Integral University, Lucknow

Effective from Session: 2026-27							
Course Code	**BE341**	**Title of the Course**	**Unit Operations In Food Processing**	**L**	**T**	**P**	**C**
Year	**III**	**Semester**	**V**	**3**	**1**	**0**	**4**
Pre-Requisite	BE-238	**Co-requisite**	None				
Course Objectives	This course is aimed to impart basic knowledge about components of different process equipment and unit operation associated with them.						

Course Outcomes	
CO1	Understand the food process engineering calculations
CO2	Apply the principles of different types of material handling equipments and their application.
CO3	Evaluate the knowledge on importance of size reduction and energy requirement
CO4	Determine the mechanism of crystallization, distillation and leaching process
CO5	Discuss and interpret the principles of mixing and homogenization.

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	**Cleaning and Conveying**	Preliminary unit operation: Cleaning, sorting and grading – aims, methods and applications, physical properties of food materials. Conveying and Handling: Various unit operations in post-harvest handling, study of different conveying systems like belt conveyors, chain conveyors, screw conveyors, pneumatic conveyors, vibrating and oscillating conveyors, bucket elevators – their selection, operation and maintenance.	8	CO1
2	**Size Reduction and Sieve Analysis**	Theory of commination, size reduction laws- calculation of energy required during size reduction, size reduction equipment's: Crushers–grinders, ultrafine grinders, cutters, size enlargement. Effects of size reduction on sensory characteristics and nutritive value of food. Sieving, separation based on size (mesh size), Types of screens: stationary screens – grizzlies, gyrating screens, vibratory screens, and effectiveness of screens.	8	CO2
3	**Mixing and Homogenization**	Mixing & Agitation: Measurement of mixing, rate of mixing, liquid mixing, mixing equipments-liquid mixer, powder & particle mixer, dough & paste mixer, jet mixer, static mixer, purpose of agitation, agitated vessels – impellors, propellers & turbines, kneading, Homogenization - Principle & equipment.	8	CO3
4	**Separation Process**	Filtration-principle of filtration; types of filtration. Equipment- filter press, rotary drum, shell & leaf filter, vacuum filter, centrifugal filter, filter media, filter aid, filter cake.	8	CO4
5	**Other Unit Operations**	Ultrafiltration, membrane filtration, reverse osmosis. Sedimentation- Stoke's law. Free and hindered settling. Crystallization, nucleation, crystal growth.	8	CO5

Reference Books:

1. Sahay, K.M. and Singh, K. K. 1998. Unit Operations of Agricultural Processing, Kalya Publishers, Ludhiana.
2. Mcabe W. L. and Smith J. C. 2005. Unit operations of chemical engineering. McGraw Hill Publication.
3. GeanKoplis C. J. (3rd Edition). Transport processes in unit operations. Prentice Hall of India.
4. P.Fellows. 2000. Food processing technology. Principles and practice. Ellis Horwood England and V C H publishers Germany.

e-Learning Source:

1. https://onlinecourses.nptel.ac.in/noc22_ag08/preview
2. http://ecoursesonline.iasri.res.in/course/view.php?id=172
3. https://www.classcentral.com/course/swayam-thermal-operations-in-food-process-engineering-theory-and-applications-14333
4. https://www.youtube.com/watch?v=fIX-nOHHExs

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)													
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	1	1	1	3	3	1					1	3	1	3
CO2	1	1	1	3	3	1					1	3	1	3
CO3	1	1	1	3	3	1					1	3	1	3
CO4	1	1	1	3	3	1				2	1	3	1	3
CO5	1	1	1	3	3	1				2	1	3	1	3

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Name & Sign of Program Coordinator	**Sign & Seal of HoD**

Integral University, Lucknow

Effective from Session: 2026-2027							
Course Code	**BE342**	**Title of the Course**	**Post-Harvest Physiology, Handling, And Storage Of Fruits And Vegetables**	**L**	**T**	**P**	**C**
Year	**III**	**Semester**	**V**	3	0	0	3
Pre-Requisite	None	**Co-requisite**	None				
Course Objectives	To provide knowledge on the composition, post-harvest physiology, ripening processes, handling, transportation, and storage of fruits and vegetables, enabling the evaluation and application of strategies to maintain quality and extend shelf life.						

Course Outcomes	
CO1	Understand the composition, nutritive value, and post-harvest changes in fruits and vegetables.
CO2	Analyze respiration, ethylene action, and physiological changes during fruit ripening.
CO3	Evaluate post-harvest handling, transportation, and factors responsible for losses.
CO4	Evaluate storage systems and develop strategies to enhance shelf life and quality.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Introduction and Composition	Composition and nutritive value of important fruits and vegetables. Post-harvest changes in fruits and vegetables. Factors responsible for changes in color, texture, and flavor after harvest.	8	CO1
2	Respiration and Ripening Physiology	Basic concept of respiration in harvested produce and factors affecting respiration rate. Water loss and its impact. Ethylene biosynthesis, regulation and role in ripening. Fruit maturation and ripening. Physiological changes during ripening. Climacteric and non-climacteric fruits with examples.	8	CO2
3	Post-Harvest Handling and Losses	Importance and need of post-harvest handling. Perishable and durable crops. Post-harvest losses and their causes. Maturity indices for harvesting. Pre-cooling and cooling methods. Transportation of fruits and vegetables.	8	CO3
4	Storage Technology	Storage systems for fruits and vegetables. Types of storage: zero energy cool chamber, low temperature storage, hypobaric storage, modified atmosphere storage, and controlled atmosphere storage.	8	CO4

Reference Books:

1. Kadar AA.1992. *Post-harvest Technology of Horticultural Crops.2nd* Ed. University of California.
2. Pantastico B. 1975. *Post-Harvest Physiology, Handling, and Utilization of Tropical and Subtropical Fruits and Vegetables.* AVI Publ.
3. Salunkhe DK, Bolia HR & Reddy NR. 1991. *Storage, Processing and Nutritional Quality of Fruits and Vegetables.* Vol. I. *Fruits and Vegetables.* CRC.
4. Thompson AK. 1995. *Post-Harvest Technology of Fruits and Vegetables. Blackwell* Sci.
5. Verma LR. & Joshi VK. 2000. *Post-Harvest Technology of Fruits and Vegetables.* Indus Publ.
6. Lloyd, A. &Penizer, R. 1998. *Handling, transportation, and storage of fruits and vegetables,* AVI Publications.

e-Learning Source:

1. https://www.youtube.com/watch?v=tyaFKBOJIHY

PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	2	2	2	2	1				2	3	2	1
CO2	3	3	2	1	2	2		1	2		2	3	3	1
CO4	2	3	3	2	2	3	2	3	1	1	2	2	2	2
CO5	3	3	3	2	3	3	2	2			2	3	3	3

2- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Name & Sign of Program Coordinator	**Sign & Seal of HoD**

Integral University, Lucknow

Effective from Session: 2026-27							
Course Code	**BE343**	**Title of the Course**	**Cereal and Legume Technology**	**L**	**T**	**P**	**C**
Year	III	**Semester**	V	**2**	**1**	**4**	**5**
Pre-Requisite	None	**Co-requisite**	None				
Course Objectives	The core competency of this course is to impart knowledge about the biochemical composition, physicochemical properties and technological advances in processing of different cereals and legumes						

Course Outcomes	
CO1	Understand the biochemical compositeon, structure, and physicochemical properties of different cereals and legumes.
CO2	Examine the processing technology of major cereals such as wheat and rice and its practical exposure by visit to a milling industry.
CO3	Assess the processing of coarse cereals, millets and analyze the principle and applications of secondary processing (extrusion technology)
CO4	Analyze the processing of legumes, methods for antinutritional factors reduction and evaluate advances in plant protein engineering.

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	Fundamentals of Cereal & Legume Science	Production & Morphology: Global utilization trends; Microstructure and ultrastructure of grains (Wheat, Rice, Barley, Maize, Millets, and various Legumes).Biochemical Composition: Advanced profiling of starch (amylose-lipid complexes), storage proteins (Glutens vs. Globulins), and dietary fiber fractions. Physicochemical Properties: Grain hydration kinetics, thermal properties (DSC analysis), and gelatinization/retrogradation behavior.	8	CO1
2	Processing Technology of Major Cereals (Wheat & Rice)	Wheat Engineering: Physicochemical characterization and grading; Advanced Roller Milling systems; Flour streams and extraction rate optimization; Milling of Durum wheat for pasta/semolina.Rice Technology: Modern milling (Rubber roll vs. Friction); Hydrothermal Treatment: Mechanisms of parboiling and its effect on milling yield and nutrition; Rice bran stabilization and Rice Bran Oil (RBO) processing. By-product Valorization: Industrial applications of husks, bran, and broken grains in the circular economy.	8	CO2
3	Coarse Cereals, Millets & Extrusion Technology	Dry & Wet Milling: Advanced milling of Maize for starch, germs, and gluten; Processing of Oats (stabilization, steaming, and rolling).Millet Technology: Decortication challenges of small millets; Shelf-life extension techniques (hydrothermal and enzymatic treatments).Secondary Processing: Principles of Extrusion Cooking (Single vs. Twin-screw); HTST processing for Ready-to-Eat (RTE) snacks, breakfast cereals, and texturized products.	8	CO3
4	Legume Processing & Plant Protein Engineering	Milling & Dehulling: Comparative study of dry and wet milling of pulses (red gram, green gram, chickpea); Milling efficiency and factors affecting dhal recovery. Antinutritional Factors (ANFs): Biochemistry of protease inhibitors, lectins, and polyphenols; Modern methods for ANF reduction (microwave, fermentation, and germination).Protein Isolation: Industrial production of Protein Concentrates and Isolates via isoelectric precipitation and membrane filtration. Advanced Applications: Legume-based meat analogues (TVP), gluten-free formulations, and composite flour technology.	8	CO4

PRACTICAL

S. No.	List of Experiments	Contact Hrs.	Mapped CO
1	Determination of physical characteristics of cereals.	4	CO1
2	Determination of moisture content of different cereal grains.	4	CO1
3	Determination of crude fibre in wheat flour. Determination of ash of flour	4	CO1
4	Determination of gluten.	4	CO3
5	Determination of sedimentation value of the Maida.	4	CO2
6	Cooking quality of rice.	4	CO2
7	Protein isolation and extraction soybeans and legumes.	4	CO4
8	Visit to local roller flour mill. Visit to local rice hulling unit.	6	CO2

Reference Books:

Chakrabarty MM. 2003. *Chemistry and Technology of Oils and Fats*. Prentice Hall.

Dendy DAV & Dobraszczyk BJ. 2001. *Cereal and Cereal Products*. Aspen.

Hoseney RS. 1994. *Principles of Cereal Science and Technology*. 2nd Ed. AACC.

Kay DE. 1979. *Food Legumes*. Tropical Products Institute.

e-Learning Source:

Legume Science - Wiley Online Library

Cereal Chemistry - Wiley Online Library

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)													
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	2	.2	2	3		1		1	3	3	3	3
CO2	3	3	2	2	2	3		1		1	3	3	3	3
CO3	3	3	3	2	2	3		1		1	3	3	3	3
CO4	3	3	3	2	2	3		1		1	3	3	3	3

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Name & Sign of Program Coordinator	**Sign & Seal of HoD**

Integral University, Lucknow

Effective from Session: 2026-27							
Course Code	**BE 344**	**Title of the Course**	**Food Additives and Ingredients**	**L**	**T**	**P**	**C**
Year	III	**Semester**	V	2	1	0	3
Pre-Requisite	None	**Co-requisite**	None				
Course Objectives	Impart comprehensive knowledge of various categories of food additives, their functional roles, and the permissible limits for their use in different food products.						

Course Outcomes	
CO1	Understanding Food Additives & their safety, evaluate health risks, and sustainable solutions for food additives, contaminants, and GRAS compliance.
CO2	Classify food additives, analyze the chemistry, functions, and applications of food additives, and evaluate their roles in food formulations using the international numbering system.
CO3	Analyze food colorants, pigments, and flavoring agents, investigate their health impacts, and design formulations using stabilizers, thickeners, and chelating agents for enhanced food safety and quality.
CO4	Understanding the classification of food ingredients, analyze sweetener chemistry and functional roles, and design optimized food formulations using sugars, starches, fibers, proteins, and fats.

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	**Additives in food processing and preservation**	Classification, functions of additives in processing/preservation; safety metrics (NOAEL, ADI, LD50, acute/chronic studies); contaminants, indirect additives. GRAS, natural compounds; FSSAI 2025 updates, clean-label trends.	8	CO1
2	**Classification of Additives**	Preservatives, antioxidants, antimicrobials, colors, flavors, emulsifiers, humectants, hydrocolloids, sweeteners, acidulants, anticaking/buffering agents: chemistry, uses, International numbering system for Food Additives, Novel enzymes from GM microbes.	8	CO2
3	**Functional Additives**	Types, applications of Natural & Synthetic food colorants, flavoring agents, flavor potentiators, Chelating agents, and their impact on health. Applications of antioxidants, Stabilizers, thickeners, Bleaching & maturing agents.	8	CO3
4	**Ingredients used in food production Ingredients used in food production**	Sweetener chemistry related to usage in food products: Ingredients used in food production e.g. sugar, sugar alcohols, potent sweeteners, sugar products; starches, modified starches; fibers; proteins, protein hydrolysates; fats etc. and their technology of production and application. Emerging Functional ingredients: nutraceuticals, probiotics, clean label additives, enzyme-based additives, plant-based functional ingredients	8	CO4

Reference Books:

Branen, A. L., Davidson, P. M., Salminen, S., & Thornton, R. J. (Eds.). (2002). *Food additives* (2nd ed.). Marcel Dekker.

Burdock, G. A. (Ed.). (1997). *Encyclopedia of food and color additives* (Vol. III). CRC Press.

Food Safety and Standards Authority of India. (2025). *Food Safety and Standards (Food Products Standards and Food Additives) Regulations, 2025*. https://fssai.gov.in/cms/food-safety-and-standards-regulations.php

IMARC Group. (2026). *India food additives market report*. https://www.imarcgroup.com

Alli, I. (2013). *Food quality assurance: Principles and practices*. CHIPS Books.

e-Learning Source:

Alli, I. (2013). *Food quality assurance: Principles and practices*. CHIPS Books.

https://faia.org.uk/educational-resources/

Food Additives Open Access Book (IntechOpen)

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)													
PO-PSO CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3	2	3	2	1	2	1	2	2	3	3	3	2
CO2	3	3	3	2	2	2	1	2	3	3	2	3	2	2
CO3	3	3	2	3	3	2	2	2	2	1	2	3	3	3
CO4	3	2	3	2	2	2	2	2	2	2	3	3	3	3

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Name & Sign of Program Coordinator	Sign & Seal of HoD

Integral University, Lucknow

Effective from Session: 2026-27							
Course Code	**BE 345**	**Title of the Course**	**Food Regulation and Quality Control**	**L**	**T**	**P**	**C**
Year	III	**Semester**	V	2	1	0	3
Pre-Requisite	None	**Co-requisite**	None				
Course Objectives	This course provides a deep understanding of food safety management systems and international food laws while mastering quality assessment techniques for various food commodities and industrial water supplies. It aims to bridge the gap between laboratory analysis and regulatory compliance within the food industry.						

Course Outcomes	
CO1	List and identify the principles of food and personal hygiene, summarize and interpret sampling techniques, and demonstrate or explain the laboratory preservation and proximate analysis methods (moisture, fat, protein) used for quality assessment.
CO2	Recognize and classify food quality attributes, such as viscosity and texture; apply and execute sensory evaluation methodologies; and analyze or compare taste and flavor profiles to meet industrial quality standards.
CO3	Outline and relate FSSAI, Codex, and FDA regulations, implement and organize HACCP and ISO 9000/22000 safety systems, and critique or judge food samples for adulteration using standard detection methods.
CO4	Differentiate the quality requirements for diverse commodities (dairy, meat, cereals), solve sanitation challenges in industrial water supplies, and design or formulate sanitary handling protocols to mitigate food hazards.

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	Hygiene, Sampling & Laboratory Analytics	General principles of food hygiene and personal hygiene. Introduction to food analysis: sampling techniques, storage, and preservation of samples. Proximate analysis principles: estimation of moisture, fat, protein, carbohydrates, fiber, minerals, and vitamins.	8	CO1
2	Physical & Sensory Quality Control	General principles of quality control and quality attributes: color, gloss, viscosity, consistency, size, shape, and texture. Advanced sensory evaluation techniques: taste, flavor, and sensory evaluation methodologies.	8	CO2
3	Global Food Regulations & Safety Systems	National Standards: FSSAI, Food laws, and standards. International Standards: National and international regulatory agencies, Codex Alimentarius, FDA, and ISO 9000/22000 series. Safety Management: Concepts of HACCP, food adulteration evaluation, and methods for detecting various food adulterants.	8	CO3
4	Commodity Quality Assessment & Sanitation	Quality assessment of specific materials: Fruits, vegetables, cereals, dairy, meat products, and eggs. Food hazards and handling habits. Sanitary aspects of water supply: sources, quality requirements, impurities, and industrial treatment.	8	CO4

Reference Books:

1. Krammar & Twigg (2017), Quality Control for The Food Industry Fundamentals & Applications, CBS Publishers.
2. Y. Pomeranz und C. E. Meloan (1978), Food Analysis: Theory and Practice, The Avi Publishing Company. Inc., Westport, Connecticut.
3. Ronald, S. Kirk, & Ronald, Sawyer (1991). Pearson's Composition & Analysis of Foods, 9th Edition, Longman Scientific & Technical, U. K.
4. Kilcast D (2010), Sensory Analysis for Food And Beverage Quality Control: A Practical Guide, Woodhead Publishing Ltd

e-Learning Source:

1. http://ecoursesonline.iasri.res.in/course/view.php?id=185
2. https://onlinecourses.swayam2.ac.in/cec20_ag06/preview
3. https://sac-elearning.com/courses/food-safety-and-quality-control-2/
4. https://onlinelibrary.wiley.com/journal/17454557

Course Articulation Matrix: (Mapping of COs with POs and PSOs)

PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	1	1	2	2	1	1	1	2	1	2	3	2	2
CO2	2	2	2	3	3	1	1	1	2	1	2	3	3	3
CO3	2	2	2	3	3	3	3	1	1	2	1	3	2	3
CO4	2	2	2	3	3	2	2	1	1	2	1	3	2	3

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Name & Sign of Program Coordinator	Sign & Seal of HoD

Integral University, Lucknow

Effective from Session: 2026-27							
Course Code	**BE310**	**Title of the Course**	**Internship I**	**L**	**T**	**P**	**C**
Year	**III**	**Semester**	**V**	**0**	**0**	**2**	**1**
Pre-Requisite	None	**Co-requisite**	None				
Course Objectives	This course enables students to remember and understand real-world bioengineering industry operations, processes, and workplace culture. It develops the ability to apply and analyze theoretical knowledge in practical industrial system. It further enhances skills to evaluate and create structured technical reports based on training experience and effectively present them in a viva voce.						

Course Outcomes	
CO1	Understand the structure, functioning, and workflow of bioengineering and associated industries.
CO2	Apply bioengineering concepts and techniques learned in academics to real industrial settings and practical tasks.
CO3	Industrial training ensures students to interact with industrial personnel and follow engineering practices and discipline prescribed in industry.
CO4	Create a detailed training report based on the industrial visit and participate in a viva voce examination to demonstrate the knowledge and skills acquired.

Unit No.	**Title of the Unit**	**Content of Unit**	**Mapped CO**
1	**Industry Orientation**	Understand the organizational structure, manufacturing processes, and workflow in bioengineering and associated industries.	CO1
2	**Practical Application**	Apply theoretical bioengineering knowledge in real-life processes and operational environments.	CO2
3	**Analytical Skills Development**	Analyze and critically evaluate processes, equipment, and workflows observed during industrial training.	CO3
4	**Communication and Reporting**	Prepare structured reports and professional presentations based on industrial experience.	CO4

Reference Books:

NA

e-Learning Source:

NA

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)													
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	1	1	2	2	1	2	2	1	2	3	3	3
CO2	2	3	2	1	2	1	1	1	2	2	2	3	2	3
CO3	3	3	3	2	2	1	2	2	1	1	2	1	2	3
CO4	2	1	1	1	1	1	3	1	2	2	2	2	2	3

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Name & Sign of Program Coordinator	**Sign & Seal of HoD**

Integral University, Lucknow

Effective from Session: 2026-27							
Course Code	**BE346**	**Title of the Course**	Novel Food Processing Technologies	**L**	**T**	**P**	**C**
Year	III	**Semester**	V	**3**	**0**	**0**	**3**
Pre-Requisite	None	**Co-requisite**	None				
Course Objectives	Develop understanding of novel and emerging food processing technologies used in modern food industries. Explain the principles of non-thermal and minimal processing techniques. Evaluate the effect of advanced processing technologies on food quality, safety and shelf life.						

Course Outcomes	
CO1	Understand principles and working mechanisms of novel food processing technologies.
CO2	Analyze non-thermal and advanced food processing techniques used in food industries.
CO3	Apply emerging food preservation technologies for improving food quality and shelf life.
CO4	Evaluate modern food processing technologies for sustainable food processing applications.

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	**Introduction to Novel Food Processing Technologies**	Need for novel food processing technologies; Limitations of conventional food processing methods; Concept of minimal processing; Non-thermal processing technologies; Hurdle technology concept; Effect of novel technologies on microorganisms; Effect on food quality attributes.	8	CO 1
2	**High Pressure and Pulsed Electric Field Processing**	High Pressure Processing: Principles, equipment and applications in food processing; Effect on microorganisms and food quality. Pulsed Electric Field Processing: Principles, processing parameters, equipment; Mechanism of microbial inactivation; Applications in liquid food processing.	8	CO 2
3	**Ultrasound, Microwave and Ohmic Heating**	Ultrasound Processing: Principles, types, applications in food processing; Extraction and preservation applications. Microwave Processing: Principles, equipment and applications; Microwave drying and heating. Ohmic Heating: Principles, mechanism and applications in liquid foods and particulate foods.	8	CO 3
4	**Emerging Non-Thermal Technologies**	Cold Plasma Technology: Principles and applications in food processing. Irradiation Technology: Principles, sources and applications. Infrared Heating: Principles and applications. Membrane Processing: Ultrafiltration, reverse osmosis and microfiltration; Applications in food industry.	8	CO 4

Reference Books:

1. Novel Food Processing Technologies by Gustavo V. Barbosa-Cánovas; Publisher: CRC Press; Year: 2005
2. Food Processing Technology by P.J. Fellows; Publisher: Woodhead Publishing; Year: 2017
3. Emerging Technologies for Food Processing by Da-Wen Sun; Publisher: Academic Press; Year: 2014
4. Innovative Food Processing Technologies by Kai Knoerzer; Publisher: Elsevier; Year: 2016
5. Non-thermal Processing Technologies for Food by Howard Q. Zhang; Publisher: Wiley-Blackwell; Year: 2011

e-Learning Source:

1.NPTEL Course on Novel Food Processing Technologies, https://onlinecourses.nptel.ac.in/noc22_ag03/preview

2. FAO Food Processing Technology Learning Resources, https://elearning.fao.org

3. NPTEL Food Engineering and Technology Courses, https://nptel.ac.in/courses/126105011

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)													
PO-PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO														
CO1	3	3	2	1					2			2	2	
CO2	3	3	3	2	2				2			3	3	
CO3	3	3	3	3	3				2			3	3	
CO4	3	3	3	2	3	2	1		2			3	3	

1-Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Name & Sign of Program Coordinator	**Sign & Seal of HoD**

Integral University, Lucknow

Effective from Session: 2026-2027							
Course Code	**BE347**	**Title of the Course**	**Analytical Techniques**	**L**	**T**	**P**	**C**
Year	**III**	**Semester**	**V**	**3**	**0**	**0**	**3**
Pre-Requisite	None	**Co-requisite**	None				
Course Objectives	To develop technical proficiency in advanced instrumental analysis, enabling students to select, calibrate, and apply high-precision techniques—including spectroscopy, chromatography, and rheometry—for the rigorous characterization, safety validation, and quality control of food systems.						

Course Outcomes	
CO1	Standardize sampling protocols and apply spectroscopic principles for the elemental and molecular characterization of food systems.
CO2	Evaluate and optimize chromatographic separation techniques for the quantification of food additives, micronutrients, and contaminants.
CO3	Utilize biomolecular, immunochemical, and rapid sensing technologies for the analysis of food allergens, proteins, and safety parameters.
CO4	Analyze and interpret the physical, textural, and rheological properties of food materials using specialized instrumental techniques.

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	**Fundamentals of Food Analysis & Spectroscopy**	**Introduction:** Safety in Laboratory; Sampling protocols for solids, liquids, and gases; Sample preparation (cleanup and extraction). **Spectroscopy:** Principles and applications of UV-Visible, Atomic Absorption Spectroscopy (AAS), Inductively Coupled Plasma (ICP) for minerals; FTIR for functional groups; Principles of Mass Spectrometry (MS).	8	CO1
2	**Advanced Separation Science**	**Chromatography:** General principles and classification. **Instrumentation & Applications:** High-Performance Liquid Chromatography (HPLC) for vitamins and additives; Gas Chromatography (GC) for fatty acids and volatiles; High-Performance Thin Layer Chromatography (HPTLC). **Hybrid Techniques:** Introduction to GC-MS and LC-MS for pesticide and residue analysis.	8	CO2
3	**Biomolecular & Rapid Analysis Techniques**	**Biochemical Analysis:** Electrophoretic techniques (SDS-PAGE, Agarose gel) for protein and DNA profiling. **Immunochemistry:** ELISA and Lateral Flow Assays for allergens and toxins. **Rapid Methods:** Near-Infrared Spectroscopy (NIRS) for rapid proximate analysis; Biosensors in food quality monitoring. **Radiochemical:** Introduction to radiotracer techniques in food research.	8	CO3
4	**Physical, Rheological & Optical Characterization**	**Texture Analysis:** Instrumental measurement of textural properties; Texture Profile Analysis (TPA); types of probes and load cells. **Rheometry:** Advanced viscometry and rheometers; flow behavior of liquid and semi-solid foods. **Optical Properties:** Food color analysis using CIELAB/Hunter Lab systems; Refractometry and Polarimetry in sugar analysis.	8	CO4

Reference Books:

1. Nielsen, S. S. (Ed.). (2017). *Food analysis* (5th ed.). Springer International Publishing.
2. Pomeranz, Y., & Meloan, C. E. (1994). *Food analysis: Theory and practice* (3rd ed.). Chapman & Hall.
3. Sun, D.-W. (Ed.). (2018). *Modern techniques for food authentication* (2nd ed.). Academic Press.
4. Rao, M. A., Rizvi, S. S., Datta, A. K., & Ahmed, J. (Eds.). (2014). *Engineering properties of foods* (4th ed.). CRC Press.
5. Otles, S. (Ed.). (2016). *Methods of analysis of food components and additives* (2nd ed.). CRC Press.
6. AOAC International. (2023). *Official methods of analysis of AOAC International* (22nd ed.). AOAC International.

e-Learning Source:

1. https://nptel.ac.in/courses/103108100
2. https://www.chromacademy.com/
3. https://www.youtube.com/watch?v=oM04xQuLOuo&list=PL04lTsIC4hVJMp1Cq16G864UI9CpbA896
4. https://www.youtube.com/watch?v=pPD3rWOplFE

Course Articulation Matrix: (Mapping of COs with POs and PSOs)

PO-PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	1	3	3	1	-	-	1	1	-	3	2	1
CO2	3	3	2	3	3	1	1	-	1	1	-	3	3	2
CO3	3	2	1	2	3	2	1	2	1	1	-	3	2	2
CO4	3	3	2	2	3	1	-	-	1	1	-	3	3	2

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Name & Sign of Program Coordinator	**Sign & Seal of HoD**

Integral University, Lucknow

Effective from Session: 2026-27							
Course Code	**BE352**	**Title of the Course**	**Novel Food Processing and Preservation Techniques**	**L**	**T**	**P**	**C**
Year	III	**Semester**	V	**3**	**0**	**2**	**4**
Pre-Requisite	None	**Co-requisite**	None				
Course Objectives	Develop understanding of novel, emerging, and non-thermal food processing technologies used in modern food industries. Emphasize analysis and evaluation of advanced preservation techniques with respect to food quality, safety, and sustainability. Promote research-oriented learning and application of modern food processing technologies to address real-world challenges in food processing and preservation.						

Course Outcomes	
CO1	Explain, analyze and interpret the principles and working mechanisms of novel and non-thermal food processing technologies.
CO2	Analyze, evaluate and compare advanced thermal and dielectric processing techniques for food preservation applications.
CO3	Apply, design and implement dehydration, membrane processing and extraction techniques for food preservation and product development.
CO4	Evaluate, assess and select emerging food processing technologies for improving food quality, safety and shelf-life.
CO5	Develop, design and propose research-based and practical solutions for real-world food preservation challenges using modern processing technologies.

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	**Non-Thermal Processing Technologies**	High Pressure Processing: Principles, equipment and processing parameters; Effect of high pressure on microorganisms, enzymes and food quality attributes; Hurdle technology concept. Pulsed Electric Field Processing: Principles, treatment chamber design, processing parameters; Mechanism of microbial inactivation; Effect on food quality. Cold Plasma Processing: Principles, plasma generation methods, applications in food processing; Effect on microorganisms and food quality. **Research Component/ Case Study** Literature review on high pressure processing applications in food industry; Case study on fruit juice preservation using HPP.	8	CO 1
2	**Advanced Thermal and Dielectric Processing**	Microwave Processing: Principles, dielectric heating, applications in food processing; Advantages and limitations. Ohmic Heating: Principles, equipment, electrical conductivity and heating characteristics; Applications in food processing. Infrared Heating: Principles, applications in drying and food preservation. Ultrasound Processing: Principles, cavitation mechanism; Applications in extraction, drying and preservation. **Research Component/ Case Study** Comparative study of conventional vs dielectric heating methods; Case study on ultrasound-assisted extraction.	8	CO 2
3	**Advanced Dehydration and Membrane Processing**	Osmotic Dehydration: Principles, osmotic agents, mass transfer mechanism, factors affecting osmotic dehydration; Applications in fruits and vegetables. Membrane Processing: Microfiltration, Ultrafiltration, Nanofiltration and Reverse osmosis; Membrane materials and configurations; Applications in dairy and beverage industries. Freeze Drying and Vacuum Drying: Principles, applications and advantages over conventional drying. **Research Component/ Case Study** Case study on cold plasma in food packaging; Critical review of irradiation technology in food preservation.	8	CO 3
4	**Emerging Technologies and Smart Preservation**	Food Irradiation: Principles, sources of radiation, dose levels; Applications in food preservation; Safety and regulatory aspects. Supercritical Fluid Processing: Principles and applications in extraction and preservation. Nano-technology in food processing and preservation; Active packaging and smart packaging technologies. Hurdle Technology and Minimal Processing Concepts. **Research Component/ Case Study** Identification of real-world food processing problem and development of novel processing solution; Presentation and report submission.	8	CO 4

S. No.	List of Experiments	Contact Hrs.	Mapped CO
1.	Perform microwave-assisted drying of fruits and vegetables and analyze drying characteristics and moisture reduction	4	CO2
2.	Perform osmotic dehydration of fruits/vegetables and determine mass transfer parameters (water loss and solid gain).	4	CO3
3.	Perform infrared drying of food materials and compare drying efficiency with conventional drying methods.	4	CO3
4.	Perform freeze drying of selected food materials and compare quality attributes with conventional hot air drying.	4	CO4
5.	Perform ohmic heating of liquid food materials and analyze heating characteristics and quality changes.	4	CO4
6.	Perform ultrasound-assisted extraction of bioactive compounds from food materials and evaluate extraction efficiency	4	CO5
7.	Develop and evaluate conventional and novel food preservation	4	CO5

	techniques based on shelf-life and quality parameters.		

Reference Books:
1. Novel Food Processing Technologies by Gustavo V. Barbosa-Cánovas; Publisher: CRC Press; Year: 2005
2. Food Processing Technology by P.J. Fellows; Publisher: Woodhead Publishing; Year: 2017
3. Emerging Technologies for Food Processing by Da-Wen Sun; Publisher: Academic Press; Year: 2014
4. Innovative Food Processing Technologies by Kai Knoerzer; Publisher: Elsevier; Year: 2016
5. Non-thermal Processing Technologies for Food by Howard Q. Zhang; Publisher: Wiley-Blackwell; Year: 2011
e-Learning Source:
1.NPTEL Course on Novel Food Processing Technologies, https://onlinecourses.nptel.ac.in/noc22_ag03/preview
2. FAO Food Processing Technology Learning Resources, https://elearning.fao.org
3. NPTEL Food Engineering and Technology Courses, https://nptel.ac.in/courses/126105011

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)													
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	2	2	2	1	1		2		3	2	1	
CO2	3	3	3	2	3	2	1	1		2	3	3	1	
CO3	3	3	3	3	3	2	1	1		2	3	3	2	
CO4	3	3	3	2	3	3	1	1		2	3	3	2	
CO5	3	3	3	3	3	3	2	2		3	3	3	3	

1-Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Name & Sign of Program Coordinator	**Sign & Seal of HoD**

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Integral University, Lucknow

Effective from Session: 2026-27							
Course Code	**BE 356**	**Title of the Course**	**Meat, Fish, and Poultry Technology**	**L**	**T**	**P**	**C**
Year	III	**Semester**	VI	3	0	4	5
Pre-Requisite	None	**Co-requisite**	None				
Course Objectives	This course explores India's meat, poultry, and fish industries, focusing on economic impact and muscle-to-meat transformation. Students evaluate preservation, packaging, value-addition, egg science, and poultry processing, emphasizing safety and techniques for aquatic products to ensure quality and compliance.						

Course Outcomes	
CO1	Identify and assess the status of Indian meat/fish industries alongside emerging alternative proteins; summarize pre-slaughter care; ensure humane stunning; and analyze the chemical composition of conventional and novel muscle/protein structures.
CO2	Explain and interpret post-mortem changes and rigor mortis, differentiate between fresh and processed meat quality, demonstrate microbiological assays (TPC, Yeast/Mold), and evaluate hygiene standards to judge product shelf life.
CO3	Classify tenderization methods, implement preservation strategies (curing, smoking, thermal processing), design and formulate value-added products (e.g., sausages or pickles), and develop a comprehensive HACCP plan for a processing line.
CO4	Compare and contrast the structure/composition of poultry, eggs, and fish; assess quality using Haugh units and TVB-N; implement specialized preservation methods (coating, canning); and critique sensory attributes using hedonic scaling.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Industry Status & Muscle Science	Importance of livestock and emerging alternative sectors (plant proteins, lab-grown meat, insect proteins, e.g., Black Soldier Fly) in the national economy. Pre-slaughter care, transport, and ante-mortem inspection. Humane stunning and dressing methods. Chemical composition and microscopic structure of conventional meat and novel proteins.	8	CO1
2	Post-Mortem Changes & Quality	Post-mortem inspection. Mechanism of Rigor mortis and its resolution. Meat aging and conditioning. Total Plate Count and microbial safety of fresh vs. processed meat. Quality grading.	8	CO2
3	Processing & Preservation Technology	Tenderization and cutting methods. Factors in curing, smoking, and pickling. Preparation of sausages and hamburgers. Preservation: refrigeration, freezing, canning, and dehydration. HACCP planning.	8	CO3
4	Poultry, Egg & Aquatic Products	Composition and nutritive value of poultry, eggs, and fish. Grading and measures of egg quality (Haugh Unit, Yolk Index). Egg preservation. Handling of freshwater vs. marine fish and biochemical indicators of freshness (TVB-N).	8	CO4

PRACTICAL

S. No.	**List of Experiments**		**Contact Hrs.**	**Mapped CO**
1	Chemical Analysis	1. Determination of Moisture, Fat, and Protein in Meat Samples.	4	CO1
2		2. Determination of Water Holding Capacity (WHC) and pH of meat.	4	CO1
3	Microbiology	3. Total Plate Count (TPC) of fresh vs. processed meat.	4	CO2
4		4. Yeast and Mold count of meat/poultry samples.	4	CO2
5	Product Tech	5. Determination of TVB-N in freshwater vs. marine fish.	4	CO4
6		6. Egg Quality Assessment: Haugh Unit, Yolk Index, and Shell thickness.	4	CO4
7		7. Preparation of a value-added product (e.g., Meat Sausage or Pickle).	4	CO3
8	Quality & Safety	8. Sensory Evaluation using Hedonic Scaling.	4	CO4
9		9. Development of a HACCP Plan for a specific processing line.	4	CO3

Reference Books:

1. Lawrie, R. A. 1975. Lawrie's Meat Science. 2nd Edn. Pergamon Press. Oxford UK.
2. G. C. Mead. 2004. Poultry Meat Processing and Quality. CRC Press
3. A K Biswas and P K Mandal. 2014. Textbook of Poultry, Egg, and Fish Processing Technology. Studium Press India Pvt Ltd

e-Learning Source:

1. Meat Science; https://www.journals.elsevier.com/meat-science
2. Animal Science Journal; http://onlinelibrary.wiley.com/journal/10.1111/(ISSN)1740-0929

Course Articulation Matrix: (Mapping of COs with POs and PSOs)

PO- PSO CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	3	2	1	2	-	3	1	-	-	-	2	3	2	2
CO2	3	3	2	3	2	2	3	2	1	-	2	3	3	2
CO3	3	2	3	2	3	2	2	3	2	3	2	3	3	3
CO4	3	3	3	3	2	2	2	2	2	-	2	3	3	3

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Name & Sign of Program Coordinator	Sign & Seal of HoD

Integral University, Lucknow

Effective from Session: 2026-27							
Course Code	**BE 357**	**Title of the Course**	**Bakery and Confectionery Technology**	**L**	**T**	**P**	**C**
Year	III	**Semester**	VI	2	0	2	3
Pre-Requisite	None	**Co-requisite**	None				
Course Objectives	Equip students with practical and industry-oriented knowledge of bakery and confectionery processing, focusing on raw material functionality, processing technologies, quality control, food safety standards, packaging, and product innovation relevant to modern bakery industries.						

Course Outcomes	
CO1	Assessment of raw material specifications as per regulatory standards and develop optimized manufacturing techniques for bakery products through practical industrial exposure and process analysis.
CO2	Classify types of bread, prepare bread, rusks, buns, and pizza bases using various methods, and evaluate the quality of bakery products.
CO3	Identify types of bakery products, demonstrate preparation methods, analyze their faults and remedies, and assessment of product quality.
CO4	Examine confectionery ingredients and manufacturing technologies, evaluate quality parameters of products, and designing plant layouts.

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	**Bakery Industry Raw Material Overview**	Raw materials for bakery ingredients as per FSSAI specifications; clean-label alternatives; vital wheat gluten production and functionality. Emerging ingredients: high-protein flours, nutraceuticals. Industrial visit to bakery plant.	8	CO1
2	**Bread and Fermented Products**	Introduction to different types of bread and Development of bread using different methods. Quality evaluation of bread, their faults and remedies. Technology of Innovative products: multi-grain/protein-enriched products; Preparation of rusks, buns, pizza bases.	8	CO2
3	**Soft Wheat Products**	Introduction to different types of Cakes, development of cakes using different methods. Quality evaluation, their faults and remedies. Technology of development, Types and quality evaluation of Biscuits, cookies, crackers and Muffins	8	CO3
4	**Confectionery Products and Bakery Plant Operations**	Different ingredients used in confectionery products. Technology of development/ manufacture and quality parameters of candy, chocolate, aerated confectionery, Lozenges, sugar panning and Chewing gum.	8	CO4

Reference Books:

Bernard W. Minifie, Chocolate, Cocoa and Confectionery (3rd Ed., 2003) [original].

R.B.L. Mathur, Handbook of Cane Sugar Technology (1999).

Hamed Faridi, Science of Cookie and Cracker Production (2003).

Samuel A. Matz, Bakery Technology and Engineering (Vols I-II) (2018).

FSSAI Manual on Bakery FSMS (2018).

IMARC Indian Bakery Market Report (2026).

e-Learning Source:

https://www.youtube.com/results?search_query=bakery+automation+india, FSSAI bakery standards.

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)													
PO-PSO CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3	-	2	-	2	2	-	2	-	2	3	2	-
CO2	3	2	2	2	2	2	-	3	2	-	2	3	3	2
CO3	3	3	2	3	2	2	-	3	2	-	2	3	3	3
CO4	3	3	3	2	3	3	2	2	3	3	3	3	3	3

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Name & Sign of Program Coordinator	Sign & Seal of HoD

Integral University, Lucknow

Effective from Session: 2026-27							
Course Code	**BE358**	**Title of the Course**	**Food Plant Layouts**	**L**	**T**	**P**	**C**
Year	III	**Semester**	VI	**2**	**1**	**0**	**3**
Pre-Requisite	None	**Co-requisite**	None				
Course Objectives	To provide comprehensive knowledge on plant location, layout design, factory building construction, cost analysis, and maintenance strategies, enabling the evaluation and optimization of industrial operations for efficiency, sustainability, and profitability.						

Course Outcomes	
CO1	To understand the factors influencing plant location and layout design, and formulate optimal layout strategies to enhance efficiency and productivity.
CO2	To analyze layout designs for various food and fermentation industries, and apply network analysis techniques like PERT and CPM to optimize process efficiency.
CO3	To analyze the factory building design and cost factors, and apply economic analysis methods to assess profitability and sustainability.
CO4	Evaluate different plant maintenance strategies and implement effective maintenance plans to enhance operational efficiency and reliability.

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	**Introduction to Plant Layout**	Plant Location and Layout-Concept and factors governing plant location. Location economics-comparison of rural vs urban plant sites, plant site selection guide. Classes of layout problems, objectives, principles and types of layouts – process layout, product layout, combination layout, fixed position layout; methods and tools of plant and factory layouts; plant layout procedures.	8	CO1
2	**Layout of Different Food Industries and Network Analysis Process**	Layouts of different types of food and fermentation industries – canning, dairy, bread, biscuit, beer, tomato processing, rice mill and wheat mill. Network Analysis of Processes-Basic terms, objectives and advantages of network analysis, various network techniques, PERT and CPM techniques, smoothing.	8	CO2
3	**Cost Analysis**	Factory Building and Cost Analysis- Considerations in building design, types of factory buildings, building construction materials for floors, walls, roofs, etc. Fixed cost, variable cost, depreciation, methods of economic analysis, profitability analysis of a plant.	8	CO3
4	**Plant Maintenance**	Plant Maintenance-Objectives and importance of maintenance, types of maintenance – corrective or breakdown maintenance, scheduled maintenance, preventive maintenance and predictive maintenance.	8	CO4

Reference Books:

1. Peters, M.S. and Timmerhaus,K.D. Plant Designs and Economics for Chemical Engineers 4th Edition. McGraw Hill(1991).
2. Antonio Lopez-Gomez, Gustavo V. Barbosa-Canovas (2005) Food Plant Design, Taylor and Francis
3. Apple, J.M. (2000). Plant Layout and Material Handling. Willey eastern Pub.
4. Sahay, K.M. and Singh, K. K. (1998) Unit Operations of Agricultural Processing, Kalya Publishers, Ludhiana.

e-Learning Source:

1. http://ecoursesonline.iasri.res.in/course/view.php?id=529
2. https://www.igmpiindia.org/industry-certificate-in-Food-Plant-Layout-and-Design.html
3. https://www.youtube.com/watch?v=kbbPtK7EQ9Y
4. https://link.springer.com/chapter/10.1007/978-1-4615-0725-3_1

PO-PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	3	2	2	2	1	1			3	3	2	1
CO2	3	3	3	2	3	3	2	1			2	3	3	1
CO3	3	3	3	3	3	3	2	1	1	1		3	3	2
CO4	2	3	3	2	2	3	2	1	1	1	2	3	2	2

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Name & Sign of Program Coordinator	**Sign & Seal of HoD**

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Integral University, Lucknow

Effective from Session: 2026-27							
Course Code	**BE 359**	**Title of the Course**	**Fruits And Vegetable Processing**	**L**	**T**	**P**	**C**
Year	III	**Semester**	VI	2	1	4	5
Pre-Requisite	None	**Co-requisite**	None				
Course Objectives	Enable students with knowledge of modern fruit and vegetable processing technologies, quality and safety management, and value-added product development aligned with current industry practices.						

Course Outcomes	
CO1	Analyze the Indian and global scenario of fruit and vegetable processing, demonstrate pre-processing operations, evaluate canning and retort methods, and interpret spoilage and packaging in canned foods.
CO2	Define fruit-based products, formulate and prepare juices, squash, cordials, syrups, nectars, pulp, jams, jellies, marmalades and juice powders, and evaluate their compliance with FPO standards.
CO3	Prepare and formulate tomato products and pickles, assess their compliance with FPO standards, and analyze spoilage and quality defects in these ready-to-use products.
CO4	Analyze freezing and drying methods (including sun drying, dehydration and osmo-dehydration), evaluate related packaging and storage, and propose solutions to key problems in fruit and vegetable processing.
CO5	Evaluate sensory quality of processed products and interpret industrial practices through plant visits.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	**Basic Processing of Fruits and Vegetables**	Indian and global production and processing scenario of fruits and vegetables; preparation and basic pre-processing steps; blanching, peeling and their role in processing; history, types and methods of canning; retortable pouches and retort processing; calculation of vacuum in cans; difference between canning and bottling; spoilage causes and defects in canned foods.	8	CO1
2	**Fruit and Vegetable Products**	Definition and classification of fruit products; formulation and preparation of fruit juices, squashes, cordials, syrups, nectars, pulp, jams, jellies, marmalades and juice powders; quality and labelling requirements as per FPO standards.	8	CO2
3	**Ready to use Products**	Tomato products: preparation and formulation of tomato juice, puree, paste, ketchup, sauce and chutney; pickling process, types of pickles and their preparation; FPO standards for tomato products and pickles; causes and analysis of spoilage and quality defects.	8	CO3
4	**Techniques-based preservation of Fruits and Vegetables**	Freezing methods for fruits and vegetables, packaging and storage; advantages and limitations of freezing; sun drying, dehydration and osmo-dehydration of fruits and vegetables; packaging and storage aspects; common technical and operational problems in the fruit and vegetable processing industry.	8	CO4

Practicals

Unit No.	**Title of Experiment**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Fruit juices	Preparation and evaluation of fruit juices.	2	CO2
2	Squashes	Preparation and evaluation of squashes.	2	CO2
3	Jam	Preparation and evaluation of jams.	2	CO2
4	Jellies, Marmalades	Preparation and evaluation of jellies, marmalades etc.	4	CO2
5	Pickles	Preparation and evaluation of pickles	4	CO3
6	Tomato Products	Preparation and evaluation of tomato puree, paste and ketchup	4	CO3
7	Dehydration & Drying	Dehydration and sun drying of fruits and vegetables.	4	CO4
8	Organoleptic evaluation	Organoleptic evaluation of fruit and vegetable products prepared in class practical.	4	CO5
9	Industrial Visit	Visit to a local fruit processing plant.	4	CO5

Reference Books:

Lal, G., Siddappa, G. S., & Tandan, G. L. (1986). *Preservation of fruits and vegetables* (Revised ed.). Indian Council of Agricultural Research.

Srivastava, R. P., & Kumar, S. (2002). *Fruit and vegetable preservation: Principles and practices* (3rd ed.). International Book Distributing Co.

Ranganna, S. (1986). *Handbook of analysis and quality control for fruit and vegetable products* (2nd ed.). Tata McGraw-Hill Education.

Siddiq, M. (Ed.). (2012). *Tropical and subtropical fruits: Postharvest physiology, processing and packaging*. Wiley-Blackwell.
Girdhari Lal & Sidappa. Fruits and vegetable preservation, ICAR (New Delhi).
Srivastava. 2000. Preservation of fruits and vegetable, IBD Co. Lucknow.
Verma. L. R. & Joshi. V. K. 2000. Post harvest technology of fruits and vegetables. Indus Publishing.
e-Learning Source:
FAO elearning Academy. (n.d.). *Food loss and waste prevention and reduction*. Food and Agriculture Organization of the United Nations. https://elearning.fao.org/
Indian Council of Agricultural Research (ICAR). (n.d.). *Post-harvest management and value addition of fruits and vegetables* [e-Course]. ICAR e-Courses Portal. https://ecourses.icar.gov.in/
National Skill Development Corporation (NSDC). (n.d.). *Skill India: Fruit and vegetable processing*. NSDC Knowledge Bank. https://www.nsdcindia.org/
Mishra, H. N. (n.d.). *Post harvest operations and processing of fruits and vegetables* [Online course]. NPTEL / SWAYAM. https://onlinecourses.nptel.ac.in/noc22_ag13/preview

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)													
PO-PSO CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	3	2	2	2	2	1	-	3	2	2	3	3	3	2
CO2	3	2	3	1	-	2	-	2	3	3	2	3	2	2
CO3	2	2	3	1	-	1	-	2	2	1	2	3	3	3
CO4	3	3	2	2	1	-	2	3	2	2	3	3	3	3
CO5	2	3	3	2	3	2	1	3	3	2	2	2	2	3

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Name & Sign of Program Coordinator	Sign & Seal of HoD

Integral University, Lucknow

Effective from Session: 2026-27							
Course Code	**BE 363**	**Title of the Course**	**Mini Project Food Technology**	**L**	**T**	**P**	**C**
Year	III	**Semester**	VI	0	0	4	2
Pre-Requisite	None	**Co-requisite**	None				
Course Objectives	The Mini Project aims to empower students to identify and analyze real-world challenges in the food sector and propose effective engineering solutions. It provides essential hands-on experience in product formulation, food analysis, and process design. Furthermore, the course is designed to sharpen technical writing, data interpretation, and presentation skills, all while fostering a commitment to ethical research practices and collaborative teamwork.						

Course Outcomes	
CO1	Conduct a systematic literature review to identify and formulate a specific problem in food engineering or technology.
CO2	Design and execute experimental protocols or process flows using modern engineering tools and methodologies.
CO3	Analyze experimental data and interpret results to substantiate conclusions on food quality and safety.
CO4	Communicate technical findings effectively through professional reports and oral presentations while adhering to ethical standards.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Problem Identification & Literature Review	Identification of research gaps in Food Technology. Literature survey using academic databases. Defining objectives, scope, and methodology. Formulation of a project proposal.	12	CO1
2	Experimental Design & Product Development	Selection of raw materials and ingredients. Optimization of food formulations or processing parameters. Application of engineering tools for experimental design and modeling.	12	CO2
3	Analytical Evaluation & Data Collection	Physicochemical, nutritional, and sensory analysis of developed products. Shelf-life studies and safety assessments. Systematic data collection and statistical analysis of results.	12	CO3
4	Documentation & Presentation	Preparation of a technical project report (Abstract, Introduction, Methodology, Results, Discussion, Conclusion). Referencing styles and plagiarism ethics. Defense of project work through viva-voce and presentations.	12	CO4

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)													
PO-PSO CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	2	3	2	2	1	2	2	2	1	2	3	3	2	2
CO2	3	2	3	3	3	2	2	3	2	3	3	3	3	3
CO3	3	3	2	3	3	2	2	2	2	2	3	2	3	2
CO4	1	1	1	2	2	2	3	3	3	3	3	1	2	3

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Name & Sign of Program Coordinator	Sign & Seal of HoD

Integral University, Lucknow

Effective from Session: 2024-2025							
Course Code	**BE360**	**Title of the Course**	**Fermentation Technology**	**L**	**T**	**P**	**C**
Year	**III**	**Semester**	**VI**	**3**		**0**	**3**
Pre-Requisite	**None**	**Co-requisite**	**None**				
Course Objectives	To impart fundamental and applied knowledge of microbial fermentation and mass transfer principles, enabling students to analyze, design, and optimize bioprocesses and traditional fermented food products.						

Course Outcomes	
CO1	Evaluate fermentation history, metabolite dynamics, raw material quality, and pre-treatment processes to design and synthesize sustainable, innovative engineering solutions.
CO2	Evaluate fermentation kinetics, design effective fermenters for aerobic/anaerobic systems, and optimize batch, fed-batch, continuous operations innovatively.
CO3	Analyze and apply mass transfer principles to evaluate oxygen dynamics and optimize bioreactor performance in bioprocesses.
CO4	Analyze microbial processes and design optimized production strategies for alcoholic beverages, fermented vegetables, baker's yeast, and cereal-based foods.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	**Introduction to Fermentation**	Definition and brief history of fermentation, Primary and secondary metabolite, Raw material availability, quality processes and pre-treatment of raw materials.	8	CO1
2	**Design and kinetics**	Design of fermenter, Aerobic and anaerobic fermentation. Biomass, Substrate and product kinetics in Batch, Fed batch Continuous mode of reaction.	8	CO2
3	**Mass transfer in fermenter**	Role of diffusion in Bioprocessing, Convective mass transfer, Gas-liquid mass transfer, Oxygen uptake in cell cultures, Factor affecting cellular oxygen demand, Oxygen transfer in bioreactors, Measurement of volumetric oxygen transfer coefficient, Oxygen transfer in large bioreactor.	8	CO3
4	**Fermented beverages, vegetables & cereals**	Fermentative Production of Beer, Wines, Cider and Vinegar. Fermented Vegetables (Pickles, Saurkarnt). Production of Baker's Yeast, Cereal based fermented food: Idli, Dosa, Dhokla, Soy sauce, Tofu, Tempeh, Natto.	8	CO4

Reference Books:

1. Steinkraus, K. H. (Ed.). (1996). Handbook of indigenous fermented foods (2nd ed.). Marcel Dekker. (ISBN-13: 978-0824793524)
2. De, S. (1980). Outlines of dairy technology. Oxford University Press. (Reprinted 2001) (ISBN-13: 978-0195611946)
3. Prescott, S. C., & Dunn, C. G. (2004). Industrial microbiology. CBS Publishers & Distributors. (ISBN-13: 978-8123910018)

e-Learning Source:

1. https://www.edx.org/learn/cooking/harvard-university-food-fermentation-the-science-of-cooking-with-microbes
2. https://onlinecourses.swayam2.ac.in/nou19_ag06/preview

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)													
PO-PSO CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3	2	3	2	2	1	1	1	1	2	3	3	2
CO2	3	3	2	2	2	2	2	1	2	1	2	3	3	3
CO3	3	3	3	3	3	2	1	1	1	2	2	3	3	2
CO4	3	3	3	2	2	3	2	1	2	2	2	3	3	3
CO5	3	3	2	3	2	2	1	1	1	1	2	3	3	2

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Name & Sign of Program Coordinator	**Sign & Seal of HoD**

Integral University, Lucknow

Effective from Session: 2026-27							
Course Code	**BE 361**	**Title of the Course**	**Nutrition and Dietetics**	**L**	**T**	**P**	**C**
Year	III	**Semester**	VI	**3**	**0**	**0**	**3**
Pre-Requisite	None	**Co-requisite**	None				
Course Objectives	Develop understanding of human nutrition and dietary requirements across different age groups. Apply principles of dietetics for balanced diet planning and disease management. Evaluate nutritional status and promote healthy dietary practices for improving public health.						

Course Outcomes	
CO1	Explain principles of human nutrition and functions of macro and micronutrients in maintaining health.
CO2	Analyze nutritional requirements for different age groups and physiological conditions.
CO3	Apply diet planning principles for balanced and therapeutic diet formulation.
CO4	Evaluate nutritional problems and dietary strategies for improving public health.

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	**Fundamentals of Nutrition**	Concept of nutrition and health; Classification of nutrients; Macronutrients — carbohydrates, proteins, lipids; Micronutrients — vitamins and minerals; Water and electrolytes; Balanced diet; Recommended Dietary Allowances (RDA); Dietary guidelines for Indians; Nutritional assessment methods. Nutritional calculation and diet planning basics.	8	CO 1
2	**Nutritional Requirements and Meal Planning**	Nutritional requirements for infants, children, adolescents, adults and elderly; Nutrition during pregnancy and lactation; Factors affecting nutritional requirements; Meal planning principles; Food exchange list; Menu planning; Portion size. Diet planning for different age groups.	8	CO 2
3	**Dietetics and Therapeutic Nutrition**	Principles of diet therapy; Modification of normal diet; Therapeutic diets for diabetes mellitus, obesity, cardiovascular diseases, hypertension, gastrointestinal disorders and malnutrition; Introduction to enteral and parenteral nutrition.	8	CO 3
4	**Community Nutrition and Public Health**	Nutritional problems in India; Malnutrition and deficiency diseases; Nutrition programs in India; Nutrition and immunity; Food fortification; Functional foods and nutraceuticals; Nutrition education and dietary counselling.	8	CO 4

Reference Books:

1. Nutrition Science by B. Srilakshmi; Publisher: New Age International (P) Ltd., New Delhi; Year: 2006.
2. Dietetics by B. Srilakshmi; Publisher: New Age International (P) Ltd., New Delhi; Year: 2007.
3. Advanced Textbook on Food and Nutrition by M. Swaminathan; Publisher: Bangalore Printing and Publishing Co. Ltd. (BAPPCO), Bangalore; Year: 1988.
4. Normal and Therapeutic Nutrition (17th Edition) by Corinne H. Robinson, Marilyn R. Lawler, Wanda L. Chenoweth, Ann E. Garwick; Publisher: Macmillan Publishing Company, New York; Year: 1990.
5. Nutrient Requirements and Recommended Dietary Allowances for Indians by ICMR-National Institute of Nutrition; Publisher: National Institute of Nutrition, Hyderabad, India; Year: 2009.

e-Learning Source:

1.NPTEL Nutrition Courses. https://nptel.ac.in/courses/109106402.

2. WHO Nutrition Resources. https://www.who.int/health-topics/nutrition#tab=tab_1

3. FAO Nutrition Portal. https://www.fao.org/nutrition/en/

4. ICMR Guidelines. https://nin.res.in/dietaryguidelines/pdfjs/locale/DGI_2024.pdf

Course Articulation Matrix: (Mapping of COs with POs and PSOs)

PO-PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	2	1					2			3	2	
CO2	3	3	3	2	2				2			3	3	
CO3	3	3	3	3	3				2			3	3	
CO4	3	3	3	2	2	2	1		2			3	3	

1-Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Name & Sign of Program Coordinator	**Sign & Seal of HoD**

Integral University, Lucknow

Effective from Session: 2026-27							
Course Code	**BE366**	**Title of the Course**	**Fermentation Technology in Food Processing**	**L**	**T**	**P**	**C**
Year	**III**	**Semester**	**VI**	**4**	**0**	**0**	**4**
Pre-Requisite		**Co-requisite**					
Course Objectives	The course aims to provide a comprehensive understanding of the biochemical and microbial principles governing food fermentation, including starter culture management, bioreactor design, and downstream processing. It integrates research-based learning to evaluate industrial fermentation processes, single-cell proteins, and food additives, ensuring the production of high-quality fermented foods within an industrial context.						

Course Outcomes	
CO1	Analyze the physiological and metabolic requirements of starter cultures to optimize inoculum development for food fermentation.
CO2	Evaluate the influence of environmental and process parameters on microbial growth kinetics and product yield.
CO3	Assess the efficiency of various bioreactor configurations and downstream separation techniques in maintaining food grade quality.
CO4	Design standardized process flowsheets for the industrial production of fermented dairy, cereal, and beverage products.
CO5	Evaluate the production processes for single-cell proteins and food additives, integrating research on their industrial food applications.

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	Starter Cultures & Inoculum Media	Introduction to food fermentation; Taxonomy of industrial microorganisms; Selection and genetic improvement of starter cultures; Preservation techniques (lyophilization, cryopreservation); Inoculum development and media formulation; **Research Task:** Comparative analysis of 2 seminal papers on "Next-generation starter cultures."	8	CO1
2	Process Control & Kinetics	Factors affecting fermentation: pH, temperature, water activity, and oxygen transfer; Microbial growth kinetics (Monod equation basics); Substrate utilization and product formation; Contamination control strategies; **Research Task:** Case Study analysis on troubleshooting fermentation failure in a commercial plant.	8	CO2
3	Bioreactors & Downstream Processing	Classification of bioreactors: Batch, Fed-batch, and Continuous; Solid-state vs. Submerged fermentation; Monitoring tools (DO probes, pH sensors); Recovery of metabolites: Centrifugation, filtration, and membrane separation; Stabilization and packaging of fermented foods. **Research Task:** Review scientific literature on the integration of membrane bioreactors for continuous food fermentation.	8	CO3
4	Industrial Fermented Products	Technology of fermented dairy (Yogurt, Cheese), cereals (Sourdough, Idli), and legumes (Tempeh, Miso); Production of alcoholic beverages (Beer, Wine); Fermented vegetables (Sauerkraut, Kimchi). **Research Task:** Formulate a novel plant-based fermented product and propose its industrial flowsheet based on recent literature.	8	CO4
5	Alternative Proteins & Food Additives	Fermentation of SCP producing organisms; mushroom, Baker's yeast, algal proteins. Food additives like coloring agents, flavoring agents, and vitamins. **Research Task:** Investigate and present the techno-economic feasibility of large-scale algal protein production for human consumption.	8	CO5

Reference Books:

Stanbury, P. F., Whitaker, A., & Hall, S. J. (2016). Principles of fermentation technology (3rd ed.). Butterworth-Heinemann. (ISBN-13: 978-0080999531)

Frazier, W. C., & Westhoff, D. C. (2013). Food microbiology (5th ed.). Tata McGraw-Hill Education. (ISBN-13: 978-1259062513)

Shetty, K., & Ranilla, L. G. (Eds.). (2025). Fermentation biotechnology of food and beverages. CRC Press. (ISBN-13: 978-1032996530)

Wood, B. J. B. (Ed.). (1998). Microbiology of fermented foods (2nd ed.). Springer Science & Business Media (ISBN-13: 978-0751402162)

Hutkins, R. W. (2018). Microbiology and technology of fermented foods (2nd ed.). Wiley-Blackwell. (ISBN-13: 978-1119027447)

e-Learning Source:

NPTEL: Food Microbiology for Safe and Sustainable Food Systems Specifically **Lecture 8: Food Fermentation**, which covers the foundational microbial processes in food. Link to Course

SWAYAM/NPTEL: Industrial Biotechnology This course provides deep insights into bioreactor design (Weeks 2–4) and the industrial production of wine, cheese, and vinegar (Weeks 6–9). Link to Course

NPTEL: Introduction to Food Technology Includes dedicated modules on **Fermentation and Pickling** as preservation operations. Link to Course

SWAYAM/NPTEL: Dairy and Food Process and Products Technology Covers the technology of fermented milk products, alcoholic beverages, and fermented vegetables. Link to Course

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)													
PO-PSO CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	3	2	1	2	1	1	-	-	-	-	2	3	2	1
CO2	3	3	2	2	2	1	-	-	-	-	1	3	3	2
CO3	3	2	3	2	3	1	-	1	1	1	1	3	2	2
CO4	2	2	3	2	2	2	1	2	2	1	2	3	3	3
CO5	3	2	2	3	2	2	2	1	2	1	2	3	2	2

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Name & Sign of Program Coordinator	Sign & Seal of HoD