FOOD ENGINEERING AND TECHNOLOGY

Proposed Revised Syllabus

The Bachelor of Technology is now a four year program, after 12th.
The structure consists of subjects common to all branches, and includes basic sciences, engineering and some humanities and management components.

In this document, the structure of the syllabus, divided into 8 semesters, is followed by the detailed syllabus for special subjects, within the Food Engineering and Technology domain.

Syllabus Structure B. Tech. First Year

Semester I									
Code	**Subjects**	**Credits**	**Hrs/Week**			**Marks for various Exams**			
			L	**T**	**P**	**C. A.**	**M.**	**E. S.**	**Total**
CHT1341	Physical Chemistry-I	3	2	1	0	10	15	25	50
CHT1401	Analytical Chemistry	3	2	1	0	10	15	25	50
MAT1101	Applied Mathematics-I	4	3	1	0	20	30	50	100
PYT1101	Applied Physics-I	4	3	1	0	20	30	50	100
CHP1343	Physical and Analytical Chemistry Lab	2	0	0	4	25	-	25	50
GEP1101	Engineering Graphics	4	2	0	6	50	-	50	100
HUP1101	Communication Skills	2	0	0	4	50	-	-	50
	TOTAL:	22	12	4	14	-	-	-	500

Semester II									
Code	**Subjects**	**Credits**	**Hrs/week**			**Marks for various Exams**			
			L	**T**	**P**	**C. A.**	**M.S.**	**E. S.**	**Total**
CHT1342	Physical Chemistry-II	3	2	1	0	10	15	25	50
CHT1132	Organic Chemistry	4	3	1	0	20	30	50	100
CET1507	Process Calculations	4	3	1	0	20	30	50	100
MAT1102	Applied Mathematics-II	4	3	1	0	20	30	50	100
PYT1103	Applied Physics-II	3	2	1	0	10	15	25	50
PYP1101	Physics Laboratory	2	0	0	4	25	-	25	50
CHP1132	Organic Chemistry Laboratory	2	0	0	4	25	-	25	50
	Total	22	13	5	8	-	-	-	500

Syllabus Structure B. Tech. Second Year

Semester III									
Code	**Subjects**	**Credits**	**Hrs /week**			**Marks for various Exams**			
			L	**T**	**P**	**C. A.**	**M.S.**	**E.S.**	**Total**
FDT1011	Spl 1: Chemistry of Food Constituents	4	3	1	0	20	30	50	100
FDT1015	Spl 2: Nutrition	4	3	1	0	20	30	50	100
FDT1030	Spl 3 Introduction to Food Systems	3	2	1	0	10	15	25	50
BST1102	Biochemistry	4	3	1	0	20	30	50	100
BST1101	Microbiology	4	3	1	0	20	30	50	100
FDP1014	Pr 1: Biochemistry	2	0	0	4	25	-	25	50
FDP1013	Pr 2: Microbiology	2	0	0	4	25	-	25	50
	Total	23	14	5	8	-	-	-	550

Semester IV									
Code	**Subjects**	**Credits**	**Hrs/week**			**Marks for various Exams**			
			L	**T**	**P**	**C. A.**	**M.S.**	**E. S.**	**Total**
GET1116	Engg. Mechanics & Strength of Materials	4	3	1	0	20	30	50	100
FDT1014	Spl 4: Food Microbiology	3	2	1	0	10	15	25	50
CET1105	Transport Phenomena	4	3	1	0	20	30	50	100
GET1105	Basic Electrical Engg and Electronics	3	2	1	0	10	15	25	50
FDT1021	Spl 5: Principles of Food Preservation	4	3	1	0	20	30	50	100
GEP1106	Electrical Engg and Electronics Lab	2	0	0	4	25	-	25	50
MAP1201	Computer Applications Lab	2	0	0	4	25	-	25	50
	Total	22	13	5	8	-	-	-	500

Syllabus Structure B. Tech. Third Year

Semester V									
Code	**Subjects**	**Credits**	**Hrs /week**			**Marks for various Exams**			
			L	**T**	**P**	**C. A.**	**M.S.**	**E. S.**	**Total**
CET1401	Chemical Engineering Operations	3	2	1	0	10	15	25	50
CET1201	Chemical Reaction Engineering	3	2	1	0	10	15	25	50
FDT1013	Spl 6: Food Chemistry	4	3	1	0	20	30	50	100
FDT1012	Spl 7: Food Additives and Ingredients	4	3	1	0	20	30	50	100
FDT1022	Spl 8: Food Engineering	4	3	1	0	20	30	50	100
FDP1011	Pr 3 : Technical Analysis	4	0	0	8	50	-	50	100
FDP1015	Pr 4 : Food Chemistry	2	0	0	4	25	-	25	50
	Total	24	13	5	12	-	-	-	550

Semester VI									
Code	**Subjects**	**Credits**	**Hrs/week**			**Marks for various Exams**			
			L	**T**	**P**	**C. A.**	**M.S.**	**E. S.**	**Total**
FDT1027	Spl 9 : Food Process Engineering	4	3	1	0	20	30	50	100
FDT1017	Spl 10: Technology of Fruits, Vegetables and Tubers	3	2	1	0	10	15	25	50
HUT 1103	Industrial Psychology and Human Resource	3	2	1	0	10	15	25	50
HUT1104	Industrial Management I	3	2	1	0	10	15	25	50
FDT1026	Spl 9: Elective-I	3	2	1	0	10	15	25	50
FDP1019	Pr 5: Food Processing and Product Development	4	0	0	8	50	-	50	100
FDP1018	Pr 6: Food Analysis-I	2	0	0	4	25	-	25	50
FDP1021	Pr 7: Food Analysis-II	2	0	0	4	25	-	25	50
	Total	24	11	5	16	-	-	-	500

Syllabus Structure B. Tech. Final Year

Semester VII (will be of 10 weeks duration)									
Code	**Subjects**	**Credits**	**Hrs/week**			**Marks for various Exams**			
			L	**T**	**P**	**C. A.**	**M.S.**	**E. S.**	**Total**
CET1703	Chemical Process Control	3	2	1	0	10	15	25	50
FDT1025	Spl 11: Technology of Dairy, Animal and Plantation Products	4	3	1	0	20	30	50	100
FDT1023	Spl 12: Technology of Cereals, Legumes and Oilseeds	3	2	1	0	10	15	25	50
FDT1051	Spl 12: Elective – II	3	2	1	0	10	15	25	50
HUT1105	Industrial Management II	3	2	1	0	10	15	25	50
CEP1714	Chem. Eng. Laboratory	2	0	0	4	25	-	25	50
FDP1022	Seminar	2	0	0	4	-	-	50	50
FDP1024	Project I	4	0	0	8	-	-	100	100
FDP1023	In plant Training	2						50	50
	Total	24	11	5	16	-	-	-	550

Semester VIII									
Code	**Subjects**	**Credits**	**Hrs /week**			**Marks for various Exams**			
			L	**T**	**P**	**C. A.**	**M.S.**	**E. S.**	**Total**
CET1504	Chemical Project Engineering and Economics	3	2	1	0	10	15	25	50
FDT1028	Spl 13: Food Safety, Quality and Regulations	3	2	1	0	10	15	25	50
FDT1019	Spl 14: Food Packaging	3	2	1	0	10	15	25	50
FDT1052	Spl 15: Principles of Food Analysis	4	3	1	0	20	30	50	100
FDT1053	Spl 16: Elective III	3	2	1	0	10	15	25	50
FDP1025	Project II	4	0	0	8	-	-	100	100
FDP1023	Pr 8: Food Processing and Engineering	4	0	0	8	50	-	50	100
	Total	24	11	5	16	-	-	-	500

FDT1026 Elective – I: Food Biotechnology
FDT1051 Elective – II: Nutraceuticals and Functional Foods
FDT1053 Elective – III: Waste Management in Food Processing

Semester I

	Course Code: CHT1341	**Course Title: Physical Chemistry I**	**Credits = 3**		
			L	**T**	**P**
	Semester: I	**Total contact hours: 45**	**2**	**1**	**0**
List of Prerequisite Courses					
	HSC chemistry				
List of Courses where this course will be prerequisite					
Description of relevance of this course in the B. Tech programme					
The course will enable the students to understand chemical and phase equlibria , direction of spontaneity and calculation of equilibrium compositions, effect of experimental parameters on phase and chemical equlibria					
	Course Contents (Topics and subtopics)		**Reqd. hours**		
1	**Introduction-** Thermodynamic systems , work , heat and energy, state and path functions		02		
2	**First law of thermodynamics** – Enthalpy and heat capacities, application of first law to gases, standard states		02		
3	**Second and third laws of thermodynamics -**. Statements and applications, entropy and calculation of entropy changes, absolute entropies ,verification of third law, molecular basis of thermodynamics		03		
4	**Spontaneous process and equilibrium:** Criteria for spontaneous processes, equilibrium states, , Maxwell relations , Gibbs and Helmholtz free energy and their temperature relations, free energy and equilibrium constant , calculation of free energy changes , free energy and entropy of mixing, thermochemistry- Hesses law, Ellingham diagrams		03		
5	**Multicomponent systems -**. Partial molar quantities and chemical potential, Gibbs Duhem equation, thermodynamics of solutions, ideal and non ideal solutions Fugacity, activity and activity coefficients, thermodynamic properties of electrolytes in solutions		02		
6	**Phase equlibria -**. Gibbs Phase rule, equilibrium between phases Gibbs enegy and phase transitions, classification of phase transitions, , one component systems – phase diagrams, Clausius- Clapeyron equation, Henry's law and Raoult's law, solubility and extraction		05		
7	**Two and three component** systems – liquid- liquid and liquid vapour systems- pressure -composition and temperature- composition phase diagrams, solid- liquid phase diagrams , three component phase diagrams, colligative properties		05		
8	**Electrochemistry –** thermodynamics of electrochemical systems- electrochemical cells, determination of electrode potentials, types of electrochemical cells, activity and activity coefficients, theory of dissociation of electrolytes, ionic equlibria		08		
List of Text Books/ Reference Books					
1	Physical chemistry – Robert G Mortimer – Elsevier publications				
2	Basic chemical thermodynamics- E. Brian smith – Oxford University press				
3	Introduction to Chemical Engineering Thermodynamics- J.M.smith , Van Ness				
4	Chemical nad Engineering thermodynamics – Milo Koretsky, Wiley publications				
5	Phase rule and its applications-Alexander Findlay, Dover publications				
Course Outcomes (students will be able to….)					
1	Appreciate the significance of thermodynamics in chemical, electrochemical and physical processes				
2	Problem solving skills				
3	significance of equilibrium and spontaneity , phases in equilibrium				

	Course Code: CHT1401	**Course Title: Analytical chemistry**	**Credits = 3**		
			L	**T**	**P**
	Semester: I	**Total contact hours:45**	**2**	**1**	**0**
List of Prerequisite Courses					
	HSC Chemistry				
List of Courses where this course will be prerequisite					
	Other Chemistry Courses, Physical and Analytical Chemistry Laboratory				
Description of relevance of this course in the B. Tech programme					
To introduce the principles and applications of analytical chemistry					
	Course Contents (Topics and subtopics)		**Reqd. hours**		
1	**Introduction** – Analytical procedures- hazards and handling, treatment of waste, good laboratory practices		04		
2	**Aspects of analysis-** errors – systematic and random errors, statistical treatment of experimental results, least square method, correlation coefficients Sampling – basics and procedures, preparation of laboratory samples		05		
3	**Applied analysis –** analytical procedures in environmental monitoring, water, soil and air quality, BOD and COD determinations,		05		
4	**Instrumental methods –** Criteria for selecting instrumental methods - precision, sensitivity, selectivity, and detection limit, transducers, sensors and detectors, signals and noise		04		
5	**Molecular spectral methods –** Uv-visible, molecular fluorescence, IR and FT-IR Mass spectroscopy		08		
6	**Atomic spectral methods –** atomic emission and absorption methods		03		
7	**Thermal methods –** TGA, DTA and DSC		04		
8	**Chromatographic and other separation methods –** GC, HPLC , ion exchange and size exclusion chromatography , super critical fluid extraction		12		
List of Text Books/ Reference Books					
1	D.A. Skoog, D.M. West, F.J. Holler, S.R. Crouch, Fundamentals of Analytical Chemistry				
2	J.G. Dick, Analytical Chemistry, R.E. Krieger Pub				
3	Environmental Chemistry, A. K. De, Wiley				
4	Chromatography				
5	Thermal Methods				
Course Outcomes (students will be able to…..)					
1	List different analytical techniques				
2	Describe the basic principles of different analytical techniques				
3	Compute the mean from a set of measurements				
4	Suggest possible analytical techniques for identification and quantification of chemicals				

	Course Code: MAT1101	Course Title: Applied Mathematics I	Credits = 4		
			L	T	P
	Semester: I	Total contact hours: 60	3	1	0

	List of Prerequisite Courses	
	HSC Standard Mathematics	

	List of Courses where this course will be prerequisite	
	This is a basic Mathematics course. This knowledge will be required in almost all subjects later on	

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

This is a basic Mathematics course. This knowledge will be required in almost all subjects later on. This knowledge is also required for solving various mathematical equations that need to be solved in several chemical engineering courses such as MEBC, momentum transfer, reaction engineering, separation processes, thermodynamics, etc.

	Course Contents (Topics and subtopics)	Reqd. Hours
1	Solutions of system of linear equations (Gauss-elimination, LU-decomposition etc.) Numerical methods for solving non-linear algebraic / transcendental etc. Newton's method, Secant, Regula Falsi, Jacobi Numerical solution set of linear algebraic equations: Jacobi, Gauss Siedel, and under / over relaxation methods	10
2	Interpolation and extrapolation for equal and non-equal spaced data (Newtons Forward, Newtons backward and Lagrange) Numerical integration (trapezoidal rule, Simpson's Rule)	10
3	Probability of Statistics: Functions of random variables, probability distribution functions, expectation, moments Statistical hypothesis tests, t-tests for one and two samples, F-test, χ^2-test Statistical Methods for Data Fitting: Linear, multi-linear, non-linear regression	10
4	Differential Calculus: Higher order differentiation and Leibnitz Rule for the derivative, Taylor's and Maclaurin's theorems, Maxima/Minima, convexity of functions, Radius of curvature;	10
5	Functions of two or more variables, Limit and continuity, Partial differentiation, Total derivatives, Taylor's theorem for multivariable functions and its application to error calculations, Maxima/Minima, Jacobian.	10
6	Integral Calculus: Beta and Gamma functions, Differentiation under the integral sign, surface integrals, volume integrals	10

	List of Text Books/ Reference Books	
1	Advanced Engineering Mathematics, Erwin Kreyszig, John-Wiely.	
2	Advanced Engineering Mathematics S. R. K. Iyengar, R. K. Jain, Narosa	
3	Introductory Methods Of Numerical Analysis, S. S. Sastry, PHI.	
4	A First Course in Probability, Sheldon Ross, Pearson Prentice Hall	
5	Probability and Statistics in Engineering , W.W. Hines, D. C. Montgomery, D.M. Goldsman, John-Wiely	

	Course Outcomes (students will be able to…..)	
1	Students should be able to solve system of linear algebraic equations	
2	Students should be able to do numerical integrations of functions.	
3	Students should be able to fit relationship between two data sets using linear, non-linear regression.	
4	Students should be able to calculate maxima/minima and functions.	

	Course Code: PYT1101	Course Title: Applied Physics I	Credits = 4		
			L	T	P
	Semester: I	Total contact hours: 60	3	1	0
	List of Prerequisite Courses				
	XIIth Standard Physics				
	List of Courses where this course will be prerequisite				
	Applied Physics – II, Physics Laboratory, Chemical Engineering Thermodynamics, Momentum and Mass Transfer, Heat Transfer, Material Science and Engineering, Structural Mechanics, etc.				
	Description of relevance of this course in the B. Tech. Program				
This is a basic physics course. This knowledge will be required in almost all subjects later on. This knowledge is also required for understanding various chemical engineering concepts that will be introduced in courses such as momentum transfer, reaction engineering, separation processes, thermodynamics, heat transfer, etc.					
	Course Contents (Topics and subtopics)		**Reqd. Hours**		
1	**Solid State Physics** Crystal structure of solids: unit cell, space lattices and Bravais lattice, Miller indices, directions and crystallographic planes, Cubic crystals: SSC, BCC, FCC, Hexagonal crystals: HCP, atomic radius, packing fraction, Bragg's law of x-ray diffraction, determination of crystal structure using Bragg spectrometer Semiconductor Physics: Formation of energy bands in solids, concept of Fermi level, classification of solids: conductor, semiconductor and insulator, intrinsic and extrinsic semiconductors, effect of doping, mobility of charge carriers, conductivity, Hall effect.		15		
2	**Fluid Mechanics** Basic concepts of density and pressure in a fluid, ideal and real fluids, Pascal's law, absolute pressure and pressure gauges, basic concepts of surface tension and buoyancy, fluid flow, equation of continuity, Bernoulli's equation, streamlined and turbulent flow, concept of viscosity, Newton's law of viscosity, brief introduction to non-Newtonian behaviour.		15		
3	**Optics and Fibre Optics** Diffraction: Introduction to interference and example; concept of diffraction, Fraunhofer and Fresnel diffraction, Fraunhofer diffraction at single slit, double slit, and multiple slits; diffraction grating, characteristics of diffraction grating and its applications. Polarisation: Introduction, polarisation by reflection, polarisation by double refraction, scattering of light, circular and elliptical polarisation, optical activity. Fibre Optics: Introduction, optical fibre as a dielectric wave guide: total internal reflection, numerical aperture and various fibre parameters, losses associated with optical fibres, step and graded index fibres, application of optical fibres.		10		
4	**Lasers** Introduction to interaction of radiation with matter, principles and working of laser: population inversion, pumping, various modes, threshold population inversion, types of laser: solid state, semiconductor, gas; application of lasers.		10		
5	**Ultrasound** Generation of ultrasound: mechanical, electromechanical transducers; propagation of ultrasound, attenuation, velocity of ultrasound and parameters affecting it, measurement of velocity, cavitation, applications of ultrasound.		10		
	List of Text Books/ Reference Books				
	Physics:Vols. I and II – D. Halliday and R. Resnick, Wiley Eastern.				
	Lectures on Physics: Vols. I, II and III – R. P. Feynman, R. B. Leighton and M. Sands, Narosa.				
	Concepts of Modern Physics – A. Beiser, McGraw-Hill.				
	Introduction to Modern Optics – G. R. Fowles , Dover Publications.				
	A Course of Experiments with LASERs – R. S. Sirohi, Wiley Eastern.				
	Optical Fibre Communication – G. Keiser, McGraw-Hill.				
	Optoelectronics – J. Wilson and J. F. B. Hawkes, 2nd ed, Prentice-Hall India.				
	Ultrasonics: Methods and Applications – J. Blitz, Butterworth.				
	Applied Sonochemistry – T. J. Mason and J. P. Lorimer, Wiley VCH.				
	Course Outcomes (students will be able to…..)				
1	Students will be able to state Bragg's Law				
2	Student will be able to apply Bernoulli equation in simple pipe flows				
3	Students will be introduced to the principles of lasers, types of lasers and applications.				
4	Students should be able to calculate resolving power of instruments.				
5	Students should be able to describe principles of optical fibre communication.				

6	Application of acaustic cavitation of Chemical Engineering Processes.				
	Course Code: CHP1343	**Course Title: Physical and Analytical Chemistry Laboratory**	**Credits = 2**		
			L	**T**	**P**
	Semester: I	**Total contact hours: 60**	**0**	**0**	**4**
List of Prerequisite Courses					
	H.S.C. Chemistry laboratory courses				
List of Courses where this course will be prerequisite					
Description of relevance of this course in the B. Tech Programme					
Students will become familiar with laboratory experimental skills , plan and interpretation of experimental tasks, understand the relevance of principles of physical chemistry in chemical processes					
	Course Contents (Topics and subtopics)		**Reqd. hours**		
1	Experiments based on chemical reaction kinetics, phase equlibria and electrolyte systems, surface and interfacial phenomena such as surface tension and CMC Measurements.		4h per session		
List of Text Books/ Reference Books					
1	Practical physical Chemistry – B.Viswanthan and P.S. Raghavan				
2	Practical physical Chemistry- Alexander Findlay				
Course Outcomes (students will be able to…..)					
1	Identify and determine physicochemical parameters using simple tools				
2	Interpretation of data and drawing scientific conclusions				

	Course Code: GEP1101	**Course Title: Engineering Graphics**	**Credits = 4**		
			L	**T**	**P**
	Semester: I	**Total contact hours: 90**	**2**	**0**	**6**
List of Prerequisite Courses					
	Basic Geometry				
List of Courses where this course will be prerequisite					
	Engineering Graphics – II, Equipment Design and Drawing-I, Equipment Design and Drawing-II, Home Paper – II, Structural Mechanics,				
Description of relevance of this course in the B..Tech. Program					
A student of Chemical Engineering is required to know the various processes and also the equipment used to carry out the processes. Some of the elementary processes like filtration, size reduction, evaporation, condensation, crystallization etc., are very common to all the branches of technology. These and many other processes require machines and equipments. One should be familiar with the design, manufacturing, working, maintenance of such machines and equipments. The subject of "drawing" is a medium through which, one can learn all such matter, because the "drawings" are used to represent objects and processes on the paper. Through the drawings, a lot of accurate information is conveyed which will not be practicable through a spoken word or a written text. Drawing is a language used by engineers and technologists. This course is required in many subjects as well as later on in the professional career.					
	Course Contents (Topics and subtopics)		**Reqd. hours**		
1	Orthographic projections				
2	Sectional views				
3	Isometric projections				
4	Missing views (or interpretation of views.)				
5	Projection of solids				
6	Sections of solids				
7	Development of surface				
8	Interpenetration of solids				
List of Text Books/ Reference Books					
	1.Engineering Drawing by N.D.Bhat				
	2. Engineering Drawing by N.H.Dubey				
Course Outcomes (students will be able to…..)					
1	Read Drawing				
2	Can understand different views.				

	Course Code: HUP1101	**Course Title: Communication Skills**	**Credits = 2**		
			L	**T**	**P**
	Semester: I	**Total contact hours: 60**	**0**	**0**	**4**
List of Prerequisite Courses					
	XIIth Standard English				
List of Courses where this course will be prerequisite					
	All				
Description of relevance of this course in the B.Tech. Program					
This is an important course for the effective functioning of an Engineer. Communication skills are required in all courses					
	Course Contents (Topics and subtopics)		**Reqd. hours**		
1	Development of communication skills in oral as well as writing.				
2	The writing skills should emphasize technical report writing, scientific paper writing, letter drafting, etc.				
3	The oral communication skills should emphasize presentation skills.				
4	Use of audio-visual facilities like powerpoint, LCD. for making effective oral presentation.				
5	Group Discussions				
List of Text Books/ Reference Books					
	Elements of style – Strunk and white				
Course Outcomes (students will be able to…..)					
1	Students should be able to write grammar error free technical reports in MS Words or equivalent software.				
2	Students should be able to make power point slides in MS PowerPoint or equivalent software.				

Semester II

	Course Code:CHT1342	**Course Title: Physical chemistry II**	**Credits = 3**		
			L	**T**	**P**
	Semester: II	**Total contact hours: 45**	**2**	**1**	**0**
List of Prerequisite Courses					
	Physical Chemistry –I, HSC Chemistry				
List of Courses where this course will be prerequisite					
Description of relevance of this course in the B. Tech programme					
Relevance of reaction rates and parameters affecting the same , concept of interfaces and surfaces and the importance of disperse systems					
	Course Contents (Topics and subtopics)		**Reqd. hours**		
1	**Chemical kinetics –** Introduction, concept of reaction rates and order, experimental methods in kinetic studies, differential and integral methods to formulate rate equations of zero, first and second order reactions		02		
2	Experimental methods of kinetic studies		01		
2	**Complex reactions**- parallel, consecutive and reversible		02		
3	**Kinetics and reaction mechanism**- steady state and rate determining step Mechanism of thermal photochemical chain reactions, polymerization reactions		02		
4	**Surface reactions –** Adsorption, kinetics of surface reactions- Hishelwood and Rideal models of surface reactions		02		
	Theories of reaction rates and temperature effects- collision theory and TST Theory of unimolecular reactions		03		
5	**Kinetics of reactions in solutions-** solvent effects		02		
6	**Fast reactions –** experimental techniques		01		
7	**Surface and interfacial Chemistry –** introduction, surface tension and surface free energy, methods of determining surface and interfacial tensions		02		
8	**Thermodynamics of surfaces –** surface excess, Gibbs adsorption equation, curved surfaces- bubbles, droplets and foams, Kelvin, Young Laplace and Thomson equations, homogeneous nucleation		03		
9	**Liquid- liquid and solid liquid interfaces** – contact angle, wetting and spreading, adhesion and cohesion, contact angle measurements and hysterisis		03		
10	**Surfactants:** Types, adsorption at surfaces and interfaces, surfactant aggregates, factors affecting aggregation phenomena, applications of surfactants and mixed surfactant systems		03		
11	**Disperse systems -** Emulsions microemulsions and foams -. Thermodynamics and stability, HLB values , colloids - preparation, stability, characterization, surface charges and electrical double layer		04		
List of Text Books/ Reference Books					
1	Chemical Kinetics – K.J.Laidler				
2	Principles of Chemical Kinetics – James E House				
2	Surfaces interfaces and colloids- Drew Myers- Wiley VCH				
3	Colloids and interfaces with polymers and surfactants - Jim Goodwin, wiley				
4	Surfactants and interfacial phenomena- Milton J Rosen – Wiley Interscience				
5	Industrial utilization of surfactants principles and applications – M.J. Rosen and M Dahanayake, AOCS Press				

6	Principles of colloids and surface Chemistry – Paul C Hemenz and Raj Rajagopalan- Marcel Dekker	
7	Foundations of Colloid science – Robert J Hunter – Oxford university Press	
Course Outcomes (students will be able to…..)		
1	Understand the importance of chemical kinetics in process design	
2	Importance and application of surface active agents	
3	Understand the stability and importance of disperse systems	

	Course Code: CHT1132	**Course Title: Organic Chemistry**	**Credits = 4**		
			L	**T**	**P**
	Semester: II	**Total contact hours: 60**	**3**	**1**	**0**
List of Prerequisite Courses					
	Organic Chemistry –I, HSC Chemistry				
	Course Contents		**Reqd. Hrs.**		
1	**Mechanisms of organic reactions:** Types of Organic Reaction, Reactive intermediates; their generation, structure, stability and general reactions. Acidity and basicity. Mechanisms of simple organic transformations.		12		
2	**Stereochemistry:** Stereodescriptors, Elements of symmetry, stereochemistry of compounds containing one and two carbon atoms. Racemates and their resolution, conformation of cyclic and acyclic systems, Idea of asymmetric synthesis.		5		
3	**Aromaticity:** Huckel's theory of Aromaticity. Aromaticity of simple benzenoid and non benzenoid species.		4		
4	**Aromatic compounds:** Sources. BTX, Aromatic hydrocarbons. General mechanisms of aromatic electrophilic and nucleophilic substitution reactions. Orientation of electrophile in arenes.		6		
5	**Friedel-Crafts and related reactions:** Friedel-Crafts alkylation and acylation reactions. Aromatic formylation reactions. Aromatic carboxylation.		5		
6	**Chemistry of enolates:** Mechanism of aldol and related reactions		5		
7	**Chemistry of ethers, epoxides, sulphonic acids.**		4		
8	**Amines:** Methods of preparation, chemistry of aromatic diazonium salts		4		
	Reference Books				
1	Organic Chemistry, J. McMurry, Brooks/Cole				
2	Organic Chemistry, T.W.G. Solomons, C.B. Fryhle, John Wiley and Sons Inc.,				
3	Organic Chemistry, L.G. Wade Jr, Pearson Education				
4	StereoChemistry of Carbon compounds, E.L. Eliel, Mcgraw-Hill				
5	Organic Chemistry, Paula Y. Bruice, Pearson Education				

	Course Code: CET 1507	Course Title: Process Calculations	Credits = 4		
			L	T	P
	Semester: II	Total contact hours: 60	2	2	0
List of Prerequisite Courses					
	XIIth Standard Mathematics, Chemistry, Physics				
List of Courses where this course will be prerequisite					
	This is a basic Course. This knowledge will be required in ALL subjects later on.				
Description of relevance of this course in the B. Tech. Program					
This is a basic course. This knowledge will be required in almost all subjects later on. This subject introduces the various concepts used in Chemical Engineering to the students. The knowledge of this subject is required for in ALL B. Tech. courses, etc. It can be applied in various situations such as process selection, economics, sustainability, environmental impacts					
	Course Contents (Topics and subtopics)		**Reqd. Hours**		
1	Introduction to Chemical process calculations, overview of single stage and multistage operations, concept of process flow sheets		2		
2	Revision of Units and Dimensions, Dimensional analysis of equations, Mathematical techniques		4		
3	Mole concept, composition relationship, types of flow rates		2		
4	Material balance in non-reacting systems: application to single and multistage processes		8		
5	Stoichiometry		2		
6	Material balance in reacting systems: application to single and multistage processes		6		
7	Behaviour of gases and vapors		4		
8	Introduction to psychrometry, humidity and air-conditioning calculations.		6		
9	Calculation of X-Y diagrams based on Raoult's law.		2		
10	Applications of material balances to Multiphase systems		6		
11	Basic concepts of types of Energy and calculations		2		
12	Application of Energy balance to non-reacting systems		6		
13	Application of Energy balance to reacting systems		6		
14	Fuels and combustion.		4		
List of Text Books/ Reference Books					
	Elementary Principles of Chemical Processes, Felder, R.M. and Rousseau, R.W.				
	Chemical Process Principles, Hougen O.A., Watson K. M.				
	Basic Principles and Calculations in Chemical Engineering, Himmelblau,				
	Stoichiometry, Bhatt B.I. and Vora S.M.				
Course Outcomes (students will be able to…..)					
1	Students will be able to convert units of simple quantities from one set of units to another set of units				
2	Students will be able to calculate quantities and /or compositions, energy usages, etc. in various processes and process equipment such as reactors, filters, dryers, etc.				

	Course Code: MAT1102	Course Title: Applied Mathematics II	Credits = 4		
			L	T	P
	Semester: II	Total contact hours: 60	3	1	0
List of Prerequisite Courses					
	XIIth Standard Mathematics, Applied Mathematics - I				
List of Courses where this course will be prerequisite					
	This is a basic Mathematics course. This knowledge will be required in almost all subjects later on				
Description of relevance of this course in the B. Tech. Program					
This is a basic Mathematics course. This knowledge will be required in almost all subjects later on. This knowledge is also required for solving various mathematical equations that need to be solved in several chemical engineering courses such as MEBC, momentum transfer, reaction engineering, separation processes, thermodynamics, etc.					
	Course Contents (Topics and subtopics)		**Reqd. Hours**		

1	Differential Equations: Solution of Higher order ODE with constant and variable coefficients and its applications to boundary and initial value problems, Series solution of differential equations, Bessel functions, Legendre Polynomials, Error function. Fourier series, Laplace Transforms and their application in differential equation (both ODEs PDEs). Partial Differential Equations, Classification of higher order PDEs, Solution of parabolic equation using separation of variables	20
2	Numerical methods for solution of initial values problems using RK method, Euler's method and Taylor series method.	20
3	Finite difference methods: Forward difference, backward difference, central differences, application of finite difference methods to ODE Boundary value problem.	20
List of Text Books/ Reference Books		
1	Advanced Engineering Mathematics, Erwin Kreyszig, John-Wiely	
2	Advanced Engineering Mathematics S. R. K. Iyengar, R. K. Jain, Narosa.	
3	Elements of *Applied Mathematics*. Volume 1, P.N.*Wartikar* and J.N.*Wartikar*, Pune Vidyarthi Graha	
4	Introductory Methods Of Numerical Analysis, S. S. Sastry, PHI.	
5	Numerical Solution of differential Equations, M. K. Jain, Wiley Eastern.	
Course Outcomes (students will be able to…..)		
1	Students should be able to solve simple first and second order ODE by Analytical methods	
2	Students will be able to solve simple first and second order differential equations numerically	
3	Students will be able to solve simple parabolic partial differential equations numerically	

	Course Code: PYT 1103	**Course Title: Applied Physics II**	**Credits = 3**		
			L	**T**	**P**
	Semester: II	**Total contact hours: 45**	**2**	**1**	**0**
List of Prerequisite Courses					
	XIIth Standard Physics, Applied Physics – I, Physics Laboratory,				
List of Courses where this course will be prerequisite					
	This is a basic physics course. This knowledge will be required in almost all subjects later on				
Description of relevance of this course in the B. Chem. Engg. Program					
This is a basic physics course. This knowledge will be required in almost all subjects later on. This knowledge is also required for understanding various chemical engineering concepts that will be introduced in courses such as momentum transfer, reaction engineering, separation processes, thermodynamics, heat transfer, etc.					
	Course Contents (Topics and subtopics)		**Reqd. Hours**		
1	**Quantum Mechanics** Introduction to quantum physics, black body radiation, explanation using the photon concept, photoelectric effect, Compton effect, de Broglie hypothesis, wave-particle duality, Born's interpretation of the wave function, verification of matter waves, uncertainty principle, Schrodinger wave equation, particle in box, quantum harmonic oscillator, hydrogen atom (no detailed derivation)		25		
2	**Dielectric and Magnetic Properties of Materials** Introduction to the 'del' operator and vector calculus, revision of the laws of electrostatics, electric current and the continuity equation, revision of the laws of magnetism. Polarisation, permeability and dielectric constant, polar and non-polar dielectrics, internal fields in a solid, Clausius-Mossotti equation, applications of dielectrics. Magnetisation, permeability and susceptibility, classification of magnetic materials, ferromagnetism, magnetic domains and hysteresis, applications.		20		
List of Text Books/ Reference Books					
	Physics:Vols. I and II – D. Halliday and R. Resnick, Wiley Eastern.				
	Lectures on Physics: Vols. I, II and III – R. P. Feynman, R. B. Leighton and M. Sands, Narosa.				
	Concepts of Modern Physics – A. Beiser, McGraw-Hill.				
	Solid State Physics – A. J. Dekker, 1957, MacMillan India.				
	Perspectives of Modern Physics – A. Beiser, 1969, McGraw-Hill.				
Course Outcomes (students will be able to…..)					
1	Students will be able to do simple quantum mechanics calculations				
2	Students will be able to define various terms related to properties of materials such as, permeability, polarization, etc.				
3	Students will be able to state some of the basic laws related to quantum mechanics as well as magnetic and dielectric properties of materials				

	Course Code: PYP1101	**Course Title: Physics Laboratory**	**Credits = 2**		
			L	**T**	**P**
	Semester: II	**Total contact hours: 60**	**0**	**0**	**4**
List of Prerequisite Courses					
	Applied Physics - I				
List of Courses where this course will be prerequisite					
	This is a basic physics Laboratory course. This knowledge will be required in almost all subjects later on.				
Description of relevance of this course in the B.Tech. Program					
This is a basic physics course. Students will be able to learn various concepts by doing experiments on different topics. This knowledge will be required in almost all subjects later on. This knowledge is also required for understanding various chemical engineering concepts that will be introduced in courses such as momentum transfer, reaction engineering, separation processes, thermodynamics, heat transfer, etc.					
	Course Contents (Topics and subtopics)		**Reqd. Hours**		
1	Viscosity				
2	Thermistor				
3	Thermal conductivity				
4	Ultrasonic interferometer				
5	Photoelectric effect				
6	Hall effect				
7	Newton's rings				
8	Dispersive power of prism				
9	Laser diffraction				
10	Resolving power of grating				
List of Text Books/ Reference Books					
1	Physics:Vols. I and II – D. Halliday and R. Resnick, Wiley Eastern.				
2	Lectures on Physics: Vols. I, II and III – R. P. Feynman, R. B. Leighton and M. Sands, Narosa.				
3	Concepts of Modern Physics – A. Beiser, McGraw-Hill.				
4	Introduction to Modern Optics – G. R. Fowles , Dover Publications.				
5	A Course of Experiments with LASERs – R. S. Sirohi, Wiley Eastern.				
6	Optical Fibre Communication – G. Keiser, McGraw-Hill.				
7	Optoelectronics – J. Wilson and J. F. B. Hawkes, 2nd ed, Prentice-Hall India.				
8	Ultrasonics: Methods and Applications – J. Blitz, Butterworth.				
9	Applied Sonochemistry – T. J. Mason and J. P. Lorimer, Wiley VCH.				
Course Outcomes (students will be able to…..)					
1	Students will be able to state various laws which they have studied through experiments				
2	Student will be able to measure transport properties like viscosity, conductivity, etc.				
3	Students will be able to state application of acoustic cavitation				

CHP1132 Organic Chemistry Laboratory

Synthesis of simple organic compounds to demonstrate various unit processes. Separation and purification of binary mixtures by physical and chemical methods. Purification of organic compounds.

SEMESTER III

	Course Code: : FDT 1011	**Course Title: Chemistry of Food Constituents**		**Credits = 4**		
				L	**T**	**P**
	Semester: III	**Total contact hours: 60**		**3**	**1**	**0**

List of Prerequisite Courses

Basics of organic and inorganic Chemistry, Physical chemistry, Analytical chemistry,

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 Engineering and Technology

Course objectives

1. To understand basic physico-chemical properties and chemical structures of food components
2. To understand the importance and mechanisms of the reactions of food components taking place during food processing,
3. To understand the significance and mechanisms of the reactions of food components taking place storage and spoilage
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)
6. To apply course concepts in solving problems related to food constituents

	Course contents (topics/subtopics)	**Related CO**	**Required hours (60)**
1	An introduction to food resources and its general composition. Water in food systems – concept of free and bound water and its impact on food processing and storage	**1, 4**	**02**
2a	Carbohydrates- classification, structure; properties. Chemical reactions such as caramelization, Maillard reaction, and dehydration; identification and estimations; Sucrose – manufacture from sugar cane and sugar beet; starches – isolation from varied sources; amylose/amylopectin, size/shape, gelatinization, gelation, retrogradation, pasting behaviour, functional properties, modification; Commercially important products – glucose, glucose syrups, high fructose corn syrups, maltodextrins and corn syrup solids	**1, 2, 3, 4, 5, 6**	**10**
2b	Glycosides in nature; pectins – structure, gelling behaviour of HMP vs. LMP, sources- manufacture and applications; Cellulose and other components of dietary fibre, hydrocolloids, mucopolysaccharides; chitin and chitosan – sources, structure, manufacture and applications; animal polysaccharides	**1, 2, 3, 4, 5, 6**	**04**
3a	Proteins- chemistry of amino acids and their properties (isoelectric pH, solubility profile); Peptides; classification of proteins; structure (primary, secondary, tertiary and quaternary); Denaturation of proteins; estimation of proteins in foods; purification methods	**1, 2, 3, 4, 5, 6**	**09**
3b	Isolation of food proteins (soya, fish, whey); Functional properties of proteins; Maillard browning; concept of modified proteins	**1, 2, 3, 4, 5, 6**	**05**
4a	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	**1, 2, 3, 4, 5, 6**	**07**

4b	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,	**1, 2, 3, 4, 5, 6**	**09**
5	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; methods of assay; processing stability in foods of all the vitamins	**1, 2, 3, 4, 5, 6**	**12**
6	Basic concept of taste, colour, flavour and texture, anti-nutritional constituents in foods	**1, 5, 6**	**02**

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. Food Chemistry- Aurand L.W and Woods A.E, Avi Publishing Company, Inc, Westport, CT (1973).
4. Sugar Chemistry- Shallenberger, R. S. and Birch, G. G. AVI Publishing Co., Inc.
5. Food Chemistry. Meyer. Cbs Publisher. (2004)

Course Outcomes (students will be able to ...)	
1	Describe the various constituents present in foods and their roles therein
2	Describe the mechanisms and significance of physicochemical reactions involved in food processing and subsequent storage
3	Describe the mechanisms and significance of physicochemical reactions involved in spoilage of foods
4	Explain the significance of water in food quality, preservation and storage
5	Describe and demonstrate the role of food constituents on nutritional/anti-nutritional and aesthetic quality of raw and processed foods
6	Extrapolate the knowledge gained on food composition to practical problems in food quality

	Course Code: BST 1102	Course Title: Biochemistry		Credits = 4		
				L	T	P
	Semester: III	Total contact hours: 60		3	1	0

List of Prerequisite Courses

Basics of organic chemistry and biology

List of Courses where this course will be prerequisite

Food chemistry, Chemistry of food constituents, Biochemistry Lab, Food Chemistry Lab

Description of relevance of this course in the B. Tech Food Engineering and Technology

Course objectives

1. To understand the important chemical reactions undergoing in cellular environment and their interactions as well as influence on other reactions occurring simultaneously
2. To understand the structural as well as metabolic role of different micro- or macro-molecules in the cell
3. To understand the role of enzymes in cellular environment and their use in industrial applications
4. To evaluate the shelf life of foods based on loss of key nutritional components
5. To evaluate the impact of different catalytic reactions involved in metabolic pathway
6. To evaluate influence and interactions of different metabolic pathway on each other

	Course contents (topics/subtopics)	Related CO	Required hours (60)
1	Classification and properties of Carbohydrates. Digestion and absorption of carbohydrates; metabolic pathways and energy yield for breakdown of carbohydrates – glycolysis, gluconeogenesis, citric acid cycle; pentose phosphate pathway, glycogen metabolism; electron transport chain and coupled oxidative phosphorylation	1, 2, 3, 4	12
2	Classification and properties of lipids. Digestion and absorption of lipids Pathways for breakdown and synthesis of fatty acids and lipids; formation of fatty acids, beta oxidation of fatty acids; control;	1, 2, 3, 4	10
3	de novo synthesis of cholesterol. Synthesis of steroid hormones and metabolic regulation; Hormones, release of energy and its trapping	1, 3	08
4	Amino acids and proteins- classification, structure and properties, isolation and purification. Pathways and metabolism of proteins (digestion and absorption), catabolic reactions of amino acids, urea cycle, in-born errors in metabolism	1, 2, 3, 4	10
5	Nucleic acid chemistry, synthesis and involvement in protein biosynthesis; genetic code, effects of mutations; DNA as carrier of genetic information; Protein biosynthesis and regulation	1, 5	10
6	Enzymes- definition, function, nomenclature, classification. Enzyme kinetics, enzyme inhibition, biosysthesis and regulation. Co-enzymes; mechanism of enzyme action; specificity	1, 6	10

List of Text Books/ Reference Books

1. Lehninger principles of biochemistry- by Nelson, D. L., Lehninger, A. L., & Cox, M. M. (2008). Publisher-Macmillan.
2. Biochemistry-by Jeremy M. Berg, John L. Tymoczko, Lubert Stryer. (2006). Publisher- WH Freeman & Company Limited, ISBN: 0716787245
3. Fundamentals of Biochemistry – Voet DJ and Voet JG, (1999), John Wiley & Sons.

Course Outcomes (students will be able to ...)	
1	Explain the fundamental knowledge of chemistry to biological systems
2	Describe the structural as well as metabolic role of different macromolecules in the cell
3	Explain and analyze the impact of different catalytic reactions involved in metabolic pathway
4	Describe the influence and interactions of different metabolic pathway on each other
5	Describe the fundamental aspect of nucleic acid chemistry and their importance in protein biosynthesis
6	Explain the fundamentals of enzymes in cellular environment and their use in industrial applications

	Course Code: BST 1109	Course Title: Microbiology	Credits = 4		
			L	T	P
	Semester: III	Total contact hours: 60	3	1	0

List of Prerequisite Courses

Basics of biology

List of Courses where this course will be prerequisite

Food Microbiology, Principle of food preservation, Food safety, quality and regulations, Food Biotechnology

Description of relevance of this course in the B. Tech Food Engineering and Technology

Course objectives

1. To understand the concept of general microbiological ecology and control of different 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 know the cultivation/control methods for diversity of microorganisms, their physiology and metabolism
4. To understand the flow of genetic information from DNA to protein and the mechanisms involved therein
5. To understand microbiological concerns in product development, e.g., new formulations, new packaging, new processes

	Course contents(topics/subtopics)	Related COs	Required hours (60)
1	Introduction to microbiology and its significance in foods- pathogenic and spoilage organisms, beneficial organisms; Prokaryotes and Eukaryotes- morphology, structure and function of microbial cells and their components; mode of reproduction in microorganisms	**1, 2, 3**	12
2	Major groups of microorganisms - bacteria, yeasts, molds and viruses; Growth curve (lag phase, log phase, stationary phase, death phase); concept of generation time; nutrient requirements and physiology of microorganisms	**1, 2, 3**	12
3	Physical and chemical factors affecting growth and destruction of microbes –aerobic, microaerophilic, anaerobic, psychrophilic, psychrotrophic, mesophilic, thermoduric, thermophilic, halophilic, osmophilic, extremophilic, and spore formers	**1, 4**	08
4	Microscopic study of bacteria, yeasts and molds with respect to morphology, Gram character and staining techniques, Isolation, preservation and maintenance of pure cultures,	**5**	10
5	Methods of sterilization, disinfection, sanitation, asepsis; Composition, preparation and sterilization of microbiological media; Classification of media;	**2, 6**	08
6	Enumeration of microorganisms (TPC, Yeast and molds count, MPN, turbidometry, rapid methods etc.); clinical tests for pathogenic microorganisms; Introduction to genetics; mutation, mutagens and mutants and their effects, Principles of immunology	**3, 6**	10

List of Text Books/ Reference Books

1. Textbook of Pharmaceutics :- A C Bentley
2. Microbiology Fundamentals and Applications: S S Purohit
3. Medical Microbiology Infections: Mackie & McCartney

Course Outcomes (students will be able to ...)	
1	Know the application of diverse microorganisms in different industries like food, dairy, oil, pharmaceutical, bio-based fermentation and bio-energy
2	Know the cultivation/control methods for diversity of microorganisms, their physiology and metabolism
3	Understand the flow of genetic information from DNA to protein and the mechanisms involved therein
4	Understand the significance of microorganisms in diseases and basic immune system
5	Explain the procedures and techniques used for the morphological study, isolation and characterization of microorganisms
6	Explain the procedures and techniques used for the enumeration of microorganisms

	Course Code: FDT 1015	Course Title: Nutrition		Credits = 4		
				L	T	P
	Semester: III	Total contact hours: 60		3	1	0

List of Prerequisite Courses

Basics of organic chemistry and biology

List of Courses where this course will be prerequisite

Food chemistry, Chemistry of food constituents

Description of relevance of this course in the B. Tech Food Engineering and Technology

Course objectives

1. To compute energy value of foods and understand body's need for energy and to explain dietary and food formulations for special needs
2. To develop products and nutritional labels as well as to market nutritionally enriched products to targeted consumers such as infants, sports personnel, geriatrics, immune compromised etc.
3. To understand the requirements and role of micronutrients in human health become aware of anti-nutrients in foods

	Course contents (topics/subtopics)	Related CO	Required hours (60)
1	Energy value of foods, physiological fuel value, and estimation of energy value from proximate composition. Metabolic rate and calorie needs; Dis orders of nutrition	1, 2, 3	12
2	Requirements and role of carbohydrates (including dietary fibres), proteins, lipids, vitamins and minerals (macro- and micro) in human health and RDA's	1, 2, 3	10
3	Biological value of proteins; Estimation of protein quality – *in vitro* and *in vivo* methods; nutritional fibres	1, 3	10
4	Principles of Diet Therapy and Therapeutic Nutrition; Formulation of diets and foods for special needs. Techniques of diet and health surveys; Anti-nutritional factors in plant foods	4	10
5	Effect of processing, preservation and storage on nutritional quality of foods	6	08
6	Sports nutrition, Nutritional labelling, Assessment of nutritional status, Nutraceuticals and functional foods	5	10

List of Text Books/ Reference Books

1. Modern Nutrition in Health & Disease by Young & Shils.
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

Course Outcomes (students will be able to ...)

1	Compute energy value of foods and understand body's need for energy
2	Describe requirements and role of macronutrients in human health
3	Describe requirements and role of micronutrients in human health become aware of anti-nutrients in foods
4	Explain dietary and food formulations for special needs
5	Comprehend how to carry out nutritional labeling of foods and assess nutritional status of individuals
6	Describe the concept of nutraceuticals and functional foods and describe effect of food processing, preservation and storage on nutritional quality of foods

	Course Code: FDT1030	Course Title: Introduction to Food Systems		Credits = 3		
				L	T	P
	Semester: III	Total contact hours: 45		2	1	0

List of Prerequisite Courses

Physical chemistry

List of Courses where this course will be prerequisite

Food engineering, Principles of Food preservation, Food process engineering lab

Description of relevance of this course in the B. Tech Food Engineering and Technology

Course objectives

1. To understand the complexity in food system and correlation with material science aspect
2. To understand and develop the fundamentals of different physical forms of food and its stability
3. To characterize the foods with specific rheological, textural and mechanical properties
4. To understand the importance of water and surface tension in food system
5. To explain the role of sensory perception in overall quality of food.

	Course contents (topics/subtopics)	Related CO	Required hours (45)
1	Food systems as biopolymer blends: Complexity and its relation with quality (Thermodynamics and kinetics) (3) Interfacial science in food system: Curved interfaces; Liquid–Liquid–Gas and Solid-liquid and gas system and case studies (3) Food as emulsions-mechanism of formation, types of emulsion, lamellar phase concept, phase separation, stabilization and case studies. (4) Foams in food systems- mechanism of formation, phase separation, stabilization, bubble containing foods, solid foams, aerosols, solid-liquid foams and case studies (5)	**1, 2**	15
2	Food as a molecular and colloidal dispersions- mechanism of formation, phase separation, stabilization and case studies. (3) Gels in food system- mechanism of formation, phase separation, stabilization and case studies. (3) Dough rheology in food systems-structure-texture relationship, viscoelasticity (3)	**1, 2, 3**	09
3	Concept of moisture content, water activity and water vapor sorption isotherms (3) phase transition, crystalline and glassy state in food; State diagrams in food and processes; Thermal properties of food material (3) Food powder; Particle size and shape; sphericity and shape factor for bulk and powder material; Flowability and dispersibility of food material; Case study on bread and chapatti; Structured cereal, meat and dairy products (6)	**2, 3**	12
4	Sensory perception in food; Role of sensory attributes specific to food products (3) Sensory evaluation techniques; Descriptive and discriminative tests (3) Conversion of subjective to objective sensory data and interpretation; Case studies on wine, beverage, fried products, dairy and cereal based products. (3)	**4**	09

Suggested readings/Reference books

1. Food Materials Science-Principles and practice – by José M. Aguilera and Peter J. Lillford (2008). Publisher: Springer, ISBN 978-0-387-71946-7
2. Food Physics: Physical Properties - Measurement and Applications – by Ludger Figura, Arthur A. Teixeira (2007). ISBN 978-3-540-34194-9

Course Outcomes (students will be able to ...)	
1	Describe the fundamental knowledge of physics and material science approach to food systems
2	Describe the physical forms, surface tension, rheology and texture of food components in processed products.
3	Explain the importance of water activity and thermal properties in food products.
4	Explain the importance of sensory attributes specific to food products.

	Course Code: FDP1013	Course Title: Food Microbiology	Credits = 2		
			L	T	P
	Semester: III	Total contact hours: 60			4P

List of Prerequisite Courses

General Microbiology

List of Courses where this course will be prerequisite

Food Microbiology, Food product development, Principle of food preservation

Description of relevance of this course in the B. Tech (Food Engg and Technology)

Course Objectives:

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

	Course Contents (Each Lab class of 4 h)	Related COs
1	Working and handling of common laboratory equipments and materials	1
2	Monochrome staining, Cell wall staining	1
3	Gram staining	1
4	Negative staining. Hanging drop technique	1
5	Capsule staining, Bacterial endospore staining	1
6	Study of Yeast, Mold and Bacteria	1
7	Phenol Coefficient of disinfectant	1
8	Microchemical test for reserve material	1
9	Isolation of Microbes from a food sample	4
10	Composition, preparation, sterilization of routine lab media	2
11	Enumeration, characterization, isolation and maintenance from air and surface	2
12	Effect of physicochemical factors on growth of microorganisms	3
13	Nutritional requirements of microorganisms	3
14	Isolation and characterization of microbes based on morphological & physiological characteristics	4
15	Evaluations of microbial quality of milk and water samples	4

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

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

1	Describe and analyze the principles of different staining techniques used for bacteria, yeast and chemical compounds within the cells
2	Describe and apply the procedure for enumerating the microorganisms in the food samples
3	Analyze the effect of different media composition and physiochemical factors for microbes
4	Isolate microorganisms from different food samples and evaluate the microbial quality of food samples

	Course Code: FDP1014	Course Title: Biochemistry	Credits = 2		
			L	T	P
	Semester: III	Total contact hours: 60			4P

List of Prerequisite Courses

None

List of Courses where this course will be prerequisite

Food chemistry, Chemistry of food constituents, Food chemistry Lab, Food analysis lab

Description of relevance of this course in the B. Tech (Food Engg and Technology)

Course Objectives:

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

	Course Contents (Each Lab class of 4 h)	Related COs
1	Estimation of protein by Biuret Method & Folin-Lowry method	1, 4
2	Estimation of protein by Microkjeldahl method & Ninhydrin method	1, 4
3	Estimation of alfa-amino nitrogen by Pope & Steven's method	1, 4
4	Estimation of proteins by Bradford method & Dye binding method	1, 4
5	Estimation of sugar by DNSA method & Phenol-H_2SO_4 method	1, 4
6	Estimation of sugar by Resorcinol method & Anthrone method	1, 4
7	Estimation of amylose & amylopectin	1, 4
8	Estimation of polyphenols by Folin-Denis method & Ferrous Tartarate method	2, 4
9	Study of Amylase	3, 4
10	Study of Proteases	3, 4
11	Study of Lipases	3, 4
12	Estimation of Pectic enzyme activity	2, 4
13	Study of Oxidoreductase & its kinetics	2, 4
14	Enzyme purification by ammonium sulphate	2, 4
15	Estimation of water soluble and insoluble vitamins	3, 4

List of Text Books/ Reference Books

1. Biochemistry Laboratory: Modern Theory and Techniques – by Rod Boyer. (2010). Publisher: Pearson Prentice Hall. ISBN: 013604302X
2. Basic Methods for the Biochemical Lab – by Martin Holtzhauer. (2006). Publisher: Springer, New York. ISBN: 978-3-540-32786-8

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

1	Describe the principles behind analytical methods used for protein and sugar estimation
2	Assay enzymes as indicators of ripening and/or blanching
3	Understand and explain the principles of different enzyme and vitamin assays
4	Develop analytical protocols of important nutrients in foods and their interpretation in the light of quality assurance programs in the industry

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

List of Prerequisite Courses

Basics of microbiology

List of Courses where this course will be prerequisite

Food Microbiology, Principle of food preservation, Food safety, quality and regulations, Food Biotechnology

Description of relevance of this course in the B. Tech Food Engineering and Technology

Course objectives

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

	Course contents (topics/subtopics)	Related COs	Required hours (45)
1	Factors affecting spoilage of foods and associated microflora; biochemical changes caused by microorganisms - putrefaction, lipolysis; Antagonism and synergism in microorganisms	1	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	2	09
3	Food borne infections and food poisoning, Microbial toxins, Newer pathogens.	3	06
4	Detection methods for *E. coli*, *Staphylococci*, *Yersinia*, *Campylobacter*, *B. cereus*, *Cl. Botulimum* & *Salmonella* from food samples. 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	4	10
5	Rapid methods of microbial analysis; applications of immunological techniques to food industry	5	06
6	Examples of microbes in manufacture of important food ingredients. fermentations – an introduction with examples (traditional Indian fermented concept of probiotics and prebiotics	6	09

List of Text Books/ Reference Books

4. Food Microbiology: Frazier W.C. and Dennis C. Westhoff 5th Edn. Tata McGraw-Hill Publishing Co. Ltd. (2013).
5. Modern Food Microbiology- Jay, James M., Loessner, Martin J., Golden, David A, Aspen Publishers, Inc, 7th ed. (2004)
6. Food Microbiology and Fundamentals and Frontiers: Doyle M.P, Beuchat L.R, Montville T.J.2nd Edn. ASM Press, Washington D.C. (2001)
7. Food Borne Bacterial Pathogens: Doyle, M.P. Marcel Dekker Inc. (1989) Basic Food Microbiology; George J. Banwart, Chapman and Hall (1999)

Course Outcomes (students will be able to ...)

1	describe the different factors associated with microbial spoilage of food and the corresponding biochemical changes in it

2	explain the spoilage and methods of controlling the microbial spoilage for specific food products
3	describe different food borne infections and food poisoning, microbial toxins and functions of newer pathogens
4	describe and analyze different detection methods of critical microorganism, rapid methods of microbial analysis, and applications of immunological techniques to food industry
5	identify the target organism in specific food and design the hazard analysis critical control points system ensuring microbiological safety and quality of foods
6	explain the role of different microorganisms with respect to certain food ingredients and describing the fundamentals of food fermentation

	Course Code: FDT 1021	Course Title: Principles of Food Preservation		Credits = 4		
				L	T	P
	Semester: IV	Total contact hours: 60		3	1	0

List of Prerequisite Courses

Chemistry of food constituents, Fundamentals of food systems

List of Courses where this course will be prerequisite

Food Engineering, Food Process Engineering, Food Processing

Description of relevance of this course in the B. Tech Food Engineering and Technology

Course objectives

1. To understand the fundamentals of different modes of food preservation methods with emphasis on inactivation, inhibition, and methods of avoiding recontamination
2. To understand the fundamentals of food preservation through dehydration
3. To understand the fundamentals of thermal processing of food
4. To explain the food preservation method at lower temperature
5. To explain the principles of the newer techniques in thermal and non-thermal processing of food
6. To explain the principles of food preservation by fermentation, chemical preservatives, bio- preservatives and hurdle technology

	Course contents (topics/subtopics)	Related CO	Required hours (60)
1	Introduction to food preservation and underlying principles (1) Water activity and moisture absorption isotherms (2) Psychometric chart (1) Dehydration and drying of foods (2) Drying curve and drying time calculation (2) Different types of dryers-Conductive, convective and combined (4) IMF foods (1) Osmotic dehydration (1)	1	14
2	Thermal processing of fruits and vegetables products (2) Sterilization and Pasteurization (1) Canning of food products (2) Classifications and structure of cans, corrosion, Lacquering (2) Spoilage in canned foods (1) Thermal death time (TDT) concept (2) Process time calculation for canned foods (2) Retort processing (1) Aseptic packaging (1)	2	14
3	Newer techniques in thermal processing – UHT (1) Ohmic, Dielectric, Infra-red Heating (3) Microwave heating (1) Frying method (1)	3	06
4	Non-thermal processing of food- High pressure processing (1) Pulsed electric field processing (1) Cold extrusion (1) Ionizing Radiations (1) Ultrasound processing (1) UV and Pulsed light processing (1) Membrane Technology (1)	4	06
5	Low temperature storage and preservation; Chilling and Freezing (1) Freezing curve and water activity (1) Properties of frozen foods (1) Enthalpy change during freezing (1) Plank's equation for freezing time (1) Cold storage and Refrigeration load (1) Refrigeration cycle (1) Cryogenic freezing and IQF (1) Freeze concentration and dehydrofreezing (1) Freeze drying (1)	5	10
6	Hurdle technology and role of acidity and pH in food preservation (2) Preservation by fermentation – Curing, Pickling and Smoking (3) Controlled and modified atmospheric packaging and storage (2) Chemical preservatives (1) Bio-preservatives (1) Antimicrobials (1)	6	10

List of Text Books/ Reference Books 1. The Technology of Food Preservation, Desrosier NW, 1977, The AVI Publishing Co. Inc. 2. Food Processing Technology: Principles and Practice, Fellows PJ, 2005, CBS Publishers. 3. Handbook of food preservation. Rahman, M. Shafiur, 2007. CRC press.	
Course Outcomes (students will be able to ...)	
1	justify significance of water activity in food preservation and principles of dehydration and describe different types of dryers
2	explain and apply the principle, technology and operations of various thermal technologies applied to food preservation
3	describe and apply the principle, technology and operations of various non-thermal technologies applied to food preservation
4	explain the principle and technology of various advanced thermal food processing
5	comprehend principles of food preservation by freezing, describe various types of freezers and freezing techniques
6	explain principles of food preservation by fermentation, chemical preservatives, bio- preservatives and hurdle technology

	Course Code: GET 1116	Course Title: Engineering Mechanics and Strength of Materials	Credits = 4		
			L	T	P
	Semester: IV	Total contact hours: 60, Marks : 100	3	1	0
List of Prerequisite Courses					
	XIIth Standard Physics and Mathematics, Applied Mathemaics-I and II, Applied Physics-I				

Description of relevance of this course in the B. Tech. (All Branches)

This subject will help students to understand use of basics of Applied Mechanics and Strength of Materials. As a practicing engineer and technologist, what are different types of forces to be considered and how to quantify them during design of equipments? To know the conditions of equilibrium and how to apply them to analyse the problems. Importance of centre of gravity and moment of Inertia in Engineering Design. Study of different types of stresses and strains occurring in various components of the structure. Advantages and disadvantages of various geometric sections available for engineering design. What are different advance fibre polymer composite materials used in Industry for various applications. Different performance enhancing construction chemicals. This is the foundation course for a good Design Engineer and Technologist.

	Course Contents (Topics and subtopics)	Reqd. hours
1	Concepts of forces, their types, Resolution of forces, Composition of forces, Steps in Engineering Design, Different types supports and free body diagram.	4
2	Equilibrium of rigid bodies - Conditions of equilibrium. Determinant and indeterminate structures. Equilibrium of beams, trusses and frames problems on analysis of beams and truss.	5
3	Concept of moment of Inertia (Second moment of area) its use. Parallel axis theorem. Problems of finding centroid and moment of Inertia of single figures, composite figures. Perpendicular axis theorem, Polar M.I., Radius of gyration.	5
4	Shear Force and Bending Moment - Basic concept, S.F. and B.M. diagram for cantilever, simply supported beams (with or without overhang). Problems with concentrated and U.D. loads.	5
5	Stresses and Strains - Tensile and compressive stresses, strains, modulus of elasticity, modulus of rigidity, bulk modulus. Thermal stresses and strains. Problems based on stresses and strains. Basics of Engineering Design - Steps in the engineering design, Importance of analysis, 1-D, 2-D and 3-D analysis and interpretation of results. Design philosophies.	5
6	Theory of Bending - Assumptions in derivation of basic equation, Basic equation, section modulus, bending stress distribution.	4
7	Problems on shear stress - Concept, Derivation of basic formula. Shear stress distribution for standard shapes. Problems of Shear stress distribution	4
8	Slope and Deflection of beams - Basic concept, Slope and Deflection of cantilever and simply supported beams under standard loading. Macaulay's method.	4
9	Short and Long Columns (Struts) – Basic Concept, Crippling load, End conditions, Euler's and Rankine's Approach (Without Derivations)	4
10	Torsion of a circular shaft – Concept, basic derivation, shear stress distribution, power transmitted by shafts, Simple problems	4
11	Thin and Thick Cylinders – Concept of circumferential, longitudinal stresses, Behaviour of thin cylinders, problems on thin cylindrical and spherical shells, Behaviour of thick cylinders (Theory only)	4
12	Natural Materials, Manmade materials, Materials used for coatings, anticorrosive coatings, special purpose floorings, water proofing compounds, Various polymers and epoxies used for industrial applications. Composite Materials – various types of fibres, fabrics used in polymer composites, Glass and Carbon fibre polymer composites, methods of manufacturing, Uses in various industrial applications.	6
13	Concrete – Basics, Ingredients of concrete, properties of concrete, testing of fresh and	6

	hardened concrete, uses of concrete. Different types of performance enhancing and special purpose construction chemicals. Plasticizers and super-plasticizers, air entraining agents, accelerators and retarders, viscosity modifying agents, corrosion inhibitors, Cement, Basic process of hardening, types of cements, blended cements, Recycling of waste – value addition.	
List of Text Books/ Reference Books		
	Engineering Mechanics Vol I Statics by B. N. Thadani, Publisher Wenall Book Corporation	
	Introduction to Mechanics of Solids by Egor Popov, Prentice Hall of India Pvt. Ltd	
	Mechanics of Materials by Ferdinand Beer and E. Russel Johnston, Tata McGraw Hill	
	Fundamentals of applied Mechanics by Dadhe, Jamdar and Walavalkar, Sarita Prakashan Pune	
	Engineering Mechanics by S. Timoshenko and D. H. Young, McGraw Hill Publications	
	Strength of Materials by Ferdinand Singer and Andrew Pytel, Harper Colins Publishers	
	Mechanics of composite Materials by Autar K. Kaw, Publisher CRC Press	
	Fundamental of Fibre reinforced composite materials by A. R. Busell and J. Renard, Taylor & Francis	
	Concrete Technology by A. M. Neville, Pearson Education ltd	
	Concrete Technology – Theory and Practice by M. S. Shetty, S. Chand & Co.	
	Corrosion and Corrosion Protection Handbook by Philip A. Schweitzer, CRC press	

Course Objectives

1) To know the various types of forces acting on the various structures in engineering. To know the conditions of equilibrium and how to apply them to analyse the structures.
2) To understand the concept and importance of centroid and moment of Inertia for different sections used in engineering and plane areas.
3) To analyse the different types of structures to know axial force, shear force and bending moment in the different parts of the body/structure.
4) To know the basics of different stresses and strains, types of materials and their properties.
5) To able to determine the axial stress, bending stress and shear stress in the structure and draw its variation across the section.
6) To understand the deformations in axial, lateral and rotational direction. Calculation of slope and deflections in different beams under simple and complex loading.
7) To understand torsional loads, Use in power transmission. Behavious of short and long columns with various end conditions.
8) To know the Thin and Thick cylinders, stresses and strains in thin cylinders.
9) To know various polymers, epoxies, fibre polymer composite materials used for various applications in engineering.
10) To make awareness about the cement and its composites, performance enhancing construction chemicals used to alter properties.

Course Outcome:

At the end of the course the student will be able to

CO 1	Quantify the actions and able to find reactions by applying conditions of equilibrium
CO 2	Find out the Centroid and Moment of Inertia for various cross sections used in engineering structures and for plane areas.
CO 3	Able to draw the Shear Force and Bending Moment diagram for different types of beams under simple and complex loading.
CO 4	Calculate the forces, reactions, stresses, strains in components of the bodies of a complex engineering structure.
CO 5	To find out the Bending Stresses at different positions and Shear Stress distribution across the cross section at various points.
CO 6	To calculate the Slope and Deflection at different points under simple and complex loading.
CO 7	To know effect of Torsion in shafts, power transmission, Euler's and Rankine's approach for columns.
CO 8	To know Thin and Thick cylinders, stresses and strains in thin cylinders.
CO 9	To know various polymers and epoxies, fibre polymer composites used in various applications in engineering. Corrosion of steel and its mitigation.
CO 10	To know most widely used cement composite – Concrete, Chemicals used to alter the properties of concrete.

Course Code: GET1105	Course Title: Basic Electrical Engineering and Electronics
Semester: IV	Total contact hours: 40

List of Prerequisite Courses

XIIth Standard Physics and Mathematics courses,

List of Courses where this course will be prerequisite

None

Course objectives

1. Students will get an insight to the importance of Electrical Energy in Chemical Plants.
2. The students will understand the basics of electricity,
3. They will get basic knowledge about Transformer and selection of different types of drives for a given application process.
4. They will get basic knowledge as regards to electronic devices and their application in Power supplies, amplifiers and other circuits.

S.No.	Topic	Hrs.
1	Basic Laws: Kirchoff's current and voltage law, Simple series and parallel connections, star and delta transformation. Mesh and nodal analysis, Basic elements R, L and C. Concept of self and mutual inductance.	6
2	Network theorems: super position, Thevenin's theorems	2
3	A.C. Fundamentals: Equations of alternating voltages and currents, cycle, frequency. Time period, amplitude, peak value average value, R.M.S. value, A.C. through resistance, inductance and capacitance, simple RL, RC and RLC circuits. Resonance in series RLC circuits, Power, power factor, series and parallel circuits.	5
4	Three Phase systems: Star and delta connections, relationship between line and phase voltages and currents, Power in three phase circuits	3
5	Transformer: Introduction, principle of operation, e.m.f. equation, phasor diagrams. Ideal transformer, transformer on no load, Transformer under load, Transformer losses, efficiency, regulation.	5
6	Introduction to dc and ac drives	3
7	Diodes and rectifiers: P-N junction diode characteristics, Zener diode, Half wave and full wave rectifiers, their waveforms, brief introduction to filters.	4
7	Bi-polar junction transistor: Current components. Modes of operation, Input and output characteristics, Regions of operation, Transistor as an amplifier, classification of amplifiers	6
8	Introduction to Uni junction transistor, Characteristics, UJT relaxation oscillator,	3
9	Silicon controlled rectifier, controlled rectification, characteristics, methods of turning-on. Applications.	3

List of Text Books/ Reference Books

Electrical Engineering Fundamentals by Vincent Deltoro

Electronic devices and circuits by Boylstead, Nashelsky

Electrical Machines by Nagrath, Kothari

Electrical Machines by P.S. Bhimbra

Electrical Technology by B.L.Theraja, A.K.Theraja vol I,II,IV

Thyristors and their applications by M.Ramamurthy

Power Electronics by P.S. Bhimbra

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

1. Understand the basic concepts of D.C circuits. Solve basic electrical circuit problems
2. Understand the basic concepts of single phase and three phase AC supply and circuits.
3. Understand the basic concepts of transformers and motors used as various industrial drives.
4. Understand the basic concepts of electronic devices and their applications

	Course Code: CET 1105	Course Title: **Transport Phenomenon**	Credits = 4		
			L	T	P
	Semester IV	Total contact hour: 60 h	3	1	0

Sr. No.	Content	Contact hours
1	Fluid Statics and applications to engineering importance.	4
2	Equations of Continuity and Motion (Cartesian, cylindrical, and spherical coordinates) in laminar flows and its applications for the calculation of velocity profiles, shear stresses, power, etc. in various engineering applications.	6
3	Basics of Turbulent flows, equations of continuity and motion for turbulent flows, Turbulent pipe flow, basis of Universal velocity profile and its use. Boundary layer separation: skin and form drag.	4
4	Fundamentals of mass transfer: Molecular diffusion in fluids, mass transfer coefficients, and interface mass transfer, steady state theories of mass transfer, Whitman's two-film theory, and its variations.	6
5	Bernoulli's Equation and engineering applications, Pressure drop in pipes and Fittings, Piping design and fluid moving machinery such as pumps, blowers, compressors, vacuum systems, etc.	6
6	Particle Dynamics, Flow through Fixed and Fluidised Beds,	4
7	Gas – liquid Two phase flow: types of flow regimes, Regime maps, estimation of pressure drop and hold-up, Blending:	4
8	Theories of homogenization, criteria for mixing, equipment and performance expressions of rate processes, mixing power estimation for impeller and liquid jets, impeller types and flow patterns	4
9	Steady state and unsteady state conduction, Fourier's law, Concepts of resistance to heat transfer and the heat transfer coefficient. Heat transfer in Cartesian, cylindrical and spherical coordinate systems, Insulation, critical radius.	4
10	Convective heat transfer in laminar and turbulent boundary layers. Theories of heat transfer and analogy between momentum and heat transfer. Heat transfer by natural convection.	4
11	Heat transfer in laminar and turbulent flow in circular pipes: Double pipe heat exchangers: Concurrent, counter-current and cross flows, mean temperature difference, NTU – epsilon method for exchanger evaluation.	6
12	Shell and tube heat exchangers: Basic construction and features, TEMA exchanger types, their nomenclature, choice of exchanger type, correction to mean temperature difference due to cross flow, multipass exchangers.	2
14	Condensation of vapours: theoretical prediction of heat transfer coefficients, practical aspects, horizontal versus vertical condensation outside tubes, condensation inside tubes, Process Design aspects of total condensers, condensers with de-superheating and subcooling, condensers of multicomponent mixture, condensation of vapours in presence of non-condensables.	4
15	Basics of Radiative heat transfer	2

Reference Books:

1. Transport Phenomena, Bird R.B., Stewart W.E., Lightfoot E.N.
2. Transport Phenomena Brodkey R.S.
3. Momentum, Heat and Mass Transfer, Bennet and Myers
4. Fluid Mechanics, Kundu Pijush K.
5. Fluid Mechanics, Subramanya K.
6. Fluid Dynamics Batchelor G.K
7. Fluid Dynamics and Heat Transfer Knudsen and Katz
8. Process Heat Transfer, Kern D.Q.
9. Heat Exchangers, Kakac S., Bergles A.E., Mayinger F.
10. Process Heat Transfer, G. Hewitt
11. Online course material from IIT and Other US Universities

COURSE OUTCOMES:

At the end of the course students should be able to:

1) Calculate velocity profiles, forces, pressure drops for simple 1 –D laminar flow situations (K3)
2) Calculate pressure drop in pipelines and equipment for different situations such as single and two phase flow, fixed and fluidized beds (K3)
3) Calculate mass transfer rates for simple multiphase processes (K4)
4) Design double pipe heat exchangers, shell and tube heat exchangers, plate heat exchangers (K3)

Mapping between Course outcomes and Program Outcome

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	**S**	**S**	**M**	**M**	**W**	**W**	**W**
CO2	**S**	**S**	**M**	**M**	**W**	**W**	**W**
CO3	**S**	**S**	**M**	**M**	**W**	**W**	**W**
CO4	**S**	**S**	**M**	**M**	**W**	**W**	**W**

	PO8	PO9	PO10	PO11	PO12	PO13	PO 14
CO1	**M**	**W**	**N**	**N**	**N**	**S**	**N**
CO2	**M**	**W**	**N**	**N**	**N**	**S**	**N**
CO3	**M**	**W**	**N**	**N**	**N**	**S**	**N**
CO4	**M**	**W**	**N**	**N**	**N**	**S**	**N**

MODE OF COURSE DELIVERY

1) Class room teaching on board
2) Sharing of videos of laminar and turbulent flow and subsequent discussions
3) Home assignments, project work related to dimensionless numbers, contribution of eminent scientists in the field of fluid mechanics and use of transport phenomena in their technology branch
4) MCQ tests

	Course Code: MAP 1201	Course Title: **Computer Applications**	Credits = 2		
			L	T	P
	Semester IV	Total contact hour: 60 h	0	0	4

Part I: Spreadsheet Programme (Microsoft Excel or LibreOffice Calc) (3 Lab Sessions)

1. Basic Introduction to Spreadsheet Programmes, Plotting Graphs of Functions and Data Plotting.
2. Exploring Basic Statistics, Hypothesis Testing with Spreadsheet.
3. Numerical Solution of Linear and Non-Linear Equations.

Part II: Statistics with R-Programming (4 Lab Sessions)

1. Basic Introduction to R and Rstudio.
2. Data Management in R.
3. Exploring Distribution Function in R.
4. Hypothesis Testing in R.
5. Basic Regression Analysis in R

Part III: C-Programming

Unit I: (2 Lab Sessions)

What is C-programming? Data Types, Variables, Constants, Arithmetic Operations, Input-Output Statements, Expressions and Expression Evaluations, Type Conversions.

Unit II: (2 Lab Sessions)

Making Decisions-if and switch statement, Repetition Statements-For Loop, While and Do-While Loops, Nested Loops, Use of Break, Continue and Goto in Loops, File Input-Output statements and its use.

Unit III: (3 Lab Sessions)

Functions- User Defined functions, Calling Function and passing arguments, Arrays-Definition, Accessing and Storing elements, Concept of Multi-dimensional Arrays, Array and Functions.

Unit IV: (2 Lab Sessions)

String Manipulation. Basic of Structures and unions. Dynamic Memory allocation.

References:

1. Programming In Ansi C, E Balagurusamy, Tata McGraw-Hill Publishing Company Limited, 2002
2. Let Us C, Yashavant P. Kanetkar, 2008, Infinity Science Press
3. Introductory Statistics with R, Peter Dalgaard, Springer, 2008
4. Basic Statistics: An Introduction with R, Tenko Raykov, George A. Marcoulides, 2013
5. Excel for Chemists: A Comprehensive guide, E. Joseph Billo, WILEY, 2011
6. Mathematical Modeling with Excel, Brian Albright, Jones & Bartlett India Private Limited, 2010
7. Statistics and Probability for Engineering Applications With Microsoft® Excel by W.J. DeCoursey, 2003

Course Code: GEP1106	Course Title: Electrical Engineering and Electronics laboratory
Semester: IV	Total contact hours:

List of Prerequisite Courses

XII Standard Physics and Mathematics courses

List of Courses where this course will be prerequisite

None

Course objectives

1. Students will get an insight to the importance of Electrical Energy in Chemical Plants.
2. The students will understand the basics of electricity.
3. They will understand the working and utility of transformers and electrical drives.
4. They will get basic knowledge as regards to electronic devices and their application in Power supplies, amplifiers and other circuits.

Suitable no of experiments out of the following will be conducted.

1. Superposition Theorem
2. Thevenin's Theorem
3. Series RL circuit
4. Reconance in Series RLC circuit
5. H.W. and F.W. Rectifiers
6. Cathode Ray Oscilloscope
7. Input and output characteristic of npn transistor in CE mode.
8. Load Test on Transformer
9. Three phase star connection
10. Three phase delta connection
11. Study of UJT relaxatation oscillator
12. Design of UJT relaxation oscillator
12. Load Test on 3 phase induction motor
13. Study of Thermo couple

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

1. Understand concepts of basic working of D.C circuits.
2. Understand the basic applications of single phase and three phase AC supply and circuits.
3. Understand the working and utility of transformers and motors used as various industrial drives.
4. Understand the basic working and applications of electronic devices and circuits

	Course Code: : FDT 1013	Course Title: Food Chemistry		Credits = 4		
				L	T	P
	Semester: V	Total contact hours: 60		3	1	0

List of Prerequisite Courses

Basics of Organic, Inorganic, Physical and Analytical Chemistry and Chemistry of Food Constituents

List of Courses where this course will be prerequisite

Food chemistry Lab, Technical Analysis Lab, Principles of Food Analysis, Food Safety, Quality & Regulations

Description of relevance of this course in the B. Tech Food Engineering and Technology

Course objectives

1. To understand chemical composition of various food commodities.
2. To understand the standards of identity based on authentic chemical composition.
3. To know the different analytical techniques for different constituents of foods.
4. To understand the interactions of different constituents within the food systems.
5. To understand the various contaminants and toxicants present in the food systems.
6. To know the presence of different anti-nutritional factors in foods
7. To apply knowledge to judge the quality and authenticity of the food.

	Course contents (topics/subtopics)	Related CO	Required hours (60)
1	Chemical composition and its effect on quality, standards of identity, purity and methodology for analysis of cereals, legumes, oilseeds, nuts, Psudo cereals and their products	**1, 2, 3, 7**	**06**
2	Chemical composition and its effect on quality, standards of identity, purity and methodology for analysis of tubers, fruits, vegetables and their products	**1, 2, 3, 7**	**06**
3	Chemical composition and its effect on quality, standards of identity, purity and methodology for analysis of plantation crops and their products (tea, coffee, cocoa, sugar and spices)	**1, 2, 3, 7**	**06**
4	Chemical composition and its effect on quality, standards of identity, purity and methodology for analysis of milk and dairy products including traditional products	**1, 2, 3, 7**	**06**
5	Chemical composition and its effect on quality, standards of identity, purity and methodology for analysis of animal products, poultry and fish products.	**1, 2, 3, 7**	**06**
6	Interactions amongst food constituents	**1, 5, 7**	**12**
7	Food toxicants and contaminants. Safety of food from chemical and microbiological considerations	**1, 5, 7**	**12**
8	Basic concept of taste, colour, flavour and texture, anti-nutritional constituents in foods	**1, 6, 7**	**06**

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. Food Chemistry- Aurand L.W and Woods A.E, Avi Publishing Company, Inc, Westport, CT (1973).
4. Food Chemistry. Meyer. Cbs Publisher. (2004)

Course Outcomes (students will be able to ...)

1	Describe the chemical composition of various food commodities

2	Describe the standards of identity based on authentic chemical composition and analytical techniques
3	Describe the interactions of different constituents within the food systems
4	Explain the various contaminants and toxicants present in the food systems
5	Describe the presence of different anti-nutritional factors in foods
6	Extrapolate the knowledge gained to judge the quality and authenticity of the food

	Course Code: : FDT 1012	Course Title: Food Additives and Ingredients		Credits = 4		
				L	T	P
	Semester: V	Total contact hours: 60		3	1	0

List of Prerequisite Courses

Chemistry of Food Constituents, Introduction to Food Systems

List of Courses where this course will be prerequisite

Technology of Fruits and Vegetables, Technology of Dairy, Animal Products and Plantation Products, Technology of Cereals, Legumes and Oilseeds, Food Safety, Quality and Regulations

Description of relevance of this course in the B. Tech Food Engineering and Technology

Course objectives

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.

	Course contents (topics/subtopics)	Related CO	Required hours (60)
1	Additives in food processing and preservation, their functions and safety	**1, 2, 3,4**	**02**
2	Safety and quality evaluation of additives and ingredients, acute and chronic studies, LD50	**2, 3, 4**	**02**
3	Analytical methods, chemical and instrumental	**3, 4, 5**	**02**
4	Various additives such as preservatives (4), antioxidants and sequesterants (4), colours and flavours (3), emulsifiers (3), humectants (3), hydrocolloids (7), stabilizers and sweeteners (3), acidulants etc (3) , with respect to chemistry, food uses and functions in formulations.	**1, 2, 3, 4, 5, 6**	**30**
5	Indirect food additives	**1, 2, 3, 4, 5, 6**	**02**
6	Natural and synthetic colours	**1, 2, 3, 4, 5, 6**	**04**
7	Classification of flavours and the process of preparing including extraction, distillation, fractionation and purification	**1, 2, 3, 4, 5, 6**	**04**
8	Stability of flavours	**2, 5**	**02**
9	Ingredients used in food production eg. sugars, starches, proteins and fats and their technology of production and application	**1, 2, 5, 6**	**12**

List of Text Books/ 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. Ullman's Encyclopedia-
4. Functional Foods – Designer Foods, Pharma Foods, Nutraceuticals, Israel Goldberg (Editor) (1994), Chapman and Hall, New York.

Course Outcomes (students will be able to ...)	
1	Describe the various additives and ingredients used in food industries
2	Describe the mechanisms of food additives involved in foods
3	Explain the significance of different additives in food quality, preservation and storage
4	Describe the safety of use of food additives and ingredients
5	Extrapolate the knowledge gained on food additives and ingredients in food industries
6	Describe the process of preparation of food additives and ingredients.

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

List of Prerequisite Courses

Principles of Food Preservation, Introduction to Food Systems

List of Courses where this course will be prerequisite

Food Process Engineering, Food Processing and Product Development, Food Processing and Engineering

Description of relevance of this course in the B. Tech Food Engineering and Technology

Course objectives

1. To develop knowledge about the concept of conservation of mass and energy as a basic tool in food engineering analysis;
2. To understand basic concept of fluid flow and its application to food process;
3. To provide a basic understanding on the mechanisms of heat and mass transfer and the ability to apply basic engineering principles to design process and equipment for food processing.

	Course contents (topics/subtopics)	Related CO	Lecture (45 h)	Tutorial (15 h)
1	Principles of mass and energy balance in food processing operations (2); Thermodynamics concepts applied to food (1);	1, 2	03	2
2	Momentum transport with respect to foods (2) Fluid dynamics (1), Newtonian and non-Newtonian fluid (1), Bernoulli's Theorem and friction factor (1); velocity profile in different case studies like pipe, conduits (2), Flow measuring instruments (1) Fluid flow through porous media (2)	3, 4	10	2
3	Principles of Heat transfer and governing equations (1). Steady state heat transfer in food systems by conduction (1), convection (1) and radiation (1); transient heat transfer (1). Estimation of Conductivity and other thermal properties of foods (1); Dimensional analysis and overall heat transfer coefficient estimation (2)	3, 4	10	2
4	Freezing and Thawing calculations; (2) Application of Plank's equation to specific food system (1); Refrigeration system and thermodynamic aspects (2); Concept of cold storage design (1)	1, 3, 4	06	2
5	Basics of mass transfer and diffusion in food systems (1); Molecular diffusion and Fick's Law (1); Steady state diffusion (1); Diffusion through solids, liquids (1); Mass transfer coefficients and Permeability (1); Analogies between heat, momentum and mass transfer (1)	3, 4	06	2
6	Mechanical operations in food: Size reduction (1); homogenization (1); centrifugation (1); settling (1) and clarification (1)	1, 2, 5	05	2
7	Process and equipment design for food processing: Dehydration and dryer (1), extrusion (1), concentration (1), Thermal processing (1) and membranes processes (1)	1, 2, 5	05	3

List of Text Books/ Reference Books

1. Engineering Properties of Foods, Rao MA and Rizvi SSH, 1986, Marcel Dekker Inc.
2. Fundamentals of Food Process Engineering, Toledo RT, 2000, Chapman and Hall.
3. Elements of Food Engineering, Watson EL and Harper JC, 1989, The Avi Publishing Co.
4. Food Process Engineering, Heldman DR and Singh RP, 1984, Chapman and Hall.

	Course Outcomes (students will be able to ...)
1	Explain the fundamental knowledge of conservation of mass and energy as a basic tool in food engineering analysis (K1, K2)
2	To solve simultaneous material and energy balances on unit operations and food processes (K3)
3	To explain the fundamental knowledge of transport phenomena in food engineering (K1, K2)
4	To describe and analyze the transport phenomena in different food processing operations (K2, K4)
5	To design and analyze the performance of heat exchanger and food process equipment (K4)

Course Outcomes (CO) and Program Outcomes (PO) mapping

	Graduate Attributes or Program Outcomes (PO)												**PSO**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CO1	3	2	1	–	–	–	–	–	–	–	1	–	–	–
CO2	3	3	2	3	–	–	–	–	–	–	–	–	2	–
CO3	3	2	–	–	–	–	–	–	–	–	1	–	–	–
CO4	3	3	3	2	–	–	–	–	–	–	–	–	1	–
CO5	3	2	3	3	2	–	–	–	–	–	–	–	1	–

3 Strong Contribution
2 Moderate Contribution
1 Low Contribution
– No Contribution

PO1 Engineering knowledge
PO2 Problem analysis
PO3 Design & Development of Solutions
PO4 Investigation of Problem
PO5 Modern tool usage
PO6 Engineer and society
PO7 Environment& sustainability
PO8 Ethics
PO9 Individual & team work
PO10 Communication
PO11 Lifelong learning
PO12 Project management & finance
PSO1 Able to have knowledge for higher studies
PSO2 Able to involve in consumer awareness program and food regulations

	FDP 1011	**Course Title: Technical Analysis**	**Credits = 4**		
			L	**T**	**P**
	Semester: V	**Total contact hours: 120**			8P

List of Prerequisite Courses
None
List of Courses where this course will be prerequisite
Principle of Food Preservation, Food Analysis Lab
Description of relevance of this course in the B. Tech (Food Engg and Technology)
Course Objectives: 5. To understand the principles behind analytical techniques associated with sugar & water sample. 6. to select the appropriate analytical technique when presented with a practical problem 7. To demonstrate practical proficiency in a food analysis laboratory 8. To use different analytical techniques to find out the properties of foods and food waste samples

Sr. No.	Course Contents (Each Lab class of 4 h)	Time (days)	Related COs
1	Estimation of Glucose by Lane and Eynon's & Willstatter's Method	1	1
2	Estimation of Sucrose by Lane and Eynon's Method	1	1
3	Estimation of Sucrose and Lactose	1	2
4	Estimation of Reducing Sugar by Bertard's Volumetric Method	1	1
5	Estimation of Glucose and Maltose by Sichert and Bleyer's Method	1	2
6	Estimate ∝-Amino Nitrogen by Sorenson's Formal Titration	1	1
7	Qualitative Analysis of Sugar	1	3
8	Qualitative Analysis of Fats	2	3
9	Proximate Analysis of Foods	2	3
10	Identification of Sugars & amino acids by Paper Chromatography	2	2
11	Protein Precipitation Reaction	1	2
12	Hardness of Water	1	3
13	Water Hardness by Soap Titration	1	3
14	Estimation of Alkalinity of Water	1	4
15	Estimation of Sulphates in Water	1	4
16	Estimation of Chloride by Mohr's Method	1	4
17	Qualitative Analysis of Amino Acid	1	4
18	Estimation of Copper	1	3
19	Estimation of Ferric Ions	1	3
20	Estimation of Zinc	1	3
21	Estimation of Manganese	1	3

22	Estimation of Nitrite	1	3
23	Estimation of Phosphate	1	3
24	Chemical Oxygen Demand	1	4
26	Biochemical Oxygen Demand	2	4

List of Text Books/ Reference Books

3. Ranganna, S. (1986). *Handbook of analysis and quality control for fruit and vegetable products*. Tata McGraw-Hill Education.
4. 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…..)

1	To explain the principles behind analytical techniques associated with sugar & water samples (K1 & K2)
2	To select the appropriate analytical technique when presented with a practical problem (K3)
3	To demonstrate practical proficiency in a food analysis laboratory (K3)
4	To use different analytical techniques to find out the properties of foods and food waste samples (K3 &K4)

*(**K1** Remembering; **K2** Understanding; **K3** Applying; **K4** Analysing; **K5** Evaluating; **K6** Creating)*

CO-PO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PO14
1	3	3	2	3	–	–	–	–	–	–	1	–	2	–
2	3	3	3	3	–	–	–	–	–	–	1	–	3	–
3	3	3	2	3	–	–	–	–	–	–	1	–	3	–
4	3	3	3	3	–	–	–	–	–	–	1	–	2	–

	Course Code: FDP 1015	Course Title: Food Chemistry Lab	Credits = 2		
			L	T	P
	Semester: V	Total contact hours: 15			4

	List of Prerequisite Courses	
	Technical Analysis I, Technical Analysis II, Food chemistry theory subject	

	List of Courses where this course will be prerequisite	
	Food Analysis, Analysis of Foods (Chemical), Principle of food analysis (Theory course), Food product development	

Description of relevance of this course in the B. Tech Food Engineering and Technology

Course objectives

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

	Course contents(topics/subtopics)	Required hrs
1	Estimation of sulphur dioxide (KMS)	01
2	Estimation of sodium benzoate	01
3	Estimation of sorbic acid and sorbate	01
4	Estimation of Propyl gallate	01
5	Estimation of artificial sweeteners (Saccharine)	01
6	Iodine estimation	01
7	Identification of hydrocolloids	01
8	Estimation of chlorophyll and carotenoids	01
9	Estimation of tin in canned foods	01
10	Food adulteration	01
11	Evaluating the effect of food processing on food constituents	01
12	Damaged starch analysis	01
13	Antioxidant Assay (DPPH/FRAP)	01
14	Estimation of anti-nutritional factors	01
15	Sensory Analysis of Foods	01

	Course Outcomes (students will be able to.....)
1	Understand the principles behind analytical techniques associated with food
2	Be able to select the appropriate analytical technique when presented with a practical problem
3	Demonstrate practical proficiency in a food analysis laboratory
4	Describe and use principal analytical methods used for quantifying the composition and reactions of food components
5	Interpret and report data derived from chemical experiments/analysis in a meaningful way
6	Apply basic statistical methods to sampling/testing and the analysis of experimental data (e.g., relate this to QC or HACCP)

	Course Code: FDT 1027	Course Title: Food Process Engineering		Credits = 4		
				L	T	P
	Semester: VI	Total contact hours: 60		3	1	0

List of Prerequisite Courses

Food Engineering

List of Courses where this course will be prerequisite

Food Processing and Engineering

Description of relevance of this course in the B. Tech Food Engineering and Technology

Course objectives

1. To understand the transport processes in food processing and its integration to actual process design.
2. To perform simultaneous material and energy balances on unit operations and food processes
3. To analyze the complexity of fluid flow problems associated with non-Newtonian fluids
4. To design and analyze the performance of dryer, evaporators and freezer.
5. To apply the knowledge of designing the process and equipment for food industry

	Course contents (topics/subtopics)	Related CO	Lecture (45 h)	Tutorial (15 h)
1	Important aspects of product and process development (2). Basic flow sheet development for food processing (2)	1	04	1
2	Thermodynamic properties of steam (2); Steam as heating medium in Food operations (1); Fire and water tube boiler (2); Design of heat exchangers for food operations (2)	2	07	2
3	Process design and equipment aspects of Thermal processing (1). Continuous sterilization (2); Canning and retort processing (2); Equipment design aspects of pasteurizer (1), homogenizer (1), evaporators (1), centrifugal separators (1) and concentrators (1); Dryers and their design parameters – tray dryer (1), spray dryer (1), fluidized bed dryer (1) and freeze dryer (1)	1, 2	14	5
4	Construction of cold storages (2) and refrigerated vans (2); Types of freezers and their design parameters – plate contact freezer (1), air blast freezer (1), cryogenic freezer (1).	4	07	2
5	Bakery machines and equipment; Sheeting (1), mixing (1) and blending (1), Process design and equipment for Extrusion (2) and other non thermal processing (2)	3	07	2
6	Food processing Plant layout (1), CGMP (1), material of construction and corrosion (1), waste utilization (1). Process control, optimization (1) and preliminary project costing (1).	5	06	2

List of Text Books/ Reference Books

1) Fundamentals of Food Process Engineering, Toledo RT, 2000, Chapman and Hall.
2) Elements of Food Engineering, Watson EL and Harper JC, 1989, The Avi Publishing Co.
3) Food Process Engineering, Heldman DR and Singh RP, 1984, Chapman and Hall.
4) Engineering Economics, Dwivedi DN and Dwivedi A, 2005; Vikas Publishing House Pvt. Ltd.
5) Plant Layout and Material Handling, Apple JM, 1977, John Wiley & Sons.
6) Manufacturing Facilities, Design and Material Handling, Meyers FE and Stephens MP, 2000, Prentice Hall.

	Course Outcomes (students will be able to ...)
1	Explain and develop basic flow sheet in food processing operations (K1, K2, K3)
2	Describe the design aspects of different thermal processes and equipment (K1, K2).
3	Describe the design aspects of different non-thermal processes and bakery equipment (K1, K2).
4	Explain the cooling technology involved in food processing operations and design the cold storage and refrigerated vans (K1, K2, K3)
5	Explain the critical process control parameters and develop plant layout of a food industry (K2, K3, K4)

Course Outcomes (CO) and Program Outcomes (PO) mapping

	Graduate Attributes or Program Outcomes (PO)												**PSO**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CO1	3	3	1	2	-	-	-	-	-	1	-	1	2	-
CO2	3	3	3	2	-	-	-	-	-	-	-	1	3	-
CO3	3	3	3	2	-	-	1	-	-	-	-	1	3	-
CO4	3	3	3	2	-	-	-	-	-	-	-	1	2	-
CO5	3	3	2	2	-	-	-	-	-	1	1	-	2	-

3 Strong Contribution
2 Moderate Contribution
1 Low Contribution
– No Contribution

PO1 Engineering knowledge
PO2 Problem analysis
PO3 Design & Development of Solutions
PO4 Investigation of Problem
PO5 Modern tool usage
PO6 Engineer and society
PO7 Environment& sustainability
PO8 Ethics
PO9 Individual & team work
PO10 Communication
PO11 Lifelong learning
PO12 Project management & finance
PSO1 Able to have knowledge for higher studies
PSO2 Able to involve in consumer awareness program and food regulations

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

List of Prerequisite Courses

Chemistry of Food Constituents, Food Chemistry, Food Additives and Ingredients, Principles of Food Preservation

List of Courses where this course will be prerequisite

Food Processing and Product Development Lab, Food Safety, Quality & Regulations

Description of relevance of this course in the B. Tech Food Engineering and Technology

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.

	Course contents (topics/subtopics)	Related CO	Required hours (30)
1	Fruits and Vegetables: Types, development, maturity indices and overall quality of fruit and vegetables for harvesting.	**1**	**03**
2	Post harvest handling, storage, ripening and control of ripening, etc. of fruits and vegetables	**1, 2**	**03**
3	Fruits: Processing techniques, juices, concentrates, preserves and other traditional products.	**1, 3**	**08**
4	Vegetables: Processing techniques, pickles, fermented pickles and other traditional products.	**1, 4**	**05**
5	Tubers: Processing and products	**5**	**03**
6	Dehydrated and specialty products and by-products of fruits and vegetables	**6**	**04**
7	Honey, Sugars and saccharine products. Soft drinks, fermented pickles.	**7**	**04**

List of Text Books/ Reference Books

1. Post harvest biotechnology of vegetables, Salunkhe D.K.
2. Post harvest biotechnology of fruits, Salunkhe D.K.
3. Handbook of fruits science and tech. Salunkhe D.K. and Kadam S.S.
4. Handbook of vegetable science and tech. Salunkhe D.K. and Kadam S.S.

Course Outcomes (students will be able to ...)

1	Describe the overall development and quality of fruits, vegetables and tubers
2	Explain the post harvest handling, storage and ripening process
3	Describe the different methods/techniques for processing of fruits
4	Describe the different methods/techniques for vegetable processing
5	Describe the understand different methods/techniques for processing of different tubers

6	Explain various by-products from fruit, vegetable and tuber processing industry
7	Describe the applications of honey, sugar, saccharine in products and soft drink

	Course Code: FDT 1026	Course Title: Food Biotechnology (Elective-I)		Credits = 2		
				L	T	P
	Semester: VIII	Total contact hours: 45		2	1	0

List of Prerequisite Courses

Biochemistry

List of Courses where this course will be prerequisite

None

Description of relevance of this course in the B. Tech Food Engineering and Technology

Course objectives

4. To describe the fundamentals of molecular biology, chemistry, biology and different mechanism of DNA, RNA and proteins
5. To explain the regulations in gene expression and recombinant DNA technology in prokaryotes and eukaryotes
6. To describe different techniques and mechanisms involved in industrial fermentation processes
7. To describe tissue culture and microalgae technique as a tool of food biotechnology
8. To describe the facts of genetically modified food and nutritional genomics applied in

	Course contents (topics/subtopics)	Related CO	Required hours (45)
1	Introductory 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	1	10
2	Regulation of gene expression in prokaryotes and eukaryotes. Recombinant DNA technology with examples	2	10
3	Introductory aspects of biochemical engineering and bioreactor designs; Application of genetic control mechanisms in industrial fermentation processes; Principles of surface and solid-state fermentations; Fermentation media and sterilization; Basics of strain improvement techniques	3	10
4	Plant tissue culture; use of microalgae in biotechnology. Tissue culture (animal/insect cell) as a tool of biotechnology; Genetically modified food – plant and animal origin; Nutritional genomics	4,5	10
5	Applications of enzymes in industry with case studies	3	5

List of Text Books/ Reference Books

4. Basic molecular and Cell Biology 3rd edition Ed. David Latchman. BMJ Publishing Group 1997. 1st Indian reprint 2006.
5. Gene cloning and DNA analysis. An Introduction 4th edition. T.A.Brown. Publishers Blackwell Sciences Ltd. UK 2001.
6. Introduction to plant biotechnology. H.S. Chawla 2nd edition. Publishers Oxford and IBH Publ. Co. Pvt. Ltd., New Delhi. 2009.
7. Cell and tissue culture; laboratory procedures in biotechnology. A. Doyle and J.B. Griffiths. John Wiley & Sons, Chichester, UK. 1998.
8. Fermentation Biotechnology: Principles, Processes and Products, Ward OP, 1989, Prentice-Hall.

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

1	Describe the fundamentals of molecular biology, chemistry, biology and different mechanism of DNA, RNA and proteins (K1, K2).
2	Explain the regulations in gene expression and recombinant DNA technology in prokaryotes and eukaryotes (K1, K2)
3	Describe different techniques and mechanisms involved in industrial fermentation
4	Describe and apply tissue culture and microalgae technique as a tool of food biotechnology (K1, K2, K3)
5	Describe the facts of genetically modified food and nutritional genomics applied in food systems (K1,K2)

CO-PO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
1	3	3	1	2	-	-	1	-	-	-
2	3	3	2	1	-	-	1	-	-	-
3	3	3	3	2	-	-	1	-	-	-
4	3	3	2	1	1	-	1	-	-	-
5	3	3	2	1	1	-	2	1	-	-

	Course Code: FDP1019	Course Title: Food Processing and Product Development	Credits = 4		
			L	T	P
	Semester: VI	Total contact hours: 120	0	0	8

List of Prerequisite Courses

Principles of Food Preservation, Food Engineering

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 and Technology)

Course Objectives:

1. To analyze 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

	Course Contents	Class (each of 4h)	Related COs
1	Preparation of mango products (minimum three types)	2	1, 2, 3, 4, 5
2	Preparation of apple products (minimum three types)	1	1, 2, 3, 4, 5
3	Preparation of pineapple products (minimum three types)	1	1, 2, 3, 4, 5
4	Preparation of guava products (minimum three types)	2	1, 2, 3, 4, 5
5	Preparation of lime products (minimum three types)	1	1, 2, 3, 4, 5
6	Preparation of tomato products (minimum three types)	1	1, 2, 3, 4, 5
7	Preparation of coconut products (minimum three types)	1	1, 2, 3, 4, 5
8	Preparation of salad dressing, mayonnaise and peanut butter	1	1, 2, 3, 4, 5
9	Preparation of fried products	1	1, 2, 3, 4, 5
10	Preparation of bread (three types)	2	1, 2, 3, 4, 5
11	Preparation of cakes (three types)	2	1, 2, 3, 4, 5
12	Preparation of biscuits (six types)	3	1, 2, 3, 4, 5
13	Preparation of rice products (minimum three types)	2	1, 2, 3, 4, 5
14	Preparation of milk products (minimum five products)	2	1, 2, 3, 4, 5
15	Preparation of fermented food products (minimum three types)	2	1, 2, 3, 4, 5
16	Preparation of fish and chicken products (minimum two of each type)	2	1, 2, 3, 4, 5
17	Preparation of white and red wine	2	1, 2, 3, 4, 5
18	Preparation of confectionary products (minimum three types)	2	1, 2, 3, 4, 5

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.

	Course Outcomes (students will be able to…..)
1	Apply the knowledge of material balance specific to different food processing operations (K1)
2	Explain the major processing steps applied for food preparations (K2)
3	Use different food processing equipment specific to the product (K3)
4	Develop protocol for different types of food preparations (K4)
5	Apply the engineering principles to design novel food product and process (K4).

Course Outcomes (CO) and Program Outcomes (PO) mapping

	Graduate Attributes or Program Outcomes (PO)												PSO	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CO1	3	2	2	1	–	–	–	–	–	–	–	–	3	–
CO2	3	2	2	–	–	–	–	–	–	–	–	–	1	–
CO3	3	3	2	–	–	–	–	–	–	–	–	–	1	–
CO4	3	3	3	2	1	–	–	–	–	–	–	–	1	–
CO5	3	3	3	3	1	–	–	–	–	–	–	–	2	–

3 Strong Contribution
2 Moderate Contribution
1 Low Contribution
– No Contribution

PO1 Engineering knowledge
PO2 Problem analysis
PO3 Design & Development of Solutions
PO4 Investigation of Problem
PO5 Modern tool usage
PO6 Engineer and society
PO7 Environment& sustainability
PO8 Ethics
PO9 Individual & team work
PO10 Communication
PO11 Lifelong learning
PO12 Project management & finance
PSO1 Able to have knowledge for higher studies
PSO2 Able to involve in consumer awareness program and food regulations

	Course Code: FDP 1018	Course Title: Food Analysis - I (Chemical)	Credits = 2		
			L	T	P
	Semester: VI	Total contact hours: 15			4

	List of Prerequisite Courses	
	Technical Analysis I, Technical Analysis II, Food chemistry Lab	

	List of Courses where this course will be prerequisite	
	Analysis of Foods (Instrumentation), Principle of food analysis (Theory course), Food product development	

Description of relevance of this course in the B. Tech Food Engineering and Technology

Course objectives

- 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
- To train them for the understanding of nutritional labeling

	Course contents(topics/subtopics)	Required hrs
1	Analysis of tea and coffee	01
2	Analysis of liquid milk, condensed milk and skim milk powder	02
3	Analysis of honey and golden syrup	01
4	Analysis of wheat flour	01
5	Analysis of beer and wine	02
6	Analysis of jam, jelly and squash	02
7	Analysis of fish	01
8	Analysis of spices	01
9	Analysis of vinegar	01
10	Analysis of ghee and edible oil	01
11	Analysis of bread	01
12	Analysis of Cake, Biscuits	01

	Course Outcomes (students will be able to.....)
1	Be able to use the laboratory techniques common to basic and applied food science
2	Understand the principles behind analytical techniques associated with food
3	Be able to select the appropriate analytical technique when presented with a practical problem
4	Demonstrate practical proficiency in a food analysis laboratory
5	Able to explain the knowledge of redox chemical reactions to develop a protocol for analyzing specific food attributes (K1)
6	Able to explain the major chemical techniques used in the food analysis (K2)
7	Able to use different chemical analysis techniques specific to food (K3)
8	Able to analyze different chemical techniques integrated to food analysis (K4)

	Course Code: FDP 1021	Course Title: Food Analysis - II (Instrumentation)	Credits = 2		
			L	T	P
	Semester: VI	Total contact hours: 15			4

List of Prerequisite Courses

	Technical Analysis I, Technical Analysis II, Food chemistry Lab, Food Analysis I, Principle of Food Analysis (Theory course)	

List of Courses where this course will be prerequisite

	Analysis of Foods (Instrumentation), Principle of food analysis (Theory course), Food product development	

Description of relevance of this course in the B. Tech Food Engineering and Technology

Course objectives

- 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

	Course contents(topics/subtopics)	Required hrs
1	Analysis of food samples for calorific value using bomb calorimeter	01
2	UV-Vis Spectro-photometric analysis of a carotenoid	01
3	Hunter Lab colorimetric studies of food samples.	01
4	Texture analysis of food samples.	01
5	Rheology of food samples	01
6	Sensory evaluation of foods	03
7	Gas chromatographic analysis of food constituents	01
8	Densitometric (HPLTC) assay of food constituents	01
9	HPLC separation of food constituents	01
10	Differential scanning calorimetry (DSC) for food samples	01
11	Polarimetric estimation of sugars	01
12	Conductometric analysis of polyelectrolytes in solution	01
13	Atomic absorption spectroscopic analysis of heavy metals in foods	01
	Course Outcomes (students will be able to.....)	
1	Understand the appropriate instrumental method when presented with a practical problem	
2	To demonstrate practical proficiency in a food analysis laboratory using advanced instruments	
3	Describe 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	
4	Choose appropriate techniques for foods and when/how to use them in a food processing environment/situation such as QA&/QC	

	Course Code: FDT 1025	Course Title: Technology of Dairy, Animal and Plantation Products	Credits = 42		
			L	T	P
	Semester: VI	Total contact hours: 60	3	1	

List of Prerequisite Courses		
	Chemistry of Food Constituents. Food Chemistry,	

List of Courses where this course will be prerequisite		
	Food processing and Engineerin	

Description of relevance of this course in the B. Tech Food Engineering and Technology

Course objectives

	Course contents(topics/subtopics)	Required hrs
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	Milk substitutes, casein and caseinates, lactose, whey protein concentrates and isolates, milk co-precipitates, and other specialty products.	03
4	Traditional dairy products, milk confections such as *yoghurt, dahi, khoa, burfi, kalakand, gulabjamun, rosogolla, srikhand, chhana, paneer, ghee, lassi* etc. Probiotic milk products.	03
5	Slaughtering technique of animal and slaughtering practices; Meat cuts and portions of meat. Post mortem changes in meat; Conversion of muscle to meat; Color of meat; Meat microbiology and safety Meat processing- Smoking and Curing; Prepared meat products including fermented meats. Frozen meat and meat storage; Packaging of meat products. Meat plant hygiene – GMP and HACCP. By-products from meat industries and their utilization; Meat industries in India	08
6	Classification of fresh water 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.	07
7	Classification of poultry meat; Composition and nutritional value of poultry meat and eggs. Processing of poultry meat and eggs; Spoilage and control. By-product utilization; Poultry farms in India	04
8	Varieties of spices/condiments grown and consumed in various countries. Post harvest handling/storage/preservation/processing	05
9	Processing of tea. Varieties and processing, green tea, oolong tea, black tea, antioxidant properties	04
10	Processing of coffee and cocoa	06
11	Miscelleneous products including sugar from sugarcane, confectionery gums etc. from plants	02

12	Milk components, composition and types; raw milk quality and processing (HTST/UHT, homogenization), CIP/COP/distribution/packaging/fermented milks/bulk starter cultures	04
	Course Outcomes (students will be able to.....)	
1	Able to explain fundamental knowledge on plantation crops/animal based products/dairy based products	
2	Able to explain the facts and unit operations/flow sheet of manufacture and technologies involved in the processing/food plant sanitation of different plantation crops/animal products/milk and dairy products	
3	Able to apply techniques suitable for the extraction/isolation of high value compounds from plantation crops/milk/animal products	
4	Able to develop/design/modify new products/processes for value-addition of plantation crop/dairy/animal products	
5	Able to explain the causes related to any aspect of quality/spoilage and processing of dairy/plantation crops/animal based products and do troubleshooting	

Graduate Attribute No.	Actual attribute	CO1	CO2	CO3	CO4	CO5
1	Engineering knowledge	1	2	2	3	1
2	Problem analysis	1	2	1	3	2
3	Design & Development of Solutions	2	2	2	3	3
4	Investigation of Problem	3	2	2	3	3
5	Modern tool usage	2	2	2	2	2
6	Engineer and society	1	3	2	3	1
7	Environment& sustainability	2	2	1	2	2
8	Ethics	-	-	1	1	2
9	Individual & team work	1	2	2	3	2
10	Communication	1	2	2	2	2
11	Lifelong learning	3	3	3	3	3
12	Project management & finance	2	1	2	2	1
PSO1	Able to have knowledge for higher studies	3	3	3	3	3
PSO2	Able to involve in consumer awareness program and food regulations	2	2	2	2	2

3	Strong Contribution
2	Moderate Contribution
1	Low Contribution
-	No Contribution

Suggested reading:

1. Spices – J.W. Purseglove, E.G. Brown and C.L.Green
1. Handbook of herbs and spices – K.V. Peter
2. Chocolate, cocoa and confectionery : Science and Technology – 3rd Edition 1989 Minifie
3. Industrial Chocolate Manufacture and Use, Edited by Stephen Beckett, 4th Edition Publisher Wiley Blackwell, ISBN: 978-1-4051-3949-6
4. Processed Meats, Pearson AM and Gillett TA, 3rd edition, 1999, An Aspen publication.

5. Development in Meat Science (Development series 3, Lawrie RA, 1981, Applied Sciences.
6. Egg and Poultry Meat Processing – Stadelman WJ, Olson VM, Shemwell GA and Pasch S, 1988, Ellis Horwood Ltd.
7. Fish as Food – Vol 1 & 2 – Borgstrom G, 1988, Academic Press.
8. Advances in Fish Processing technology, Sen DP, 2005, Allied Publishers Pvt. Ltd.
9. Aneja *et al.* 2002. Technology of Indian Milk Products. Dairy India Publ. De S.1980. Outlines of Dairy Technology. Oxford Univ. Press.
10. Rathore,NS et al. 2008.Fundamentals of Dairy Technology- Theory & Practices. Himanshu Publ
11. Walstra et al. 2006. Dairy Science and Technology. 2nd Ed. Taylor & Francis.
12. Web BH. et al. 1987. Fundamental of Dairy Chemistry. 3rd Ed. AVI Publ.
13. Walstra et al. 1999. Dairy Technology. Marcel Dekker.

	Course Code: FDT 1023	Course Title: Technology of Cereal, Legume and oilseeds	Credits = 4		
			L	T	P
	Semester: IV	Total contact hours: 60	3	1	0

List of Prerequisite Courses

	Chemistry of food constituents, basic knowledge of food science, food processing and food chemistry, food biochemistry	

List of Courses where this course will be prerequisite

	Food Engineering and Product Development	

Description of relevance of this course in the B. Tech Food Engineering and Technology

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.

	Course contents(topics/subtopics)	Required hrs
1	Processing of grains (01), different milling technology (include chakki, roller mills) used on wheat and rice (02). Milling unit operations and process flow of Milling (01), Milling losses and Milling Efficiency (01)	05
2	Process of parboiling in rice milling (01), processing of pearling in barley (01). Wheat: Processing of Maida, Suji resultant atta and chakki atta (01) Different Indian wheat variety and it's impact on flour quality. Biscuit Maida, Bread Maida, Speciality Maida based on protein quantity and quality (03). Dough rheology and its impacts on final product quality, unit operations in manufacturing Breads and other flavour based products (01). Chapatti atta manufacturing using Chakki, (include flow sheet), impact of wheat and it's processing on eating quality of chapatti (01),. Corn: Manufacturing process of corn starch, corn grits corn flakes(01). Oats: Processing and oats milling, Flaked oats in breakfast cereals, Malting process and malt based foods (01).	10
3	Bakery Products: Biscuits, Breads, Cakes, Different types of biscuits, short, hard and fermented Biscuits (02), Advanced bakery products such as croissants, puffs, muffins and filled cookies and muffins (01), Different functional ingredients used in baking (01), New trends in bakery, such as Gluten free, multigrain biscuits etc. (01)	05
4	Other cereal based products, traditional Indian Foods (Namkin and Samosas and extruded, puffed) (02), Traditional Breakfast fermented products like idli, Dossa, Appam (01).	03

5	Processing and technology of legumes such as Moong, Channa, Arhar, Urd, whole as well split dal (03). Technology of oilseeds such as peanut, sesame, sunflower etc (02). Utilisation in food industry as protein and oil source and their use in Indian diet (02).	**07**
Course Outcomes (students will be able to.....)		
1	Develop a critical understanding of the uniqueness of cereal grain, legume and oilseed in the world food supply and the scientific nature of the functionality and inter-relationships of the key constituents in them for food utilization. (K1, K2, K3,K4)	
2	Develop competency to critically evaluate quality of finished baked products in terms of underlying properties of flour, dough/batter, ingredient function, product formulation and processing, and molecular mechanisms.	
3	Able to explain and apply different processing operations applied to legume and oilseed based products (K1, K2, K3)	
4	Able to describe the processing methods applied for wheat, malt and their products (K1, K2)	
5	Able to explain different baking operations involved in the processing of cereal products (K1, K2)	
6	Able to explain and apply the technology involved in extruded, puffed and fermented cereal, legumes and oilseeds products and Indian traditional products (K1, K2, K3)	

Suggested reading

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 Code: FDT 1051	Course Title: Nutraceuticals and Functional Foods		Credits 2		
				L	T	P
	Semester: VI	Total contact hours: 45		2	1	0

List of Prerequisite Courses

Nutrition, Biochemistry

- *Digestive system for understanding the bioavailability*

List of Courses where this course will be prerequisite

None

Description of relevance of this course in the B. Tech Food Engineering and Technology

Course objectives

1. To understand the fundamental knowledge on various nutraceuticals and functional foods and their mechanism
2. To explain the basics of nutrigenomics and its relation with nutraceuticals
3. To describe the basic terminologies and regulatory issues in the field of their applications
4. To explain the roles of various nutraceuticals in different physiological conditions
5. To know the manufacturing of different functional foods and nutraceuticals

	Course contents (topics/subtopics)	Related CO	Required hours (45)
1	Introduction to nutraceuticals: definitions, synonymous terms, basis of claims for a compound as a nutraceuticals, regulatory issues for nutraceuticals including CODEX; nutrigenomics - an introduction and its relation to nutraceuticals	1	9
2	Clinical testing of nutraceuticals and health foods; interactions of prescription drugs and nutraceuticals; adverse effects and toxicity of nutraceuticals	2	9
3	Concept of angiogenesis and the role of nutraceuticals/functional foods; Nutraceuticals for life-style associated diseases such as atherosclerosis, heart disease and stroke; obesity and type 2 diabetes; and diseases associated with smoking and alcohol and drug abuse and their mechanisms of action, dosage levels, contraindications if any etc.	3	9
4	Nutraceuticals for aging associated diseases such as cancer, arthritis, cataracts, osteoporosis, type 2 diabetes, 36hypertension and Alzheimer's disease, age related macular degeneration and their mechanisms of action, dosage levels, contraindications if any etc.	4	9
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	5	9

List of Text Books/ Reference Books

1. Joyce I. Boye, Nutraceuticals and Functional Food Processing Technology, Wiley-Blackwe
2. Aluko Rotimi E. Functional Foods and Nutraceuticals, Food Science Text Series, Springer 2
3. Brian Lockwood, Nutraceuticals: A Guide for Healthcare Professionals, Pharmaceutical Pre 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.
7. 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 ...)	
1	Describe the fundamental knowledge on various nutraceuticals and functional foods and their mechanism (K1 & K2)
2	Explain the basics of nutrigenomics and its relation with nutraceuticals (K1,&K2)
3	Describe the basic terminologies and regulatory issues in the field of their applications (K2)
4	Explain the roles of various nutraceuticals in different physiological conditions (K2)
5	Describe the manufacturing of different functional foods and nutraceuticals (K2)

CO and PO mapping:

CO's	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PO 13	PO 14
1	3	1	1	1	–	3	1	–	–	–	1	–	1	–
2	3	1	1	1	–	1	1	–	1	–	1	–	3	2
3	3	1	3	3	–	3	3	–	–	–	3	–	3	–
4	3	3	1	1	–	1	3	–	–	–	1	–	3	–
5	3	2	1	3	–	3	1	–	–	–	3	–	1	–
6	3	1	1	1	–	3	1	–	–	–	1	–	1	–

No relation '-' Low 1 Moderate 2 High 3

	Course Code: FDP 1023	**Course Title: Seminar**		**Credits 2**		
				L	**T**	**P**
	Semester: VI	**Total contact hours: 45**		**0**	**0**	**4**

	Course Code: FDP 1024	**Course Title: Project -I**		**Credits 4**		
				L	**T**	**P**
	Semester: VI	**Total contact hours: 45**		**0**	**0**	**8**

	Course Code: FDT 1028	Course Title: Food Safety and Quality Regulations		Credits = 2		
				L	T	P
	Semester: VIII	Total contact hours: 45		2	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 Engineering and Technology

Course objectives

9. To explain the functional role and safety issues of food contaminants, food adulteration,
10. To describe the hygiene and sanitation in food processing plant, equipment, storage and handling
11. To explain the various quality attributes of food and emphasizing on microbial quality control in food and water quality
12. To identify and analyze the critical quality control point in different stages of production of food and thereby designing the HACCP system

	Course contents (topics/subtopics)	Related COs	Required hours (45)
1	Introduction to food safety and security: Hygienic design of food plants and equipment, Food Contaminants (Microbial, Chemical, Physical), Food Adulteration (Common adulterants), Food Additives (functional role, safety issues), Food Packaging & labelling. Sanitation in warehousing, storage, shipping, receiving, containers and packaging materials. Control of rats, rodents, mice, birds, insects and microbes. Cleaning and Disinfection	1,2	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.	3	8
3	Critical Quality control point in different stages of production including raw materials and processing materials. Food Quality and Quality control including the HACCP system. Food inspection and Food Law.	4	8
4	Indian and global regulations: FAO in India, 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.	5	14

List of Text Books/ Reference Books	
12. Handbook of Food Toxicology by S. S. Deshpande 13. The Food Safety Information Handbook by Cynthia A. Robert, 2009 14. Nutritional and Safety Aspects of Food Processing by Tannenbaum SR 15. Microbiological Safety of Food by Hobbs BC, 1973 16. Food Safety Handbook by Ronald H. Schmidt, Gary E. Rodrick	
Course Outcomes (Students will be able to ...)	
1	Describe the functional role and safety issues of food contaminants, food adulteration, food additives, food packaging & labeling (K1, K2).
2	Design the hygiene and sanitation in food processing plant, equipment, storage and handling (K1, K2, K3)
3	Analyze the various quality attributes of food and especially on microbial quality control of food and water in Food Processing Industry (K1, K2)
4	Identify and analyze the critical quality control point in different stages of production of food and thereby designing the HACCP system. (K1, K2, K3, K4)
5	Explain the role, standard and law set by Indian and global regulatory authorities with respect to food quality control (K1, K2) (K2)

CO and PO mapping:

CO's	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PO13	PO14
1	3	3	1	2	-	2	2	-	-	-	-	2	2	3
2	3	3	2	1	-	2	1	-	-	-	-	2	3	3
3	3	3	3	2	-	2	1	-	-	-	-	2	3	-
4	3	3	2	3	-	2	1	-	-	-	-	2	2	3
5	3	3	2	1	-	3	2	-	-	-	-	2	2	3

No relation '-'
Low 1
Moderate 2
High 3

	Course Code: FDT 1019	Course Title: Food Packaging	Credits = 3		
			L	T	P
	Semester: VIII	Total contact hours: 45	2	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 Engineering and Technology

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

	Course contents(topics/subtopics)	Related COs	Required hours (45)
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; Levels of packaging; Food labeling	**CO1**	7
2	Different materials used in food packaging such as paper, board, glass, metal containers, aluminium foil, plastics, composites, traditional materials and their physico –chemical characteristics, their advantages and limitations, method of manufacture	**CO2**	8
3	Packaging of various food commodities including fresh produce (fruits and vegetables), meat, fish, poultry, milk and processed foods.	**CO3**	7
4	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	**CO4**	8
5	Food and Packaging material interactions including migration, scalping of flavour; biodegradable packaging; application of nanotechnology in food packaging; environmental concerns and lifecycle assessment	**CO5**	7
6	Newer packaging technologies- CAP/MAP packaging; aseptic processing and packaging; irradiated packaging; retort pouch; microwaveable packaging; packaging for high pressure processing; active packaging; smart/ intelligent packaging	**CO6**	8

List of Text Books/ Reference Books

1. Packaging Media by Paine F.A. Publisher: Blackie and son Ltd., Bishop Briggs (1977)
2. Food Packaging and Preservation : theory and practice by Mathlouthi.,M. Publisher Elsevier applied science publishers. London (1966)
3. Food and Packaging Interactions by Risch.S.H. Publisher American chemical society, Washington (1991).
4. Handbook of Food Packaging by F.A. Paine and H.Y. Paine Publisher: Blackie and son Ltd. London. (1983)
5. Food Packaging Technology (Vol.1 & 2) by G. Bureau and J.L.Multon, Publisher:VCH, New York (1996)
6. Packaging Materials and Containers by Paine, F.A.Publisher: Blackie and sons Ltd.., London, 1967.

Course Outcomes (students will be able to ...)	
1	justify the role of food packaging in food preservation
2	describe different food packaging materials and their properties
3	describe packaging of various food commodities
4	explain and interpret various tests used in evaluating quality and safety of food packaging
5	comprehend food and packaging material interactions
6	describe newer food packaging technologies

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2
CO 1	3	2	1	2	-	-	1	-	-	-	-	2	2	-
CO 2	3	2	1	2	-	-	1	-	-	-	-	2	2	-
CO 3	3	2	2	2	-	-	1	-	-	-	-	2	2	-
CO 4	3	2	2	2	-	-	1	-	-	-	-	2	2	-
CO 5	3	2	1	2	-	-	1	-	-	-	-	2	2	-
CO 6	3	2	2	2	-	-	1	-	-	-	-	2	2	-

No	Graduate attributes
1	Engineering knowledge
2	Problem analysis
3	Design & Development of Solutions
4	Investigation of Problem
5	Modern tool usage
6	Engineer and society
7	Environment& sustainability
8	Ethics
9	Individual & team work
10	Communication
11	Lifelong learning
12	Project management & finance

	Course Code: FDT 1052	Course Title: Principles of Food Analysis		Credits = 4		
				L	T	P
	Semester: VII	Total contact hours: 60		3	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 Engineering and Technology

Course objectives

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

	Course contents (topics/subtopics)	Related CO	Required hours (60)
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	1	8
2	Analysis of chemical constituents, their characterization and significance- moisture, ash, minerals, lipids, fat, proteins, fibre, titratable acidity, starch, reducing sugars	2	10
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	3	12
4	Analysis of vitamins, pigments, flavours, extraneous matter, pesticides and mycotoxins. Microscopic analysis of foods Other methods- potentiometry, enzymatic, immunoassays, thermal analysis. Analysis of genetically modified foods.	4	12
5	Techniques for sensory analysis – statistical techniques such as PCA, discriminant analysis etc.	1,3	5
6	Other techniques in food analysis – polarimetry, surface tensions, XRD, electronic tongue/nose	1,3	6
7	Life cycle analysis	5	5
8	Detection of irradiated foods	1,3	2

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. Notarnicola B. Salomone, R., Petti, L., Renzulli, P.A., Roma, R., Cerutti, A.K. (Eds) 2015 Life Cycle Assessment in the Agri-food Sector Springer International Publishing
9. Elvers B. 1992. Ullaman's Encyclopedia of Industrial Chemistry. Wiley Publishers.
10. Paré J.R.J. and Bélanger J.M.R.1997. Instrumental Methods in Food Analysis. Elseveir

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

1	To comprehend the basic principles of physical, chemical, biological and instrumental techniques used in food analysis for quality assurance (K1, K2, K3, K4, K5, K6)
2	Design labels for food products on the basis of food analysis (K2, K3 K4, K5, K6)
3	Able to develop analytical techniques for on-line monitoring of food quality during processing and storage (K2, K3, K4, K5, K6)
4	Ensure consumer safety through analysis of food contaminants and adulterants and apply them in the light of regulatory requirements (K1, K2, K3, K4, K5, K6)
5	Assess the environmental impact of products life from farm to fork.
6	Explain newer and relevant analytical techniques in food systems

CO and PO mapping:

CO's	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO8	PO9	PO 10	PO 11	PO1 2	PO1 3	PO1 4
1	3	3	2	2	2	-	2	-	1	2	1	-	3	2
2	3	2	2	2	1	-	1	1	1	1	2	-	3	2
3	3	3	1	2	1	1	1	-	1	1	1	-	2	1
4	3	1	1	1	-	-	-	1	1	1	1	-	2	3
5	3	3	2	3	3	3	3	3	1	1	2	2	3	2
6	3	3	2	2	3	1	1	1	1	1	1	2	2	2

No relation '-' Low 1 Moderate 2 High 3

	Course Code: FDT 1053	Course Title: Waste Management in Food Processing		Credits = 2		
				L	T	P
	Semester: VIII	Total contact hours: 45		2	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 Engineering and Technology

Course objectives

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

	Course contents (topics/subtopics)	Related CO	Required hours (45)
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.	1	10
2	Effluent and solid waste utilization food processing industry by biological methods – for SCP, biogas and other products	2	9
3	Waste management strategies and value added products from of agri-food processing industry	3	9
4	Recovery of biological from dairy, meat, fish and poultry processing industry	4	8
5	Case studies: Cane Sugar waste, molasses for alcohol, bagasse for paper pulp, chemicals, bioethanol, cogeneration. Other processes including vermiculture.	5	9

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. I Arvanitoyannis, 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 ...)	
1	To define and describe different terminologies in wastewater treatment (K1 & K2)
2	To describe different treatment methods used in wastewater treatment (K2)
3	To explain waste management strategies for food processing industries (K2)
4	To explain the recovery of biological from various food wastes (K2)
5	To design and develop waste treatment protocol for different food wastes (K3)

CO and PO mapping:

)'s	**)1**	**)2**	**)3**	**)4**	**)5**	**)6**	**)7**	**)8**	**)9**	**)10**	**)11**	**)12**	**)13**	**)14**
	3	1	1	1	–	3	3	–	–	3	–	–	2	1
	3	3	3	2	–	3	3	–	–	3	–	–	2	1
	3	3	3	3	–	3	3	–	–	3	–	–	3	1
	3	3	3	–	–	3	3	–	–	3	–	–	3	1
	3	3	3	3	–	3	3	–	–	3	–	–	3	1
	3	1	1	1	–	3	3	–	–	3	–	–	2	1

No relation '-' Low 1 Moderate 2 High 3

	Course Code: FDP 1025	**Course Title: Project -II**		**Credits 4**		
				L	**T**	**P**
	Semester: VI	**Total contact hours: 45**		**0**	**0**	**8**

	Course Code: FDP1023	Course Title: Food Processing and Engineering	Credits = 4		
			L	T	P
	Semester: VIII	Total contact hours: 120	0	0	8

List of Prerequisite Courses

Food Processing and Product Development, Food Engineering, Food Process Engineering

List of Courses where this course will be prerequisite

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Description of relevance of this course in the B. Tech (Food Engg and Technology)

Course Objectives:

9. To apply the food processing principles to develop a process for a food product.
10. To develop hands- on experience on different mechanical operations in food processes
11. To develop hand on experiences on different types of thermal operations in food process
12. Ability to analyze the integration of processing in food formulations

	Course Contents	Class (each of 4h)	Related COs
1	Particle size and sieve analysis of cereal and wheat flour	1	1, 2
2	Efficacy of size reduction process through hammer and ball mill	1	1, 2
3	Milling of grains: Estimating the milling efficiency	1	1, 2
4	Milk homogenization: Effect of product and process variables	2	1, 2
5	Effect of process parameters on viscosity of liquid food	2	1, 2
6	Rheological study of food slurry, paste and dough	2	1, 2
7	Estimating the mixing index in a food mixture (solid and liquid)	1	1, 2
8	Kinetic in thermal process design: Pasteurization of liquid food	2	1, 2
9	Thermal death time in Canning of fruits and vegetables	2	1, 2
10	Retort processing of vegetable products	1	1, 2
11	Effect of process and product parameters on baking of bread	2	1, 3
12	Effect of process and product parameters on baking of biscuit	2	1, 3
13	Effect of material and air properties on tray drying of food materials	2	1, 3
14	Effect of material and air properties on spray drying of food materials	2	1, 3
15	Freezing of food material (rate and time of freezing)	2	1, 3
16	Study of extraction of oleoresins from spices using liquid carbon dioxide	1	1, 3
17	Use of experimental design and sensory evaluation in product formulation: Beverage (fermented and non-fermented); premix	3	3, 4
18	Non-thermal processing of food	1	1, 2

List of Text Books/ Reference Books

5. Fuller, G.W. (2011). *New Food Product Development: From Concept to Marketplace*, 3rd ed, CRC Press, UK.
6. Barbosa-Cánovas, G. V., Ma, L., & Barletta, B. J. (1997). *Food Engineering Laboratory Manual*. CRC Press. UK
7. Ibarz, A., & Barbosa-Canovas, G. V. (2002). *Unit Operations in Food Engineering*. CRC Press, UK.

	Course Outcomes (students will be able to…..)
1	Apply the knowledge of different unit operations in developing a process specific to food (K3, K4, K5)
2	Analyze the effect of different process variables on the quality of food product (K4, K5)
3	Analyze the effect of compositional variables on quality of food products (K4, K5)
4	Design the food process and products using the experimental design concept (K3, K4, K5)

Course Outcomes (CO) and Program Outcomes (PO) mapping

	Graduate Attributes or Program Outcomes (PO)												PSO	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CO1	3	2	2	3	1	3	–	–	–	–	1	–	3	–
CO2	3	3	2	2	2	3	–	–	–	–	1	–	1	–
CO3	3	3	3	2	2	3	–	–	–	–	1	–	1	–
CO4	3	3	3	3	1	3	–	–	–	–	1	–	2	–

3 Strong Contribution
2 Moderate Contribution
1 Low Contribution
– No Contribution

PO1 Engineering knowledge
PO2 Problem analysis
PO3 Design & Development of Solutions
PO4 Investigation of Problem
PO5 Modern tool usage
PO6 Engineer and society
PO7 Environment& sustainability
PO8 Ethics
PO9 Individual & team work
PO10 Communication
PO11 Lifelong learning
PO12 Project management & finance
PSO1 Able to have knowledge for higher studies
PSO2 Able to involve in consumer awareness program and food regulations