
| 3 | 0 | 0 | 3  |

**Course Title: Food Additive and Toxins**

**Total Hours - 45**

**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 |
|--------------------------|---|------------------|
| <b>Unit I/10 hours</b>   | <b>Overview of Food Additives and Toxins:</b> Definitions; General classification and principles; Nutritional and non-nutritional additives and natural vs synthetic additives; Uses/applications; Functions; Risks and benefits<br><b>Learning Activities:</b> <i>Assignments on above topics</i>  | <b>CLO1</b>      |
| <b>Unit II/ 11 hours</b> | <b>Common food additives I:</b> 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<br><b>Learning Activities:</b> <i>Term paper based discussions on the topics</i> | <b>CLO2</b>      |
| <b>Unit III/11 hours</b> | <b>Common food additives II:</b> Nutritional additives; Fat substitutes and replacers; Nutritive and non-nutritive sweeteners; Antioxidants; Natural colour additives; Antibrowning agents; Emulsifiers and stabilizers   | <b>CLO2</b>      |

|                          |  |                      |
|--------------------------|--|----------------------|
|                          | <b>Learning Activities:</b> <i>Group discussions and seminars on food additives</i>  |                      |
| <b>Unit IV/ 11 hours</b> | <b>Toxins in foods:</b> 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.<br><b>Learning Activities:</b> <i>Group discussions and seminars on toxins in foods</i> | <b>CLO3 and CLO4</b> |

**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).

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|----------|----------|----------|-----------|
| <b>L</b> | <b>T</b> | <b>P</b> | <b>Cr</b> |
| 3        | 0        | 0        | 3         |

**Course Code: FST.517**

**Course Title: Processing of Legumes and Oilseeds**

**Total Hours - 45**

**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 production of edible oil, protein and starch-rich products
- CLO4:** To develop/ design technologies/processing methods for improving nutritional properties of pulses and oilseeds

| <b>Unit /Hours</b>     | <b>Content</b>  | <b>Mapping with CLO</b> |
|------------------------|---|-------------------------|
| <b>Unit I/11 hours</b> | <b>Legumes:</b> 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<br><b>Learning Activities:</b> <i>Group discussions and seminars on the legumes and their constituents</i> | <b>CLO1</b>             |

|                                  |   |                          |
|----------------------------------|---|--------------------------|
| <b>Unit II/<br/>12<br/>hours</b> | <b>Processing of legumes/pulses:</b> 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.<br><b>Learning Activities:</b> <i>Group discussions and seminars on the legumes processing</i>   | <b>CLO2 and<br/>CLO3</b> |
| <b>Unit<br/>III/11<br/>hours</b> | <b>Oilseeds:</b> 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)<br><b>Rice bran as a source of edible oil:</b> Rice bran stabilization; Extraction of oil.<br><b>Learning Activities:</b> <i>Group discussions on major sources of edible oils and their composition and processing</i> | <b>CLO2 and<br/>CLO3</b> |
| <b>Unit IV/<br/>11 hours</b>     | <b>Processing and refining of Oil and oil cake/meal:</b> 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<br><b>Learning Activities:</b> <i>Term paper based discussions on refining of oil/fats and by-product utilization</i>   | <b>CLO4</b>              |

#### 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**

| L | T | P | Cr |
|---|---|---|----|
| 3 | 0 | 0 | 3  |

**Total Hours - 45**

**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     |
|--------------------------|--|----------------------|
| <b>Unit I/12 hours</b>   | <b>Introduction:</b> 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<br><b>Learning Activities:</b> <i>Seminars on the above topics</i>  | <b>CLO1</b>          |
| <b>Unit II/ 11 hours</b> | <b>Processing of fluid milk:</b> Processing technology and regulations agencies, standards/specifications for full-cream, standardized, toned, skim, reconstituted, recombined, toned, double-toned, standardized; flavoured, filled-milk, etc.<br><b>Cream:</b> Types of creams; Composition of cream; Production methods; Neutralization of cream; Ripening of cream for butter making (natural ripening, ripening with starter cultures)<br><b>Learning Activities:</b> <i>Term paper based discussion on milk and milk products processing</i> | <b>CLO2</b>          |
| <b>Unit III/11 hours</b> | <b>Butter:</b> Types; Composition; Preparation of butter; Churning theories; Defects (causes and prevention)<br><b>Condensed and evaporated milk:</b> Standards; Composition; Nutritive Value; Manufacture; Defects (causes and prevention)<br><b>Milk powders:</b> Standards; Composition; Nutritive value; Process of manufacture; Defects (causes and prevention); Instantiation<br><b>Learning Activities:</b> <i>Term paper based discussion on products processing</i>   | <b>CLO2 and CLO3</b> |
| <b>Unit IV/ 11 hours</b> | <b>Cheese:</b> Classification, Composition; Nutritive value; Process of manufacture of cheddar, mozzarella and processed cheese  | <b>CLO4 and CLO5</b> |

|  |  |  |
|--|--|--|
|  | <p><b>Ice cream:</b> Standards; Composition; Nutritive value, Process of manufacture, Ingredients and their roles; Defects (causes and prevention)</p> <p><b>Indigenous milk products:</b> Ghee, Dahi, Desi Butter, Chhanna, Khoa, Srikhand, rabri, etc.<br/>FSSAI norms for Adulteration in milk</p> <p><b>Learning Activities:</b> <i>Assignments and Term paper based discussion on products processing</i></p> |  |
|--|--|--|

**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**

| L | T | P | Cr |
|---|---|---|----|
| 3 | 0 | 0 | 3  |

**Total hours - 45**

**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

| <b>Unit /Hours</b>       | <b>Content</b>  | <b>Mapping with CLO</b> |
|--------------------------|---|-------------------------|
| <b>Unit I/12 hours</b>   | <b>Food safety:</b> Definition; Need; Factors affecting food safety<br><b>Concept of quality control:</b> 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<br><b>Learning Activities:</b> <i>Seminars on food safety and quality control</i>   | <b>CLO1</b>             |
| <b>Unit II/ 11 hours</b> | <b>Methods of quality assessment:</b> fruits and vegetables, cereals and cereal products, dairy product, fats and oils, meat and meat products, poultry and eggs, oils and fats, spices, etc.<br><b>Sensory characteristics of food:</b> Colour, taste, aroma, texture, Panellist (Types, ideal panelist requirement),<br><b>Sensory test:</b> Types of sensory test-difference, rating, sensitivity, testing time, design of sensory experiment-evaluation card, testing laboratory, sample preparation<br><b>Learning Activities:</b> <i>Seminars and group discussions on assessment of chemical and sensory quality attributes of foods</i> | <b>CLO2 and CLO3</b>    |
| <b>Unit III/11 hours</b> | <b>Food laws and regulations:</b> Importance and application of food regulatory system; Food Safety and Standards Act, 2006 (transition from PFA, FPO, MMPO, MFPO); AGMARK; BIS; QCI; Export promotion bodies and inspection council; International Food Regulation/Authorities (WTO, SPS, TBT Bilateral agreement, Codex Alimentarius, ISO)<br><b>Learning Activities:</b> <i>Term paper based discussions on the topics</i>   | <b>CLO4</b>             |
| <b>Unit IV/ 11 hours</b> | <b>Food safety management and quality control systems:</b> 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 amendments in FSSAI.<br><b>Learning Activities:</b> <i>Group discussions on the topics</i>  | <b>CLO5</b>             |

**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 Kapisris, 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).

| L | T | P | Cr |
|---|---|---|----|
| 0 | 0 | 4 | 2  |

**Course Code: FST.553**

**Course Title: Milk and Milk Processing - Practical**

**Total Hours - 60**

**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). | <b>CLO1</b>          |
| 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.                 | <b>CLO1</b>          |
| 6    | Preparation and quality evaluation of butter.                              | <b>CLO3 and CLO4</b> |
| 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   | <b>CLO1 and CLO2</b> |
| 2    | Test for assessment of quality of cereals<br>a) Estimation of Amylose content in rice<br>b) Estimation of gluten content in dough<br>c) Estimation of 1000kernel weight, porosity, bulk density, density, Angle of repose<br>d) Quality and safety of rice-mycotoxins determination |                      |
| 3    | Test for assessment of quality of pulses<br>a)Evaluation of cooking quality of legume<br>b)Estimation of 1000-grain weight, porosity, bulk density, density, Angle of repose  | <b>CLO3 and CLO4</b> |
| 4    | Test for assessment of quality of fats and oils-physical and chemical parameters.   |                      |
| 5    | Determination of different components of egg (albumin content, yolk content and shell content)  |                      |
| 6    | Sensory test - difference test (paired comparison test, duo trio test, triangle test); Rating test -Ranking test, Hedonic test, Single sample difference test, Two sample difference test.  |                      |

**Transactional Modes:**

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

**Course Code: FST.577**

| L | T | P | Cr |
|---|---|---|----|
| 2 | 0 | 0 | 2  |

**Course Title: Competitive Exam Preparatory Course**



**Total hours - 30**

**Course Learning Outcome (CLO):**

**CLO1:** The course will enable students to succeed in various competitive exam by providing information about various tests of national levels

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

**Mapping with course learning outcome: CLO1**

**Transactional Modes:**

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

**Course Code: FST.528**

| L | T | P | Cr |
|---|---|---|----|
| 3 | 0 | 0 | 3  |

**Course Title: Fermented Foods**

**Total Hours - 45**

**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   | <b>Microorganisms used in food fermentation:</b> 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)<br><b>Learning Activities:</b> <i>Seminars and group discussions on the topics</i>                          | CLO1             |
| Unit II/ 11 hours | <b>Starter cultures:</b> Introduction, history, concentrated cultures, starter culture problems, yeast and mould cultures<br><b>Fermented milk and milk products:</b> Cheese, cultured cream, curd/dahi, kefir; kumis; yogurt, bulgarian milk, acidophilus milk, etc.); Health benefits of fermented milk products<br><b>Fermented fruits and vegetables:</b> pickles; kimchi; sauerkraut, etc.<br><b>Soy-based fermented foods:</b> miso, natto, temph, soy sauce, sofu, etc. | CLO2 and CLO3    |

|                          |  |                      |
|--------------------------|--|----------------------|
|                          | <b>Learning Activities:</b> <i>Seminars and group discussions on the topics</i>  |                      |
| <b>Unit III/11 hours</b> | <b>Fermentation for food processing:</b> 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<br><b>Learning Activities:</b> <i>Term paper based discussions on application of fermentation in food processing</i> | <b>CLO3 and CLO4</b> |
| <b>Unit IV/ 11 hours</b> | <b>Fermentative production:</b> Baker's yeast; Aminoacids (glutamic acid, lysine); Organic acids (citric and lactic acid); Enzymes; Polysaccharides (dextran, xanthan, pullulan, alginate, etc.); Single cell proteins<br><b>Learning Activities:</b> <i>Term paper based discussions on application of fermentation in food processing</i>  | <b>CLO4 and CLO5</b> |

**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).

| L | T | P | Cr |
|---|---|---|----|
| 3 | 0 | 0 | 3  |

**Course Code: FST.529**

**Course Title: Beverages Technology**

**Total Hours - 45**

**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

| <b>Unit /Hours</b>       | <b>Content</b>   | <b>Mapping with CLO</b> |
|--------------------------|--|-------------------------|
| <b>Unit I/12 hours</b>   | <p><b>Introduction:</b> Types of beverages and their importance; Status of beverage industry in India</p> <p><b>Packaged drinking water:</b> Definition; Technology; Quality evaluation; Methods of water treatment, BIS quality standards of bottled water;</p> <p><b>Synthetic/soft drinks:</b> Types; Role of various ingredients of soft drinks; Technology of carbonated soft drinks, synthetic beverages and sports drinks; Microbial stability of carbonated beverages</p> <p><b>Learning Activities:</b> <i>Seminars and group discussions on the topics</i></p>   | <b>CLO1 and CLO2</b>    |
| <b>Unit II/ 11 hours</b> | <p><b>Tea:</b> Types; Technology of black tea, green tea, pickled tea, instant tea and decaffeinated tea; Quality evaluation and grading</p> <p><b>Coffee:</b> Technology; Fermentation of coffee beans; Changes during fermentation; Drying; Roasting; Process flow sheet for the manufacture of coffee powder, instant coffee; Decaffeination; Quality grading</p> <p><b>Learning Activities:</b> <i>Seminars and group discussions on processing of tea and coffee</i></p>  | <b>CLO2 and CLO3</b>    |
| <b>Unit III/11 hours</b> | <p><b>Cocoa and chocolate-based beverages:</b> Processing of cocoa beans and nibs; Technology of cocoa-based beverages</p> <p><b>Beer:</b> 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</p> <p><b>Learning Activities:</b> <i>Term paper based discussions on processing of cocoa and beer</i></p> | <b>CLO2 and CLO3</b>    |
| <b>Unit IV/ 11 hours</b> | <p><b>Wine:</b> Types; Production of the must and pressing; Fermentation; Maturation; Filtration, clarification and bottling; Special wines; Colouring and flavouring compounds in wine; Quality evaluation</p> <p><b>Distilled alcoholic beverages:</b> 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</p> <p><b>Learning Activities:</b> <i>Seminars and term paper based discussions on processing of alcoholic beverages</i></p>   | <b>CLO4 and CLO5</b>    |

**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).

| L | T | P | Cr |
|---|---|---|----|
| 3 | 0 | 0 | 3  |

**Course Code: FST.554**

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

**Total Hours - 45**

**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     |
|--------------------------|--|----------------------|
| <b>Unit I/10 hours</b>   | <b>Introduction:</b> 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<br><b>Learning Activities:</b> <i>Seminars on the topics</i>                       | <b>CLO1</b>          |
| <b>Unit II/11 hours</b>  | <b>By-product utilization I:</b> 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<br><b>Learning Activities:</b> <i>Group discussions on by-product utilization</i> | <b>CLO2 and CLO3</b> |
| <b>Unit III/11 hours</b> | <b>Status of waste from food industry:</b> 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<br><b>Learning Activities:</b> <i>Term paper based discussions on by-product utilization</i> | <b>CLO2 and CLO3</b> |
| <b>Unit IV/12 hours</b>  | <b>Food Waste management:</b> Types of food processing wastes (oil, fruit juice, cereal, meat waste, dairy and food packaging); Methods for waste treatment (physical, chemical and biological methods); Biomethanation and biocomposting; Incineration; Efficient combustion technology                           | <b>CLO4</b>          |

|  |   |  |
|--|---|--|
|  | <b>Learning Activities:</b> <i>Assignments and term paper based discussions on waste management</i> |  |
|--|---|--|

**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).

| 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

| 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.