Integral University, Lucknow

Effective from Session: 2020-21							
Course Code	BE-550	**Title of the Course**	Fundamental Food Microbiology	**L**	**T**	**P**	**C**
Year	**I**	**Semester**	I	2	1	0	3
Pre-Requisite	BE-550	**Co-requisite**	None				
Course Objectives	Course is designed to introduce the students to developments and research in the field of microbiology, to enhance their ability to characterize bacteria, yeasts, algae and molds alongwith their reproductive aspects. The students would be made aware of various aspects of spoilage and poisoning along with its safety measures.						

Course Outcomes	
CO1	Having a detailed idea regarding the developments and research in the field of microbiology from historic era, would be able to characterize bacteria, yeasts, algae and molds along with their reproductive aspects.
CO2	Given a microbial culture, would be able to draw out its growth, growth curve, growth rate, generation time and understand the effects of various environmental factors on its growth mechanism and will able to control its growth through various physical, chemical and biological agents
CO3	Given food products like milk products; cereals and cereal products; meat and meat products, fish and fish products; poultry and eggs; spices and condiments; canned foods, would be able to understand its sources of contamination and its preventive measures.
CO4	Given a microbial mass, would be able to isolate and preserve varied microorganisms accordingly; would be aware of its various aspects of spoilage and poisoning along with its safety measures.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	**Introduction**	Historical development, Discovery of microbial world, Biogenesis, abiogenesis controversy, germ theory of disease, immunization, chemotherapy, discovery of viruses, applied microbiology, Microbiology in twentieth century. General characteristics of bacteria, yeast, mold, viruses and algae. Brief account of bacterial, yeast and mold reproduction.	8	CO1
2	**Microbial Growth**	Definition of growth, growth curve, growth rate, generation time, measurement of growth, effect of environmental factors such as temperature, moisture, salt, pH, oxidation reduction potential and radiation on growth. Control of microorganisms by physical, chemical and biological agents, thermal death time, Z, F and D values.	8	CO2
3	**Prevention of Microbial Growth**	Sources and prevention of contamination. General principles of food preservation. Microbiology of air, water, milk products; cereals and cereal products; meat and meat products, fish and fish products; poultry and eggs; spices and condiments; canned foods.	8	CO3
4	**Microbial Techniques**	Isolation and preservation of microbial cultures (Brief introduction). Methods of genetic improvement (Recombinant DNA Technology). Bacterial toxins and mycotoxins with special reference to Staphylococcus, Clostridium, Aspergillus. Food poisoning and safety measures.	8	CO4

Reference Books:

1. Dubey, R.C., and Maheshwari, D. K. (2001). *A text book of microbiology*, S. Chand and Co., New Delhi.
2. Pelezar, M. J., Chan, E. G. S. and Krieg, N.R. (2002). , *Microbiology 5th edition*, Tata McGraw Hill and Co, New Delhi.
3. Purohit, S. S. (2001). *Microbiology*, Fundamentals and applications.
4. Sharma, P.D. (2000). *Microbiology*, A text book for university students.
5. Frazier, W. C. &Westhoff, D. C. (1996). *Food Microbiology*, Tata McGraw Hill and Co.

e-Learning Source:

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)																	
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3	2	1	1	1	1	3					3	3	3	3			
CO2	2	3	1	3	1	1	2					3	3	2	3			
CO3	3	3	3	3	2	3	3		2			3	3	3	3			
CO4	3	3	3	3	3	3	2		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: 2020-21							
Course Code	**BE-551**	**Title of the Course**	**INTRODUCTION TO FOOD ENGINEERING**	**L**	**T**	**P**	**C**
Year	**1st**	**Semester**	1st	**3**	**1**	**0**	**4**
Pre-Requisite	None	**Co-requisite**	None				
Course Objectives	This course is aimed to impart basic knowledge about food engineering processes and unit operations associated with them						

Course Outcomes	
CO1	Students would understand and comprehend the principle fluid mechanics.
CO2	Students can be familiarized with basic principles of heat and mass transfer.
CO3	From food industrial point of view students can apply these principles for solving numerical problems

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	Fluid Mechanics	Liquid Transport Systems, Properties of Liquids, Handling Systems for Newtonian Liquids, Force Balance on a Fluid Element Flowing in a Pipe—Derivation of Bernoulli Equation, Pump Selection and Performance Evaluation, Flow Measurement, Measurement of Viscosity.	8	1,3
2	Mass Transfer	The Diffusion Process, Steady-State Diffusion of Gases (and Liquids) through Solids, Convective Mass Transfer, Laminar Flow over a Flat Plate, Turbulent Flow Past a Flat Plate, Laminar Flow in a Pipe, Turbulent Flow in a Pipe, Mass Transfer for Flow over Spherical Objects, Unsteady-State Mass Transfer, Transient-State Diffusion, Diffusion of Gases.	8	2,3
3	Mass Transfer Applications	Distillation: Role of Raoult's Law and Dalton's Law, Types of Distillation, Important Applications. Leaching: Process description, Types of equipment. Supercritical Fluid Extraction: The Supercritical State, Process Description, Advantages of SCFE, Food Applications of SCFE.	8	2,3
4	Heat Transfer	Thermal Properties of Foods. Specific Heat, Thermal Conductivity, Thermal Diffusivity. Modes of heat transfer: Conductive Heat Transfer, Convective Heat Transfer, and Radiation Heat Transfer. Steady and unsteady heat transfer. Heat transfer equipment: Plate Heat Exchanger, Tubular Heat Exchanger, Scraped-surface Heat Exchanger, Steam-infusion Heat Exchanger.	8	2,3
5	Heat Transfer Applications	Processing Systems: Pasteurization and Blanching Systems, Commercial Sterilization Systems, Ultra-High Pressure Systems. Microbial Survivor Curves. Thermal Death Time F. Spoilage Probability. Process Calculation. Evaporation: Types of Evaporators, Single-Effect Evaporator, Multiple-Effect Evaporator, Vapor Recompression Systems.	8	2,3

Reference Books:

Sahay, K.M. and Singh, K. K. 1998. *Unit Operations of Agricultural Processing* by Kalya Publishers, Ludhiana.

Lloyd, A. &Penizer, R. 2006. *Handling, Transportation and storage of Fruits and Vegetables,* AVI Publications, UK.

Mcabe W. L. and Smith J. C. 2005. *Unit operations of chemical engineering.* Mc Graw Hill Publication.

GeanKoplis C. J. (3rd Edition). Transport processes in unit operations. Prentice Hall of India.

e-Learning Source:

Food Engineering Reviews | Home (springer.com)

Journal of Food Engineering | ScienceDirect.com by Elsevier

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)																	
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO4	PSO5	PSO6	PSO7
CO1	**3**	**3**	1	1	**1**	**1**	**1**	**1**	**1**	1	**1**	**3**	**3**	**3**	**3**			
CO2	**3**	**3**	1	1	**1**	**1**	**1**	**1**	**1**	1	**1**	**3**	**3**	**3**	**3**			
CO3	**3**	**3**	1	1	**1**	**1**	**1**	**1**	**1**	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: 2020-21							
Course Code	BE-552	**Title of the Course**	PRINCIPLES OF FOOD CHEMISTRY	**L**	**T**	**P**	**C**
Year	1st	**Semester**	1st	**2**	**1**	**0**	**3**
Pre-Requisite	None	**Co-requisite**	None				
Course Objectives	This subject aims to give students an understanding of the properties of food constituents, and the interactions between these constituents during food processing, storage and digestion. Students will gain knowledge of relationship between chemical composition and properties of macroconstituents (carbohydrates, proteins, lipids) and microconstituents (vitamins, minerals, antioxidants, and flavor) and their functions in plant- and animal-based foods.						

Course Outcomes	
CO1	Understand and describe the general chemical structures of the major components of foods (water, proteins, carbohydrates, and lipids).
CO2	Give a molecular rationalization for the observed physical properties and reactivity of major food components.
CO3	Provide a theoretical explanation for observed extent and rates of reactions that are common to foods predict how processing conditions are likely to change the reactivity of food components.
CO4	To predict how changes in overall composition are likely to change the reactivity of individual food.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	**Water**	Physical properties of water. Structure of water molecule. Structure of ice and liquid water. Water-Solute Interactions. Types of water in foods. Water activity: Definition and Measurement of Water Activity, Moisture Sorption Isotherms, Water Activity and Food Stability, Hysteresis, Intermediate-Moisture Foods	8	1
2	**Carbohydrates and Lipids**	Structure and functional properties of mono, oligo, & polysaccharides, gelatinization and retrogradation of starch. Classification and structure of lipids, Autoxidation, photooxidation, rancidity & flavor reversion, Hydrogenation & interesterification. Physical properties of fats.	8	2
3	**Proteins and Enzymes**	Classification and structure of proteins in food, Functional properties, Protein denaturation. Animal proteins: Milk Proteins, Meat Proteins, Egg Proteins. Plant proteins: Wheat Proteins, Maize Proteins, Soybean Proteins. Enzymes: Specificity, simple and inhibition kinetics, coenzymes, enzymatic and Nonenzymatic browning.	8	3
4	**Pigments and Flavors**	Pigments in Animal and Plant Tissues: Myoglobin/hemoglobin, Carotenoids, chlorophylls, anthocyanins and betalains. Food flavors: Introduction, Vegetable, fruit and spice flavors, Flavor Volatiles from Fats and Oils.	8	4

Reference Books:

1. Srinivasan Damodaran and Kirk L. Parkin (2017), Fennema's Food Chemistry, Taylor & Francis
2. Jianquan Kan and Kewei Chen (2021), Essentials of Food Chemistry, Springer
3. Walstra, P. (2003), Physical Chemistry of Foods, Marcel Dekker
4. Chopra, H.K and Panesar, P.S. (2010), Food Chemistry, Narosa.

e-Learning Source:

1. http://ecoursesonline.iasri.res.in/course/view.php?id=89
2. https://onlinecourses.swayam2.ac.in/cec20_ag10/preview
3. https://www.youtube.com/watch?v=O3gPACVV1a0
4. https://www.sciencedirect.com/journal/food-chemistry

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)																	
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	1	1	1	3	3	1	1	1	1	2	1	3	3	1	3			
CO2	1	1	1	3	3	1	1	1	1	2	1	3	3	1	3			
CO3	1	1	1	3	3	1	1	1	1	2	1	3	3	1	3			
CO4	1	1	1	3	3	1	1	1	1	2	1	3	3	1	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: 2020-21							
Course Code	BE 553	**Title of the Course**	Food Processing Technology	**L**	**T**	**P**	**C**
Year	**I**	**Semester**	I	3	1	0	4
Pre-Requisite	None	**Co-requisite**	None				
Course Objectives	This course is about the basic principles and practices that help in preserving the foods.						

Course Outcomes	
CO1	The students will have knowledge about different processing and preservation methods and principals involved
CO2	Students will understand the relationship of low temperature, drying and aseptic processing in food preservation
CO3	Students will learn the utility of radiations and additives in food preservation
CO4	To understand the efficacy of microwave, hydrostatic pressure, ohmic and extrusion techniques in food processing
CO5	To learn the concepts of fermentation and hurdle technology in food preservation

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	**Basic Principles**	Introduction and Historical Development of Food Preservation. Preservation by heat; Principles of heat preservation, heat resistance of microorganisms and their spores. Thermal death time; Heat treatments- steam under pressure: In-container sterilization, Ultra high-temperature (UHT)/aseptic processes, Effect on foods. Pasteurization: Theory, Equipment, Effect on foods, canning; Heat penetration studies.	8	CO1
2	**Preservation by Low Temperature and Drying**	Preservation by low temperature- Chilling, Chill storage, Equipment, Effect on foods. Freezing: Theory, Equipment, Changes in foods, freeze drying and freeze concentration. Preservation by drying: Phenomenon, Drying using heated air, Drying using heated surfaces, Equipment, Effect on foods, sun drying.	8	CO2
3	**Food Additives and Food irradiation**	Preservation by food additives- definitions, classification and functions.Preservation by radiations; Ultraviolet and ionizing irradiations. Equipment, Their effect on microorganisms, use in the treatment of food.Effect on foods	8	CO3
4	**Novel Techniques**	Microwave heating- Properties, mechanism, microwave generator and microwave food application. Introduction to hydrostatic pressure technology, ohmic heating and extrusion cooking. Use of ultrasounds in food processing.	8	CO4
5	**Other Techniques**	Preservation by fermentation- Definition, Advantages, disadvantages, types, equipment. Hurdle technology: concept and advantages. Intermediate moisture foods.	8	CO5

Reference Books:

1. Sahay, K.M. and Singh, K. K. 1998. *Unit Operations of Agricultural Processing* by Kalya Publishers, Ludhiana.
2. Lloyd, A. &Penizer, R. 2006. *Handling, Transportation and storage of Fruits and Vegetables,* AVI Publications, UK.
3. P.Fellows. 2000. *Food processing technology. Principles and practice.* Ellis Horwood England and V C H publishers Germany
4. Earl, P. 1994. *Unit operation in Food Processing,* Elsevier Science UK.
5. Potter & Hotchkiss. Food Science, CBS Publishers, 2007
6. Sahay, K.M. and Singh, K. K. 1998. *Unit Operations of Agricultural Processing* by Kalya Publishers, Ludhiana.

e-Learning Source:

https://www.youtube.com/watch?v=HVcY6HpWdaA

https://www.youtube.com/watch?v=BMIUAVhzRuc&list=PLgYHty1vjcGjhmAnec3LVKxnahBRR9aGx

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)																	
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	2	1	1	1	1	1	1	1	1	1	1	1	3	3	3			
CO2	1	1	1	2	1	1	1	1	1	1	1	1	3	3	3			
CO3	1	1	1	1	2	1	1	2	1	1	1	1	3	3	3			
CO4	1	1	1	1	2	1	1	1	1	1	1	1	3	3	3			
CO5	1	1	1	1	1	1	1	1	1	1	1	1	3	3	3			

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

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

Integral University, Lucknow

Effective from Session: 2020-21							
Course Code	BE-554	**Title of the Course**	FOOD ANALYSIS AND QUALITY CONTROL	**L**	**T**	**P**	**C**
Year	**1**	**Semester**	1	**3**	**1**	**0**	**4**
Pre-Requisite		**Co-requisite**					
Course Objectives	This subject aims to give students an understanding of laboratory testing which is important for the scientific analysis to identify problems with food products, to compliance with regulations, research and development of new products.						

Course Outcomes	
CO1	The students will develop the concept of proximate composition and different biochemical tests used to determine the proximate composition of food samples for various applications. Gain awareness about the basic principles and working of the instruments used for food analysis and quality control.
CO2	Students will develop understanding of the role of microbial agents in food industry and know the basic concepts of microbiological techniques that support their food handling and preservation skills.
CO3	Students will become acquainted about the sensory evaluation techniques, analysis of the data obtained (with the help of different statistical approaches) and to know about the acceptability of any new/modified product in the market
CO4	Student will learn about different modern analytical techniques to analysis the sample.
CO5	They will also understand different regulations and standards that need to be meet by the food product before reaching to the market.

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	Proximate Composition	Sampling, Moisture, Ash and mineral matter, Titrable acidity, Crude fat, Sugar, Crude protein, Crude fibre, Starch.	8	1
2	Microbiological Examination	Basic Microbiological Techniques; Cultivation, Pure Culture Technique. Enumeration of Microorganisms; Dilution, Methods of counting microorganisms, Pour Plate and spread plate methods, Most probable number technique, Turbidity, Metabolic activity, Dry mass. Testing Methods for Quality and Safety; Total plate count, Yeast and mould count, Pathogens, Indicator microorganisms.	8	2
3	Sensory Evaluation	Quality, Laboratory set-up and equipment, Panel selection, Judging quality, Paired comparison test, Duo-Trio test, Triangle test, Ranking test, Hedonic rating test.	8	3
4	Objective Analysis	UV-VIS molecular absorption spectrometry, atomic absorption spectrometry, HPLC, GC, Super critical fluid extraction, chromatography, Texture analysis, Colour analysis	8	4
5	Quality Control and Network Analysis	FSSA—2006, BIS—1952, Agmark—1937, FPO—1955, PFA—1954, ISO—9000 series, ISO 22000, Codex Alimentarius, Total Quality Management, Hazard Analysis Critical Control Point, PERT and CPM network, Six Sigma	8	5

Reference Books:

1. Pare, J. R. *I.* and Bélanger, *!.* M. R. (2015). *Instrumental Methods of Food Analysis:* Elsevier
2. Pomeranz, Y. and Meloan, C. E. (1996). *Food Analysis: Theory and Practice* (3 ed.): CBS Publications, New Delhi.
3. Winton, A. L. (2001). *Techniques of Food Analysis:* Agrobios, Jodhpur.
4. Sharma, B. K. (1994). *Instrumental Methods of Chemical Analysis:* Krishna, Meerut.

e-Learning Source:

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)														
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1		1	1	2						2	2	1	2
CO2	3		2		1		1	2				1	2	1	
CO3	1	2		2	1			1	2			2	3	1	1
CO4	3	2	2	1	3	1		1				1	3	1	2
CO5						1		2				2	1	1	2

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

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

Integral University, Lucknow

Effective from Session: 2020-21							
Course Code	BE-555	**Title of the Course**	Quality control lab	**L**	**T**	**P**	**C**
Year	**1**	**Semester**	1	0	0	6	3
Pre-Requisite	None	**Co-requisite**	Food analysis and quality control				
Course Objectives	The aim of Quality Control lab is to determine the proximate, sensory and microbial analysis of various food products						

Course Outcomes	
CO1	The students will learn the proximate analysis
CO2	The students will learn the sensory analysis of foods
CO3	The students will learn the microbial analysis of foods
CO4	The students will get acquainted with the various foods present in market

Unit No.	**Title of the Experiments**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Proximate analysis	Determination of moisture content of a given food sample Determination of mineral content of a given food sample Determination of Titrable acidity of a given food sample Determination of crude fat of a given food sample Determination of reducing and non-reducing sugar content of a given food sample Determination of crude protein of a given food sample	16	1
2	Sensory analysis	Determine the threshold value of any flavour Duo-Trio test and Triangle test Rate any food sample by using Hedonic rating test	8	2
3	Microbial analysis	Determine yeast and mold count of a given food sample Determine total plate count of a given food sample	8	3
4	Market analysis	Market analysis of various food as per governing standards	4	4

Reference Books:

S.S. Neilson, Food analysis, Springer.

AOAC methods for Food Analysis.

Y. Pomeranz and C. E Meloan, Food Analysis, Theory and practice; AVI Publishing Company, INC West Port, Connecticut, USA.

Fung, D.Y.C. and Matthews, R., Instrumental Methods for Quality Assurance in Foods; Marcel Dekker, Inc. New York.

e-Learning Source:

Journal of Food Composition and Analysis | ScienceDirect.com by Elsevier

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)																	
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO5	PSO6	PSO7
CO1	3	1	1	2	1	1	1	1	1	1	1	3	3	3	3			
CO2	3	1	1	2	1	1	1	1	1	1	1	3	3	3	3			
CO3	3	1	1	2	1	1	1	1	1	1	1	3	3	3	3			
CO4	3	1	1	2	1	1	1	1	1	1	1	3	3	3	3			
CO5																		

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

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

Integral University, Lucknow

Effective from Session: 2020-21							
Course Code	BE556	**Title of the Course**	Unit Operations in Agricultural Processing	**L**	**T**	**P**	**C**
Year	**1st**	**Semester**	2nd	**3**	**1**	**0**	**4**
Pre-Requisite	None	**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	Develop the understanding of material handling.
CO2	Apply his/her computational skills in calculating the energy required in size reduction, understand the processing of foods in terms of common unit operations like size reduction, sieving etc.
CO3	Understand the construction, working and applicability of various mixing equipment.
CO4	Ability to understand the principle and application of filtration.
CO5	Develop the knowledge for various thermal operations.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Preliminary Unit Operations	Cleaning, sorting and grading – aims, methods and applications, physical properties of food materials. Conveying and 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	1
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	2
3	Mixing & Agitation	Liquid mixing, mixing equipment-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	3
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. Ultrafiltration, membrane filtration, reverse osmosis. Sedimentation- Stoke's law. Free and hindered settling. Crystallization, nucleation, crystal growth.	8	4
5	Thermal operations	Basic principle, theory and types of equipment of thermal operations. Heat processing using steam or water; Blanching, Pasteurization, Sterilization, Evaporation. Heat processing using hot air; Dehydration, Baking and roasting.	8	5

Reference Books:

Sahay, K.M. and Singh, K. K. 1998. *Unit Operations of Agricultural Processing* by Kalya Publishers, Ludhiana.

Mcabe W. L. and Smith J. C. 2005. *Unit operations of chemical engineering.* Mc Graw Hill Publication.

GeanKoplis C. J. (3rd Edition). Transport processes in unit operations. Prentice Hall of India.

P.Fellows. 2000. *Food processing technology. Principles and practice.* Ellis Horwood England and V C H publishers Germany

e-Learning Source:

Journal of Food Engineering | ScienceDirect.com by Elsevier

Journal Reports | Journal of Food Processing and Preservation | Hindawi

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)																	
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO5	PSO6	PSO7
CO1	3	3	2	1	1	1	1	1	1	1	1	3	3	3	3			
CO2	3	3	2	1	1	1	1	1	1	1	1	3	3	3	3			
CO3	3	3	2	1	1	1	1	1	1	1	1	3	3	3	3			
CO4	3	3	2	1	1	1	1	1	1	1	1	3	3	3	3			
CO5	3	3	2	1	1	1	1	1	1	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: 2021							
Course Code	BE 557	**Title of the Course**	MILK AND MILK PRODUCTS TECHNOLOGY	**L**	**T**	**P**	**C**
Year	**I**	**Semester**	II	3	1	0	4
Pre-Requisite	None	**Co-requisite**	None				
Course Objectives	To impart knowledge of principles of processing of milk and milk products.						

Course Outcomes	
CO1	The student will gain basic knowledge of technology and methods for development of various dairy products.
CO2	Students also will gain the fundamental aspects of Cream, butter, margarine, spreads and cheeses- Handling of cream, processing steps along with chemistry and microbiology of cream and its application in non-dairy products as well as nutritive value of cream-based milk products.
CO3	Student would have acquired basic knowledge of physico-chemical nature of ice cream and microbiology of ice creams. Scope of Indian dairy products how produced or manufacture of Dahi, Srikand, Panir, Ghee, Khoa and Channa in simple ways without contaminations.
CO4	Understand the application of hygiene and sanitation and CIP and COP scheduling, deposit formation, cleaning and disinfection. And legal standards for milk and milk products in dairy industry
CO5	Know about the symptoms as well as detection of food borne diseases along with fundamental knowledge of toxins produced by Staphylococcus, Clostridium, Aspergillus.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	**Introduction**	The milk: definition by PFA, nutritional importance and status of milk production and processing. Milk constituents: their roles and nutritional significance. Properties of milk: chemical and physical. Microorganisms in milk and their roles	8	CO1
2	**Quality testes of milk**	Quality testes of milk: platform tests (sensory test, COB test, sedimentation test), alcohol alizarin, resazurine, MBR test, acidity, protein, fat, etc. Handling of milk: milk cleaning, chilling and transportation.	8	CO2
3	**Milk processing**	Full cream, standardized milk, toned, double toned milks and their production methods. Processing of fluid milk: pasteurization, sterilization, separation and homogenization.	8	CO3
4	**Technology of milk products**	Technology of milk products: cream, butter, cheese, khova, whey, yoghurt, ice-cream, condensed and dried milk	8	CO4
5	**Packaging and Sanitation**	Packaging of fluid milk and dairy products: glass bottles, flexible pouches, aseptic packaging system. Cleaning and sanitization of dairy plant equipments/machineries: types of dairy detergents, methods and procedure of cleaning, basic principle of CIP cleaning.	8	CO5

Reference Books:

1. The Technology of Milk Processing- CP Anantakrishnan and AQ Khan and PN Padmanabhan, Shri Lakshmi Publications, Madras
2. Milk Products Preparation and Control- CP Anantakrishnan and AQ Khan and PNPadmanabhan, Shri Lakshmi Publications, Madras
3. Outline of Dairy Technology- Sukumar De, Oxford University Press
4. Dairy Plant Engineering and Management- Tufail Ahmad, Kitab Mahal, Allahabad

e-Learning Source:

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

PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	**2**	**2**	**2**	**1**	**2**	**2**	**1**	**2**	**2**	**1**	**2**	**3**	**2**	**2**	**2**
CO2	**2**	**2**	**3**	**2**	**3**	**1**	**1**	**2**	**1**	**2**	**2**	**2**	**1**	**3**	**3**
CO3	**1**	**2**	**2**	**1**	**2**	**3**	**2**	**2**	**1**	**1**	**3**	**2**	**2**	**3**	**3**
CO4	**1**	**2**	**3**	**2**	**3**	**1**	**3**	**3**	**2**	**2**	**2**	**2**	**1**	**2**	**3**
CO5	**2**	**2**	**3**	**3**	**1**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**3**	**2**

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

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

Integral University, Lucknow

Effective from Session: 2020-21							
Course Code	BE 558	**Title of the Course**	Post Harvest Technology	**L**	**T**	**P**	**C**
Year	**I**	**Semester**	II	**2**	**1**	**0**	**3**
Pre-Requisite	BE558	**Co-requisite**	None				
Course Objectives	To acquaint with postharvest physiology of fruit and vegetables and to impart knowledge ofprocessing of fruit and vegetables.						

Course Outcomes	
CO1	Better understanding of the concepts of physiological characteristics of fruits and vegetables.
CO2	Better insight about the composition and physiology of fruits and vegetables.
CO3	Better understanding of chilling injury and mineral deficiency disorders.
CO4	Understandings of the application of scientific principles in the processing technologies specific to the materials.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Introduction	Status of production and processing of fruits and vegetables in India. Challenges before fruit and vegetable processing industry in India and government promotional policies. Postharvest losses in fruits and vegetables and their reasons.	8	1
2	Composition and physiology	Chemical composition and nutritional values of fruits and vegetables. Postharvest physiology of fruits and vegetables: biochemistry of respiration, respiratory responses of climacteric and non climacteric fruits. Physiological developments during maturation: Chemical and nutritional changes.	8	2
3	Physiological Disorders	Chilling injury, its mechanism and preventive measures, mineral deficiency related disorders and their preventions.	8	3
4	Processing Techniques	Thermal processing: canning and bottling, drying/dehydration, concentration/ evaporation. Freezing, methods and equipment. Fermented and unfermented fruit beverages. Quality evaluation of fruit and vegetable products. By - product utilization, economic considerations in fruit and vegetable processing.	8	4

Reference Books:

1. Post Harvest- Wills, Mc Glasson, Graham, Lee and Hall,CBS Publishers and Distributors,New Delhi
2. Postharvest Physiology of Perishable Plant products- Stainley J Kays, CBS Publishers and Distributors, New Delhi.
3. Fruit & Vegetable Preservation- R.P. Srivastava and S. Kumar, International Book Distributing Co., Lucknow.
4. Preservation of Fruits and Vegetables- Lal, Siddappaa and Tandon, Publications and Information Division, ICAR, New Delhi

e-Learning Source:

https://www.youtube.com/watch?v=ynGDvy4MQUo

https://www.youtube.com/watch?v=vUy0ixZOrMQ

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)																	
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3	1	3	3	3	3	3	3	2	3	3	3	3	3	3			
CO2	3	3	2	2	2	3	3	3	1	1	2	3	3	3	3			
CO3	3	3	3	1	2		1		1			3	3	3	3			
CO4	3	3	3	2	3		3		1			3	3	3	3			

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

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

Integral University, Lucknow

Effective from Session: 2020-21							
Course Code	**BE-559**	**Title of the Course**	**Engineering Properties & Food Storage Technology**	**L**	**T**	**P**	**C**
Year	2nd	**Semester**	2nd	**2**	**1**	**0**	**3**
Pre-Requisite	None	**Co-requisite**	None				
Course Objectives	To acquaint with properties of bio materials helpful in designing of machines and equipment. To impart knowledge which would be useful to the students after they complete the program and go to practical field. To acquaint with design aspects of food crop storage structures/systems.						

Course Outcomes	
CO1	Explain the role of engineering properties of biomolecules in food processing, packaging, storage and transport.
CO2	Understand the role of frictional and aerodynamic properties in designing food processing equipment.
CO3	Explain the relationship between rheological properties and flow behavior of food pastes.
CO4	Apply the knowledge for the design of food storage.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	**Physical Properties and Thermal Properties**	Importance of the engineering properties of the biological materials, physical properties of food materials, viz. shape, size, specific gravity, porosity, and their methods of determinations. Thermal properties: viz. specific heat, thermal conductivity and thermal diffusivity and their determinations, Dielectric properties of foods, Optical Properties.	10	1
2	**Aerodynamic Properties**	Aerodynamic and Hydrodynamic and Frictional, properties, Drag coefficient, terminal velocity, Relation between Drag coefficient and Reynolds number, terminal velocity from time distance relation, Application to agricultural products, Frictional properties, rolling resistance, angle of repose, definition and method of determination.	10	2
3	**Rheological Properties**	Rheological properties: concept of Rheology and ASTM definitions of terms related to mechanical properties, Force-deformation curve of the agricultural products, Classical ideal materials, basic rheological models and their interpretation, rheological properties of solid and liquid food, rheological equations.	10	3
4	**Storage**	Rural storage structures for grains. Design considerations of bulk storage structures - grain pressure theories, air distribution systems and aeration fans. Design considerations of bag storage structures.	10	4

Reference Books:

1. Engineering Properties of Foods (2014) Rao and Rizwi, CRC Press, Taylor & Francis Group.
2. Physical Properties of Plant and Animal Materials (1970) Mohsenin N.N., Gordon and Breach.
3. Physical Properties of Foods (2006) Serpil Sahin, Servet and Gülüm Sumnu, Springer
4. Unit Operations of Agricultural Processing (2004), KM Sahay and KK Singh, Vikas Publishing House Pvt. Ltd., New Delhi.

e-Learning Source:

1. http://ecoursesonline.iasri.res.in/course/view.php?id=25
2. https://www.youtube.com/watch?v=8ewhFYPI9S4
3. https://onlinecourses.nptel.ac.in/noc20_ag01/preview
4. http://ecoursesonline.iasri.res.in/mod/page/view.php?id=1008

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)														
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2	3	1	1	1	1	1	1	1	1	1	3	2	2
CO2	2	2	2	2	1	1	1	1	1	1	1	1	3	2	2
CO3	2	2	2	1	2	1	1	2	1	1	1	1	3	2	2
CO4	2	1	3	1	2	1	1	1	1	1	1	1	3	2	2

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

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

Integral University, Lucknow

Effective from Session: 2021-2022							
Course Code	BE561	**Title of the Course**	Fermentation Technology	**L**	**T**	**P**	**C**
Year	I	**Semester**	II	**2**	**1**	**0**	**3**
Pre-Requisite	None	**Co-requisite**	None				
Course Objectives	This paper provides the knowledge of basic principle of fermentation process, which help students to design, develop and operate industrial level fermentation process.						

Course Outcomes	
CO1	Understand the basis of fermentation.
CO2	Understand the working and parts of fermenter.
CO3	Understand the process of production of fermented beverages and vegetables
CO4	Understand the process of production of fermented cereals

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Introduction	Introduction to fermentation, Primary and secondary metabolite. Raw material availability, quality processes and pre-treatment of raw materials.	8	CO1
2	Fermentation Types and Methods	Design of fermenter, Aerobic and anaerobic fermentation. Biomass, Substrate, and product kinetics in kinetics in Batch, Fed batch Continuous mode of reaction.	8	CO2
3	Fermented beverages and vegetables	Fermentative Production of Beer, Wines, Cider and Vinegar. Fermented Vegetables (Pickles, Saurkarnt).	8	CO3
4	Fermented cereals	Production of Baker's Yeast, Cereal based fermented food: Idli, Dosa, Dhokla, Soy sauce, Tofu, Tempeh, Natto.	8	CO4

Reference Books:

1. K.H. Steinkrus Handbook of Indigenous Fermented Foods.
2. Sukumar De Outlines of Dairy Technology.
3. Prescott & Dunn Industrial Microbiology.
4. L.E. Casida Industrial Microbiology.
5. W.C. Frazier and D.C. Westhoff Food Microbiology.

e-Learning Source:

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)																		
PO-PSO CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO6**
CO1	2	2	1	1		1	2	1	1			3	3	2	1				
CO2	2	2	1	1		1	2	1	1			3	3	2	1				
CO3	2	2	1	1		1	2	1	1			3	3	2	1				
CO4	2	2	1	1		1	2	1	1			3	3	2	1				

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

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

Integral University, Lucknow

Effective from Session: 2020-21							
Course Code	BE 562	**Title of the Course**	GM Food and Biosafety	**L**	**T**	**P**	**C**
Year	I	**Semester**	II	**2**	**1**	**0**	**3**
Pre-Requisite	None	**Co-requisite**	None				
Course Objectives	As a Food Technologist, it is necessary to know that the new varieties of foods and crops are developed. It is also necessary to know how to develop hybrid and GM food as well as well as the patenting issues related to the use of technology.						

Course Outcomes	
CO1	The student will gain basic knowledge of GMOs/GMCs, Role of microorganism in food biotechnology and their various applications in food sector.
CO2	Students would be made aware about the fundamental aspects of r-DNA technology, gene cloning methodology and their significance in different biotechnological research.
CO3	Student would have acquired basic knowledge of molecular level vectors used as genetic engineering tool for development of new plant varieties.
CO4	The student will gain basic knowledge of IPR (patent, design, copyright and Geographical indication). Significance of IPR and how to obtain patent or filing process of patent. Regulatory and Social aspects of Food Biotechnology.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Introduction to Food Biotechnology	Introduction to Food Biotechnology: definition and scope, Signification of DNA and RNA in GMO/GMC, Role of microorganism in food biotechnology. Merits and demerits and Applications of GMOs/GMCs.	8	CO1
2	Concept of Genetic Engineering	Introduction to GE plants, Concept of gene cloning and rDNA technology, Enzymes involved in rDNA technology, Basic concept of gene expression and gene complexity in prokaryotes and eukaryotes, Applications of GMOs/GMCs in agriculture and pharmaceutical sector.	8	CO2
3	Genetic Engineering in Food Industry	Cloning vectors (Plasmid and Ti plasmid) for production of GMOs/GMCs, (eg: Bt. Cotton, Bt. Brinjal etc.) Developmental technique for new plant varieties.	8	CO3
4	Application of Food Biotechnology, Biosafety and IPRs	Regulatory framework for GMOs Food safety and Environmental assessment of GE Plants. Basic concept of IPR (patent with patenting step, copy right, trademarks, GI and PBR), Indian patent Act and Infringement.	8	CO4

Reference Books:

1. Principles of gene manipulation-Old and Primrose
2. Molecular Cloning (Vol 1,2,3)-Sambrook and Russell
3. Food Biotechnology: Dietrich Knorr,Inc.New York and Basel

4.Perry Johnson-Green. *Introduction to Food Biotechnology.* CRC Press

Genetic Engineering by Neelam Pathak and SmitaRastogi.

e-Learning Source:

PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	1	2	1	2	2	3	3	1	1	1	2	2	2	3
CO2	1	1	2	1	2	2	3	3	1	1	1	2	1	2	3
CO3	1	1	2	1	2	2	3	3	1	1	1	2	3	3	2
CO4	1	1	2	1	2	2	3	3	1	1	1	2	2	2	3

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

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

Integral University, Lucknow

Effective from Session: 2020-21							
Course Code	BE563	**Title of the Course**	Introduction to Bioinformatics	**L**	**T**	**P**	**C**
Year	I	**Semester**	II	**2**	**1**	**0**	**3**
Pre-Requisite	None	**Co-requisite**	None				
Course Objectives	The first aim of bioinformatics is to store the biological data organized in form of a database. The second aim is to develop tools and resources that aid in the analysis of data.						

Course Outcomes	
CO1	Understand the basics of Bioinformatics.
CO2	Understand the basic concepts of primary protein databases.
CO3	Understand the concepts of secondary and composite databases.
CO4	Understand the concepts of literature databases and file formats.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Introduction	Definition of Bioinformatics, Biological databases: Nucleotide databases (e.g., GenBank, EMBL, and DDBJ), Biological search engines (e.g., Entrez, SRS, and ARSA).	8	CO1
2	Biological Databases	Protein databases- Primary protein databases (e.g., SwissProt, Tr-EMBL, and PIR).	8	CO2
3	Secondary protein databases	Secondary protein databases (e.g., PROSITE, PRINTS, IDENTIFY, BLOCK, andPFAM), Composite database (e.g., OWL, and NRDB).	8	CO3
4	Literature databases	Literature databases: (e.g., PubMed and PubChem), Biological file formats(e.g., GenPept/GenBank, FASTA, and EMBL), Applications of Bioinformatics.	8	CO4

Reference Books:

1. D. W. Mount: Bioinformatics-sequence and genome analysis
2. JinXiong: Essential Bioinformatics

e-Learning Source:

https://www.uniprot.org/

https://pubmed.ncbi.nlm.nih.gov/

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)																	
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3	1	1	1	3	3	1	1				3	3	1				
CO2	3	1	1	1	3	3	1	1				3	3	1				
CO3	3	1	1	2	3	3	1	1				3	3	1				
CO4	3	3	3	3	3	3	1	1				3	3	1				

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

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

Integral University, Lucknow

Effective from Session: 2020-21							
Course Code	**BE560**	**Title of the Course**	**Food processing lab**	**L**	**T**	**P**	**C**
Year	**1st**	**Semester**	2nd	**0**	**0**	**6**	**3**
Pre-Requisite	None	**Co-requisite**	BE-557, BE-558, BE559				
Course Objectives	To inculcate in the students the practical application of food processing and get to know about the preparation of various food products and the detection and estimation of food quality characteristics.						

Course Outcomes	
CO1	The students will be able to analyze quality characteristics of fats and oils.
CO2	The students will be able to analyze quality characteristics of milk and milk products.
CO3	The students will be able to the physical properties of foods.
CO4	The students will be able to prepare different food products.

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	Fat analysis	Estimation of saponification value of fats and oils Estimation of iodine value of fats and oils	9	1
2	Milk analysis	Determine the fat by garbar method and SNF content in the milk Perform Alkaly Test of milk. Determine pH content of milk.	12	2
3	Physical properties of foods	Determination of apparent density and sphericity of a given food sample Determination of surface area of a leaf. To study the drying characteristics of a given food sample in a dryer.	9	3
4	Fruit and vegetable products	Preparation of jam Preparation of jelly Preparation of pickles Preparation of tomato products	12	4

Reference Books:

The Technology of Milk Processing- CP Anantakrishnan and AQ Khan and PN Padmanabhan,Shri Lakshmi Publications, Madras.

Food Processing: Biological Appl.-Marwara S., Engineering Properties of Foods- Rao and Rizwi, CRC Press, Taylor & Francis Group.

Post Harvest- Wills, Mc Glasson, Graham, Lee and Hall,CBS Publishers and Distributors,New Delhi.

e-Learning Source:

food engineering rpaulsingh

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)																	
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO5	PSO6	PSO7
CO1	1	3	1	1	1	1	2	1	1	1	1	3	3	3	3			
CO2	1	3	1	1	1	1	2	1	1	1	1	3	3	3	3			
CO3	2	3	1	1	1	1	1	1	1	1	1	3	3	3	3			
CO4	1	3	1	1	1	1	2	1	1	1	1	3	3	3	3			

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

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