SYLLABUS OF THE CURRICULUM

for

BACHELOR OF TECHNOLOGY

in

FOOD ENGINEERING AND TECHNOLOGY

Department of Food Engineering and Technology
Institute of Chemical Technology
Mumbai – 400019
SEPTEMBER 2021

Preamble

The undergraduate programmes at the Institute of Chemical Technology are reputed worldwide. Alumni from these programmes have found a place of pride in the Indian chemical industry including some top names and many as entrepreneurs, in Universities/ Institutes and Research Organisations throughout India and the world. The B.Tech. programmes in the then Department of Chemical Technology, University of Mumbai started in 1934 as post B.Sc., second graduation as B.Sc. (Tech.). Keeping national, societal needs in focus, post-independence, the programme grew into multiple branches keeping connection with chemical engineering content. Once the Institute became a university in 2009, these became independent B. Tech. Programmes retaining their dual core nature. The Institute of Chemical Technology is committed to keeping its syllabi updated and globally relevant for the industry. We have revamped the syllabi of all the B. Tech. programmes now in 2021. The 205 credit programmes each have around 6% humanities, 23% basic sciences, 8% engineering sciences, 12% chemical engineering plus 51% special subjects.

All the courses are credit based and the evaluation are grade based. The credit system is a systematic way of describing an educational programme by attaching credits to its components. The definition of credits is based on student workload, learning outcomes and contact hours. This system is described in detail in Regulation No.9 of the Institute. Each theory course consists of lectures (L) and tutorials (T). During tutorial session, it is expected that the problem solving / case studies / relevant real-life applications / student presentations / home assignments / individual or group projects are discussed in the presence of the teacher. Teacher can have the freedom to interchange lectures / tutorials depending upon the topic. Institute gives emphasis on continuous evaluation with considerable freedom to the teacher in deciding the mode of evaluation.

DEPARTMENT OF FOOD ENGINEERING AND TECHNOLOGY

Vision

Establishing a center of excellence to provide demand-driven, value-based and quality technical education to make India a developed country through socio-economic transformation

Mission Statements

- **M1:** Creating an atmosphere to deliver fundamental knowledge in Food Engineering and Technology for the students to fulfil the need of all segments of society and the environment.

- **M2:** Starting from the classroom teaching and simultaneously creating a multi-disciplinary platform capable of conducting research, technology development, and solving industrial challenges.

- **M3:** Providing leadership and training personnel for the benefit of the industry and society complying with overall activity towards the economic growth of the country.

Program Educational Objectives (PEOs)

- **PEO1: Successful Career:** Graduates from the programme will have successful careers in food and allied industries at various levels of management

- **PEO2: Higher Study:** Graduates from the programme will pursue higher study related to food engineering and technology and allied disciplines in premier institutions across the world and make a career in academics or research

- **PEO3: Multi-disciplinary Skills:** Graduates from the programme will work in a multi-disciplinary environment in the domain of food technology.

Consistency with PEOs with Department Mission

Mission Statements	PEO1: Successful Career	PEO2: Higher Study	PEO3: Multi-disciplinary Skills
M1: Creating an atmosphere to deliver fundamental knowledge in Food Engineering and Technology for the students to fulfil the need of all segments of society and the environment.	2	2	3
M2: Starting from the classroom teaching and simultaneously creating a multi-disciplinary platform capable of conducting research, technology development, and solving industrial challenges.	3	2	3
M3: Providing leadership and training personnel for the benefit of the industry and society complying with overall activity towards the economic growth of the country.	3	3	3

3, 2, 1 refers strong, medium, and weak correlations, respectively

Programme Outcomes (POs) for B. Tech. (Food Engg. & Tech.)

PO1	Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2	Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4	Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5	Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
PO6	The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO7	Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO8	Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO9	Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings
PO10	Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO11	Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO12	Life-long learning: Recognize the need for and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
PSO1	Food Analysis: Able to apply analytical techniques for food safety & quality assurance
PSO2	Innovations in Food Products and Process Development: Able to translate emerging science in various commodity products and newer technologies.

Syllabus Structure for B. Tech. First Year

Semester I									
Course Code	Subjects	Credits	Hrs/Week			Marks for various Exams			
			L	T	P	C.A.	M.S.	E. S.	Total
	Analytical Chemistry	3	2	1	0	10	15	25	50
	Physical Chemistry	3	2	1	0	10	15	25	50
	Applied Physics	2	1	1	0				
	Engineering Mathematics	3	2	1	0	10	15	25	50
	Engineering Graphics and Elementary Autocad	4	3	1	0	50	-	50	100
	SPL1: Introduction to Food Science and Technology	2	1	1	0				
	Communication Skills (English)	2	0	0	4				
	Yoga	2	0	0	4				
	Physics Laboratory	2	0	0	4	25	-	25	50
	TOTAL:	**22**	**9**	**5**	**16**				

Semester II									
Subject Code	Subjects	Credits	Hrs/week			Marks for various Exams			
			L	T	P	C.A.	M.S.	E. S.	Total
	Organic Chemistry	3	2	1	0	10	15	25	50
	Industrial Chemistry	3	2	1	0	10	15	25	50
	SPL-2: Principles of Food Analysis	2	1	1	0				
	Basic Mechanical Engineering	2	1	1	0				
	Process Calculations	2	1	1	0				
	Electrical Engg. and Electronics	2	1	1	0				
	Physical and Analytical Chemistry Lab	2	0	0	4	25	-	25	50
	Organic Chemistry Laboratory	2	0	0	4	25	-	25	50
	CCA	2	0	0	4	50	-	-	50
	IKS	2	0	0	4	50	-	-	50
	TOTAL:	**22**	**8**	**6**	**16**				

Syllabus Structure for B. Tech. Second Year

Semester III

Subject Code	Subjects	Credits	Hrs /week			Marks for various Exams			
			L	T	P	C.A.	M.S.	E.S.	Total
	SPL-3: Biochemistry and Microbiology	4	3	1	0	20	30	50	100
	SPL-4: Nutrition	2	1	1	0				
	Food Behaviour and Supply Chain Management	4	3	1	0	20	30	50	100
	From Chemical Tech/ General Engg / any other Basic Science disicipline	2	2	1	0				
	Regional Lang. Marathi	2	1	1	0				
	Basic Economics and Finance for non-finance students	2	1	1	0				
	Value Education-I	2	1	1	0				
	PR1: Biochemistry	2	0	0	4	25	-	25	50
	PR2: Food Microbiology	2	0	0	4	25	-	25	50
	TOTAL:	**22**	**9**	**5**	**16**				

Semester IV

Subject Code	Subjects	Credits	Hrs/week			Marks for various Exams			
			L	T	P	C. A.	M.S.	E. S.	Total
	Transport Phenomena	4	3	1	0	20	30	50	50
	SPL-5: Food Chemistry	3	2	1	0	10	15	25	50
	SPL-6: Food Safety, Quality and Regulations	3	2	1	0	10	15	25	50
	From Chemical Tech / General Engg or any other Basic Science disicipline	2	1	1	0				
	Environmental Sci and Tech	2	1	1	0				
	Chemical Process Economics	2	1	1	0				
	Value Education-II	2	1	1	0				
	Field Project	2	0	0	4	25	-	25	50
	Pr3: Technical Analysis Lab 1	2	0	0	4	25	-	25	50
	TOTAL:	**22**	**11**	**7**	**8**				

Syllabus Structure for B. Tech. Third Year

Semester V

Subject Code	Subjects	Credits	Hrs /week			Marks for various Exams			
			L	T	P	C. A.	M.S.	E. S.	Total
	Chemical Reaction Engg	2	1	1	0				
	Chemical Engg Operations	2	1	1	0				
	SPL-7: Food Additives and Ingredients	4	3	1	0	20	30	50	100
	From Chemical Tech / Engg or General Engg or any other Basic Science disicipline	4	3	1	0	20	30	50	100
	SPL-8: Food Engineering	4	3	1	0	20	30	50	100
	Honors Course -I (Food Biotechnology)	4	3	1	0	20	30	50	100
	Pr5: Food Chemistry Lab	2	0	0	4	25		25	50
	MOOCs	2	1	1	0			25	50
	Pr4: Technical Analysis Lab II	2	0	0	4	25		25	50
	TOTL:	**26**	**14**	**7**	**8**				

Semester VI

Subject Code	Subjects	Credits	Hrs/week			Marks for various Exams			
			L	T	P	C.A.	M.S.	E. S.	Total
	SPL-9: Food Microbiology	3	2	1	0	10	15	25	50
	SPL-10: Principles of Food Preservation	3	2	1	0	10	15	25	50
	SPL-11: Food Packaging	4	2	1	0	20	30	50	100
	Honors Course-II (Food Process Engineering)	4	3	1	0	20	30	50	100
	SPL-12: Technology of Dairy and Animal Products	4	3	1	0	20	30	50	100
	From Chemical Tech/ General Engg or any other Basic Science disicipline	2	1	1	0				
	Chemical Engg. Lab	2	0	0	4	25	-	25	50
	Pr6: Food Processing and Product Development Lab	2	0	0	4	25	-	25	50
	Pr7: Food Analysis Lab I	2	0	0	4	25	-	25	50
	TOTAL:	**2**	**13**	**6**	**12**				

Syllabus Structure for B. Tech. Final Year

Semester VII									
Subject Code	**Subjects**	**Credits**	**Hrs/week**			**Marks for various Exams**			
			L	**T**	**P**	**C.A.**	**M.S.**	**E.S.**	**Total**
	SPL-13: Technology of Cereals, Legumes and Oilseeds	3	2	1	0	10	15	25	50
	SPL-14: Technology of Plantation Products I	2	1	1	0				
	Pr8: Food Analysis-II	2	2	1	0				
	Nutraceuticals & Functional Foods	3	2	1	0	10	15	25	50
	Waste Management in Food Processing	2	1	1	0				50
	Honors-III (Pr9: Food Processing and Engineering)	4	0	0	8	50	-	50	100
	From Chemical Tech / Engg or General Engg or any other Basic Science disicipline	2	1	1	0				
	Research Methodology	4	0	0	4	50	-	50	100
	Project -I	4	0	0	4	-	-	50	50
	TOTAL:	**26**	**9**	**3**	**16**				

Semester VIII									
Subject Code	**Subjects**	**Credits**	**Hrs /week**			**Marks for various Exams**			
			L	**T**	**P**	**C.A.**	**M.S.**	**E. S.**	**Total**
	Project-II	3	0	0	6	0	0	50	50
	SPL-17: Technology of Fruits, Vegetables and Tubers	3	2	1	0	10	15	25	50
	Technology of Plantation Products II	2	1	1	0				
	From Chemical Tech / Engg or General Engg or any other Basic Science disicipline	2	1	1	0				
	Honors Course-IV: Insights in to Indian Traditional Foods	3	0	0	6	10	15	25	50
	Honors Course-V: Flavour Science and Technology	3	3	0	0	10	15	25	50
Sem VIII									100
	Internship with Industry	12	0	0	0				
	Total	**28**	**9**	**4**	**6**				

Semester I

	Course Code:	Course Title: SPL1: Introduction to Food Science and Technology	Credits = 2		
			L	T	P
	Semester: I	Total Contact Hours: 30	1	1	0
List of Prerequisite Courses					
	None				
List of Courses where this course will be Prerequisite					
	Food Chemistry, Food additives and ingredients, Food Microbiology, Technical Analysis Lab, Food Chemistry Lab				

Description of relevance of this course in the B. Tech. (Food Engg. & Tech.) Programme

Course objectives

1. To understand basic physico-chemical properties and chemical structures of food constituents
2. To understand the properties, method of preparation and applications of food constituents
3. To understand the importance and mechanism of the reactions of food constituents taking place during food processing and storage,
4. To think critically on the role of water and its various forms in food preservation
5. To understand the role of food constituents responsible for nutritional/anti-nutritional, and aesthetic quality of foods (such as texture, flavor, and color)

Sr. No.	Course Contents (Topics and subtopics)	Required Hours
1	An introduction to food resources and its general composition. proximate analysis of foods, water in food systems – concept of free and bound water, water activity and its impact on food preservation and storage. Basic concept of taste, colour, flavour and texture, sensory analysis, anti-nutritional constituents in foods.	4
2	Carbohydrates- classification, structure, properties. Chemical reactions such as caramelization, Maillard reaction, and dehydration; identification and estimations; Sucrose – manufacture from sugar cane and sugar beet; hydrolysis of sucrose (inversion), Starches – isolation from varied sources; amylose/amylopectin, size/shape, gelatinization, gelation, retrogradation, pasting behaviour, functional properties, modification; Commercially important products – glucose, glucose syrup, high fructose corn syrup, maltodextrins. Glycosides in nature; pectin – structure, gelling behaviour of HMP vs. LMP, sources- manufacture and applications; Cellulose and other components of dietary fibre, hydrocolloids (plant/seaweed/ microbial polysaccharides), mucopolysaccharides; chitin and chitosan – sources, structure, manufacture and applications.	9

3	Proteins- chemistry of amino acids, structure, classification and their properties (isoelectric pH, solubility profile), special amino acids, non-protein amino acids; Peptides, bioactive peptides; Classification of proteins; protein structure (primary, secondary, tertiary and quaternary); Denaturation of proteins; determination of primary sequence, quantitative estimation of amino acids and proteins in foods; functional properties of proteins, isolation and purification methods for proteins; Isolation of food proteins (soya, fish, whey); Maillard browning; concept of modified proteins; Major food protein systems (milk, egg, wheat, meat)	9
4	Chemistry of lipids- fatty acids, mono-, di and triacylglycerols; Classification of lipids- simple, compound and derived; unsaponifiable constituents of lipids such as sterols and hydrocarbons and waxes; Nutritional overview on fats and oils. Rancidity and reversion of fats and oils and thermal stability- its measurement and inhibition; analytical parameters of oils and fats. Extraction, alkali refining, degumming, deodorization, winterization, inter-esterification, hydrogenation etc. of vegetable and animal fats, manufacturing of products such as margarines, hydrogenated vegetable oil and spreads.	8
	Total	30

List of Textbooks / Reference Books	
1	Belitz, H.D, Grosch, W., & Schieberle, P. Food Chemistry; 3rd ed.; Springer, Germany; 2005.
2	Damodaran, S., & Parkin, K.L. Fennema's Food Chemistry; 5th ed.; CRC Press, Boca Raton; 2017.
3	Velisek, J., The Chemistry of Food; Wiley-Blackwell; 2013.
4	Meyer, L.H., Food Chemistry. Cbs Publisher; 2004.
5	Velisek, J., Koplik, R., Cejpek, K. The Chemistry of Food; 2nd ed.; Wiley-Blackwell; 2020
Course Outcomes (Students will be able to…..)	
CO1	Describe the various constituents present in foods and their roles therein and solve practical problems in food quality (K3)
CO2	Describe the properties, method of preparation and applications of food constituents (K2)
CO3	Describe the mechanisms and significance of physicochemical reactions involved in food processing and storage (K2)

CO4	Explain the significance of water in food quality, preservation and storage (K2)
CO5	Describe and demonstrate the role of food constituents on nutritional/anti-nutritional and aesthetic quality of raw and processed foods (K3)

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)															
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
		K3	K4	K6	K5	K6	K3	K3+S	K3	K3+A	K2+A	K3	K6+A+S	K3	K4
CO1	K3	3	3	2	2	2	3	3	3	3	3	3	2	3	3
CO2	K2	3	2	1	2	1	3	3	3	3	3	3	1	3	2
CO3	K2	3	2	1	2	1	3	3	3	3	3	3	1	3	2
CO4	K2	3	2	1	2	1	3	3	3	3	3	3	1	3	2
CO5	K3	3	3	2	2	2	3	3	3	3	3	3	2	3	3
Course	K3	3	3	2	2	2	3	3	3	3	3	3	2	3	3

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; − No Contribution
K, knowledge level from cognitive domain; A, Affective domain; S, Psychomotor domain

Semester II

	Course Code:	Course Title: SPL2: Principles of Food Analysis	Credits = 2		
			L	T	P
	Semester: II	Total contact hours: 30	1	1	0
List of Prerequisite Courses					
	Technical analysis lab, Food analysis Lab				
List of Courses where this course will be Prerequisite					
	Food Safety and Quality Regulations				

Description of relevance of this course in the B. Tech. (Food Engg. & Tech.) Programme

1. To comprehend the basic principles of physical, chemical, biological and instrumental techniques used in food analysis for quality assurance
2. Design labels for food products on the basis of food analysis
3. To develop analytical techniques for on-line monitoring of food quality during processing and storage
4. To ensure consumer safety through analysis of food contaminants and adulterants and apply them in the light of regulatory requirements

Sr. No.	Course Contents (Topics and subtopics)	Required Hours
1	Types of samples analysed, steps in analysis, choice of methods; sampling procedures, considerations and sample preparation; Evaluation of analytical data – accuracy and precision, sources of errors, specificity, sensitivity and detection limits, regression analysis, reporting results	4
2	Analysis of chemical constituents, their characterization and significance-moisture, ash, minerals, lipids, fat, proteins, fibre, titratable acidity, starch, reducing sugars	7
3	Spectroscopic analysis of foods – basic principles, UV, visible, fluorescence, IR, AAS, MS, NMR. Chromatographic analysis of foods – basic principles, HPLC, GC, GLC, principles and applications	12
4	Analysis of vitamins, extraneous matter, pesticides and mycotoxins. enzymatic, immunoassays, thermal analysis, and rheological profile.	7
	Total	**30**

List of Text Books / Reference Books

1	AOAC International. 2003. Official methods of analysis of AOAC International. 17th Ed. Gaithersburg, MD, USA, Association of Analytical Communities
2	Kirk, RS and Sawyer, R. 1991. Pearson's Chemical Analysis of Foods. 9th Ed. Harlow, UK, Longman Scientific and Technical.
3	Leo ML.2004. Handbook of Food Analysis. 2nd Edition. Vol 1,2 and 3, Marcel Dekker.
4	Linden G. 1996. Analytical Techniques for Foods and Agricultural Products. VCH.

5	Nielsen, S.(Eds) 1994. Introduction to Chemical Analysis of Foods. Jones & Bartlett
6	Pomrenz Y & Meloan CE. 1996. Food Analysis - Theory and Practice. 3rd Ed. CBS.
7	Ranganna, S. 2001. Handbook of Analysis and Quality Control for Fruit and Vegetable Products, 2nd Ed, Tata-McGraw-Hill Publ
8	Cruz RMS, Khmelinskii, I & Vieira MC. 2016. Methods in Food Analysis, CRC Press.
9	Galanakis CM (Editor). 2020. Innovative Food Analysis. Elsevier Science.
10	Gruenwedel. 2017. Food Analysis: Principles and Techniques (4 volumes). CRC Press.
11	Gentili A. & Fanali C. 2019. Advances in Food Analysis. MDPI AG.

Course Outcomes (Students will be able to…..)	
CO1	Describe the basic principles of physical, chemical, biological and instrumental techniques used in food analysis for quality assurance (K2)
CO2	Explain newer and relevant analytical techniques in food systems and design labels for food products on the basis of food analysis (K3)
CO3	Develop analytical techniques for on-line monitoring of food quality during processing and storage (K3)
CO4	Ensure consumer safety through analysis of food contaminants and adulterants and apply them in the light of regulatory requirements (K3)
CO5	Assess the environmental impact of products life from farm to fork (K4)

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)

		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
		K3	K4	K6	K5	K6	K3	K3+S	K3	K3+A	K2+A	K3	K6+A+S	K3	K4
CO1	K2	3	2	1	2	1	3	3	3	3	3	3	1	3	2
CO2	K3	3	3	2	2	2	3	3	3	3	3	3	2	3	3
CO3	K3	3	3	2	2	2	3	3	3	3	3	3	2	3	3
CO4	K3	3	3	2	2	2	3	3	3	3	3	3	2	3	3
CO5	K4	3	3	2	3	2	3	3	3	3	3	3	2	3	3
Course	K4	3	3	2	3	2	3	3	3	3	3	3	2	3	3

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; − No Contribution
K, knowledge level from cognitive domain; A, Affective domain; S, Psychomotor domain

Semester III

	Course Code:	Course Title: SPL3: Biochemistry and Microbiology	Credits = 4		
			L	T	P
	Semester: III	Total Contact Hours: 60	3	1	0

List of Prerequisite Courses

Standard XII Biology and Chemistry

List of Courses where this course will be prerequisite

Principles of Food Preservation, Food Microbiology, Nutrition

Description of relevance of this course in the B. Tech. Program

- To train the students with respect to the core chemistry principles involved in functioning of biological systems, structural and chemical biology of macromolecules, including proteins, carbohydrates, lipids, nucleic acid and vitamins, structure, function and kinetic properties of enzymes and their role in metabolism of living cells, major catabolic as well as anabolic pathways involved in cell metabolism and quantitative aspects of biochemical analysis of macromolecules
- To familiarize students with diverse microorganisms in different industries like food, dairy, bio-based fermentation, oil, pharmaceutical industry and bioenergy, with diversity of microorganisms, microbial cell structure and function, microbial growth and metabolism, environmental factors affecting their growth and cultivate/control growth of microbes using physical and chemical technologies; with basics of microbial replication, transcription, translation and mutagenesis and involvement of microorganisms in diseases and role of immune system in defending invading pathogens

	Course Contents (Topics and Subtopics)	Required Hours
	Biochemistry	
1	**Carbohydrates:** Fundamentals of chemistry of carbohydrates; Qualitative tests / colour reaction; Metabolic pathways and energy yield for breakdown of carbohydrates **Lipids:** Types; Functions & comparative distribution of lipids; beta-oxidation; functions; quantitatie analysis **Proteins:** Chemistry; types, qualitative and quantitative analysis; Structural analysis	15
2	**Nucleic acids**: Types; Chemistry; Functions; Genetic code **Enzymes**: definition, function, nomenclature, classification, mechanism of enzyme action, enzyme kinetics, enzyme inhibition and regulation **Vitamins & Co-enzymes**: Structures& function of Nicotinamide, nicotinic acid, riboflavin, lipoic acid, biotin, thiamine, B6, folic acid, B12, pantothenic acid, ascorbic acid, vitamins A, D, K, and E	15
	Microbiology	
3	**Introduction,** Prokaryotes and Eukaryotes (morphology, structure and function of microbial cells and their components) Major groups of microorganisms - Bacteria, Virus, Yeasts and Molds, Rickettsia, Chlamydia and Algae	10
4	**Characterization**: Gram character and staining techniques, Isolation, preservation and maintenance of pure cultures	5
5	**Growth Studies**: (lag phase, log phase, stationary phase, death phase); concept of generation time; Physical and chemical factors affecting growth of microbes **Nutrient requirements** of microorganism, Composition, preparation and sterilization of microbiological media; Classification of media, Methods of sterilization, disinfection, sanitation, asepsis Growth studies	8
6	**Microscopy** (dark, Fluorscence, atomic force, scanning tunnel, confocal etc.); Enumeration of microorganisms (TPC, Yeast and molds count, MPN, turbidometry, rapid methods like flow cytometry, etc.)	5
7	**Introduction to immunology**	2
	Total	**60**

List of Textbooks/Reference Books

1	Principles of Biochemistry, Lehninger AL, Nelson DL and Cox MM, 5th Edition, 2008, MacMillan
2	Biochemistry, Stryer L, Berg JM and Tymoczko JL, 5th Edition, 2002, Freeman & Co.

3	Fundamentals of Biochemistry – Voet DJ and Voet JG, Upgrade edition, 2002, John Wiley & Sons
Course Outcomes (Students will be able to…..)	
CO1	apply of fundamental knowledge of chemistry to biological systems and understand and elucidate structural as well as metabolic role of different macromolecules in the cell (K3)
CO2	apply analytical tests involved in detection of macromolecules in/derived from biological samples (K3)
CO3	understand the role of enzymes in cellular environment and their use in industrial applications for their practical applications and evaluate and elucidate impact of different catalytic reactions involved in metabolic pathway (K4)
CO4	Explain the application of diverse microorganisms in different industries like food, dairy, oil, pharmaceutical, bio-based fermentation and bio-energy (K2)
CO5	Describe the cultivation/control methods for diversity of microorganisms, their physiology and metabolism (K2)
CO6	Understand and apply the significance of microorganisms in diseases and basic immune system against invading pathogens (K3)

Mapping of Course Outcomes (Cos) with Programme Outcomes (Pos)

		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
		K3	K4	K6	K5	K6	K3	K3+S	K3	K3+A	K2+A	K3	K6+A+S	K3	K4
CO1	K3	3	3	2	2	2	3	3	3	3	3	3	2	3	3
CO2	K3	3	3	2	2	2	3	3	3	3	3	3	2	3	3
CO3	K4	3	3	2	3	2	3	3	3	3	3	3	2	3	3
CO4	K2	3	3	2	3	2	3	3	3	3	3	3	2	3	3
CO5	K2	3	2	2	3	2	3	3	3	3	3	2	2	3	2
CO6	K3	3	2	2	3	2	3	3	3	3	3	2	2	3	2
Course	K4	3	3	2	3	2	3	3	3	3	3	3	2	3	3

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; − No Contribution
K, knowledge level from cognitive domain; A, Affective domain; S, Psychomotor domain

	Course Code:	Course Title: SPL4: Nutrition	Credits = 2		
			L	T	P
	Semester: III	Total Contact Hours: 30	1	1	0
List of Prerequisite Courses					
	Principles of Food Analysis, Introduction to Food Science and Technology				
List of Courses where this course will be Prerequisite					
	Food Chemistry, Nutraceuticals and Functional Foods				

Description of relevance of this course in the B. Tech. (Food Engg. & Tech.) Programme

Course objectives

1. To understand basic concepts of nutrition, compute energy value of foods and understand body's need for energy
2. To understand the role of different constituents of carbohydrates and lipids in human nutrition
3. To understand the role of proteins in human nutrition, explain concept of protein quality and methods of estimation and to identify anti-nutritional factors in food sources
4. To understand the requirements and role of micronutrients (vitamins /minerals) in human health
5. To understand formulation of diets, techniques of health surveys, nutritional assessment etc.

Sr. No.	Course Contents (Topics and subtopics)	Required Hours
1	Food composition and nutrients present in foods, terminologies used in nutrition, Food pyramid, my pyramid, my plate, Food exchanges and measures used, Energy value of foods, bomb calorimeter, physiological fuel value, estimation of energy value of foods from proximate composition. Basal Metabolic Energy, factors affecting, and calorie needs for B. M. E., physical activity and diet induced thermogenesis; energy imbalance and body weight regulation; Nutrition through lifecycle.	5
2	Role of carbohydrates in human nutrition- nutritionally important carbohydrates, physiological functions, digestion and absorption of available carbohydrates, dietary fiber, non-digestible oligosaccharides, resistant starch and its types, carbohydrates as prebiotics, dental carries and role of sugar, Lactose intolerance and galactosemia, Glycemic index and glycemic load of carbohydrate containing foods. Role of lipids in Human Nutrition- nutritionally important lipid constituents, physiological functions, digestion and absorption of lipids, conjugated linoleic acid, trans fats, medium chain triglycerides, fat replacers and mimetics, keto diet, Cholesterol, Phytosterols, blood lipids	7

	(LDL, HDL, VLDL etc), essential fatty acids, their functions and deficiency, omega 3 and omega 6 PUFAs and their dietary sources, eicosanoids.	
3	Role of proteins in Human Nutrition- essential/ non-essential amino acids, complete/ incomplete proteins, limiting amino acid, complementary proteins, physiological functions of proteins, daily protein requirements, digestion absorption and utilization of proteins, common food sources of proteins, protein deficiency (PEM/PCM)- prevalence, causes, effects, remedial measures Concept and estimation of protein quality – *in vitro* (scoring methods, indices, microbiological methods, enzymatic methods) and *in vivo* methods (growth response methods like PER and Nitrogen balance methods like BV), PDCAAS; Anti-nutritional factors present in foods- antiproteins (trypsin inhibitor), antiminerals (phytate), anti- vitamins (ascorbic acid oxidase) and others- their chemistry, occurrence in food sources, mechanism of anti-nutritional action, processing stability, and remedial measures to reduce them	6
4	Role of micronutrients (Vitamins and minerals) Vitamins– classification- water soluble (all the B vitamins and C) and fat soluble (Vitamins A, D, E and K); Chemistry, structure and properties; physiological functions; absorption and metabolism; food sources, deficiency and hypervitaminosis; RDA Minerals- Nutritional and anti-nutritional mineral elements in food, their physiological role, food sources, deficiency diseases, bioavailability, Fortification of foods with vitamins and minerals	8
5	Principles of Diet Therapy and Therapeutic Nutrition; Formulation of diets and foods for special needs; Techniques of diet and health surveys; Assessment of nutritional status; Effect of food processing, preservation and storage on nutritional quality of foods; Food nutrification; Sports nutrition;	4
	Total	**30**

List of Text Books / Reference Books	
1	Maurice E. Shils, James A. Olson, Moshe Shike, A. Catherine Ross Modern Nutrition in Health & Disease by Young & Shils. Jones & Bartlett Learning; Subsequent edition. 1999. ISBN-10: 068330769X
2	Food, Nutrition and Diet Therapy by Krause and Mahan 1996, Publisher- W.B. Saunders, ISBN: 0721658350
3	Nutritive Value of Indian Foods by C. Gopalan, B. V. Rama Sastri, S. C. Balasubramanian Published by National Institute of Nutrition, Indian Council of Medical Research, 1989
4	Introduction to Human Nutrition by Gibney, Lahnam-New, Cassidy and Vorster, 2009, Nutrition Society Textbook Series, Second Edition, Wiley Blackwell Publisher
5	Molecular Basis of Human Nutrition by Sanders and Emery, 2003, Taylor & Francis Publication, ISBN 0-415-29917-9 (hbk)

6	Principles of Human Nutrition by M. Eastwood, 2003, Blackwell Science. ISBN 0-632-05811-0

Course Outcomes (Students will be able to…..)	
CO1	Explain basic concepts of nutrition, compute energy value of foods and understand body's need for energy (K3)
CO2	Explain the role of different constituents of carbohydrates and lipids in human nutrition (K3)
CO3	Describe the role of proteins in human nutrition, explain concept of protein quality and methods of estimation and identify anti-nutritional factors in food sources (K2)
CO4	Describe the requirements and role of micronutrients (vitamins /minerals) in human health. (K2)
CO5	Explain formulation of diets, techniques of health surveys, nutritional assessment etc. (K3)

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)															
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
		K3	K4	K6	K5	K6	K3	K3+S	K3	K3+A	K2+A	K3	K6+A+S	K3	K4
CO1	K3	3	3	2	2	2	3	3	3	3	3	3	2	3	3
CO2	K3	3	3	2	2	2	3	3	3	3	3	3	2	3	3
CO3	K2	3	2	1	2	1	3	3	3	3	3	3	1	3	2
CO4	K2	3	2	1	2	1	3	3	3	3	3	3	1	3	2
CO5	K3	3	3	2	2	2	3	3	3	3	3	3	2	3	3
Course	K3	3	3	2	2	2	3	3	3	3	3	3	2	3	3

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; − No Contribution
K, knowledge level from cognitive domain; A, Affective domain; S, Psychomotor domain

	Course Code: FDP 1014	Course Title: Pr1: Biochemistry Lab	Credits = 2		
			L	T	P
	Semester: III	Total Contact Hours: 60	0	0	4

List of Prerequisite Courses	
	None

List of Courses where this course will be Prerequisite	
	Food Chemistry **(FDT1032)**, Chemistry of Food Constituents **(FDT1011)**, Food Chemistry Lab **(FDP1015)**, Food Analysis Lab **(FDP1018)**

Description of relevance of this course in the B. Tech. (Food Engg. & Tech.) Programme

- To understand the principles of analytical methods used for protein and sugar estimation.
- To understand the analytical methods used for vitamin estimation.
- To decipher on extraction and assay of quality indicator enzymes in food
- To develop analytical protocols for quantifying the sensitivity of critical nutrients in foods

Sr. No.	Course Contents (Topics and subtopics)	Required Hours
1	Estimation of protein by Biuret Method & Folin-Lowry method	4
2	Estimation of protein by Microkjeldahl method & Pope & Steven's method	4
3	Estimation of proteins by Bradford method & Dye binding method	4
4	Estimation of sugar by DNSA method & Phenol-H_2SO_4 method	4
5	Estimation of sugar by Resorcinol method & Anthrone method	4
6	Estimation of amylose & amylopectin	4
7	Estimation of polyphenols by Folin-Denis method & Ferrous Tartarate method	4
8	Study of Amylase and kinetic study	4
9	Study of Proteases	4
10	Study of Lipases	4
11	Enzymes as indicators of thermal processing	4
12	Enzyme purification by ammonium sulphate	4
13	Estimation of trypsin inhibitors	4
14	Estimation of thiamine and vitamin C	4
15	Estimation of vitamin E	4
	Total	**60**

List of Text Books / Reference Books	
1	Boyer R., Biochemistry Laboratory: Modern Theory and Techniques; 2nd Ed.; Pearson Prentice Hall; 2012; ISBN: 978-0-13-604302-7
2	Holtzhauer M., Basic Methods for the Biochemical Lab; Springer, New York; 2006; ISBN: 978-3-540-32786-8

Course Outcomes (Students will be able to…..)	
CO1	Analyse different analytical methods used for protein and sugar estimation (K4)

CO2	Analyse different enzyme assay, their purification and applications (K4)
CO3	Demonstrate and analyse the analytical methods for vitamin estimation (K4)
CO4	Develop analytical protocols of important nutrients in foods (K3)
CO5	Apply the concept of biochemical analysis in quality assurance of food industry (K3)

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)															
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
		K3	K4	K6	K5	K6	K3	K3+S	K3	K3+A	K2+A	K3	K6+A+S	K3	K4
CO1	K4	3	3	2	3	2	3	3	3	3	3	3	2	3	3
CO2	K4	3	3	2	3	2	3	3	3	3	3	3	2	3	3
CO3	K4	3	3	2	3	2	3	3	3	3	3	3	2	3	3
CO4	K3	3	3	2	2	2	3	3	3	3	3	3	2	3	3
CO5	K3	3	3	2	2	2	3	3	3	3	3	3	2	3	3
Course	K4	3	3	2	3	2	3	3	3	3	3	3	2	3	3

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; − No Contribution
K, knowledge level from cognitive domain; A, Affective domain; S, Psychomotor domain

	Course Code: FDP1013	Course Title: Pr2: Food Microbiology Lab	Credits = 2		
			L	T	P
	Semester: III	Total contact hours: 60	0	0	4
List of Prerequisite Courses					
	None				
List of Courses where this course will be Prerequisite					
	Food Microbiology, Principles of Food Preservation				

Description of relevance of this course in the B. Tech. (Food Engg. & Tech.) Programme

1. To understand the principles of different staining techniques used for specific group of microorganism and chemical compounds within the cells
2. To identify and enumerate the contaminating microorganisms in the food samples
3. To identify the microbial resistance towards different types of disinfectants and the effects of physiochemical factors for microbes
4. To develop a specific media and isolate microorganisms from different food samples

Sr. No.	Course Contents (Topics and subtopics)	Required Hours
1	Working and handling of common laboratory equipment and materials	4
2	Monochrome staining, Cell wall staining	4
3	Gram staining	4
4	Negative staining. Hanging drop technique	4
5	Capsule staining, Bacterial endospore staining	4
6	Study of Yeast, Mold and Bacteria	4
7	Phenol Coefficient of disinfectant	4
8	Microchemical test for reserve material	4
9	Isolation of Microbes from a food sample	4
10	Composition, preparation, sterilization of routine lab media	4
11	Enumeration, characterization, isolation and maintenance from air and surface	4
12	Effect of physicochemical factors and nutritional requirements on growth of microorganisms	4
13	Isolation and characterization of microbes based on morphological & physiological characteristics	4
14	Evaluations of microbial quality of milk and water samples	4
15	Spread Plate, pour Plate methods for cultivation of microbes, Streaking, and point inoculation methods for bacteria, fungi, and actinomycetes.	4
	Total	**60**

List of Text Books / Reference Books	
1	Laboratory Experiments in Microbiology (10th Edition) - by Ted R. Johnson and Christine L. Case, (2012). Publisher: Benjamin Cummings, ISBN: 0321794389
2	Microbiology Lab Manual (8th Edition) - by John Harley. (2010). Publisher: McGraw-Hill Science, ISBN: 0077292812
3	Fundamental Food Microbiology (3rd Edition) – by Bibek Ray. CRC Press: ISBN - 0-8493-1610-3
4	Modern Food Microbiology (Seventh Edition) – by James M. Jay, Martin J. Loessner and David A. Golden. Springer-Food Science Text Series ISBN 0·387·23180-3
5	{FSSAI Lab Manual 14} Manual of Methods of Analysis of Foods [Microbiological Testing]. FSSAI, MoHFW, GoI - 2012
Course Outcomes (Students will be able to…..)	
CO1	Describe and analyze the principles of different staining techniques used for bacteria, yeast and chemical compounds within the cells (K4)
CO2	Describe and apply the procedure for enumerating the microorganisms in the food samples (K3)
CO3	Analyse the effect of different media composition and physiochemical factors for microbes (K4)
CO4	Isolate and characterize different microorganisms from food samples (K4)
CO5	Assess the microbial quality of various food samples (K4)

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)															
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
		K3	K4	K6	K5	K6	K3	K3+S	K3	K3+A	K2+A	K3	K6+A+S	K3	K4
CO1	K4	3	3	2	3	2	3	3	3	3	3	3	2	3	3
CO2	K3	3	3	2	2	2	3	3	3	3	3	3	2	3	3
CO3	K4	3	3	2	3	2	3	3	3	3	3	3	2	3	3
CO4	K4	3	3	2	3	2	3	3	3	3	3	3	2	3	3
CO5	K4	3	3	2	3	2	3	3	3	3	3	3	2	3	3
Course	K4	3	3	2	3	2	3	3	3	3	3	3	2	3	3

Open Elective	Course code:	**Course Title: Food Behaviour and Supply Chain Management**	**Credits = 4**		
			L	**T**	**P**
	Semester:	**Total contact hours: 60**	**3**	**1**	**0**
List of Prerequisite courses					
	None				
List of Courses where this course will be Prerequisite					
	None				

Description of relevance of this course in the B. Tech. (Food Engg. & Tech.) Programme

1. Understanding the overall management of all stages of food supply chain
2. Understand the food choices/taste preferences, food aversions, the regulation of hunger and satiety and the influence of environment and biology thereon
3. Neurological, psychological, cultural and social aspects of our relationship with food and their effect on eating behaviour, physical and psychological health
4. Eating disorders, and the global obesity epidemic; ethically-inspired vegans, the paradox of growing obesity amidst malnourishment and eating disorders.
5. The impact of food advertising aimed at children; poverty and food

S. No.	**Syllabus**	**No. of Lectures**
1	**Food Supply Chain Management** (a) **Introduction and overview of supply chain management:** Agriculture and food supply chain management, supply chain as a source of competitive advantage, performance measurement in agri-food supply chains. (b) **Management challenges in cold chain**: Post-harvest food management – supply chain management, the major cold chain technologies dry ice, gel packs, eutectic plates, liquid nitrogen, quilts, reefers refrigerated containers, managerial economics – fresh food and supply chain management challenges, life cycle assessment studies of food product, retail logistics changes and challenges retail logistics and supply chain transformation the cold chain and its logistics, from a geographical perspective, the cold chain has the following impacts the major cold chain technologies, value chain, global value chain (c) Risk and Uncertainty: Types and sources of risk in agricultural & food supply chain, managing risk and uncertainty, FMEA, method for coping with bullwhip effect, supply chain integration, push vs. pull systems. Managing Inventories and Coordination: Inventory management, types of inventories, inventory management, economic order quantity (EOQ), inventory classification and control – ABC Analysis. (d) Logistics & Strategic Alliances: Inbound and outbound logistics, 3rd/4th Party Logistics (3PL/4PL), cross docking, retailer-supplier partnerships, buyer vendor coordination, procurement, vendor development and evaluation-factor rating method. Outbound logistics: Designing supply chain network, system view of logistics-coordination and management of	**40**

	transportation, inter model transportation and third-party transportation services, characteristics of different transportation services, distribution strategies. (e) Procurement & Outsourcing Strategies: Buy-make decision, procurement strategy, framework of e-Procurement. (f) Strategic considerations for supply chain, Porter's industry analysis and value-chain models, Reverse Logistics.	
2	**Food Psychology** (a) Psychology of eating: the nexus of nutrition, brain, and behavior (b) The chemical senses (c) You are what you eat: evolution, energy, and foraging (d) Basic learning processes and eating behavior (e) The development of eating behaviors (f) Social influences on eating (g) Mood, cravings, and addiction (h) Hunger, satiety, and the brain (i) Eating disorders and treatment (j) Genes, epigenetics, and obesity (k) Treatments for obesity and where do we go from here? (l) Psychology of food advertising and marketing	**20**

List of Text Books / Reference Books	
1	Chopra, S, and P. Meindl (2004), Supply Chain Management – Strategy, Planning and Operation, Pearson Education.
2	Raghuram, G. and N. Rangaraj (2000), Logistics and Supply Chain Management: Cases and Concepts, Macmillan, New Delhi.
3	Simchi-Levi, D., P. Kaminski and E. Simchi-Levi (2003). Designing and Managing the Supply Chain: Concepts, Strategies and Case Studies, 2nd Edition, Irwin, McGraw-Hill.
4	Shapiro, J.(2001), "Modelling the Supply Chain", Duxbury Thomson Learning.
5	Dani, S. (2015). Food Supply Chain Management and Logistics: From farm to Fork, Kogan Page Ltd, ISBN (Print) 9780749473648
6	Pullmann, M. And Wu, Z. (2021). Food Supply Chain Management: 7Building a Sustainable Future, Taylor & Francis.
7	A Guide to the Psychology of Eating, Leighann R. Chaffee, Dr Stephanie P. da Silva, Bloomsbury Academic, 2022.
8	The Psychology of Food Marketing and Overeating (2019). Edited By Frans Folkvord, Published by Imprint Routledge, DOI: https://doi.org/10.4324/9780429274404. eBook ISBN9780429274404.
9	Psychology of Eating: From Biology to Culture to Policy, Emily Splane, Neil Rowland, Anaya Mitra, 2nd edition, Routledge, 2020.
10	The Psychology of Eating: From Healthy to Disordered Behavior, Jane Ogden, Edition 2, Wiley, 2010. ISBN 1405191201, 9781405191203.
11	The Psychology of Overeating: Food and the Culture of Consumerism, Kima Cargill, Bloomsbury Publishing, 2015.

12	Food Advertising and Childhood Obesity: Examining Food Type, Brand Mascot Physique, Health Message, and Media (2020). *Fariba Esmaeilpour and Mitra Shabani Nashtaee, Imprint Routledge,* DOI https://doi.org/10.4324/9780429344435. eBook ISBN9780429344435.
13	The Social Psychology of Food, Mark Conner, Christopher J. Armitage, Open University Press, 2002.

Course Outcomes (Students will be able to…..)

CO1	Describe and analyze the overall management of all stages of food supply chain (K4)
CO2	Describe and apply the the food choices/taste preferences, food aversions, the regulation of hunger and satiety and the influence of environment and biology thereon (K3)
CO3	Describe and analyse the effect of neurological, psychological, cultural and social aspects of our relationship with food and their effect on eating behaviour, physical and psychological health (K4)
CO4	Analyse and implement the impact of food advertising aimed at children; poverty and food (K4)

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)

		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
		K3	K4	K6	K5	K6	K3	K3+S	K3	K3+A	K2+A	K3	K6+A+S	K3	K4
CO1	K4	3	3	3	3	2	3	3	3	3	3	3	2	3	3
CO2	K3	2	3	3	3	2	3	3	3	3	2	3	3	3	3
CO3	K4	2	3	3	3	2	3	3	3	3	2	3	3	3	3
CO4	K4	3	3	3	3	2	3	3	3	3	3	3	2	3	3
Course	K5	3	3	3	3	2	3	3	3	3	3	3	2	3	3

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; − No Contribution
K, knowledge level from cognitive domain; A, Affective domain; S, Psychomotor domain

Semester IV

	Course Code: FDT 1032	Course Title: SPL5: Food Chemistry	Credits = 3		
			L	T	P
	Semester: IV	Total contact hours: 45	2	1	0
List of Prerequisite Courses					
	Basics of Organic, Inorganic, Physical and Analytical Chemistry and SPL 1: Chemistry of Food Constituents, Organic Chemistry I, Physical Chemistry-I, Analytical Chemistry, Industrial Inorganic Chemistry				
List of Courses where this course will be Prerequisite					
	Food chemistry Lab, PR 3: Technical Analysis Lab, Principles of Food Analysis, Food Safety, Quality & Regulations				

Description of relevance of this course in the B. Tech. (Food Engg. & Tech.) Programme

1. To understand the interactions of different constituents within the food systems and their effects on processing, nutritional and sensory quality.
2. To understand the various anti-nutritional factors, contaminants and toxicants present in food systems.
3. To understand the generation of flavors in processed food systems

Sr. No.	Course Contents (Topics and subtopics)	Required Hours
1	Interactions amongst food constituents including those between the constituents themselves and with each other (water, protein, lipids, carbohydrates, minerals, vitamins), and the consequences thereof on nutritional, safety & sensory quality such as color & texture of foods. Examples include starch-lipid complexes, protein-polysaccharide interactions, protein-protein interactions leading to unnatural amino acids and racemization of amino acids, starch-polyphenol complexes.	09
2	Interactions of food constituents with external agents such as with flavours, food additives; among food additives; packaging materials and flavours; and the consequences thereof on nutritional, safety and sensory quality of foods	06
3	Contaminants generated during food processing (acrylamide, benzene, hydroxymethyl furfural, nitrosamines) and those that find their way in to foods as environmental contaminants (polychlorinated biphenyls, polychlorinated aromatic hydrocarbons, dioxins and furans, pesticide residues)	06
4	Anti-nutritional factors of significance in foods (trypsin inhibitors, phytates, tannins, hemagglutinins) and ways to mitigate them in products as legumes and millets	03
5	Microbial toxins of concern in foods and the effect of food processing therein. Examples are aflatoxin, patulin, bacterial toxins, zearalenone and such others.	03
6	Browning reactions in foods – Caramelization, enzymatic, non-enzymatic, ascorbic acid induced, and approaches to mitigate them. Impact of food processing on browning reactions, Role of browning reactions in foods; beneficial and adverse impacts of browning reactions on food organoleptic properties, browning and food quality, impact of browning reactions on nutritive value of foods.	07
7	Natural colors in foods: chemical structure, extraction, stability in food products and during processing	02
8	Flavours in foods – classification of flavours (natural, nature-identical and artificial); chemical pathways for generation of flavours in thermally processed and biochemical pathways for generation of flavours in fermented foods; quality assurance of flavours; selection of flavours for different types of foods, e.g. bakery, confectionary, microwaveable foods etc; off flavours and taints in foods	09
	Total	**45**

List of Text Books / Reference Books

1	Food Chemistry – Belitz H.D, Grosch W, and Schieberle. P.3rd Edn. Springer Berlin / Heidelberg
2	Food Chemistry- Fennema O.R 2nd Edn., Marcel Dekker, New york. (1985)
3	Principles of Food Chemistry by JM deMan, JW Finley, WJ Hurst, CY Lee. Springer Nature. Fourth Edition (2018). ISBN – 9783319636078
4	Ingredient interactions: Effects on food quality by AK Gaonkar, Andrew McPherson. CRC Press, 2nd Edition (2016). ISBN 9780824757489
5	Interactions of food components, Dose DJ & Robertson A, Campden Food Preservation Research Association (1990).
6	Natural toxic compounds of foods by J Davidek. CRC Press (2018). ISBN 9781315895833
Course Outcomes (Students will be able to…..)	
CO1	Describe the chemical composition of various food commodities and the interactions of different constituents within the food systems (K2)
CO2	Describe the standards of identity based on authentic chemical composition and analytical techniques (K2)
CO3	Explain the various contaminants and toxicants present in the food systems (K2)
CO4	Describe the presence of different anti-nutritional factors in foods (K2)
CO5	Extrapolate the knowledge gained to judge the quality and authenticity of the food (K3)

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)

		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
		K3	K4	K6	K5	K6	K3	K3+S	K3	K3+A	K2+A	K3	K6+A+S	K3	K4
CO1	K2	3	2	1	2	1	3	3	3	3	3	3	1	3	2
CO2	K2	3	2	1	2	1	3	3	3	3	3	3	1	3	2
CO3	K2	3	2	1	2	1	3	3	3	3	3	3	1	3	2
CO4	K2	3	2	1	2	1	3	3	3	3	3	3	1	3	2
CO5	K3	3	3	2	2	2	3	3	3	3	3	3	2	3	3
Course	K3	3	3	2	2	2	3	3	3	3	3	3	2	3	3

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; − No Contribution
K, knowledge level from cognitive domain; A, Affective domain; S, Psychomotor domain

	Course Code: FDT 1028	Course Title: SPL6: Food Safety and Quality Regulations	Credits = 3		
			L	T	P
	Semester: IV	Total contact hours: 45	2	1	0
List of Prerequisite Courses					
	Introduction to Food Science and Technology, Principles of Food Analysis				
List of Courses where this course will be Prerequisite					
	None				

Description of relevance of this course in the B. Tech. (Food Engg. & Tech.) Programme
1. To explain the functional role and safety issues of food contaminants, food adulteration, 2. To describe the hygiene and sanitation in food processing plant, equipment, storage and handling 3. To explain the various quality attributes of food and emphasizing on microbial quality control in food and water quality 4. To conduct a food safety-based risk assessment at different stages of production of food and thereby designing the HACCP, VACCP and TACCP system 5. To explain the role, standard and law set by Indian and global regulatory authorities with respect to food quality control

Sr. No.	Course Contents (Topics and subtopics)	Required Hours
1	**India Regulations** Overview of FSSAI. Detail of FSS Regulations relevant to products and labelling. (FSS Licensing & Registration including Schedule IV, Product Standards & Additives, Labelling & Display, Advertisement & Claims) Introduction to food safety and security: Hygienic design of food plants and equipment,	15
2	**Food quality**: Various Quality attributes of food, Instrumental, chemical and microbial Quality control. Sensory evaluation of food and statistical analysis. Water quality and other utilities.	8
3	**Food Safety Management System**: Food Safety, Threat and Fraud Management based on international standards (HACCP / VACCP / TACCP)?	14
4	**Global regulations:** FAO, Technical Cooperation programmes, Bio-security in Food and Agriculture, World Health Organization (WHO), World Animal Health Organization (OIE), International Plant Protection, Convention (IPPC) Codex Alimentarius Commission - Codex India – Role of Codex Contact point, National Codex contact point (NCCP), National Codex Committee of India – ToR, Functions, Shadow Committees etc. **Overview of US and EU regulations for food**	8
	Total	**45**

List of Text Books / Reference Books	
1	Handbook of Food Toxicology by S. S. Deshpande
2	The Food Safety Information Handbook by Cynthia A. Robert, 2009
3	Nutritional and Safety Aspects of Food Processing by Tannenbaum SR
4	Microbiological Safety of Food by Hobbs BC, 1973
5	Food Safety Handbook by Ronald H. Schmidt, Gary E. Rodrick
Course Outcomes (Students will be able to…..)	
CO1	Describe the functional role and safety issues of food contaminants, food adulteration, food additives, food packaging & labelling (K2).
CO2	Design the hygiene and sanitation in food processing plant, equipment, storage, and handling (K3)
CO3	Analyse the various quality attributes of food and especially on microbial quality control of food and water in Food Processing Industry (K4)
CO4	Identify and analyze the critical quality control point in different stages of production of food and thereby designing the HACCP system. (K4)
CO5	Explain the role, standard and law set by Indian and global regulatory authorities with respect to food quality control (K2)

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)

		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
		K3	K4	K6	K5	K6	K3	K3+S	K3	K3+A	K2+A	K3	K6+A+S	K3	K4
CO1	K2	3	2	1	2	1	3	3	3	3	3	3	1	3	2
CO2	K3	3	3	2	2	2	3	3	3	3	3	3	2	3	3
CO3	K4	3	3	2	3	2	3	3	3	3	3	3	2	3	3
CO4	K4	3	3	2	3	2	3	3	3	3	3	3	2	3	3
CO5	K2	3	2	1	2	1	3	3	3	3	3	3	1	3	2
Course	K4	3	3	2	3	2	3	3	3	3	3	3	2	3	3

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; − No Contribution
K, knowledge level from cognitive domain; A, Affective domain; S, Psychomotor domain

	Course Code:	Course Title: Pr3: Technical Analysis Lab I	Credits = 2		
			L	T	P
	Semester: IV	Total Contact Hours: 60	0	0	4

List of Prerequisite Courses

None

List of Courses where this course will be Prerequisite

SPL 2: Principle of Food Preservation **(FDT1031)**, Food Analysis - I Lab **(FDP1018)**

Description of relevance of this course in the B. Tech. (Food Engg. & Tech.) Programme

- To understand the principles behind analytical techniques associated with sugar & water sample.
- To select the appropriate analytical technique when presented with a practical problem
- To demonstrate practical proficiency in a food analysis laboratory
- To use different analytical techniques to find out the properties of foods and food waste samples

Sr. No.	Course Contents (Topics and subtopics)	Required Hours
1	Hardness of Water	4
2	Water Hardness by Soap Titration	4
3	Estimation of Alkalinity of Water	4
4	Estimation of Sulphates in Water	4
5	Estimation of Chloride by Mohr's Method	4
6	Qualitative Analysis of Amino Acid	4
7	Estimation of Copper	4
8	Estimation of Ferric Ions	4
9	Estimation of Zinc	4
10	Estimation of Manganese	4
11	Estimation of Nitrite	4
12	Estimation of Phosphate	4
13	Chemical Oxygen Demand	4
14	Biochemical Oxygen Demand	8
	Total	**60**

List of Text Books / Reference Books

1. Ranganna, S. (1986). *Handbook of analysis and quality control for fruit and vegetable products*. Tata McGraw-Hill Education.
2. Kirk, S., & Sawyer, R. (1991). *Pearson's composition and analysis of foods* (No. Ed. 9). Longman Group Ltd..

Course Outcomes (Students will be able to…..)

CO1	Perform and demonstrate the analytical techniques associated with sugar & water samples (K3)
CO2	Demonstrate the analytical techniques associated with mineral estimation in food samples (K3)

CO3	Select the appropriate analytical technique when presented with a practical problem (K4)
CO4	Demonstrate practical proficiency in a food analysis laboratory (K3)
CO5	Categorize and recommend suitable analytical technique to find out the properties of foods and food waste samples (K4)

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)

		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
		K3	K4	K6	K5	K6	K3	K3+S	K3	K3+A	K2+A	K3	K6+A+S	K3	K4
CO1	K3	3	3	2	2	2	3	3	3	3	3	3	2	3	3
CO2	K3	3	3	2	2	2	3	3	3	3	3	3	2	3	3
CO3	K4	3	3	2	3	2	3	3	3	3	3	3	2	3	3
CO4	K3	3	3	2	2	2	3	3	3	3	3	3	2	3	3
CO5	K4	3	3	2	3	2	3	3	3	3	3	3	2	3	3
Course	K4	3	3	2	3	2	3	3	3	3	3	3	2	3	3

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; − No Contribution
K, knowledge level from cognitive domain; A, Affective domain; S, Psychomotor domain

Semester V

	Course Code: FDT 1012	Course Title: SPL7: Food Additives and Ingredients	Credits = 4		
			L	T	P
	Semester: V	Total contact hours: 60	3	1	0
List of Prerequisite Courses					
	Introduction to Food Science and Technology				
List of Courses where this course will be Prerequisite					
	Technology of Fruits, Vegetables and Tubers; Technology of Dairy and Animal Products; Technology of Plantation Products; Technology of Cereals, Legumes and Oilseeds				

Description of relevance of this course in the B. Tech. (Food Engg. & Tech.) Programme

1. To understand the classification of food additives and ingredients.
2. To understand the significance of different food additives and ingredients in food quality, preservation and storage
3. To understand the safety of use of food additives and ingredients
4. To understand their Maximum Permissible Limit (MPL) of additives and ingredients in foods.
5. To understand the effect of different process conditions on stability of food additives and ingredients.
6. To understand the process of preparation of food additives and ingredients.

Sr. No.	Course Contents (Topics and subtopics)	Required Hours
1	Additives in food processing and preservation, their functions and safety	**02**
2	Safety and quality evaluation of additives and ingredients, acute and chronic studies, LD50	**02**
3	Analytical methods, chemical and instrumental	**02**
4	Various additives such as preservatives (4), antioxidants and sequestrants (4), colours and flavours and flavor enhancers (4), emulsifiers (3), humectants (3), hydrocolloids (6), stabilizers and sweeteners (3), acidulants etc (3), with respect to chemistry, food uses and functions in formulations. New emerging additives, regulations as per CODEX and FSSAI	**30**
5	Indirect food additives	**02**
6	Colour additives in foods and their stability	**04**
7	Classification of flavours and the process of preparing including extraction, distillation, fractionation and purification; Stability of flavours	**06**
8	Ingredients used in food production e. g. sugars, starches, proteins/protein hydrolysates/isolates, fats, prebiotic oligosaccharides, pectin, chitin, and their technology of production and application, unusual protein sources such as insect proteins, mycoproteins	**12**
	Total	**60**

List of Textbooks / Reference Books	
1	Food Additives, 2nd and, AL Brannen, PM Davidson, S Salminen, JH Thorngate III, 2002 (eds). Marcel Dekker Inc, New York, pp. 1-9
2	Handbook of Food Additivies, 2nd edn, TE Furia, 1972, (ed) CRC Press, Cleveland, Ohio.
3	Functional Foods – Designer Foods, Pharma Foods, Nutraceuticals, Israel Goldberg (Editor) (1994), Chapman and Hall, New York.
4	The chemistry of food additives and preservatives, Titus A. M. Msagati, (2012)
5	Natural food additives, ingredients, and flavourings, D Baines, R Seal, (2012), Woodhead Publishing Series in Food Science, Technology and Nutrition.
6	Indirect Food Additives and Polymers: Migration and Toxicology, Victor O. Sheftel, CRC Press (2000)
7	The Role of Alternative and Innovative Food Ingredients and Products in Consumer Wellness, Charis M. Galankis, Academic Press (2019)
8	Essential guide to food additives, Mike Saltmarsh, 4 th Edition, Royal Society of Chemistry, UK (2019).
Course Outcomes (Students will be able to…..)	
CO1	Describe the various additives and ingredients used in food industries (K2)
CO2	Describe the mechanisms of food additives involved in foods and explain their significance in food quality, preservation, and storage (K2)
CO3	Describe the safety of use of food additives and ingredients (K2)
CO4	Extrapolate the knowledge gained on food additives and ingredients in food industries (K3)
CO5	Describe the process of preparation of food additives and ingredients (K2)

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)

		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
		K3	K4	K6	K5	K6	K3	K3+S	K3	K3+A	K2+A	K3	K6+A+S	K3	K4
CO1	K2	3	2	1	2	1	3	3	3	3	3	3	1	3	2
CO2	K2	3	2	1	2	1	3	3	3	3	3	3	1	3	2
CO3	K2	3	2	1	2	1	3	3	3	3	3	3	1	3	2
CO4	K3	3	3	2	2	2	3	3	3	3	3	3	2	3	3
CO5	K2	3	2	1	2	1	3	3	3	3	3	3	1	3	2
Course	K3	3	3	2	2	2	3	3	3	3	3	3	2	3	3

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; − No Contribution
K, knowledge level from cognitive domain; A, Affective domain; S, Psychomotor domain

	Course Code: FDT 1022	Course Title: SPL7: Food Engineering	Credits = 4		
			L	T	P
	Semester: V	Total Contact Hours: 60	3	1	0

List of Prerequisite Courses	
	Principles of Food Preservation

List of Courses where this course will be Prerequisite	
	Food Process Engineering, Food Processing and Engineering Lab

Description of relevance of this course in the B. Tech. (Food Engg. & Tech.) Programme

1. To apply the concept of material and energy balance in food operations.
2. To apply the concept of fluid flow, heat, and mass transfer in food processes.
3. To apply basic engineering principles to design mechanical operations in food processing.

Sr. No.	Course Contents (Topics and subtopics)	Required Hours
1	**Material and Energy Balance:** Principles of mass, material, and energy balance in food processing operations; Case studies like dehydration, crystallization, and evaporation; Thermodynamics concepts applied to food.	4
2	**Momentum Transport with respect to Foods:** Fluid dynamics; Newtonian and non-Newtonian fluid; Bernoulli's Theorem and friction factor; Flow measuring instruments; Velocity profile in different case studies like pipe, conduits; fluid flow between plates and outside a falling film; Fluid flow through porous media; Fluidization.	12
3	**Heat Transfer in Food Operations:** Steady state heat transfer in food systems; Transient heat transfer; Estimation of thermal conductivity; Dimensional analysis; Overall heat transfer coefficient estimation; Performance analysis of pasteurizer and sterilizer.	8
4	**Freezing and Thawing:** Freezing and Thawing calculations; Application of Plank's equation to specific food system; Refrigeration system and thermodynamic aspects; Concept of cold storage design; Refrigeration load for chilling and freezing process.	10
5	**Mass Transfer in Food Operations:** Basics of mass transfer and diffusion in food systems; Molecular diffusion and Fick's Law; Steady state diffusion; Diffusion through solids, liquids; Mass transfer coefficients and Permeability; Analogies between heat, momentum and mass transfer.	10
6	**Mechanical Operations in Food Processes:** Laws for size reduction; Sieving; Mixing; Homogenization; Centrifugation; Settling; Filtration; Extrusion.	10
7	**Thermal Operations in Food Processes:** Equipment and process for dehydration, evaporation, concentration, pasteurization, and sterilization.	6
	Total	**60**

List of Text Books / Reference Books

1	Das, S.K., & Das, M. Fundamentals and Operations in Food Process Engineering; 1st ed.; CRC Press; 2019.
2	Varzakas, T., Tzia, C. Food Engineering Handbook; 1st ed.; CRC Press; 2015.
3	Heldman, D.R. & Singh, R.P. Introduction to Food Engineering; 4th ed.; Academic Press; Elsevier; 2009.
4	Geankoplis, J. Transport Processes and Separation Process Principles, Pearson Publisher; 4th ed.; 2003.
5	Das, H. Food Processing Operations Analysis; Asian Books Pvt. Ltd.; 2008.
6	Stoecker, W.F. Industrial Refrigeration Handbook, McGraw-Hill Companies, Inc.; 1998.
Course Outcomes (Students will be able to…..)	
CO1	Apply and analyse the fundamental knowledge of material and energy as a basic tool in food engineering analysis (K4)
CO2	Analyse the performance of heat exchangers applied in food processes (K4)
CO3	Analyse the efficacy of different mass and momentum transfer operations in food processing (K4)
CO4	Design the cold storage and refrigerated vans in food operations (K3)
CO5	Analyse the performance of various mechanical operations applied in food industry (K4)

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)

		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
		K3	K4	K6	K5	K6	K3	K3+S	K3	K3+A	K2+A	K3	K6+A+S	K3	K4
CO1	K4	3	3	2	3	2	3	3	3	3	3	3	2	3	3
CO2	K4	3	3	2	3	2	3	3	3	3	3	3	2	3	3
CO3	K4	3	3	2	3	2	3	3	3	3	3	3	2	3	3
CO4	K3	3	3	2	2	2	3	3	3	3	3	3	2	3	3
CO5	K4	3	3	2	3	2	3	3	3	3	3	3	2	3	3
Course	K4	3	3	2	3	2	3	3	3	3	3	3	2	3	3

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; − No Contribution
K, knowledge level from cognitive domain; A, Affective domain; S, Psychomotor domain

	Course Code: FDP 1015	Course Title: Pr4: Food Chemistry Lab	Credits = 2		
			L	T	P
	Semester: V	Total contact hours: 60			4
List of Prerequisite Courses					
	Technical Analysis Lab I, Food Chemistry				
List of Courses where this course will be Prerequisite					
	Food Analysis, Analysis of Foods (Chemical), Food Processing and Product Development				

Description of relevance of this course in the B. Tech. (Food Engg. & Tech.) Programme

1. To train the students with hands on experience with chemical compositions of foods
2. To assist them in analysis of various food constituents, additives present in the food such as nutrients (vitamins), antinutritional factor (tannins, anthocyanins, flavonoids) etc

Sr. No.	Course Contents (Topics and subtopics)	Required Hours
1	Estimation of sulphur dioxide (KMS)	04
2	Estimation of sodium benzoate	04
3	Estimation of sorbic acid and sorbate	04
4	Estimation of Propyl gallate	04
5	Estimation of iodine in iodized salt	04
6	Identification of hydrocolloids	04
7	Estimation of chlorophyll and carotenoids and their separation on column chromatography	04
8	Estimation of tin in canned foods	04
9	Detection of food adulteration	04
10	Demonstration experiments on isolation of starch, proteins and hydrocolloids	04
11	Estimation of lipid oxidation parameters	04
12	Estimation of damaged starch in cereal flour	04
13	Antioxidant Assay (DPPH/FRAP)	04
14	Estimation of anti-nutritional factors	04
15	Sensory analysis of foods	04
	Total	60

List of Text Books / Reference Books	
1	Handbook of food analysis. Volume I- Nollet, Leo M. L., Toldrá, Fidel. CRC Press: ISBN – 9781482297843 (Third edition - 2005)
2	Food Analysis- S. Suzanne Nielsen. Springer Food Science Text Series: ISBN – 9783319457741 (5th ed. 2017)
3	Food Analysis Laboratory Manual- S. Suzanne Nielsen. Springer International Publishing Food Science Text Series: ISBN – 9783319441276 (3rd Ed. 2017)
4	Methods in Food Analysis- Rui M. S. Cruz, Igor Khmelinskii, Margarida Vieira. CRC Press: ISBN – 9781482231953 (2014)
5	Handbook of food analysis- Leo M L Nollet. Marcel Dekker-Food science and Technology Series: ISBN – 9780824750381 (2nd Ed 2004)
Course Outcomes (Students will be able to…..)	
CO1	Understand the principles of different analytical techniques associated with food and demonstrate practical proficiency in a food analysis laboratory (K4)
CO2	Identify the appropriate analytical technique when presented with a practical problem (K3)
CO3	Describe and use principal analytical methods used for quantifying the composition and reactions of food components (K3)
CO4	Interpret and report data derived from chemical experiments/analysis in a meaningful way (K4)
CO5	Apply basic statistical methods to sampling/testing and the analysis of experimental data (e.g., relate this to QC or HACCP) (K3)

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)

		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
		K3	K4	K6	K5	K6	K3	K3+S	K3	K3+A	K2+A	K3	K6+A+S	K3	K4
CO1	K4	3	3	2	3	2	3	3	3	3	3	3	2	3	3
CO2	K3	3	3	2	2	2	3	3	3	3	3	3	2	3	3
CO3	K3	3	3	2	2	2	3	3	3	3	3	3	2	3	3
CO4	K4	3	3	2	3	2	3	3	3	3	3	3	2	3	3
CO5	K3	3	3	2	2	2	3	3	3	3	3	3	2	3	3
Course	K4	3	3	2	3	2	3	3	3	3	3	3	2	3	3

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; − No Contribution
K, knowledge level from cognitive domain; A, Affective domain; S, Psychomotor domain

	Course Code:	Course Title: Pr5: Technical Analysis II	Credits = 2		
			L	T	P
	Semester: V	Total Contact Hours: 60	0	0	4

List of Prerequisite Courses

None

List of Courses where this course will be Prerequisite

Food Analysis - I Lab

Description of relevance of this course in the B. Tech. (Food Engg. & Tech.) Programme

- To understand the principles behind analytical techniques associated with sugar & water sample.
- To select the appropriate analytical technique when presented with a practical problem
- To demonstrate practical proficiency in a food analysis laboratory
- To use different analytical techniques to find out the properties of foods and food waste samples

Sr. No.	Course Contents (Topics and subtopics)	Required Hours
1	Estimation of Glucose by Lane and Eynon's & Willstatter's Method	4
2	Estimation of Sucrose by Lane and Eynon's Method	4
3	Estimation of Sucrose and Lactose	4
4	Estimation of Reducing Sugar by Bertard's Volumetric Method	4
5	Estimation of Glucose and Maltose by Sichert and Bleyer's Method	4
6	Estimate $\propto$-Amino Nitrogen by Sorenson's Formal Titration	4
7	Qualitative Analysis of Sugar	4
8	Qualitative Analysis of Fats	8
9	Proximate Analysis of Foods	12
10	Identification of Sugars & amino acids by Paper Chromatography	8
11	Protein Precipitation Reaction	4
	Total	**60**

List of Text Books / Reference Books

1. Ranganna, S. (1986). *Handbook of analysis and quality control for fruit and vegetable products*. Tata McGraw-Hill Education.
2. Kirk, S., & Sawyer, R. (1991). *Pearson's composition and analysis of foods* (No. Ed. 9). Longman Group Ltd..

Course Outcomes (Students will be able to…..)

CO1	Perform and demonstrate the analytical techniques associated with sugar & water samples (K3)
CO2	Demonstrate the analytical techniques associated with mineral estimation in food samples (K3)
CO3	Select the appropriate analytical technique when presented with a practical problem (K4)
CO4	Demonstrate practical proficiency in a food analysis laboratory (K3)

CO5	Categorize and recommend suitable analytical technique to find out the properties of foods and food waste samples (K4)

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)															
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
		K3	K4	K6	K5	K6	K3	K3+S	K3	K3+A	K2+A	K3	K6+A+S	K3	K4
CO1	K3	3	3	2	2	2	3	3	3	3	3	3	2	3	3
CO2	K3	3	3	2	2	2	3	3	3	3	3	3	2	3	3
CO3	K4	3	3	2	3	2	3	3	3	3	3	3	2	3	3
CO4	K3	3	3	2	2	2	3	3	3	3	3	3	2	3	3
CO5	K4	3	3	2	3	2	3	3	3	3	3	3	2	3	3
Course	K4	3	3	2	3	2	3	3	3	3	3	3	2	3	3

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; − No Contribution
K, knowledge level from cognitive domain; A, Affective domain; S, Psychomotor domain

Semester VI

	Course Code: FDT 1014	Course Title: SPL9: Food Microbiology	Credits = 3		
			L	T	P
	Semester: VI	Total contact hours: 45	2	1	0

List of Prerequisite Courses	
	Basics of Microbiology

List of Courses where this course will be Prerequisite	
	Food Biotechnology

Description of relevance of this course in the B. Tech. (Food Engg. & Tech.) Programme

1. To understand the concept of general microbiological ecology and control of food and food-based products.
2. To identify the conditions, including sanitation practices, under which the important pathogens and spoilage microorganisms are commonly inactivated, killed or made harmless
3. To understand microbiological concerns in product development, e.g., new formulations, new packaging, new processes

Sr. No.	Course Contents (Topics and subtopics)	Required Hours
1	Factors affecting spoilage of foods and associated microflora; Intrinsic and extrinsic factors affecting spoilage of foods; biochemical changes caused by microorganisms - putrefaction, lipolysis; Antagonism and synergism in microorganisms	05
2	Microbiological spoilage problems associated with typical food products such as dairy products, fruits and vegetables, grains and oilseeds, meat/fish and poultry, spices, and their control	09
3	Food borne infections and food poisoning, Microbial toxins, Emerging pathogens.	06
4	Detection methods for *E. coli*, *Staphylococci*, *Yersinia*, *Campylobacter*, *B. cereus*, *C. Botulinum* & *Salmonella* from food samples.	10
5	Indicator organisms, microbiological quality assurance systems in food industry, use of the hazard analysis critical control points system to ensure microbiological safety and quality of foods, microbiological food standards	06
6	Rapid methods of microbial analysis; applications of immunological techniques to food industry	09
	Total	**45**

List of Text Books / Reference Books	
1	Food Microbiology: Frazier W.C. and Dennis C. Westhoff 5th Edn. Tata McGraw-Hill Publishing Co. Ltd. (2013).
2	Modern Food Microbiology- Jay, James M., Loessner, Martin J., Golden, David A, Aspen Publishers, Inc, 7th ed. (2004)

3	Food Microbiology and Fundamentals and Frontiers: Doyle M.P, Beuchat L.R, Montville T.J.2nd Edn. ASM Press, Washington D.C. (2001)
4	Food Borne Bacterial Pathogens: Doyle, M.P. Marcel Dekker Inc. (1989) Basic Food Microbiology; George J. Banwart, Chapman and Hall (1999)
5	Food Microbiology (Third Edition). Martin R. Adams and Maurice O. Moss. RSC Publishing. ISBN 978-0-85404-284-5
Course Outcomes (Students will be able to…..)	
CO1	Describe the different factors associated with microbial spoilage of food and the corresponding biochemical changes in it (K2)
CO2	Explain the spoilage and methods of controlling the microbial spoilage for specific food products and describing the fundamentals of food fermentation (K2)
CO3	Describe different food borne infections and food poisoning, microbial toxins and functions of newer pathogens (K2)
CO4	describe and apply different detection methods of critical microorganism, rapid methods of microbial analysis, and applications of immunological techniques to food industry (K3)
CO5	Identify the target organism in specific food and design the hazard analysis critical control points system ensuring microbiological safety and quality of foods (K3)

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)

		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
		K3	K4	K6	K5	K6	K3	K3+S	K3	K3+A	K2+A	K3	K6+A+S	K3	K4
CO1	K2	3	2	1	2	1	3	3	3	3	3	3	1	3	2
CO2	K2	3	2	1	2	1	3	3	3	3	3	3	1	3	2
CO3	K2	3	2	1	2	1	3	3	3	3	3	3	1	3	2
CO4	K3	3	3	2	2	2	3	3	3	3	3	3	2	3	3
CO5	K3	3	3	2	2	2	3	3	3	3	3	3	2	3	3
Course	K3	3	3	2	2	2	3	3	3	3	3	3	2	3	3

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; − No Contribution
K, knowledge level from cognitive domain; A, Affective domain; S, Psychomotor domain

	Course Code:	Course Title: SPL10: Principles of Food Preservation	Credits = 3		
			L	T	P
	Semester: VI	Total Contact Hours: 45	2	1	0
List of Prerequisite Courses					
	Chemistry of Food Constituents, Microbiology, Biochemistry				
List of Courses where this course will be Prerequisite					
	Food Engineering, SPL8: Food Process Engineering, Food Processing and Engineering				

Description of relevance of this course in the B. Tech. (Food Engg. & Tech.) Programme

- To understand the fundamentals of food preservation through dehydration, high and low temperature processing of food
- To explain the principles of advanced thermal and non-thermal processing of food
- To explain the principles of food preservation by fermentation, chemical preservatives, bio-preservatives and hurdle technology

Sr. No.	Course Contents (Topics and subtopics)	Required Hours
1	**Introduction to food preservation:** Food spoilage; Underlying principles of different modes of food preservation; Preservation methods with emphasis on inactivation, inhibition, and avoiding recontamination.	4
2	**Dehydration and drying of foods:** Drying curve and drying time calculation; Water activity and moisture absorption isotherms; Psychometric chart; Different types of dryers-Conductive, convective, and combined; IMF foods; osmotic dehydration.	7
3	**Thermal processing of food products:** Sterilization and Pasteurization; Canning of food products; Classifications and structure of cans, corrosion, Lacquering; Spoilage in canned foods (1) Thermal death time (TDT) concept; Process time calculation for canned foods; Retort processing; Aseptic packaging.	8
4	**Newer techniques in thermal processing:** Concept of HTST; UHT; Ohmic, Dielectric, Infra-red Heating; Microwave heating; Frying method.	6
5	**Non-thermal processing of food:** High pressure processing; Pulsed electric field processing; Cold extrusion; Plasma processing; Ionizing Radiations; Ultrasound processing; UV and Pulsed light processing; Membrane Technology.	10
6	**Low temperature storage and preservation:** Chilling and Freezing; Freezing curve and water activity; Properties of frozen foods; Enthalpy change during freezing; Plank's equation for freezing time; Cold storage and Refrigeration load; Refrigeration cycle; Cryogenic freezing and IQF; Freeze concentration and freeze drying.	5
7	**Hurdle technology:** Role of acidity and pH in food preservation; Preservation by fermentation – Curing, Pickling and Smoking; Controlled and modified atmospheric packaging and storage; Chemical and Bio-preservatives; Antimicrobials.	5

	Total	**45**

List of Text Books / Reference Books	
1	Toledo, R.T. Fundamentals of Food Process Engineering, Chapman and Hall; 2000,
2	Fellows, P.J. Food Processing Technology: Principles and Practice, CBS Publishers; 2005.
3	Rahman, M.S. Handbook of food preservation, CRC Press; 2007.
4	Cullen, P.J., Brijesh, K.T., Vasilis, Valdramidis, P. Novel Thermal and Non-Thermal Technologies for Fluid Foods, Elsevier Academic Press; 2012.
5	Zhang, H.Q., Barbosa-Cánovas, G.V., Balasubramaniam, V.M., Dunne, C.P., Farkas, D.F., Yuan, J.T.C. Non-thermal Processing Technologies for Food, John Wiley & Sons; 2011.
6	Shakuntala, N., & Many, O. Food: Facts and Principles, New Age International; 2001.
Course Outcomes (Students will be able to…..)	
CO1	Apply the principles and develop operations using thermal technologies for food preservation (K4)
CO2	Apply the principle, technology and operations of various non-thermal technologies for food preservation (K3)
CO3	Analyse the concept of various advanced thermal food processing (K4)
CO4	Apply the technique of low temperature in food preservation and analyse the process efficiency (K4)
CO5	Apply the principles of hurdle technology in food preservation (K3)

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)															
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
		K3	K4	K6	K5	K6	K3	K3+S	K3	K3+A	K2+A	K3	K6+A+S	K3	K4
CO1	K4	3	3	2	3	2	3	3	3	3	3	3	2	3	3
CO2	K3	3	3	2	2	2	3	3	3	3	3	3	2	3	3
CO3	K4	3	3	2	3	2	3	3	3	3	3	3	2	3	3
CO4	K4	3	3	2	3	2	3	3	3	3	3	3	2	3	3
CO5	K3	3	3	2	2	2	3	3	3	3	3	3	2	3	3
Course	K4	3	3	2	3	2	3	3	3	3	3	3	2	3	3

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; − No Contribution
K, knowledge level from cognitive domain; A, Affective domain; S, Psychomotor domain

	Course Code:	Course Title: SPL11: Food Packaging	Credits = 4		
			L	T	P
	Semester: VIII	Total Contact Hours: 60	3	1	0
List of Prerequisite Courses					
	Chemistry of Food Constituents, Food Microbiology				
List of Courses where this course will be Prerequisite					
	Principles of Food Preservation				

Description of relevance of this course in the B. Tech. (Food Engg. & Tech.) Programme

Course objectives:

1. To understand the role of food packaging in food preservation
2. To understand the nature of different materials used in food packaging
3. To understand the various food packaging applications with respect to various food commodities
4. To understand different types of package testing methods employed to evaluate quality, performance and safety of food packaging materials
5. To understand various food-package interactions and environmental issues related to packaging
6. To understand newer food packaging application technologies

Sr. No.	Course Contents (Topics and subtopics)	Required Hours
1	Introduction to food packaging; Causes of food spoilage; Factors affecting food spoilage; Packaging as a method for preservation of foods; Functions of food packaging including new packaging technologies; Levels of packaging; Food labelling	9
2	Different materials used in food packaging such as paper, board, glass, metal containers, aluminium foil, plastics, composites, traditional materials and their physicochemical characteristics, their advantages and limitations, method of manufacture	9
3	Testing of various packaging materials and packages for evaluation of quality, for identification, for evaluation of barrier and strength properties for transport-worthiness, for biodegradability, for migration etc; Criteria for selection of packaging materials; Shelf-life testing of packaged foods	9
4	Food and Packaging material interactions including migration, scalping of flavour; biodegradable packaging; application of nanotechnology in food packaging; environmental concerns and lifecycle assessment Packaging of various food commodities including fresh produce (fruits and vegetables), meat, fish, poultry, milk, cereals and processed foods.	9
5	Newer packaging technologies- CAP/MAP packaging; aseptic processing and packaging; irradiated packaging; retort pouch; microwaveable packaging; packaging for non-thermal processing of foods (pulsed electric field, high pressure processing, irradiation etc.); active packaging; intelligent packaging	9
6	Emerging trends in polymers for food packaging, green packaging materials, nanoparticles in food packaging	9
7	Recycling of food packaging materials and use of recycled materials in food packaging, edible packaging	6

	Total	**60**

List of Text Books / Reference Books	
1	Sustainable Food Packaging Technology, Athanassia Athanassiou, John Wiley & Sons, 2021
2	Environmentally compatible Food Packaging, E. Chiellini, Elsevier, 2008
3	Packaging for nonthermal processing of food, Melvin A. Paschall and Jung H. Han, John Wiley & Sons, 2018
4	Edible food packaging: Materials and processing technology, Miquel Angelo Parente Ribeiro Cerqueira, Ricardo Nuno Correia Pereira, Oscar Leandro da Silva Ramos, Jose Antonio Couto Teixeira, Antonio Augusto Vicente, CRC Press, 2017
5	Nanomaterials for food packaging: Materials, processing technologies, and safety issues, Miguel Angelo Parente Ribei Cerqueira, Jose Maria Lagaron, Lorenzo Miguel Pastrana Castro, Antonio Augusto Martins de Oliveira Soares Vicente, Elsevier, 2018
6	Packaging Media by Paine F.A. Publisher: Blackie and son Ltd., Bishop Briggs (1977)
7	Food and Packaging Interactions by Risch.S.H. Publisher American chemical society, Washington (1991).
8	Handbook of Food Packaging by F.A. Paine and H.Y. Paine Publisher: Blackie and Son Ltd. London. (1983)
9	Food Packaging Technology by G Bureau and JL Multon, VCH, New York (Vol.1 & 2) (1996). ISBN: 1560819324, 9781560819325
10	Food Packaging and Shelf Life: A Practical Guide by Gordon L. Robertson. CRC Publication. Edition 1 (2009). ISBN: 9781420078442
11	Food Packaging - Principles and Practice (3rd Edition) by Gordon L. Robertson. Taylor & Francis. Edition 3 (2013). ISBN: 9781628706529
12	Innovations in Food Packaging by Jung H. Han. Academic Press- Food Science and Technology International Series. Edn 1 (2005. ISBN: 9780123116321)
Course Outcomes (Students will be able to…..)	
CO1	Discuss and analyze the role of food packaging in food preservation (K4)
CO2	Describe different food packaging materials, properties, and interactions (K2)
CO3	Apply the concept of packaging with respect to various food commodities (K3)
CO4	Explain and interpret various tests used in evaluating quality and safety of food packaging materials (K2)
CO5	Describe newer food packaging technologies (K2)

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)

		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
		K3	K4	K6	K5	K6	K3	K3+S	K3	K3+A	K2+A	K3	K6+A+S	K3	K4
CO1	K4	3	3	2	3	2	3	3	3	3	3	3	2	3	3
CO2	K2	3	2	1	2	1	3	3	3	3	3	3	1	3	2
CO3	K3	3	3	2	2	2	3	3	3	3	3	3	2	3	3
CO4	K2	3	2	1	2	1	3	3	3	3	3	3	1	3	2
CO5	K2	3	2	1	2	1	3	3	3	3	3	3	1	3	2
Course	K4	3	3	2	3	2	3	3	3	3	3	3	2	3	3

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; − No Contribution
K, knowledge level from cognitive domain; A, Affective domain; S, Psychomotor domain

	Course Code: FDT 1033	Course Title: SPL12: Technology of Dairy and Animal Products	Credits = 4		
			L	T	P
	Semester: VI	Total contact hours: 60	3	1	0
List of Prerequisite Courses					
	Introduction to Food Science and Technology; Food Chemistry				
List of Courses where this course will be Prerequisite					
	Food Processing and Engineering				

Description of relevance of this course in the B. Tech. (Food Engg. & Tech.) Programme

1. To understand the role of chemical constituents on the raw material quality and nutritional, processing, sensory, and storage quality as of a wide range of dairy and animal-based products
2. To understand the vulnerability of dairy and animal-based products to microbial contamination and steps to mitigate them
3. To understand the steps involved in the processing of dairy and animal-based products and the significance thereof
4. To get an idea of the regulatory aspects of dairy and animal-based products

Sr. No.	Course Contents (Topics and subtopics)	Required Hours
Dairy Technology		
1	Milk components, composition and types; raw milk quality and processing (HTST/UHT, homogenization), CIP/COP/distribution/packaging/fermented milks/bulk starter cultures	04
2	Manufacture of milk-based products - condensed and evaporated milk, milk powder, cheese, ice-cream, cream, butter, ghee; their evaluation and quality parameters, defects encountered during production, packaging and storage.	14
3	Non-dairy milk and milk products; Casein and caseinates, lactose, whey protein concentrates and isolates, milk co-precipitates, and other specialty products	06
4	Traditional dairy products, milk confections such as yoghurt, *dahi, khoa, burfi, kalakand, gulab jamun, rosogolla, shrikhand, chhana, paneer, ghee, lassi* etc. Probiotic milk products.	06
	Total	**30**
Animal Products		
1	**Slaughter of food animals:** Plan and layout of slaughterhouse, Religious and scientific methods of Slaughter of Food animals; Principle and Methods of Stunning of Food Animals	02
2	**Handling and Transport of Food Animals:** Animal welfare and pre-slaughter care, handling and transport of meat animals including poultry. Stress and Meat quality (DFD and PSE conditions)	01
3	**AM and PM and Dressing of Food Animals:**Procedures of Ante-mortem and post mortem examination of meat animals, Emergency and casualty slaughter;	02
4	**Structure, Composition and Nutritive Value of Meat, Postmortem changes in meat:** Conversion of muscle to meat, Ageing of meat	03
5	**Meat Quality:** Factors affecting microbial growth, spoilage of meat; Physicochemical parameters of meat, colour, texture, Sensory evaluation of meat and meat products	02

6	**Meat Processing, preservation and packaging**: Meat processing- Basic processing techniques of meat viz. Smoking and Curing, emulsification; Preparation of meat products including fermented meats, Preservation of meat and meat products; Packaging of meat and meat products.	04
7	**Meat plant hygiene:** GMP and HACCP. National and International Laws related to meat	01
8	**Slaughterhouse by products:** By-products from meat industries and their utilization	02
9	**Meat trade:** Statistics of meat industry in India	01
10	**Poultry meat and Egg:** Composition and nutritional value of poultry meat and eggs, Processing of poultry meat and eggs; Preparation of different poultry and egg products, Evaluation of external and internal quality of egg; Egg preservation, Utilization of poultry by products, Microbial Spoilage and control.	05
11	**Fish and Fish Products:** Classification of freshwater fish and marine fish; Commercial handling, storage and transport of raw fish. Average composition of fish; Freshness criteria and quality assessment of fish; Spoilage of fish. Methods of processing and preservation of fish- Canning, Freezing, Drying, Smoking and Curing. Fish products – fish meal, fish protein concentrate, fish liver oil, fish sauce and surimi; Fish processing industries in India.	04
12	**Cultured meats and plant-based alternatives**	03
	Total	**30**

List of Text Books / Reference Books	
1	Aneja et al. 2002. Technology of Indian Milk Products. Dairy India Publ. De S.1980. Outlines of Dairy Technology. Oxford Univ. Press
2	Rathore,NS et al. 2008.Fundamentals of Dairy Technology- Theory & Practices. Himanshu Publ
3	Walstra et al. 2006. Dairy Science and Technology. 2nd Ed. Taylor & Francis.
4	Spreer E. Milk and dairy product technology. CRC Press, (2017).
5	Sebnem Ozturkoglu Budak and H. Ceren Akal, (Eds). Microbial cultres and enzymes in dairy technology. IGO Global (2018).
6	Goyal MR & Chavan RS (Eds). Technological interventions in dairy science: Innovatives approaches to processing, preservation and analysis of milk products, Apple Academic Press (2018).
7	Meghwal M, Goyal MR & Chavan RS (Eds). Dairy Engineering: Advanced Technologies and Their Applications, Apple Academic Press (2017).
8	Web BH. et al. 1987. Fundamental of Dairy Chemistry. 3rd Ed. AVI Publ.
9	Walstra et al. 1999. Dairy Technology. Marcel Dekker.
10	Sharma BD. Modern Abattoir Practices and Animal by Products Technology, Jaypee Publisher (2003).
11	Sharma BD. Outlines of Meat Science and Technology, Jaypee Publisher (2011).

12	Aberele ED, Forrest JC, Gerrard, D. E., & Mills, E. W. Principles of Meat Science, Kendll Hunt (2001).
13	**Warris, PD. Meat Science- An Introductory Text. CABI Publsihing, 2nd Edition (2010)**
14	**Kinsman, DM, Kotula DW & Btendstein BC. Muscle Food.** destein, Marcel Dekker Inc. (1994)
15	**Ockerman HW & Hansen CL. Animal By-product Processing and Utilization.** CRC Press, 1st Edition (1999).
16	**Toldra F. Handbook of Meat Processing, Wiley Blackwell (2010)**
17	**Gracey G, Collins DS & Huey R. Meat Hygiene,** W.B. Saunders Company Ltd., CRC Press (1999).
18	**Mountney GJ & Parkhurst CR. Poultry Products Technology.** Haworth Press, 3rd edition (1995).
19	**Feiner G. Meat Products Handbook,** Woodhead Publishing (2006).
20	**Lawrie RA. Lawrie's Meat Science,** CRC Press, 8th edition (2017)
21	**Meilgaard, M, Civille GV & Thomas Carr** B. Sensory Evaluation Technique, **, CRC Press (2016)**

Course Outcomes (Students will be able to…..)	
CO1	Explain fundamental knowledge on dairy-based and animal-based products (K2)
CO2	Explain the facts and unit operations/flow sheet of manufacture and technologies involved in the processing/food plant sanitation of different animal products/milk and dairy products (K2)
CO3	Apply techniques suitable for the extraction/isolation of high value compounds from milk/animal products (K3)
CO4	Develop/design/modify new products/processes for value-addition of dairy/animal products (K3)
CO5	Explain the causes related to any aspect of quality/spoilage and processing of dairy/animal based products and do troubleshooting (K3)

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)

		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
		K3	K4	K6	K5	K6	K3	K3+S	K3	K3+A	K2+A	K3	K6+A+S	K3	K4
CO1	K2	3	2	1	2	1	3	3	3	3	3	3	1	3	2
CO2	K2	3	2	1	2	1	3	3	3	3	3	3	1	3	2
CO3	K3	3	3	2	2	2	3	3	3	3	3	3	2	3	3
CO4	K3	3	3	2	2	2	3	3	3	3	3	3	2	3	3
CO5	K3	3	3	2	2	2	3	3	3	3	3	3	2	3	3
Course	K3	3	3	2	2	2	3	3	3	3	3	3	2	3	3

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; − No Contribution
K, knowledge level from cognitive domain; A, Affective domain; S, Psychomotor domain

	Course Code: FDP 1034	Course Title: Pr6: Food Processing and Product Development	Credits = 2		
			L	T	P
	Semester: VI	Total Contact Hours: 60	0	0	4

List of Prerequisite Courses

	Principles of Food Preservation, Food Engineering

List of Courses where this course will be Prerequisite

	Food Process Engineering

Description of relevance of this course in the B. Tech. (Food Engg. & Tech.) Programme

1. To analyse the integration of processing in food formulations
2. To design and develop the process flow chart for any product development.
3. To design the product and process formulations in food industry
4. To evaluate the processing cost of any developed product

Sr. No.	Course Contents (Topics and subtopics)	Required Hours
1	Preparation of various degree brix Syrups (rose syrup and almond syrup)	04
2	Preparation, packaging, sensory and evaluation of Jam, jelly marmalade from different fruits	08
3	Preparation of Ketchup, Sauces and chutneys	08
4	Preparation of Squashes (lemon squash, orange squash, pineapple squash)	08
5	Preparation of variety of pickles (lemon, mango, chilli, mixed etc)	08
6	Preparation of different types of breads	08
7	Preparation of different types of cakes	08
8	Preparation of different types of biscuits	04
9	Preparation of milk products	04
	Total	**60**

List of Text Books / Reference Books

1	Fuller, G.W. (2011). *New Food Product Development: From Concept to Marketplace*, 3rd ed, CRC Press, UK.
2	Theodoros Varzakas, Constantina Tzia. (2015). *Handbook of Food Processing: Food Safety, Quality, and Manufacturing Processes*, CRC Press, UK.
3	Giridhari Lal, G.S. Siddappa, G.L. Tandon. (1998). *Preservation of Fruits and Vegetables*, ICAR, New Delhi.
4	Khurdia DS. (1995). Preservation of fruits and vegetables. Indian Council of Agriculture Research, New Delhi.
5	Ramaswamy H and Marcott M. (2005). Food Processing Principles and Applications. CRC Press.
6	The Food Safety and Standards Act along with Rules and Regulations (2011). Delhi: Commercial Law Publishers (India) Pvt Ltd.
Course Outcomes (Students will be able to…..)	
CO1	Explain and develop basic flow sheet in food processing operations (K3)
CO2	Analyse the major food processing steps applied during various food preparations (K4)
CO3	Describe and design novel food products (K3)
CO4	Use different food processing equipment for product development (K3)
CO5	Analyse the developed food products (K4)

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)

		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
		K3	K4	K6	K5	K6	K3	K3+S	K3	K3+A	K2+A	K3	K6+A+S	K3	K4
CO1	K3	3	3	2	2	2	3	3	3	3	3	3	2	3	3
CO2	K4	3	3	2	3	2	3	3	3	3	3	3	2	3	3
CO3	K3	3	3	2	2	2	3	3	3	3	3	3	2	3	3
CO4	K3	3	3	2	2	2	3	3	3	3	3	3	2	3	3
CO5	K4	3	3	2	3	2	3	3	3	3	3	3	2	3	3
Course	K4	3	3	2	3	2	3	3	3	3	3	3	2	3	3

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; − No Contribution
K, knowledge level from cognitive domain; A, Affective domain; S, Psychomotor domain

	Course Code: FDP 1018	Course Title: Pr7: Food Analysis - I	Credits = 2		
			L	T	P
	Semester: VI	Total Contact Hours: 60	0	0	4

List of Prerequisite Courses

	PR 3: Technical Analysis, PR 4: Food Chemistry

List of Courses where this course will be Prerequisite

	Food Analysis-II

Description of relevance of this course in the B. Tech. (Food Engg. & Tech.) Programme

1. To give students hands on training on chemical analysis or food compositions (moisture, fat, protein, fiber, ash and carbohydrate) determinations of wide range of fruit, vegetables, cereal, legume based food products available in the market
2. To train them acquire laboratory skills required for performing a range of chemical and physicochemical analyses of food components
3. To train them for the understanding of nutritional labelling

Sr. No.	Course Contents (Topics and subtopics)	Required Hours
1	Analysis of tea and coffee	04
2	Analysis of liquid milk, condensed milk and skim milk powder	08
3	Analysis of honey and golden syrup	04
4	Analysis of wheat flour	04
5	Analysis of beer and wine	08
6	Analysis of jam, jelly and squash	08
7	Analysis of fish	04
8	Analysis of spices	04
9	Analysis of vinegar	04
10	Analysis of ghee and edible oil	04
11	Analysis of bread	04
12	Analysis of Cake, Biscuits	04
	Total	**60**

List of Text Books / Reference Books	
1	Sehgal S. (2016). A Laboratory Manual of Food Analysis. I.K. International Publishing House Pvt. Ltd.
2	Nielsen, S. Suzanne (2017). Food Analysis Laboratory Manual II. (Ed.) 5th edition. Springer, New York
3	The Food Safety and Standards Act along with Rules and Regulations (2011). Delhi: Commercial Law Publishers (India) Pvt Ltd.
Course Outcomes (Students will be able to…..)	
CO1	Apply the fundamental knowledge in the analysis of plantation crops/animal-based products/dairy based products (K3)
CO2	Analyse the unit operations involved in the processing of different plantation crops/animal products/milk and dairy products (K4)
CO3	Select and demonstrate a suitable extraction/isolation technique for high value compounds from plantation crops/milk/animal products (K4)
CO4	Develop new products and processes for value-addition of plantation crop/dairy/animal products (K4)
CO5	Develop strategies related to processing of dairy/plantation crops/animal based products and do troubleshooting (K4)

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)															
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
		K3	K4	K6	K5	K6	K3	K3+S	K3	K3+A	K2+A	K3	K6+A+S	K3	K4
CO1	K3	3	3	2	2	2	3	3	3	3	3	3	2	3	3
CO2	K4	3	3	2	3	2	3	3	3	3	3	3	2	3	3
CO3	K4	3	3	2	3	2	3	3	3	3	3	3	2	3	3
CO4	K4	3	3	2	3	2	3	3	3	3	3	3	2	3	3
CO5	K4	3	3	2	3	2	3	3	3	3	3	3	2	3	3
Course	K4	3	3	2	3	2	3	3	3	3	3	3	2	3	3

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; − No Contribution
K, knowledge level from cognitive domain; A, Affective domain; S, Psychomotor domain

Semester VII

	Course Code: FDT 1023	Course Title: SPL13: Technology of Cereals, Legumes and Oilseeds	Credits = 3		
			L	T	P
	Semester: VII	Total Contact Hours: 45	2	1	0

List of Prerequisite Courses

SPL1: Chemistry of Food Constituents **(FDT1011)**, SPL 2: Principles of Food Preservation **(FDT1031)**, SPL5: Food Engineering **(FDT1022)**, SPL6: Food Chemistry **(FDT1032)**, SPL 9: Food Additives and Ingredients **(FDT1012)**

List of Courses where this course will be Prerequisite

PR 8: Food Processing and Engineering **(FDP1026)**, Spl 14: Food Safety, Quality and Regulations **(FDT1028)**

Description of relevance of this course in the B. Tech. (Food Engg. & Tech.) Programme

Course objectives

1. To train students in post-harvest handling, storage of cereals, grains, legumes and oilseeds
2. To give them the concept related to changes taking place in them during processing and on processing to value-added products such as flours, extruded products, noodles, breakfast cereals etc
3. To acquaint students with production trends, structure, composition, quality evaluation and processing technologies for product development and value addition of various cereals, pulses and oilseeds.

Sr. No.	Course Contents (Topics and subtopics)	Required Hours
1	**Cereals and millets**: Morphology: physicochemical properties; chemical composition and nutritional value	04
2	**Wheat**: Milling (chakki, roller) break system, purification system and reduction system; Maida, suji, chakki atta, extraction rate and its effect on flour composition; damaged starch, Quality characteristics of flour and their suitability for baking variety of products	06
3	**Rice**: Paddy processing and rice milling: conventional milling, modern milling operations, milling machines, milling efficiency, byproducts of rice milling. Quality characteristics influencing final milled products.	05
	Parboiling: Parboiling of rice, Rice bran stabilization and its methods; Aging of rice; Enrichment – need, methods; processed foods from rice – breakfast cereals, flakes, puffing, canning and instant rice	05
4	**Corn**: Corn milling – dry and wet milling, starch and gluten separation, milling fractions ad modified starches, corn grits and flakes	03
5	**Barley**: Pearling / milling, Malting process, malt based foods. **Oats**: Processing and oats milling, Flaked oats in breakfast cereals	02
6	**Sorghum**: Milling, Malting, Pearling and industrial utilization	02

7	**Millets**: Importance of Millet, composition, processing of millets for food uses, major and minor millets	02
8	**Bakery Products**: Breads, Cakes, Biscuits, Different types of biscuits, short, hard and fermented Biscuits (02), Advanced bakery products such as croissants, puffs, muffins and filled cookies and muffins, Different functional ingredients used in baking, Gluten free, multigrain products	08
9	**Processing and technology of legumes and oilseeds:** Moong, Channa, Arhar, Urd, whole as well split dal. Technology of oilseeds such as peanut, sesame, sunflower etc, Utilisation in food industry as protein and oil source and their use in Indian diet.	08
	Total	**45**

List of Text Books / Reference Books	
1	The chemistry and technology of cereals as food and feed, Matz S.A., 1991
2	Cereal Processing and Technology, Gavin Owens, CRC Press, 2001
3	Wheat – Chemistry and Technology, Pomeranz, Y, 1991
4	Cereals and Cereal Products: Technology and Chemistry, Dendy, David A.V., Dobraszczyk, Bogdan J., Springer, 2001
5	Handbook of Cereal Science and Technology, Karel Kulp, CRC Press, 2000
6	Principles of Cereal Science and Technology, Jan A. Delcour, R. Carl Hoseney, 2010
7	Food and Feed from Legumes and Oilseeds, J. Smartt, Emmanuel Nwokolo, Chapman & Hall, 1996
Course Outcomes (Students will be able to…..)	
CO1	Explain the uniqueness of cereal grain, legume and oilseed and inter-relationships of the key constituents (K2)
CO2	Infer about the quality of finished baked products, ingredient function, product formulation and processing, and molecular mechanisms (K4).
CO3	Apply different processing operations applied to legume and oilseed-based products (K3)
CO4	Describe the processing methods applied for wheat, malt and their products (K2)
CO5	Apply the technology involved in baked, extruded, puffed and fermented cereal, legumes and oilseeds products and Indian traditional products (K3)

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)

		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
		K3	K4	K6	K5	K6	K3	K3+S	K3	K3+A	K2+A	K3	K6+A+S	K3	K4
CO1	K2	3	2	1	2	1	3	3	3	3	3	3	1	3	2
CO2	K4	3	3	2	3	2	3	3	3	3	3	3	2	3	3
CO3	K3	3	3	2	2	2	3	3	3	3	3	3	2	3	3
CO4	K2	3	2	1	2	1	3	3	3	3	3	3	1	3	2
CO5	K3	3	3	2	2	2	3	3	3	3	3	3	2	3	3
Course	K4	3	3	2	3	2	3	3	3	3	3	3	2	3	3

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; − No Contribution
K, knowledge level from cognitive domain; A, Affective domain; S, Psychomotor domain

	Course Code	Course Title: SPL14: Technology of Plantation Products I	Credits = 2		
			L	T	P
	Semester: VII	Total Contact Hours: 30	1	1	0
List of Prerequisite Courses					
	Introduction to Food Science and Technology; Food Chemistry				
List of Courses where this course will be Prerequisite					
	Flavour Science and Technology				

Description of relevance of this course in the B. Tech. (Food Engg. & Tech.) Programme

Course objectives

1. To understand the process of cocoa fermentation and unit operations involved in extracting cocoa butter and producing cocoa powder
2. To describe cocoa butter replacement fats and the method of manufacture of chocolate-based confectionery
3. To understand tea/coffee cultivation, composition, processing, products and analysis

Sr. No.	Course Contents (Topics and subtopics)	Required Hours
1	Cultivation of cocoa, microbiology/biochemistry of cocoa bean fermentation, development of cocoa flavour precursors, drying, roasting, alkalization (Dutching), NARS process, winnowing, nib grinding, liquor processing, expeller pressing, cocoa cake grinding, cocoa products, analysis of cocoa powder, cocoa butter-chemistry and properties	10
2	Cocoa butter replacement fats (CBS and CBE fats and other fats), antibloom fat, lecithin as emulsifier in chocolate; Chocolate based confectionery-Bulk chocolate manufacture: raw materials, milk chocolate process including milk crumb process, melangeuring, refining, pasting, conching; tempering, moulding, enrobing, panning.	10
3	Tea cultivation, constituents of tea leaf, chemistry and technology of fermentation and black tea manufacture, characteristics and quality of tea beverage, types of tea- black tea, green tea, oolong tea, speciality teas, herbal teas; analysis of tea, iced tea, other tea-based products, kombucha tea Coffee varieties, cultivation, coffee bean composition, processing of berries (wet and dry process), roasting, grinding, brewing, instant coffee manufacture, decaffeination; analysis of coffee and chicory, green coffee, filter coffee and its packaging, health benefits of coffee	10
	Total	30

List of Text Books / Reference Books

1	Chocolate, cocoa and confectionery: Science and Technology – 3rd Edition 1989 Minifie B.W.

2	Industrial Chocolate Manufacture and Use, Edited by Stephen Beckett, 4th Edition Publisher Wiley Blackwell, ISBN: 978-1-4051-3949-6
3	Science of Tea Technology by PS Ahuja, A Gulati, RD Singh, RK Sud & RC Boruah. Scientific Publishers (2013). ISBN-13: 978-8172338312
4	Coffee: planting, production and processing by S K Mangal. Gene-Tech Books. 1st Edition (2007). ISBN: 9781441653093
5	Introduction to Spices, Plantation Crops, Medicinal and Aromatic Plants, N. Kumar, - Oxford and IBH Publishing, (2021)
Course Outcomes (Students will be able to…..)	
CO1	Explain the process of cocoa fermentation and unit operations involved in extracting cocoa butter and producing cocoa powder (K2)
CO2	Describe cocoa butter replacement fats and analyse the method of manufacture of chocolate-based confectionery (K4)
CO3	Explain tea/coffee cultivation, composition, processing, products and analysis (K2)

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)

		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
		K3	K4	K6	K5	K6	K3	K3+S	K3	K3+A	K2+A	K3	K6+A+S	K3	K4
CO1	K2	3	2	1	2	1	3	3	3	3	3	3	1	3	2
CO2	K4	3	3	2	3	2	3	3	3	3	3	3	2	3	3
CO3	K2	3	2	1	2	1	3	3	3	3	3	3	1	3	2
Course	K4	3	3	2	3	2	3	3	3	3	3	3	2	3	3

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; − No Contribution
K, knowledge level from cognitive domain; A, Affective domain; S, Psychomotor domain

	Course Code: FDP 1021	Course Title: Pr8: Food Analysis II (Instrumentation)	Credits = 2		
			L	T	P
	Semester: VI	Total Contact Hours: 60	0	0	4

List of Prerequisite Courses

PR3: Technical Analysis Lab **(FDP1011)**, PR4: Food Chemistry Lab **(FDP1015)**, PR6: Food Analysis I **(FDP1018)**

List of Courses where this course will be Prerequisite

SPL7: Principle of Food Analysis **(FDT1052)**

Description of relevance of this course in the B. Tech. (Food Engg. & Tech.) Programme

- To educate the students on the significance, purpose and principle of food analysis using instruments (basics and advanced)
- To teach them the various basics and advanced methods of analysis of major and minor food constituents
- To train them towards the selection of correct method based on the precision, accuracy, food system and availability
- To explain the principles of various types of chromatographic and spectroscopic techniques suitable in food analysis
- To explain the principles of thermal analysis, food rheology, colour measurements and their applications in food analysis

Sr. No.	Course Contents (Topics and subtopics)	Required Hours
1	Analysis of food samples for calorific value using bomb calorimeter	4
2	UV-Vis Spectro-photometric analysis of a carotenoid	4
3	Hunter Lab colorimetric studies of food samples.	4
4	Texture analysis of food samples.	4
5	Rheology of food samples	4
6	Sensory evaluation of foods	4
7	Gas chromatographic analysis of food constituents	4
8	Densitometric (HPLTC) assay of food constituents	4
9	HPLC separation of food constituents	4
10	Differential scanning calorimetry (DSC) for food samples	4
11	Polarimetric estimation of sugars	4
12	Conductometric analysis of polyelectrolytes in solution	4
13	Atomic absorption spectroscopic analysis of heavy metals in foods	4
	Total	**60**

List of Text Books / Reference Books

1	Neilsen Suzanne S., Food Analysis, Fourth Edition, Springer; 2010.
2	Günzler H. and Williams A., Handbook of Analytical Techniques, Wiley-VCH Verlag GmbH Publishing; 2001
3	Otles S., Handbook of Food Analysis Instruments; 1st ed.; CRC Press; Elsevier; 2008.
Course Outcomes (Students will be able to…..)	
CO1	Select the appropriate instrumental method when presented with a practical problem (K5)
CO2	Demonstrate practical proficiency in a food analysis laboratory using advanced instruments (K3)
CO3	Evaluate the basic methods of instrumental and subjective sensory evaluation, including when certain methods might be used, the type of data derived, and how that data might be used in decision-making (K5)
CO4	Demonstrate practical proficiency in chromatographic techniques applied in food analysis (K3)
CO5	Choose appropriate techniques for foods and when/how to use them in a food processing environment/situation such as QA&/QC (K5)

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)															
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
		K3	K4	K6	K5	K6	K3	K3+S	K3	K3+A	K2+A	K3	K6+A+S	K3	K4
CO1	K5	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO2	K3	3	3	2	2	2	3	3	3	3	3	3	2	3	3
CO3	K5	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO4	K3	3	3	2	2	2	3	3	3	3	3	3	2	3	3
CO5	K5	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Course	K5	3	3	3	3	3	3	3	3	3	3	3	3	3	3

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; − No Contribution
K, knowledge level from cognitive domain; A, Affective domain; S, Psychomotor domain

	Course Code: FDT 1051	Course Title: Nutraceuticals and Functional Foods	Credits = 3		
			L	T	P
	Semester: VII	Total Contact Hours: 45	2	1	0
List of Prerequisite Courses					
	SPL1: Chemistry of Food Constituents **(FDT 1011)**, SPL4: Nutrition **(FDT 1015)**, Biochemistry **(BST 1102)**, Gut physiology				
List of Courses where this course will be Prerequisite					
	None				

Description of relevance of this course in the B. Tech. (Food Engg. & Tech.) Programme

Course objectives

1. To understand the fundamental knowledge on various nutraceuticals and functional foods and their mechanism of action
2. To explain the basics of nutrigenomics and its relation with nutraceuticals
3. To be aware of safety/ toxicity aspects of nutraceuticals and interactions with drugs
4. To describe the basic terminologies and regulatory issues in the field of their applications
5. To explain the roles of various nutraceuticals in different physiological/disease conditions
6. To know the manufacturing of different nutraceuticals and functional foods

Sr. No.	Course Contents (Topics and subtopics)	Required Hours
1	Introduction to nutraceuticals: definitions, synonymous terms, basis of claims for a compound as a nutraceutical, regulatory issues for nutraceuticals including CODEX; nutrigenomics - an introduction and its relation to nutraceuticals	9 (6L+3T)
2	Clinical testing of nutraceuticals and functional foods; interactions of prescription drugs and nutraceuticals; adverse effects and toxicity/safety of nutraceuticals	9 (6L+3T)
3	Nutraceuticals/ functional foods for life-style associated diseases such as atherosclerosis, hypertension, heart disease, stroke, obesity, type 2 diabetes, and diseases associated with smoking, alcohol and drug abuse and their mechanisms of action, dosage levels, contraindications if any.	9 (6L+3T)
4	Nutraceuticals/ functional foods for aging associated diseases such as cancer, arthritis, cataract, osteoporosis, Alzheimer's disease, age related macular degeneration and their mechanisms of action, dosage levels, contraindications if any.	9 (6L+3T)
5	Manufacturing aspects of selected nutraceuticals such as lycopene, isoflavonoids, prebiotics and probiotics, glucosamine, phytosterols etc.; formulation of functional foods containing nutraceuticals, stability, and analytical issues, labelling issues	9 (6L+3T)
	Total	**45**

List of Text Books / Reference Books

1	Joyce I. Boye, Nutraceuticals and Functional Food Processing Technology, Wiley-Blackwell 2014.
2	**Aluko** Rotimi E. Functional Foods and Nutraceuticals, Food Science Text Series, Springer 2012.
3	Brian Lockwood, Nutraceuticals: A Guide for Healthcare Professionals, Pharmaceutical Press, 2007
4	Robert E.C. Wildman, Robert Wildman, Taylor C. Wallace Handbook of Nutraceuticals and Functional Foods, Second Edition, CRC Press 2006.
5	Geoffrey P. Webb. 2006. Dietary supplements and functional foods. Blackwell Publishing
6	Losso, J. N. Angi-angiogenic functional and medicinal foods. CRC Press 2007.
	Shi J.2007. Functional Food Ingredients and Nutraceuticals: Processing Technologies. Taylor & Francis Publ. CRC Press.
8	Robert E.C. 2006. Handbook of Nutraceuticals and Functional Foods. 2nd Ed. Wildman.
9	Brigelius-Flohé, J and Joost H.G. 2006. Nutritional Genomics: Impact on Health and Disease. Wiley-VCH
10	Neeser J.R. and German B.J. Bioprocesses and Biotechnology for Functional Foods and Nutraceuticals. Marcel Dekker, 2004.
11	Gibson, GR and William, CM. Functional foods - Concept to Product. Woodhead, 2000.
Course Outcomes (Students will be able to…..)	
CO1	Describe the fundamental knowledge on various nutraceuticals and functional foods and their mechanism of action and manufacturing aspects (K2)
CO2	Explain the basics of nutrigenomics and its relation with nutraceuticals (K2)
CO3	Explain the safety/ toxicity aspects of nutraceuticals and interactions with prescribed drugs (K3)
CO4	Describe the basic terminologies and regulatory issues in the field of their applications (K2)
CO5	Explain the roles of various nutraceuticals in different physiological/disease conditions (K2)

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)

		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
		K3	K4	K6	K5	K6	K3	K3+S	K3	K3+A	K2+A	K3	K6+A+S	K3	K4
CO1	K2	3	2	1	2	1	3	3	3	3	3	3	1	3	2
CO2	K2	3	2	1	2	1	3	3	3	3	3	3	1	3	2
CO3	K3	3	3	2	2	2	3	3	3	3	3	3	2	3	3
CO4	K2	3	2	1	2	1	3	3	3	3	3	3	1	3	2
CO5	K2	3	2	1	2	1	3	3	3	3	3	3	1	3	2
Course	K3	3	3	2	2	2	3	3	3	3	3	3	2	3	3

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; − No Contribution
K, knowledge level from cognitive domain; A, Affective domain; S, Psychomotor domain

	Course Code: FDT 1053	Course Title: Waste Management in Food Processing	Credits = 2		
			L	T	P
	Semester: VII	Total Contact Hours: 30	1	1	0

List of Prerequisite Courses

None

List of Courses where this course will be Prerequisite

None

Description of relevance of this course in the B. Tech. (Food Engg. & Tech.) Programme

- To define and describe different terminologies in wastewater treatment
- To describe different treatment methods used in wastewater treatment
- To explain waste management strategies for food processing industries
- To explain the recovery of biological from various food wastes
- To design and develop waste treatment protocol for different food wastes

Sr. No.	Course Contents (Topics and subtopics)	Required Hours
1	Water quality, treatment and recycle. BOD, COD and definitions, Discharge limits for effluents. Primary treatment, secondary and tertiary treatments by physical, chemical and biological methods.	7
2	Effluent and solid waste utilization food processing industry by biological methods – for SCP, biogas and other products	5
3	Waste management strategies and value-added products from of agri-food processing industry	8
4	Recovery of biological from dairy, meat, fish and poultry processing industry	5
5	Case studies: Cane Sugar waste, molasses for alcohol, bagasse for paper pulp, chemicals, bioethanol, cogeneration. Other processes including vermiculture.	5
	Total	**30**

List of Text Books / Reference Books

1	Wastewater Engineering; Treatment and Reuse, Metcalf & Eddy, Fourth Edition, Tata McGraw-Hill Edition
2	Wastewater treatment for pollution Control and Reuse, Soli. J Arceivala & Shyam. R Asolekar Third Edition, Tata McGraw-Hill Edition, 2006.
3	Arvanitoyannis I., Waste Management for the Food Industries, 1st Edition, Academic Press, 2007.
4	Lawrence K. Wang, Yung-Tse Hung, Howard H. Lo, Constantine Yapijakis, Waste Treatment in Food Processing Industries, Taylor and Francis, 2005.
5	Handbook of Waste management and co-product recovery in Food Processing – Vol.1- Keith Waldron, 2009.

Course Outcomes (Students will be able to…..)

CO1	Describe and interpret about different terminologies in wastewater treatment (K3)
CO2	Explain and analyse different treatment methods used in wastewater treatment (K4)
CO3	Develop waste management strategies for food processing industries (K4)
CO4	Explain and recommend the strategies for the recovery of biological from various food wastes (K5)

CO5	Design and develop waste treatment protocol for different food wastes (K4)

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)														
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
		K3	K4	K6	K5	K6	K3	K3+S	K3	K3+A	K2+A	K3	K6+A+S	K3	K4
CO1	K3	3	3	2	2	2	3	3	3	3	3	3	2	3	3
CO2	K4	3	3	2	3	2	3	3	3	3	3	3	2	3	3
CO3	K4	3	3	2	3	2	3	3	3	3	3	3	2	3	3
CO4	K5	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO5	K4	3	3	2	3	2	3	3	3	3	3	3	2	3	3
Course	K5	3	3	3	3	3	3	3	3	3	3	3	3	3	3

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; − No Contribution
K, knowledge level from cognitive domain; A, Affective domain; S, Psychomotor domain

Semester VIII

SPL	Course Code: FDT 1017	Course Title: SPL17: Technology of Fruits, Vegetables and Tubers	Credits = 3		
			L	T	P
	Semester: VI	Total Contact Hours: 45	2	1	0

List of Prerequisite Courses

SPL1: Chemistry of Food Constituents **(FDT1011)**, SPL 2: Principles of Food Preservation **(FDT1031)**, SPL5: Food Engineering **(FDT1022)**, SPL6: Food Chemistry **(FDT1032)**, SPL 9: Food Additives and Ingredients **(FDT1012)**

List of Courses where this course will be Prerequisite

PR 5: Food Processing and Product Development Lab **(FDP1034)**, Spl 14: Food Safety, Quality and Regulations **(FDT1028)**

Description of relevance of this course in the B. Tech. (Food Engg. & Tech.) Programme

Course objectives

1. To know overall development and quality of fruits, vegetables and tubers.
2. To understand the post-harvest handling, storage and ripening process.
3. To understand different methods/techniques for processing of fruits.
4. To understand different methods/techniques for vegetable processing.
5. To understand different methods/techniques for processing of different tubers.
6. To know the various by-products from fruit, vegetable and tuber processing industry.
7. To know the applications of honey, sugar, saccharine in products and soft drink.

Sr. No.	Course Contents (Topics and subtopics)	Required Hours
1	**Fruits and Vegetables:** Types, Structure and composition, development, maturity indices, Methods, importance and overall quality of fruit and vegetables for harvesting.	05
2	**Post-harvest Processing:** Handling, storage, ripening and control of ripening, chemical changes etc. of fruits and vegetables	05
3	**Fruits:** Processing techniques, juices, juice extraction process, causes of juice spoilage, Methods of juice preservation, concentrates, preserves, Jams/Marmalades, Squashes/cordials, Candied Fruits Fruit Bar, and other traditional products	12
4	**Vegetables:** Processing techniques, vegetable juices, preservation, Ketchup/sauces, Chutneys, Soup powders, pickles, fermented pickles and other traditional products. Dried powders (Onion, garlic, potato, carrot starch), dried Cauliflower and cabbage: Sauerkraut, Pickles, Dried Leafy Vegetables. (Spinach, Fenugreek, Coriander leaves, Curry leaves). Bitter gourd: Pickle, Dried bitter gourd.	10
5	**Tubers:** Processing and products (Potato, Sweet potato, turnips, beetroot, Taro, yam and others)	06

6	Dehydrated and specialty products and by-products of fruits and vegetables	04
7	Honey, Sugars and saccharine products. Soft drinks, fermented pickles.	03
	Total	**45**

List of Text Books / Reference Books	
1	Handbook of Fruits Science and Technology: Production, Composition, Storage and Processing by Salunkhe D.K. and Kadam S.S. (1995) CRC press
2	Handbook of Vegetable Science and Technology: Production, Composition, Storage and Processing, Salunkhe D.K. and Kadam S.S., (1998) CRC press
3	Preservation of Fruits and Vegetables – Girdhari Lal, Siddhapa and Tondon, ICAR, New Delhi.
4	Hand Book of Analysis and Quality Control of Fruits and Vegetable Products – S. Ranganna Tata McGraw Hill, New Delhi.
5	Commercial Vegetable Processing–Wood Roof and Lue.
6	Commercial Fruit and Vegetable Processing–W.V. Cruses.
7	Y. H. Hui, S. Ghazala, D.M. Graham, K.D. Murrell & W.K. Nip Handbook of Vegetable Preservation and Processing Marcel Dekker (2003).
Course Outcomes (Students will be able to…..)	
CO1	Explain and develop basics of Fruits and vegetables processing operations (K3)
CO2	Analyse the process protocols of different fruit and vegetable based products and quality (K4)
CO3	Describe the maturity indices, methods, their importance during harvesting and processing (K2)
CO4	Explain the tuber processing, various products process protocol and design the novel food products out of them (K3)
CO5	Analyse the quality characteristics of importance in fresh and processed fruit, vegetable and tuber products in food industry (K4)

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)															
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
		K3	K4	K6	K5	K6	K3	K3+S	K3	K3+A	K2+A	K3	K6+A+S	K3	K4
CO1	K3	3	3	2	2	2	3	3	3	3	3	3	2	3	3
CO2	K4	3	3	2	3	2	3	3	3	3	3	3	2	3	3
CO3	K2	3	2	1	2	1	3	3	3	3	3	3	1	3	2
CO4	K3	3	3	2	2	2	3	3	3	3	3	3	2	3	3
CO5	K4	3	3	2	3	2	3	3	3	3	3	3	2	3	3
Course	K4	3	3	2	3	2	3	3	3	3	3	3	2	3	3

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; − No Contribution
K, knowledge level from cognitive domain; A, Affective domain; S, Psychomotor domain

	Course Code:	Course Title: Technology of Plantation Products II	Credits = 2		
			L	T	P
	Semester: VIII	Total Contact Hours: 30	1	1	0
List of Prerequisite Courses					
	Introduction to Food Science and Technology; Food Chemistry				
List of Courses where this course will be Prerequisite					
	Flavour Science and Technology				

Description of relevance of this course in the B. Tech. (Food Engg. & Tech.) Programme

Course objectives

1. To describe spices, their chemical constituents and post-harvest handling and processing
2. To describe different types of sugar-based confections including manufacturing process, equipment used and physico-chemical analysis
3. To understand the Chemistry and technology of coconut, arecanut, cashew, palmrah, cinchona and rubber and their processing to value added products
4. Chemistry, technology and processing of medicinal and aromatic plants including floral concerts

Sr. No.	Course Contents (Topics and subtopics)	Required Hours
1	Varieties of spices/condiments grown and consumed in various countries including India, nomenclature, properties and culinary uses, preservative action, medicinal uses, analysis of spices, post-harvest handling/ storage/ preservation/ processing of spices, spice-based products, major individual spices- turmeric, cardamom, asafoetida, cinnamon, cloves, nutmeg, capsicum, pepper, ginger, saffron, anise, ajwain, coriander, cumin, celery, caraway, dill, fenugreek, fennel etc.	8
2	Sugar based confectionery- ingredients used including sugar and alternative sweeteners, description of types of confections like HBC, toffee, fudge, gums and jellies, aerated confectionery, sugar panned confections, chewing gum etc, manufacturing process and equipment, structure of sugar confection, chemical analysis and quality assurance. Indian confectionery- types, description of characteristics, method of preparation	8
3	Cashewnut chemistry, technology, processing and by-products – cashewnut shell liquid, nuts, cashew apple	3
4	Coconut processing in to value added products- coconut water, coconut milk, dessicated coconut, coconut oil, grated coconut and their products; by-product utilization; Other lesser-known nuts such as arecanut, rubber, cinchino and palmyrah	3
5	Commercial floriculture - Production and trade of cut flowers, foliage plants, potted plants, landscape plants, bedding plants, seed production, dried flowers and plant parts, perfumes and essential oils and natural dyes for viable agri-business option, extension of shelf life of flowers, edible flowers and their bioactivities,	4
6	Medicinal plants of commercial importance in nutraceutical formulations, processing, formulations and applications, quality assurance	4

	Total	30

List of Text Books / Reference Books	
1	Handbook of herbs and spices by KV Peter. Woodhead Publishing Limited. 2nd Edition, Vol II (2012)
2	Spices by JW Purseglove, EG Brown, CL Green & SRJ Robbins. Longman Group Ltd. Vol. 2 (1981) (pp. 447-813).
3	Sugar Confectionery and Chocolate Manufacture by R. Lees and E. B. Jackson. Springer US. 1st Edition (1995). ISBN: 9781468414950
4	Introduction to Spices, Plantation Crops, Medicinal and Aromatic Plants, N. Kumar, - Oxford and IBH Publishing, (2021
5	The Complete Book on Cashew (Cultivation, Processing & By-Products), H. L. Panda, Asia Pacific Business Press, 2013. Review papers from recent publications
6	Postharvest technologies for commercial floriculture, Anil Kumar Verma, New India Publishing Agency, 2012 Review papers from recent publications
7	The Complete Book on Coconut & Coconut Products (Cultivation and Processing), Asia Pacific Business Press, 2006
8	Cultivation and Processing of Selected Medicinal Plants, Asia Pacific Busines Press, 2006
Course Outcomes (Students will be able to…..)	
CO1	Describe spices, their chemical constituents and solve the problems related to post-harvest handling and processing (K3)
CO2	Explain the production and processing of plantation crops of commercial importance such as cashewnut, coconut, their by-product utilization, value added products (K3)
CO3	Explain the techniques used in commercial utilization of flowers for economic gains, post-harvest processing, bioactives from flowers, shelf-life extension of flowers (K3)
CO4	Describe the medicinal plants that are used commercially for manufacture of nutraceuticals, their processing technologies and formulations, quality assurance (K3)
CO5	Describe different types of sugar-based confections including manufacturing process, equipment used and analysis (K2)

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)														
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
		K3	K4	K6	K5	K6	K3	K3+S	K3	K3+A	K2+A	K3	K6+A+S	K3	K4

CO1	K3	3	2	1	2	1	3	3	3	3	3	3	1	3	2
CO2	K3	3	3	2	3	2	3	3	3	3	3	3	2	3	3
CO3	K3	3	2	1	2	1	3	3	3	3	3	3	1	3	2
CO4	K3	3	3	2	2	2	3	3	3	3	3	3	2	3	3
CO5	K4	3	3	2	2	2	3	2	3	3	3	2	2	2	3
Course	K4	3	3	2	3	2	3	3	3	3	3	3	2	3	3

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; − No Contribution
K, knowledge level from cognitive domain; A, Affective domain; S, Psychomotor domain

HONORS

	Course Code:	Course Title: Honors1: Food Biotechnology	Credits = 4		
			L	T	P
	Semester: V	Total Contact Hours: 60	3	1	0

List of Prerequisite Courses	
	Biochemistry, Microbiology
List of Courses where this course will be Prerequisite	
	None

Description of relevance of this course in the B. Tech. (Food Engg. & Tech.) Programme

Course objectives

1. To describe the fundamentals of molecular biology, chemistry, biology and different mechanisms of DNA, RNA and protein synthesis
2. To explain the regulations in gene expression and recombinant DNA technology in prokaryotes and eukaryotes
3. To describe different techniques and mechanisms involved in industrial fermentation processes
4. To describe tissue culture, microalgae, genetically modified foods and nutritional genomics applied in food biotechnology
5. To describe the various industrial applications of enzymes

Sr. No.	Course Contents (Topics and subtopics)	Required Hours
1	Introduction to Food of Biotechnology with applications in Industry, Basics of Molecular Biology - Chemistry and Biology of DNA, RNA and proteins, DNA replication, transcription and translation in prokaryotes and eukaryotes	10
2	Regulation of gene expression in prokaryotes and eukaryotes. Recombinant DNA technology with examples	10
3	Introductory aspects of biochemical engineering and bioreactor designs; Application of genetic control mechanisms in industrial fermentation processes; Principles of submerged and solid-state fermentations; Fermentation media and sterilization; Basics of strain improvement techniques.	10
4	Basic concepts of Plant tissue culture and its applications in Biotechnology; Use of microalgae in biotechnology, Animal tissue culture as a tool of biotechnology; Genetically modified foods – plant and animal origin; Nutritional genomics	10
5	Applications of enzymes in food and feed industry	10
6	Fermentative production of food additives and ingredients	10
	Total	**60**

List of Text Books / Reference Books

1	Basic molecular and Cell Biology 3rd edition Ed. David Latchman. BMJ Publishing Group 1997. 1st Indian reprint 2006.
2	Gene cloning and DNA analysis. An Introduction 4th edition. T.A.Brown. Publishers Blackwell Sciences Ltd. UK 2001.
3	Introduction to plant biotechnology. H.S. Chawla 2nd edition. Publishers Oxford and IBH Publ. Co. Pvt. Ltd., New Delhi. 2009.
4	Cell and tissue culture; laboratory procedures in biotechnology. A. Doyle and J.B. Griffiths. John Wiley & Sons, Chichester, UK. 1998.
5	Fermentation Biotechnology: Principles, Processes and Products, Ward OP, 1989, Prentice-Hall.
Course Outcomes (Students will be able to…..)	
CO1	Describe the fundamentals of molecular biology, chemistry, biology and different mechanisms of DNA, RNA and protein synthesis (K2).
CO2	Explain the regulations in gene expression in prokaryotes and eukaryotes and recombinant DNA technology (K2)
CO3	Describe different techniques and mechanisms involved in industrial fermentation processes (K2)
CO4	Describe and apply tissue culture and microalgae techniques as a tool of food biotechnology and describe the facts of genetically modified foods and nutritional genomics (K3)
CO5	Describe various applications of enzymes in industrial processes (K2)

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)

		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
		K3	K4	K6	K5	K6	K3	K3+S	K3	K3+A	K2+A	K3	K6+A+S	K3	K4
CO1	K2	3	2	1	2	1	3	3	3	3	3	3	1	3	2
CO2	K2	3	2	1	2	1	3	3	3	3	3	3	1	3	2
CO3	K2	3	2	1	2	1	3	3	3	3	3	3	1	3	2
CO4	K3	3	3	2	2	2	3	3	3	3	3	3	2	3	3
CO5	K2	3	2	1	2	1	3	3	3	3	3	3	1	3	2
Course	K3	3	3	2	2	2	3	3	3	3	3	3	2	3	3

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; − No Contribution
K, knowledge level from cognitive domain; A, Affective domain; S, Psychomotor domain

	Course Code: FDT 1027	Course Title: Honor2: Food Process Engineering	Credits = 4		
			L	T	P
	Semester: VI	Total Contact Hours: 60	3	1	0
List of Prerequisite Courses					
	Principles of Food Preservation,Food Engineering				
List of Courses where this course will be Prerequisite					
	Food Processing and Engineering Lab				

Description of relevance of this course in the B. Tech. (Food Engg. & Tech.) Programme

1. To acquaint the students with different thermal and mechanical operations in food processing and its integration to actual process design.
2. To design and analyse the performance of food processing equipment such as dryer and evaporators.

Sr. No.	Course Contents (Topics and subtopics)	Required Hours
1	**Product & Process Development:** Important aspects of product and process development. Basic flow sheet development for food processing	4
2	**Boiler & Heat Exchanger:** Thermodynamic properties of steam; Steam as heating medium in Food operations; Fire and water tube boiler; Design of heat exchangers for food operations.	8
3	**Thermal Processing & Equipment:** design and equipment aspects of Thermal processing; Continuous sterilization; Canning and retort processing. Equipment design aspects of pasteurizer, evaporators, and concentrators. Nonthermal processes.	12
4	**Mechanical Operations & Equipment:** Process design aspects of homogenizer, centrifugal separators, extruder, filtration system, Bakery Machines and Equipment: Sheeting, mixing and blending	10
5	**Dryer and their Design Parameters:** Tray dryer, spray dryer, fluidized bed dryer, heat-pump assisted dryer, and freeze dryer	10
6	**Freezing & Cold Storage:** Construction of cold storages and refrigerated vans. Types of freezers and their design parameters – plate contact freezer, air blast freezer, cryogenic freezer.	10
7	**Plant Layout and Costing:** Food processing Plant layout, CGMP, material of construction and corrosion, waste utilization, Process control, optimization and preliminary project costing.	6
	Total	**60**

List of Text Books / Reference Books	
1	Toledo, R.T. Fundamentals of Food Process Engineering, Chapman and Hall; 2000,
2	Watson, E.L., & Harper, J.C. Elements of Food Engineering, The Avi Publishing Co.; 1989
3	Heldman, D.R. & Singh, R.P. Introduction to Food Engineering; 4th ed.; Academic Press; Elsevier; 2009.
4	Geankoplis, J. Transport Processes and Separation Process Principles, Pearson Publisher; 4th ed.; 2003.
5	Das, H. Food Processing Operations Analysis; Asian Books Pvt. Ltd.; 2008.
6	Meyers, F.E. & Stephens, M.P. Manufacturing Facilities, Design and Material Handling, Pearson Education Inc.; 2013
Course Outcomes (Students will be able to…..)	
CO1	Explain and develop basic flow sheet in food processing operations (K3)
CO2	Analyse the design aspects of different thermal processes and equipment (K4)
CO3	Design different non-thermal processes and bakery equipment (K3)
CO4	Explain the cooling technology in food processing and design the cold storage and refrigerated vans (K3)
CO5	Analyse the critical process control parameters and develop plant layout of a food industry (K4)

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)

		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
		K3	K4	K6	K5	K6	K3	K3+S	K3	K3+A	K2+A	K3	K6+A+S	K3	K4
CO1	K3	3	3	2	2	2	3	3	3	3	3	3	2	3	3
CO2	K4	3	3	2	3	2	3	3	3	3	3	3	2	3	3
CO3	K3	3	3	2	2	2	3	3	3	3	3	3	2	3	3
CO4	K3	3	3	2	2	2	3	3	3	3	3	3	2	3	3
CO5	K4	3	3	2	3	2	3	3	3	3	3	3	2	3	3
Course	K4	3	3	2	3	2	3	3	3	3	3	3	2	3	3

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; − No Contribution
K, knowledge level from cognitive domain; A, Affective domain; S, Psychomotor domain

	Course Code: FDP 1026	Course Title: Honors3: Food Processing and Engineering	Credits = 4		
			L	T	P
	Semester: VII	Total Contact Hours: 60	0	0	8
List of Prerequisite Courses					
	SPL2: Principles of Food Preservation **(FDT1031)**, SPL5: Food Engineering **(FDT1022)**, SPL8: Food Process Engineering **(FDT1027)**.				
List of Courses where this course will be Prerequisite					
	None				

Description of relevance of this course in the B. Tech. (Food Engg. & Tech.) Programme
1. To evaluate the performance of thermal and mechanical operations in food processes 2. To analyse the integration of experimental design in food processing and formulations

Sr. No.	Course Contents (Topics and subtopics)	Required Hours
1	Particle size and sieve analysis of cereal and wheat flour	4
2	Efficacy of size reduction process through hammer and ball mill	4
3	Milling of grains: Estimating the milling efficiency	4
4	Milk homogenization: Effect of product and process variables	8
5	Effect of process parameters on viscosity of liquid food	8
6	Rheological study of food slurry, paste and dough	8
7	Estimating the mixing index in a food mixture (solid and liquid)	4
8	Kinetic in thermal process design: Pasteurization of liquid food	8
9	Thermal death time in Canning of fruits and vegetables	8
10	Retort processing of vegetable products	4
11	Effect of process and product parameters on baking of bread	8
12	Effect of process and product parameters on baking of biscuit	8
13	Effect of material and air properties on tray drying of food materials	8
14	Effect of material and air properties on spray drying of food materials	8
15	Freezing of food material (rate and time of freezing)	8
16	Study of extraction of oleoresins from spices using liquid carbon dioxide	4

17	Use of experimental design and sensory evaluation in product formulation: Beverage (fermented and non-fermented); premix	12
18	Non-thermal processing of food	4
	Total	**120**

List of Text Books / Reference Books	
1	Ibarz, A., & Barbosa-Canovas, G. V. Unit Operations in Food Engineering. CRC Press, UK; 2002.
2	Barbosa-Cánovas, G. V., Ma, L., & Barletta, B. J. Food Engineering Laboratory Manual. CRC Press. UK; 1997.
3	Heldman, D.R. & Singh, R.P. Introduction to Food Engineering; 4th ed.; Academic Press; Elsevier; 2009.
4	Stoecker, W.F. Industrial Refrigeration Handbook, McGraw-Hill Companies, Inc.; 1998.
5	Das, H. Food Processing Operations Analysis; Asian Books Pvt. Ltd.; 2008.
6	Fuller, G.W. New Food Product Development: From Concept to Marketplace, 3rd ed, CRC Press, UK; 2011.
Course Outcomes (Students will be able to…..)	
CO1	Analyse the different unit operations in developing a process specific to food products (K4)
CO2	Analyse different thermal processes for food preservations (K4)
CO3	Analyse and evaluate the effect of different process variables on the quality of food product (K5)
CO4	Analyse and evaluate the effect of compositional variables on quality of food products (K5)
CO5	Develop and optimize the food process and products using the experimental design concept (K5)

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)															
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
		K3	K4	K6	K5	K6	K3	K3+S	K3	K3+A	K2+A	K3	K6+A+S	K3	K4
CO1	K4	3	3	2	3	2	3	3	3	3	3	3	2	3	3
CO2	K4	3	3	2	3	2	3	3	3	3	3	3	2	3	3
CO3	K5	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO4	K5	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO5	K5	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Course	K5	3	3	3	3	3	3	3	3	3	3	3	3	3	3

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; − No Contribution
K, knowledge level from cognitive domain; A, Affective domain; S, Psychomotor domain

	Course code:	**Course Title: Honors4: Insights in to Traditional Foods**	**Credits = 3**		
			L	**T**	**P**
	Semester: **VIII**	**Total contact hours: 45**	**2**	**1**	**0**

List of Prerequisite courses	
	All the previous courses in the program
List of Courses where this course will be Prerequisite	
	Project I, Project II and all the subsequent courses of the program

Description of relevance of this course in the B. Tech. (Food Engg. & Tech.) Programme

1. To understand the history, philosophy, science and technology of traditional Indian foods
2. To understand the engineering properties and processes related to Indian traditional foods
3. To understand the nutritional and nutraceutical aspects of Indian traditional foods
4. To understand the use of food additives and ingredients and packaging requirements of Indian traditional foods

Sr. No.	**Course Contents**	**Required Hours**
1	History and Philosophy of Indian traditional foods and food systems: Concept of Annamaykosha; intertwining of food, God and religion; concept of Vasudeva kutumba; concept of fasting; food pairing system; Rasayanas in Indian food systems; main course vs. vyanjanas; biodiversity of Indian food systems	4
2	Chemistry and Technology of traditional Indian foods with respect to commodity technologies (cereals/millets/legumes, dairy, animal foods, plantation foods such as tea/coffee/cocoa/spices/coconut/arecanut etc) and their combinations	10
3	Engineering processes and engineering properties of traditional Indian foods	4
4	Machinery development and scale-up of Indian traditional foods	5
5	Traditional foods for specific population groups such as pregnant and lactating mothers (galactogues), elderly, infants and children	5
6	Traditional foods and food groups as nutraceuticals, Ayurceuticals (traditional adaptogens such as ashwagandha and others listed in FSSAI)	8
7	Geographical indicator (GI) tag and its significance in traditional Indian foods	3
8	Miscellaneous topics such as packaging requirements, mouth fresheners, confectionaries ad savouries in traditional Indian food systems	6
	TOTAL	**45**

List of Text Books / Reference Books

1. Traditional Foods: History, Preparation, Processing and Safety, Mohammed Al-Khusaibi, Nasser Al-Habsi, Mohammad Shafiur Rahman, Springer Nature, 18-Oct-2019.
2. Functional Properties of Traditional Foods, Kristberg Kristbergsson, Semih Otles, Springer, 2016
3. Innovations in traditional foods, Edited by Charis M. Galanakis, Elsevier Science, 2019, ISBN: 9780128148877, 012814887X
4. Eating traditional food: politics, identity and practices, Brigitte Sebastia, Routledge, 2016.
5. Social Ecological Diversity And Traditional Food Systems: Oppurtunities From The Biocultural World, Ranjay K. Singh, New India Publishing Agency, New Delhi, 2014.

6	Modernization of Traditional Food Processes and Products, edited by Anna McElhatton, Mustapha Missbah El Idrissi, Springer, 2016
7	Revisiting Indian traditional foods-A critical review of the engineering properties and process operations, S Basak, S Chakraborty, RS Singhal, Food Control, 143, 109286 (2023).
8	Regulating Safety of Traditional and Ethnic Foods, edited by V. Prakash, Olga Martin-Belloso, Larry Keener, Siân B. Astley, Susanne Braun, Helena McMahon, Huub L. M. Lelieveld, Academic Press, 2015.

Course Outcomes (Students will be able to…..)	
CO1	Describe the philosophy, chemistry, technology and nutrition of traditional Indian foods and food systems (K2)
CO2	Describe the engineering properties and processes for commercialization of Indian traditional foods (K2)
CO3	Describe the nutraceutical aspects of traditional Indian foods (K2)
CO4	Describe the significance of GI, regulatory and safety aspects of traditional Indian foods (K2)
CO5	Extrapolate the knowledge gained on commodity technologies in previous courses to traditional Indian foods (K3)

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)

		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
		K3	K4	K6	K5	K6	K3	K3+S	K3	K3+A	K2+A	K3	K6+A+S	K3	K4
CO1	K2	3	2	1	2	1	3	3	3	3	3	3	3	3	2
CO2	K2	3	2	2	2	1	3	3	3	3	3	3	3	3	2
CO3	K2	3	2	2	2		3	3	3	3	3	3	3	3	2
CO4	K3	3	3	2	2	2	3	3	3	3	3	3	3	3	3
CO5	K2	3	2	2	2	1	3	3	3	3	3	3	3	3	2
Course	K3	3	3	2	2	2	3	3	3	3	3	3	3	3	3

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; − No Contribution

K, knowledge level from cognitive domain; A, Affective domain; S, Psychomotor domain

	Course code:	Course Title: Honors5: Flavour Science and Technology	Credits = 3		
			L	T	P
	Semester: VIII	Total contact hours: 45	2	1	0
List of Prerequisite courses					
	Basics of Organic, Inorganic, Physical and Analytical Chemistry and Chemistry of Food Constituents, Organic Chemistry, Food Additives & Ingredients; Unit operations in Chemical Engineering, Food Chemistry, Food Processing and Product development Lab				
List of Courses where this course will be Prerequisite					
	Project I, Project II				

Description of relevance of this course in the B. Tech. (Food Engg. & Tech.) Programme

1. To understand the flavours and flavourings used in food systems
2. To understand the science and technology of extraction and synthesis of various flavours and flavourings
3. To understand the generation of flavours and off flavours in processed food systems
4. To understand the science and technology of microencapsulation of flavours, reaction flavours, WOF in foods; flavours for processed foods such as microwaveable foods, aseptically processed and non-thermal treated foods
5. Rational behind application of flavours in different food and allied products

Sr. No.	Course Contents (Topics and subtopics)	Required Hours
1	Understanding of terms like Flavour and Flavouring agents. Attributes of flavour, taste, odour, odour stimulation, basic tastes and the human olfactory system, Flavour enhancers, modifiers, precursors, suppressors, major chemicals and raw materials, solvents.	05
2	Flavours and flavourings- classification of flavours; processes of preparing flavours such as extraction, distillation, fractionation and purification-natural and synthetic sources; microbial production of flavours	05
3	Important chemical reactions involved in converting raw materials to flavour chemicals; Synthetic methods for various functional groups;	06
4	Biogenesis of flavours in various commodity food products (eg. fruits and vegetables, fermented products, bakery products etc), reaction flavours, flavours for processed foods such as microwaveable foods; WOF; off flavours and taints in foods	06
5	Isolation, purification of flavour compounds, re-enforcement of top notes in flavour formulation/foods; basics of blending of flavours and flavourings	05
6	Methods of formulating flavours in liquid, emulsion and solid forms; Flavour encapsulation and stabilization: Principles and techniques of flavour encapsulation, types of encapsulations, factors affecting stabilization of encapsulated flavour and their applications in food industry	06
7	Application in aqueous, oleophilic systems, beverages, bakery products, confectionery products, various commodity products, low-fat, low-sugar, high-protein food products	06
8	Analysis of flavours: Techniques for sensorial evaluation of flavours; psychophysiology of flavours; Instrumental analysis (Absorption Spectroscopy (W/VIS), chromatography, mass spectrometry); legislation of flavours	06
	TOTAL	**45**

List of Text Books / Reference Books	
1	Chemistry and technology of flavor fragrances – D. J. Rowe
2	Perfumery and Flavoring synthetics – Bedaukian
3	Natural food additives, ingredients, and flavourings, D Baines, R Seal, (2012), Woodhead Publishing Series in Food Science, Technology and Nutrition.
4	Fuller, G.W. New Food Product Development: From Concept to Marketplace, 3rd ed, CRC Press, UK; 2011.
5	Unit processes in organic chemical industries – Desikan P.

Course Outcomes (Students will be able to…..)	
CO1	Describe the various flavours and flavourings used in food products (K2)
CO2	Describe the mechanisms of natural and synthetic pathways of flavour generation (K2)
CO3	Describe the techniques of extraction and formulation of flavours and flavourings (K2)
CO4	Describe the forms of use of flavours in different food systems (K2)
CO5	Extrapolate the knowledge gained on flavours and flavourings in food products in food industries (K3)

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)														
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
		K3	K4	K6	K5	K6	K3	K3+S	K3	K3+A	K2+A	K3	K6+A+S	K3	K4
CO1	K2	3	2	1	2	1	3	3	3	3	3	3	3	3	2
CO2	K2	3	2	2	2	1	3	3	3	3	3	3	3	3	2
CO3	K2	3	2	2	2	2	3	3	3	3	3	3	3	3	2
CO4	K3	3	3	2	2	2	3	3	3	3	3	3	3	3	3
CO5	K2	3	2	3	3	2	3	3	3	3	3	3	3	3	2
Course	K3	3	3	2	2	2	3	3	3	3	3	3	3	3	3

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; − No Contribution

K, knowledge level from cognitive domain; A, Affective domain; S, Psychomotor domain