SYLLABUS OF THE CURRICULUM

for

BACHELOR OF TECHNOLOGY

in

FOOD ENGINEERING AND TECHNOLOGY

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

Preamble

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

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

DEPARTMENT OF FOOD ENGINEERING AND TECHNOLOGY

Vision

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

Mission Statements

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

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

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

Program Educational Objectives (PEOs)

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

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

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

Consistency with PEOs with Department Mission

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

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

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

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

B. Tech. in Food Engineering and Technology

Syllabus Structure for B. Tech. First Year

Semester I									
Course Code	**Subjects**	**Credits**	**Hrs/Week**			**Marks for various Exams**			
			L	**T**	**P**	**C.A.**	**M.S.**	**E. S.**	**Total**
CHT1137	Organic Chemistry - I	3	2	1	0	10	15	25	50
CHT1341	Physical Chemistry - I	3	2	1	0	10	15	25	50
CHT1139	Industrial Inorganic 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	25	100
GEP1113	Engineering Graphics and Elementary Autocad	4	2	0	4	50		50	100
CHP1343	Physical and Analytical Chemistry Laboratory	2	0	0	4	25		25	50
	TOTAL:	**23**	**14**	**5**	**8**				**500**

Semester II									
Subject Code	**Subjects**	**Credits**	**Hrs/week**			**Marks for various Exams**			
			L	**T**	**P**	**C.A.**	**M.S.**	**E. S.**	**Total**
CHT1401	Analytical Chemistry	3	2	1	0	10	15	25	50
CHT1342	Physical Chemistry - II	3	2	1	0	10	15	25	50
CHT1138	Organic Chemistry - II	3	2	1	0	10	15	25	50
PYT1103	Applied Physics - II	3	2	1	0	10	15	25	50
MAT1102	Applied Mathematics - II	4	3	1	0	20	30	50	100
CET1507	Process Calculations	4	3	1	0	20	30	50	100
PYP1101	Physics Laboratory	2	0	0	4	25		25	50
CHP1132	Organic Chemistry Laboratory	2	0	0	4	25		25	50
HUP1101	Communication Skills	2	0	0	4	50			50
	TOTAL:	**26**	**14**	**6**	**12**				**500**

Syllabus Structure for B. Tech. Second Year

Semester III									
Subject Code	**Subjects**	**Credits**	**Hrs /week**			**Marks for various Exams**			
			L	**T**	**P**	**C.A.**	**M.S.**	**E.S.**	**Total**
BST1110	Basics of Biology and Applications to Technology	3	2	1	0	10	15	25	50
GET1110	Basic Mechanical Engineering	3	2	1	0	10	15	25	50
FDT 1011	SPL1: Chemistry of Food Constituents	4	3	1	0	10	15	50	100
CET 1302	Material Technology	3	2	1	0	10	15	25	50
BST 1102	Biochemistry	4	3	1	0	20	30	50	100
BST 1109	Microbiology	3	2	1	0	10	15	25	50
FDP 1014	PR1: Biochemistry	2	0	0	4	25		25	50
FDP 1013	PR2: Food Microbiology	2	0	0	4	25		25	50
	TOTAL:	**24**	**14**	**6**	**8**				**500**

Semester IV									
Subject Code	**Subjects**	**Credits**	**Hrs/week**			**Marks for various Exams**			
			L	**T**	**P**	**C. A.**	**M.S.**	**E. S.**	**Total**
GET1117	Engineering Mechanics and Strength of Materials	3	2	1	0	10	15	25	50
CET1105	Transport Phenomena	4	3	1	0	20	30	50	100
GET1105	Electrical Engineering and Electronics	3	2	1	0	10	15	25	50
FDT 1031	SPL2: Principles of Food Preservation	4	3	1	0	20	30	50	100
FDT 1014	SPL3: Food Microbiology	3	2	1	0	10	15	25	50
FDT 1015	SPL4: Nutrition	3	2	1	0	10	15	25	50
GEP1106	Electrical Engineering and Electronics Laboratory	2	0	0	4			25	50
MAP1201	Computer Applications Laboratory	2	0	0	4			25	50
	TOTAL:	**24**	**14**	**6**	**8**				**500**

Syllabus Structure for B. Tech. Third Year

Semester V									
Subject Code	**Subjects**	**Credits**	**Hrs /week**			**Marks for various Exams**			
			L	**T**	**P**	**C. A.**	**M.S.**	**E. S.**	**Total**
CET1401	Chemical Engineering Operations	3	2	1	0	10	15	25	50
CET1212	Chemical Reaction Engineering	3	2	1	0	10	15	25	50
FDT 1022	SPL5: Food Engineering	4	3	1	0	20	30	50	100
FDT 1032	SPL6: Food Chemistry	3	2	1	0	10	15	25	50
FDT 1052	SPL7: Principles of Food Analysis	3	2	1	0	10	15	25	50
MAT1106	Design and Analysis of Experiments	4	2	2	0	20	30	50	100
FDP 1011	PR3: Technical Analysis	4	0	0	8			50	100
FDP 1015	PR4: Food Chemistry	2	0	0	4			25	50
	TOTAL:	**26**	**13**	**7**	**12**				**550**

Semester VI									
Subject Code	**Subjects**	**Credits**	**Hrs/week**			**Marks for various Exams**			
			L	**T**	**P**	**C.A.**	**M.S.**	**E. S.**	**Total**
FDT 1027	SPL8: Food Process Engineering	4	3	1	0	20	30	50	100
FDT 1012	SPL9: Food Additives and Ingredients	4	3	1	0	20	30	50	100
FDT 1017	SPL10: Technology of Fruits, Vegetables and Tubers	3	2	1	0	10	15	25	50
HUT1103	Industrial Psychology & Human Resource Management	3	2	1	0	10	15	25	50
HUT1106	Environment Science and Technology	3	2	1	0	10	15	25	50
	Institute Elective – I	3	2	1	0	10	15	25	50
FDP 1033	Seminar	3	0	0	6				50
FDP 1034	PR5: Food Processing and Product Development	2	0	0	4	25		25	50
FDP 1018	PR6: Food Analysis-I	2	0	0	4	25		25	50
	TOTAL:	**27**	**14**	**6**	**14**				**550**

In-plant Training / Internship

- After the end of the sixth semester examination and before the start of the seventh semester, every student will have to undergo an internship. The Internship would be of 6 credits.
- The internship (preferably Industrial Internship) would be assigned to the student by the Departmental Internship Coordinator, with the approval of the Head of the Department.
- The total duration of the internship would be for a period equivalent to 12 Calendar weeks.
- This period typically start from 1st May and end before 30th July every year. This means the end semester examination of T. Y. Tech (Semester VI) should be completed by 25th April every year.
- The Semester VII (4th Year B.Tech.) should commence w.e.f. 1st Aug every year. The internship may be completed in one or more organizations as described below.

- The internship could be of the following forms:
  - Industrial internship in a company (within India or Abroad) involved in R & D/design/ manufacturing (QA/QC/Plant Engineering/Stores and Purchase)/marketing /finance/consultancy/Technical services/Engineering / Projects, etc.
  - Research internship in reputed Institutes (within India or Abroad) like, ICT, IITs, NITs, IISC, NCL, IICT etc.

- At the end of the internship, each student will submit a written report based on the work carried
- Out during the Internship. The report will be countersigned by the Supervisor from Industry/ Institute, as the case may be.
- Performance of the student will be assessed based on the written report and a presentation to a committee consisting of two faculty members from the Department.
- Students will be assigned a grade based on the written report and a presentation; evaluated by a committee of faculty members.

Syllabus Structure for B. Tech. Final Year

Semester VII									
Subject Code	**Subjects**	**Credits**	**Hrs/week**			**Marks for various Exams**			
			L	**T**	**P**	**C.A.**	**M.S.**	**E.S.**	**Total**
CET1703	Chemical Process Control	3	2	1	0	10	15	25	50
FDT 1024	SPL11: Technology of Plantation Products	3	3	1	0	10	15	25	50
FDT 1023	SPL12: Technology of Cereals, Legumes and Oilseeds	3	2	1	0	10	15	25	50
	Institute Elective- II	3	2	1	0	10	15	25	50
FDP 1035	In-plant Training	6	0	0	0				50
HUT1203	Industrial Management	4	3	1	0	20	30	50	100
CEP1714	Chemical Engineering Laboratory	2	0	0	4	25		25	50
FDP 1021	PR7: Food Analysis-II	2	0	0	4	25		25	50
FDP 1027	Project I	2	0	0	4				50
	TOTAL:	**28**	**12**	**5**	**12**				**500**

Semester VIII									
Subject 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
FDT 1033	SPL13: Technology of Dairy and Animal products	4	3	1	0	20	30	50	100
FDT 1028	SPL14: Food Safety, Quality and Regulations	3	2	1	0	10	15	25	50
FDT 1019	SPL15: Food Packaging	3	2	1	0	10	15	25	50
	Program Elective	3	2	1	0	10	15	25	50
	Pre-approved Open Electives from MOOOCs/NPTEL	3	2	1	0	10	15	25	50
FDP 1025	Project II	4	0	0	8				100
FDP 1026	PR8: Food Processing and Engineering	4	0	0	8	50		50	100
	Total	**27**	**13**	**6**	**16**				**550**

Institutional Electives Offered by Department of Food Engineering & Technology

Subject Code	Subject	Credit	Mark	Semester
FDT 1026	Food Biotechnology	**3**	**50**	**VI**
FDT 1051	Nutraceuticals and Functional Foods	**3**	**50**	**VII**

Program Electives Offered by Department of Food Engineering & Technology

Subject Code	Subject	Credit	Mark	Semester
FDT 1053	Waste Management in Food Processing	**3**	**50**	**VIII**
FDT 1034	Flavours and Flavourings in Food Products	**3**	**50**	**VIII**

Semester I

	Course Code: CHT1132	Course Title: Organic Chemistry - I	Credits = 3		
			L	T	P
	Semester: I	Total Contact Hours: 45	2	1	0

List of Prerequisite Courses

This is a Basic Organic Chemistry Course. The Organic Chemistry studied at HSC is the basis for building up Advanced Organic Chemistry knowledge.

List of Courses where this course will be Prerequisite

Organic Chemistry – II **(CHT1138)**, Biochemistry **(BST 1102)** and several Special Subjects of individual departments

Description of relevance of this course in the B. Tech. (Pharm. Chem. Tech.) Programme

To acquaint the students with IUPAC and other types of Nomenclature of organic compounds, fundamentals of Organic Chemistry including reaction mechanisms, organic transformations, types of reactions, selectivity of chemical transformations, etc., stereochemical implications of organic reactions, functional group identification and reactions

Sr. No.	Course Contents (Topics and Subtopics)	Required Hours
1	**a. IUPAC Nomenclature of Organic Compounds**	3
	b. Reactive intermediates Carbocations, Carbanions, Carbon radicals and Carbenes – Generation, Structure, Stability and Reactions	5
2	**Stereochemistry of Organic Compounds** containing one and two asymmetric carbon atoms, Stereo descriptors – R/S, E/Z, erythro and thero, Conformation – Ethane and butane Enantiomers and Diastereomers, meso compounds, different representations of stereoisomers – Saw-horse, Newmann, Wedge and dash and Fischer and their interconversions	8
3	**Haloalkanes** Aliphatic Nucleophilic Substitution Reactions: S_N1, S_N2 Elimination Reactions: E1, E2	7
4	**Chemistry of Carbonyl Compounds** Concept of acidity and tautomerism of carbonyl compounds, General methods of preparation and Nucleophilic Addition reactions Enolate chemistry, Aldol and related condensation reactions, Michael reaction, Robinson annulation, Claisen condensation, Dieckmann condensation, Mannich reaction	9
5	**Chemistry of Aromatic Compounds** Hückel rules, Aromatic, Non-aromatic and Anti-aromatic compounds, Benzenoid and non-benzenoid aromatic compounds	3
6	**Electrophilic Aromatic Substitution Reactions** Nitration, Halogenation, Alkylation, Acylation and Sulfonation Activating, deactivating and orienting effects of functional groups in mono- and poly-substituted benzenes Friedel-Crafts alkylation, Acylation, Gattermann, Gattermann-Koch, Riemer-Tiemann reactions	10
	Total	**45**

List of Text Books/Reference Books

1	Clayden, J., Greeves, N., Warren, S.; Organic Chemsitry; 2nd ed.; Oxford University Press (2012)
2	Graham Solomons, T. W.; Fryhle, Craig B.; Snyder, Scott A. Organic Chemistry; 12th Ed.; John Wiley & Sons. Inc. (2016)
3	Smith, M. B.; March's Advanced Organic Chemistry: Reactions, Mechanisms and Structure; 7th ed.; Wiley, India (2015)

4	Carey F. A., Sundberg, R. J. Advanced Organic Chemistry: Part A: Structure and Mechanisms; 5th ed.; Springer (2005)
5	Carey F. A., Sundberg, R. J.; Advanced Organic Chemistry: Part B: Reaction and Synthesis; 5th ed.; Springer (2007)
6	Wade, L. G.; Simek, J. W.; Singh, M. S. Organic Chemistry; 9th Ed.; Pearson Education (2019)
7	Eliel, E. L. Stereochemistry of Carbon Compounds; Mcgraw-Hill (2001)
8	Bruice, Paula, Y. Organic Chemistry; 8th Ed.; Pearson Education (2020)

Course Outcomes (Students will be able to…..)	
CO1	draw structures of organic compounds and write their IUPAC names correctly (K2)
CO2	appreciate the stereochemical implications of organic compounds and visualize and appreciate chirality concept (K2)
CO3	understand organic chemistry reactions related to aliphatic as well as aromatic compounds as well as decipher the outcome of a given organic transformation (K3)
CO4	interpret and analyze reactions having different functionalities, deduce and solve problems related to the reactions as well as apply them, if need be (K4)

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

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

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

	Course Code: CHT1341	Course Title: Physical Chemistry - I	Credits = 3		
			L	T	P
	Semester: I	Total Contact Hours: 45	2	1	0

List of Prerequisite Courses

Standard XII Chemistry

List of Courses where this course will be Prerequisite

Physical and Analytical Chemistry Laboratory **(CHP1343),** Physical Chemistry - II **(CHT1342)**

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

The course will enable the students to understand and apply the principles of thermodynamics to real-world systems. The students would be able to apply the insights to understand the stability of solutions, spontaneity of physical/chemical processes, effect of thermodynamics parameters on phase and chemical equilibria, etc.

Sr. No.	Course Contents (Topics and Subtopics)	Required Hours
1	**Introduction -** Thermodynamic systems, Work, Heat and Energy, State and Path functions, Intensive and Extensive variables	3
2	**First Law of Thermodynamics -** Enthalpy and heat capacities, Application of First Law to gases, Standard states, Enthalpy changes of chemical and physical conversions, Thermochemistry – Hess's Law	6
3	**Second and Third Laws of Thermodynamics -** Statements and applications of Second Law of thermodynamics, Clausius inequality, Entropy as a state function, Entropy changes for reversible and irreversible processes, Entropy and probability Third Law of Thermodynamics, Absolute entropies, Verification of Third Law	6
4	**Spontaneous Process and Equilibrium -** Combined statement of First and Second Laws of thermodynamics, Helmholtz and Gibbs free energy, Spontaneity and Free energy, Maxwell's relations, Effect of T and P on free energy, Van't Hoff equation, Free energy and equilibrium constant, Ellingham diagrams	7
5	**Multicomponent Systems -** Free energy and entropy of mixing, Partial molar quantities and chemical potential, Gibbs Duhem equation	5
6	**Phase Equilibria -** Gibbs Phase rule, Clausius- Clapeyron equation, Stability of phases, First and second order phase transitions, Phase diagrams of one and two two-component systems, l-L systems - TC, PC phase diagrams, distillation and azeotropes, L/S systems, S/S – eutectics and deep eutectics, Phase diagram of three-component systems	3
7	**Equilibrium in Solutions –** Ideal and non-ideal solutions, Henry's law and Raoult's law, Colligative properties Solubility Equilibria – Solubility constant, Common ion effect, Effect of added salts on solubility, pH, Weak and strong acids and bases, Buffer solutions, Ionic solutions, Activity and activity coefficients, Thermodynamic properties of electrolytes in solutions	6
8	Chemical Equilibria - Equilibrium constants, Le Chaterlier's principle, Effect of temperature, pressure and composition on equilibrium	6
9	Electrochemistry – Thermodynamics of electrochemical systems - Types of electrochemical cells, Determination of electrode potentials, Activity and activity coefficients, Dissociation of electrolytes, Ionic equilibria	3
	Total	**45**

List of Text Books/Reference Books

1	Atkins, Peter W.; Paula, Julio de; Keeler, James. Atkin's Physical Chemistry; 11th Ed.; Oxford University Press (2018)
2	Atkins, Peter W.; Paula, Julio de. Elements of Physical Chemistry; 7th Ed.; Oxford University Press (2017)
3	Levine, Ira. Physical Chemistry; 6th Ed.; McGraw-Hill Education (2009)

Course Outcomes (Students will be able to…..)	
CO1	comprehend the laws of thermodynamics and related concepts and to explain the molecular basis for the same (K2)
CO2	apply the concepts of partial molar quantities to explain the behaviour of pure substances and solutions (K3)
CO3	apply principles of phase equilibria in two- and three-component systems (K3)
CO4	elucidate the effect of thermodynamic quantities on chemical equilibria and relate it to properties of chemical systems (K2)

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

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

	Course Code: CHT1139	Course Title: Industrial Inorganic Chemistry	Credits = 3		
			L	T	P
	Semester: II	Total Contact Hours: 45	2	1	0

List of Prerequisite Courses

Standard XII Inorganic Chemistry

List of Courses where this course will be Prerequisite

Material Technology **(CET1302)**, Engineering Mechanics and Strength of Materials **(GET1117)**, Environment Science and Technology **(HUT1106)**

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

To acquaint the students with synthesis, properties and applications of various industrial inorganic chemicals

Sr. No.	Course Contents (Topics and Subtopics)	Required Hours
1	**Primary Inorganic Materials:** Water, Hydrogen, Hydrogen Peroxide and Inorganic Peroxo Compounds, Nitrogen, Ammonia, Nitric acid, and Nitrogen Compounds, Phosphorus, Phosphoric acid and its Compounds, Sulfur, Sulfuric acid and Sulfur Compounds, Halogens, Chloralkali and Halogen Compounds	12
2	**Metals and Their Compounds:** Alkali and Alkaline Earth Metals and their Compounds, Aluminum and its Compounds, Chromium Compounds and Chromium, Silicon and its Inorganic Compounds, Manganese Compounds and Manganese, Metallurgy of Iron	10
3	**Organo-Silicon Compounds:** Industrially Important Organo-silicon Compounds, Industrially Important Silanes, Silicones, Industrial Silicone Products	7
4	**Inorganic Solids:** Silicate Products, Inorganic Fibers, Construction Materials, Enamel, Ceramics, Metallic Hard Materials, Carbon Modifications, Fillers, Inorganic Pigments, Cement, Glass	8
5	**Nuclear Cycle:** Economic Importance of Nuclear Energy, General Information about the Nuclear Fuel Cycle, Availability of Uranium, Nuclear Reactor Types, Nuclear Fuel Production Disposal of Waste from Nuclear Power Stations	8
	Total	**45**

List of Text Books/ Reference Books

1	Büchel, Karl Heinz; Moretto, Hans-Heinrich; Woditsch, Peter. Industrial Inorganic Chemistry, Second, Completely Revised Edition; Wiley-VCH (2008)
2	Benvenuto, Mark Anthony. Industrial Inorganic Chemistry; de Gruyter (2015)
3	Swaddle, T. W. Inorganic Chemistry – An Industrial and Environmental Perspective; 1st Ed.; Academic Press (1997)
4	House, James, E. Inorganic Chemistry; 3rd Ed.; Academic Press, Inc. (2019)

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

CO1	Explain various industrial chemicals of nitrogen, sulfur, hydrogen, phosphorus and halogens (K2)
CO2	Explain and apply the concept the alkali and alkaline-earth metal based industrial chemicals, iron metallurgy (K3)
CO3	Explain inorganic solid materials like glass, silicone, cement, ceramics, etc. (K2)
CO4	Explain the concept of nuclear fuel and power industry (K2)

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

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

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

	Course Code: 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.

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

Applied Mathematics is beyond crunching numbers. It is useful for solving real-life problems and make an impact in the world, technology being one of those fields. The knowledge gained is required for solving various mathematical equations in several Chemical Engineering courses such as MEBC, Momentum Transfer, Reaction Engineering, Separation Processes, Thermodynamics, and several others.

Sr. No.	Course Contents (Topics and Subtopics)	Required Hours
1	**Linear Algebra:** Vectors in IR^n, Notion of linear independence and dependence. Vector subspaces of IR^n, Basis of a vector subspace, Row space, Null space, and Column space, Rank of a matrix, Determinants and rank of matrices Abstract vector spaces, Linear transformations in IR^n, Matrix of a linear transformation, Change of basis and similarity, Rank-nullity theorem, and its applications Inner product spaces, Orthonormal bases, Gram-Schmidt orthogonalization process, Eigenvalues and eigenvectors, Characteristic polynomials, Eigenvalues of special orthogonal projection and its application to least methods Diagonalization of matrices and its applications stochastic matrices, Solving initial value system of linear ordinary differential equations	15
2	**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. 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	15
3	**Integral Calculus:** Beta and Gamma functions, Differentiation under the integral sign, Multiple integrals, Line and surface integrals, Applications of Green's, Gauss-Divergence and Stokes theorems	15
4	**Probability & Statistics:** Random variables and cumulative distribution function, Probability mass function and probability density function, Some common univariate distributions: Binomial, Poisson, Uniform, exponential, Normal, Expectation and Moments, Moment generating function, Multiple random variables and Joint distribution, Marginal distributions, Covariance and Correlation Concept of parameter estimation: Maximum likelihood estimation, Method of least squares and Simple linear regression, Nonlinear regression	15
	Total	**60**

List of Textbooks/Reference Books

1	Stang, G. Linear Algebra and its Applications; 4th Ed.; Thomson (2006)
2	Anton, Howard; Kaul, Anton. Elementary Linear Algebra; 12th Ed.; Wiley (2019)
3	Friedberg, Stephen H.; Insel, Arnold J.; Spence, Lawrence E. Linear Algebra; 5th Ed.; Pearson Education (2019).
4	Hughes-Hallett, Deborah; Gleason, Andrew M.; McCallum, William G. Calculus: Single and Multivariable; 6th Ed.; John Wiley & Sons, Inc. (2012)
5	Kreyszig, E.; Advanced Engineering Mathematics; 10th Ed.; Wiley Global Education (2010) (Officially Prescribed)
6	Iyengar, S. R. K.; Jain, R. K. Advanced Engineering Mathematics; 4th Ed.; Alpha Science (2014)
7	Ross, Sheldon M. A First Course in Probability; 10th Ed.; Pearson Education (2018)
8	Hines, William W.; Montgomery, Douglas C.; Goldsman, David M.; Borror, Connie M. Probability and Statistics in Engineering; 4th Ed.; John Wiley & Sons, Inc. (2003)

9	Boes, Duane C.; Graybill, Franklin A.; Mood, Alexander McFarlane. Introduction To the Theory of Statistics; 3rd Ed.; McGraw Hill Education (India) (2013)
Course Outcomes (Students will be able to…..)	
CO1	understand the notion of differentiability and be able to find maxima and minima of functions of one and several variables (K3)
CO2	compute surface and volume integrals (K3)
CO3	Understand and explain the notion of vectors and vector spaces (K2)
CO4	solve systems of linear equations and eigenvalue problems analytically and numerically (K3)
CO5	fit relationship between two data sets using linear, non-linear regression (K3)

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

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

	Course Code: PYT1101	Course Title: Applied Physics – I	Credits = 4		
			L	T	P
	Semester: I	Total Contact Hours: 60	3	1	0

List of Prerequisite Courses

Standard XII Physics

List of Courses where this course will be prerequisite

Applied Physics – II **(PYT1103)**, Physics Laboratory **(PYP1101)**, 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.

Sr. No.	Course Contents (Topics and Subtopics)	Required 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 least squares and Simple linear regression, Nonlinear regression	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
	Total	**60**

List of Textbooks/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…..)	
CO1	apply acoustic cavitation of Chemical Engineering Processes (K3)
CO2	apply Bernoulli equation in simple pipe flows (K3)
CO3	explain the principles of lasers, types of lasers and applications (K2)
CO4	calculate resolving power of instruments (K3)
CO5	describe principles of optical fibre communication (K2)

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

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

	Course Code: GEP1113	Course Title: Engineering Graphics and Elementary AUTOCAD	Credits = 4		
			L	T	P
	Semester: I	Total Contact Hours: 90	2	0	4

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 Chemical Engineering student is required to know various processes and equipments used in the processes. Some of the elementary processes such as filtration, size reduction, evaporation, condensation, crystallization etc., are very common to all the branches of Technology. These and several other processes require machines and equipments. One should be familiar with the design, manufacturing, working, and maintenance of such machines and equipments. The subject of 'Drawing' is a medium through which, one can learn all such matters, because the drawings are used to represent the objects and the processes on paper. With the help of the drawings, a lot of accurate information is conveyed, which otherwise will not be practicable through spoken words or 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)	Required Hours
1	**Orthographic Projections:** Conversion of 3D object or pictorial view into front view, top view and side views using first angle method of projection Sectional views draw sectional front view, top view, and side view Problems with section plane cutting object exactly at centre or off centre Orthographic views of at least 15 machine parts using mini drafter and drawing board	20
2	**Isometric Projections and Isometric Views:** Isometric scale, draw pictorial view or 3D view using front and top view or front view and any one side view Machine parts with circle, semicircle in the orthographic views and slots on inclined planes At least 10 isometric drawings using mini drafter and drawing board	12
3	**Missing Views:** Draw top view when front and any one side view is given Draw any one side view or both the side views when front view and top view is given. Problems involving sectional views. At least 6 machine parts using mini drafter and drawing board.	12
4	**Assembly Drawing**: Draw front view and top view or side view of assembly after assembling all the details of machine parts Convert assembly into details Assembly drawing of Nut and bolt, footstep bearings, Plummer block, etc.	20
5	**Introduction to Computer-Aided Drawing:** Role of CAD in design and development of new products, Advantages of CAD. Creating two-dimensional drawing with dimensions using suitable software (Minimum 2 exercises mandatory) Introduction to Solid Modelling: Creating 3D models of various components using suitable modelling software (Minimum 2 exercises mandatory)	26
	Total	**90**

List of Textbooks/Reference Books

1	Bright, Steven. AutoCAD Fundamentals: A Comprehensive Guide on Engineering Drawing and Modeling (2020)
2	Rathnam, K. A First Course in Engineering Drawing; Springer (2017)
3	Agrawal, Basant. Engineering Drawing; McGraw-Hill Education (2015)
4	Bhatt, N. D. Engineering Drawing by N. D. Bhatt.; 11th Ed.; C. Publishing House Pvt. Ltd. (2011)
5	Shah, M. B.; Rana, B. C. Engineering Drawing; 2nd Ed.; Pearson Education (2014)
6	Giesecke, Frederick E.; Lockhart, Shawna; Goodman, Marla; Johnson, Cindy M. Technical Drawing with Engineering Graphics; 15th Ed.; Pearson Prentice Hall (2016)
7	Dubey, N. H. Engineering Drawing; 15th Ed.; Nandu (2015)

Course Outcomes (Students will be able to…..)	
CO1	prepare multi view orthographic projections of objects by visualizing them in different positions. (K3)
CO2	draw sectional views and develop surfaces of a given object. (K3)
CO3	prepare pictorial drawings using the principles of isometric projections to visualize objects in three dimensions. (K3)
CO4	prepare assembly drawing. (K3)
CO5	obtain Multiview projections and solid models of objects using CAD tools (K3)

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

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

	Course Code: CHP1343	Course Title: Physical and Analytical Chemistry Laboratory	Credits = 2		
			L	T	P
	Semester: II	Total Contact Hours: 60	0	0	4

List of Prerequisite Courses
Standard XII Chemistry Laboratory Course
List of Courses where this course will be prerequisite
This is a basic Course. This knowledge will be required in Applied Chemistry subjects later.
Description of relevance of this course in the B. Tech. Program
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

Sr. No.	Course Contents (Topics and Subtopics)	Required Hours
1	Experiments based on chemical reaction kinetics, phase equilibria and electrolyte systems, surface and interfacial phenomena such as surface tension and CMC measurements	4 hrs/session X 15 sessions
	Total	**60**

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…..)	
CO1	identify and determine physicochemical parameters using simple tools (K3)
CO2	interpretation of data and drawing scientific conclusions, dryers, etc (K4)

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

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

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

Semester II

	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

Standard XII Chemistry

List of Courses where this course will be prerequisite

Physical and Analytical Chemistry Laboratory (**CHP1343**)

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

The course introduces the students to key concepts of chemical analysis – sampling, selection of analytical method and data analysis. It presents basic techniques like spectroscopy and chromatography. The students should be able to select an appropriate analytical technique and apply it in accordance with its strengths and limitations.

Sr. No.	Course Contents (Topics and Subtopics)	Required Hours
1	Introduction to Chemical Analysis, Terminology (technique/method/procedure /protocol), Broad classification of analytical techniques, Good Laboratory Practices (GLP)	5
2	Sampling: Basics and procedures, preparation of laboratory samples Criteria for selecting analytical methods – accuracy, precision, sensitivity, selectivity, and detection limit Calibration and validation	8
3	Data Analysis: Errors – Systematic and random errors, statistical treatment of experimental results (F, Q and t tests, rejection of data, and confidence intervals), least square method, correlation coefficients	6
4	Spectroscopic Methods: General principle, instrumentation and applications of - UV-visible spectroscopy - Fluorescence spectroscopy	8
5	Electrochemical Methods: General principles, instrumentation and applications of – Conductometry, Potentiometry, Coulometry, Voltammetry	8
6	Chromatographic Methods: General principle, instrumentation and applications of - Gas chromatography (GC), High-performance liquid chromatography (HPLC), Ion-exchange chromatography, Size-exclusion chromatography	10
	Total	**45**

List of Textbooks/Reference Books

1	Modern Analytical Chemistry by David Harvey, McGraw-Hill, 1999.
2	Quantitative Analysis by R. A. Day and A. L. Underwood, Prentice Hall of India, 2001.
3	Instrumental Methods of Analysis by H. H. Willard, L. L. Merritt, J. A. Dean and F. A. Settle, Wadsworth Publishing, USA
4	Fundamentals of Analytical Chemistry by D. A. Skoog, D. M. West, F. James Holler and S. R. Crouch, Cengage Learning, 2014
5	Principles of Instrumental Analysis by D. A. Skoog, F. James Holler and S. R. Crouch, Cengage Learning, 2007

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

CO1	Apply the knowledge of sampling, data analysis and select proper analytical method (K3)
CO2	Explain the principles of UV Visible and Fluorescence spectroscopic methods (K2)
CO3	Explain the principles of electrochemical methods (K2)
CO4	Explain the principles of chromatographic methods (K2)

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

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

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

	Course Code: CHT1342	Course Title: Physical Chemistry - II	Credits = 3		
			L	T	P
	Semester: II	Total Contact Hours: 45	2	1	0

List of Prerequisite Courses

Standard XII Chemistry, Physical Chemistry - I **(CHT1341)**

List of Courses where this course will be prerequisite

Other Chemistry and Applied Chemistry courses

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

Students should learn to appreciate the relevance of kinetic studies and parameters affecting the same. The understanding of kinetic principles should be applied towards understanding complex reaction pathways and their mechanistic studies. The concept of interfaces and surfaces are instrumental in conveying the applications and importance of disperse systems.

Sr. No.	Course Contents (Topics and Subtopics)	Required Hours
1	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 Experimental methods of kinetic studies	3
2	Kinetics and reaction mechanism – rate determining step, steady state approximation Complex reactions- parallel, consecutive and reversible reactions Mechanism of thermal, photochemical chain reactions, polymerization reactions Fast reactions – experimental techniques	6
3	Homogenous catalysis – homogeneous acid / base catalysis (specific and general acid catalysis), enzyme catalysis (Michalis-Menten kinetics)	4
4	Reactions at interface – Adsorption isotherms, kinetics of surface reactions- Hishelwood and Rideal models of surface reactions	4
5	Theories of reaction rates - Theory of unimolecular reactions, collision theory and transition state theory, Effect of temperature, Solvent effects on reaction rates	6
6	Surface and interfacial Chemistry – introduction, surface tension and surface free energy, methods of determining surface and interfacial tensions	10
7	Thermodynamics of surfaces – surface excess, Gibbs adsorption equation, curved surfaces- bubbles, droplets and foams, Kelvin, Young Laplace and Thomson equations, homogeneous nucleation	4
8	Liquid-liquid and solid-liquid interfaces – contact angle, wetting and spreading, adhesion and cohesion, contact angle measurements and hysteresis	4
9	Surfactants: Types, adsorption at surfaces and interfaces, surfactant aggregates, factors affecting aggregation phenomena, applications of surfactants and mixed surfactant systems	4
10	Colloids: preparation, stability, characterization, surface charges and electrical double layer Emulsions: Thermodynamics and stability of emulsions, microemulsions and foams, HLB values	5
	Total	**45**

List of Textbooks/Reference Books

1	Physical Chemistry (11th edition) by P. W. Atkins, J. de Paula and J. Keeler, Oxford University Press, 2017.
2	Chemical Kinetics (3rd edition) by Keith J. Laidler, New York : Harper & Row, 1987.
3	Introduction to Colloid and Surface Chemistry (4th edition) by Duncan Shaw, Butterworth-Heinemann 2013.
4	Surfaces, Interfaces, and Colloids: Principles and Applications (2nd edition) by Drew Myers, John Wiley & Sons, Inc., 1999
5	Surfactants and Interfacial Phenomena (4th edition) by M. J. Rosen, John Wiley & Sons, Inc., 2012

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

CO1	comprehend fundamental knowledge in chemical kinetics with basics of order, molecularity and temperature effect (K2)

CO2	examine kinetics for complex, fast as well as surface reactions and comprehend different theories in kinetics (K4)
CO3	comprehend fundamental knowledge and thermodynamics in surface and interfacial chemistry (K3)
CO4	evaluate the behavior of surface-active agents and disperse systems based on the knowledge of interfacial phenomena (K4)

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

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

	Course Code: CHT1138	Course Title: Organic Chemistry - II	Credits = 3		
			L	T	P
	Semester: II	Total Contact Hours: 45	2	1	0

List of Prerequisite Courses

Organic Chemistry - I **(CHT1137)**

List of Courses where this course will be prerequisite

Other Chemistry and Applied Chemistry courses

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

To acquaint the students with concepts related to aromatic, heteroaromatic and pericyclic reactions so that they are perfectly aligned to apply the same for the future courses and in their professional career

Sr. No.	Course Contents (Topics and Subtopics)	Required Hours
1	Nitro and amino arenes Reactions, basicity of aminoarenes, diazotisation reactions	5
2	Aromatic nucleophilic substitution reactions Addition, elimination mechanism; elimination – addition mechanism (benzyne), Sandmeyer reaction	5
3	Pericyclic Reactions Symmetry of molecular orbitals, frontier orbitals of ethylene, 1,3-butadiene, 1,3,5-hexatriene and allyl system, classification of pericyclic reactions; Woodward-Hoffmann correlation diagrams, FMO and PMO approaches; electrocyclic reaction -conrotatory and disrotatory motions of 4n, 4n+2 and allyl systems; cycloaddition -antara facial and suprafacial addition, 4n and 4n+2 systems, 2+2 addition of ketenes, 1,3 dipolar cycloadditions and cheleotropic reactions; sigmatropic rearrangements - suprafacial and antarafacial shifts of hydrohen, sigmatropic shifts involving carbon moieties, 3,3- and 5,5-sigmatropic rearrangements, Claisen, Cope and Aza-Cope rearrangements, ene reaction.	13
4	Heteroaromatic compounds IUPAC nomenclature, structures and common names, comparison with benzenoid compounds, reactivity and synthesis – pyrroles, furans, thiophenes and pyridines	10
5	Named Organic reactions Perkin reaction (Mauvine synthesis-dyes), Fischer indole synthesis, (dyes), Jacobson Corey epoxide synthesis (Pharmaceutical), Ziegler Natta polymerisation (polymer), Multicomponent reactions, Mailard reaction (foods), Strecker amino acid synthesis (Pharmaceuticals & Food), Wittig reactions, Prilezhaev reaction	12
	Total	**45**

List of Textbooks/Reference Books

1	Clayden, J., Greeves, N., Warren, S.; Organic Chemsitry; 2nd ed.; Oxford University Press (2012)
2	Graham Solomons, T. W.; Fryhle, Craig B.; Snyder, Scott A. Organic Chemistry; 12th Ed.; John Wiley & Sons. Inc. (2016)
3	Smith, M. B.; March's Advanced Organic Chemistry: Reactions, Mechanisms and Structure; 7th ed.; Wiley, India (2015)
4	Carey F. A., Sundberg, R. J. Advanced Organic Chemistry: Part A: Structure and Mechanisms; 5th ed.; Springer (2005)
5	Carey F. A., Sundberg, R. J.; Advanced Organic Chemistry: Part B: Reaction and Synthesis; 5th ed.; Springer (2007)
6	Wade, L. G.; Simek, J. W.; Singh, M. S. Organic Chemistry; 9th Ed.; Pearson Education (2019)
7	Eliel, E. L. Stereochemistry of Carbon Compounds; Mcgraw-Hill (2001)
8	Bruice, Paula, Y. Organic Chemistry; 8th Ed.; Pearson Education (2020)

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

CO1	Explain the aromatic chemistry and interpret the outcome of general transformations (K3)
CO2	appreciate and visualize the reactions involving radicals such as cyclizations, pericyclic reactions in synthesis (K3)

CO3	understand the importance of heterocycles, learn the properties and synthetic routes, interpret IUPAC of compounds and decipher outcomes of various transformations involving heterocycles (K3)
CO4	apply the knowledge obtained through the course to predict the outcome of reactions and devise solutions to unknown problems (K3)

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

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

	Course Code: PYT1103	Course Title: Applied Physics - II	Credits = 3		
			L	T	P
	Semester: II	Total Contact Hours: 45	2	1	0

List of Prerequisite Courses

Standard XII Physics, Applied Physics – I **(PYT1101)**, Physics Laboratory **(PYP1101)**

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. Tech. Program

The knowledge gained from this course is 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.

Sr. No.	Course Contents (Topics and Subtopics)	Required 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
	Total	**45**

List of Textbooks/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	Solid State Physics – A. J. Dekker, 1957, MacMillan India.
5	Perspectives of Modern Physics – A. Beiser, 1969, McGraw-Hill.

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

CO1	do simple quantum mechanics calculations (K3)
CO2	define various terms related to properties of materials such as, permeability, polarization, etc (K2)
CO3	state some of the basic laws related to quantum mechanics as well as magnetic and dielectric properties of materials (K2)

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

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

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

	Course Code: MAT1102	Course Title: Applied Mathematics – II	Credits = 4		
			L	T	P
	Semester: II	Total Contact Hours: 60	3	1	0

List of Prerequisite Courses

HSC Standard Mathematics, Applied Mathematics – I **(MAT1101)**

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.

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

Applied Mathematics is beyond crunching numbers. It is useful for solving real-life problems and make an impact in the world, technology being one of those fields. The knowledge gained is required for solving various mathematical equations in several Chemical Engineering courses such as MEBC, Momentum Transfer, Reaction Engineering, Separation Processes, Thermodynamics, and several others.

Sr. No.	Course Contents (Topics and Subtopics)	Required Hours
1	**Numerical Methods I:** Solutions of system of linear equations (Gauss-elimination, LU-decomposition, and others) Numerical methods for solving non-linear algebraic/transcendental, Newton's method, Secant, Regula Falsi methods Numerical solution set of linear algebraic equations: Jacobi, Gauss Siedel, and under /over relaxation methods	15
2	**Numerical Methods II:** Interpolation and extrapolation for equal and non-equal spaced data (Newtons Forward, Newtons backward and Lagrange) Numerical integration (trapezoidal rule, Simpson's Rule) Numerical methods for solution of initial values problems using RK method, Euler's method and Taylor series method	15
3	**Differential Equations I:** 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	15
4	**Differential Equations II:** 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	15
	Total	**60**

List of Textbooks/ Reference books

1	Kreyszig, E.; Advanced Engineering Mathematics; 10th ed.; Wiley Global Education (2010) (Officially Prescribed)
2	Iyengar, S. R. K.; Jain, R. K. Advanced Engineering Mathematics; 4th ed.; Alpha Science (2014)
3	Jain, M. K.; Iyengar, S. R. K.; Jain, R. K. Numerical Methods for Scientific and Engineering Computation; 4th Ed.; New Age International (P) Ltd. (2004)
4	Boyce, W. E.; DiPrima R. C. Elementary Differential Equations; 10th ed.; John Wiley & Sons (2012)
5	Brown, J. W.; Churchill, R. V. Fourier Series and Boundary Value Problems; 8th ed.; McGraw-Hill Higher Education (2011)

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

CO1	solve system of linear algebraic equations (K3)
CO2	do numerical integrations of functions (K3)
CO3	solve higher order ODE by analytical methods (K4)
CO4	solve initial value problems using numerical methods (K3)
CO5	apply Fourier series and Laplace transform techniques to solve ODE and PDE (K3)

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

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

K, Knowledge level from cognitive domain; A, Affective domain; P, Psychomotor domain

	Course Code: CET1507	Course Title: Process Calculations	Credits = 4		
			L	T	P
	Semester: II	Total Contact Hours: 60	2	2	0

List of Prerequisite Courses

Standard XII 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.

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

The course introduces various concepts used in Chemical Engineering to the students. The knowledge of this course is required for in ALL B. Tech. courses in the subsequent semesters including the project work. It can be applied in various situations such as process selection, economics, sustainability, environmental impact and others.

Sr. No.	Course Contents (Topics and Subtopics)	Required Hours
1	Introduction to chemical process calculations, Overview of single- 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	Behavior 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
	Total	**60**

List of Text Books/ Reference Books

1	Elementary Principles of Chemical Processes, Felder, R.M. and Rousseau
2	Chemical Process Principles, Hougen O.A., Watson K. M.
3	Basic Principles and Calculations in Chemical Engineering, Himmelblau,
4	Stoichiometry, Bhatt B.I. and Vora S.M.

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

CO1	convert units of simple quantities from one set of units to another set of units (K2)
CO2	calculate quantities and /or compositions, energy usages, etc. in various processes and process equipment such as reactors, filters, dryers, etc. (K3)
CO3	apply material balances in multiphase systems (K3)
CO4	apply energy balance to various systems (K3)

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

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

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

	Course Code: 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 **(PYT1101)**

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

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.

Sr. No.	Course Contents (Topics and Subtopics)	Required Hours
1	Viscosity	5
2	Thermistor	6
3	Thermal conductivity	5
4	Ultrasonic interferometer	6
5	Photoelectric effect	5
6	Hall effect	6
7	Newton's rings	5
8	Dispersive power of prism	8
9	Laser diffraction	8
10	Resolving power of grating	6
	Total	**60**

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	Optical Fibre Communication – G. Keiser, McGraw-Hill.
6	A Course of Experiments with LASERs – R. S. Sirohi, Wiley Eastern
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…..)

CO1	Apply various laws which they have studied through experiments (K3)
CO2	Measure transport properties like viscosity, conductivity, etc.(K4)
CO3	Explain the application of acoustic cavitation (K2)

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

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

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

	Course Code: CHP1132	Course Title: Organic Chemistry Laboratory	Credits = 2		
	Semester: I	Total Contact Hours: 60	L	T	P
			0	0	4

List of Prerequisite Courses

Standard XII Organic Chemistry Laboratory

List of Courses where this course will be prerequisite

All the Applied Chemistry Practicals Physical and Analytical Chemistry Laboratory **(CHP1343)**

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

The course is relevant for training the students for working with binary mixtures. The students are exposed to basics of organic separations and identification of organic compounds based on their physicochemical properties. The laboratory training is crucial for the students to carry out work-up of organic reactions leading to separation of crude products followed by purification using recrystallization and/or distillation or related methods.

	Course Contents (Topics and Subtopics)	Required Hours
1	a) Principles of qualitative separation of organic mixtures using physical properties, chemical properties and their combination b) Principles of quantitative separation of organic mixtures using physical properties, chemical properties and their combination	4 4
2	a) Separation of solid-solid water insoluble binary organic mixtures b) Separation of solid-solid partly water soluble binary organic mixtures c) Separation of solid-solid mixtures by fractional crystallization d) Separation of liquid-liquid mixtures by distillation e) Separation of liquid-liquid mixtures by solvent extraction	5X4 2X4 2X4 2X4 2X4
	Total	**60**

List of Textbooks/Reference Books

1	Arthur, Vogel. Textbook of practical organic chemistry, 5th edition, publishers Longman group Ltd, 1989
2	F.G. Mann and B.C. Saunders, Practical Organic Chemistry, 4thedition published by Orient Longman
3	Keese, R, Martin P. B, and Trevor P. Toube. Practical organic synthesis: a student's guide. John Wiley & Sons, 2006.

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

CO1	work safely in the organic chemistry laboratory (K3)
CO2	separate binary organic mixtures by multiple techniques (K4)
CO3	understand basic principles for separation of binary organic mixtures qualitatively and quantitatively (K3)

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

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

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

	Course Code: HUP1101	Course Title: Communication Skills	Credits = 2		
			L	T	P
	Semester: II	Total Contact Hours: 60	0	0	4

List of Prerequisite Courses

Standard XII 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 and a Technologist. Communication skills are required in all courses and professional career.

Sr. No.	Course Contents (Topics and Subtopics)	Required Hours
1	Development of communication skills in oral as well as writing	10
2	The writing skills should emphasize technical report writing, scientific paper writing, letter drafting, etc.	14
3	The oral communication skills should emphasize presentation skills.	10
4	Use of audio-visual facilities like powerpoint, LCD. for making effective oral presentation	14
5	Group Discussions	12
	Total	**60**

List of Text Books/ Reference Books

1	Elements of Style – Strunk and White

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

CO1	write grammar error free technical reports in MS Word or equivalent software (K3)
CO2	make power point slides in MS PowerPoint or equivalent software (K3)

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

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

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

Semester III

	Course Code: BST1110	Course Title: Basics of Biology and Applications to Technology	Credits = 3		
			L	T	P
	Semester: III	Total Contact Hours: 45	2	1	0

List of Prerequisite Courses

Standard XII Biology

List of Courses where this course will be prerequisite

Safety studies pertaining to Chemicals, Pharmaceuticals, Polymers, cosmetics, Lubricants, Textiles, etc.

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

This interdisciplinary course will help a student understand basics of Human biology along with certain terminologies to enable them to read contemporary research pertaining to important technological developments. The course will help a student to understand the safety evaluation of materials as per regulatory guidelines

	Course Contents (Topics and Subtopics)	Required Hours
1	Overview of basics of Human Anatomy and Physiology, the terminologies used etc. Definitions of Anatomy, Physiology, Histology, Biochemistry, Homoeostasis, Health, Disease, Toxicity, Safety, Genotoxicity, etc. Systems that make the human body, the rationale behind introducing the subject to the technology students of Pharma, foods, Polymers, Surface coatings, Oils, Textiles, Dyes	7
2	Overview of the cell functioning as a whole unit and its organelles with their functions and its applications to technology. An overview of normal cell division, cell death by apoptosis, necrosis , Cancerous growth, metabolites/ energy production , cellular secretions, different types of cells, cell repair, biomarkers, etc.	8
3	Overview of Biomaterials: Biodegradable, Biocompatible and their technological applications	5
4	Practical applications: design some simple experiments to evaluate toxicity using cellular experiments, organisms, animals etc. OECD guidelines. Concept of Safety studies and industrial relevance. (oral, dermal, inhalation)	5
5	Toxicity evaluation in terms of mortality, Genotoxicity, hypersensitivity (allergy), biocompatibility as per various international guidelines namely, ICH, OECD, ISO to name a few.	10
6	Toxicity evaluation in terms of mortality, Genotoxicity, hypersensitivity (allergy), biocompatibility as per various international guidelines namely, ICH, OECD, ISO to name a few.	5
7	Irritation potential evaluation of Lubricants, surfactants, excipients, etc.	5
	Total	**45**

List of Textbooks/Reference Books

1	Human Anatomy and Physiology R. K. Goyal, Ahmedabad, India.
2	Pharmacology H. P. Rang, M. M. Dale, J. M. Ritter
3	Ross and Wilson's Anatomy and Physiology in Health and Illness Anne Waugh and All
4	Online guidelines of OECD, ISO, ICH

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

CO1	understand and explain the basic concepts and terminologies of Biology (K2)
CO2	Appreciate interdisciplinary nature of biology and will be able to design and execute simple experiments (K3)
CO3	understand about the concept of toxicity/safety and its relevance to technology and its applications in everyday life (K2)

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

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

	Course Code: GET1110	Course Title: Basic Mechanical Engineering	Credits = 3		
			L	T	P
	Semester: III	Total Contact Hours: 45	2	1	0

List of Prerequisite Courses

None

List of Courses where this course will be Prerequisite

Material Technology **(CET1302)**, Strength of Materials, Environment Science and Technology **(HUT1106)**

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

To acquaint the students with synthesis, properties and applications of various industrial inorganic chemicals

Sr. No.	Course Contents (Topics and subtopics)	Required Hours
1	**Introduction to Thermodynamics:** First Law of Thermodynamics, Steady-flow energy equation, Second Law of Thermodynamics	3
2	**Properties of Steam and Boilers:** Steam formation, Types of steam, Steam Properties – Enthalpy, Simple numerical for finding enthalpy and dryness fraction Steam Boilers: Classification, Working principle of Cochran, Babcock & Wilcox, etc. boilers	6
3	**I. C. Engines:** Classification, Working of 2-stroke, 4-stroke C.I. and S.I. Engines with P-V diagrams, Definitions and simple numerical for determining indicated power, Brake power, Mechanical efficiency, Indicated thermal efficiency, and Brake thermal efficiency	6
4	**Prime Movers:** Classification of Prime movers, Working principle of steam, gas and water turbines, Concept of impulse and reaction steam turbines	4
5	**Compressors:** Classification of compressors, Reciprocating compressors, Single-stage and multistage compressors, P-V diagram, Rotary compressors, Fan, Blower & Compressors, Centrifugal and axial compressors, Application of compressors	4
6	**Pumps:** Classification of pumps, Reciprocating pumps, Centrifugal pumps, Axial pumps, Gear pumps, Maintenance of pumps	4
7	**Refrigeration:** COP of refrigerator and heat pumps, Classification of refrigerants, Nomenclature, Properties desired by refrigerants, Vapour compression refrigeration cycle, Methods of increasing COP of VCRS, Vapour absorption refrigeration systems	5
8	**Renewable Energy:** Role and importance of nonconventional and alternate energy sources such as solar, wind, ocean, bio-mass and geothermal	4
9	**Transmission of Power:** Introduction to various drives such as belt, rope, chain and gear drives, Introduction to mechanical elements such as keys, couplings and bearings in power transmission (No numericals)	5
10	**Properties and Applications of Engineering Materials:** Metals –ferrous, cast-iron, tool steels and stainless steels and non-ferrous aluminium, brass, bronze Polymers – Thermoplastic and thermosetting polymers Ceramics – Glass, optical fibre, glass, cermets Composites – fibre-reinforced composites, metal-matrix composites	4
	Total	**45**

List of Text Books/ Reference Books

1	Nag, P. K. Engineering Thermodynamics; 5th Ed.; McGraw Hill Education (2013)
2	Morse, Frederick T. Power Plant Engineering; 3rd Ed.; Van Nostrand Reinhold Inc. (1953)
3	Ballaney, P. L. Thermal Engineering: Engineering Thermodynamics & Energy Conversion Techniques; 5th Ed.; Khanna Publishers (1966)
4	Lal, J. Hydraulic Machines Including Fluidics; 6th Ed.; Metropolitan Book Co. Pvt. Ltd. (2016)
5	Twidell, John; Weir, Tony. Renewable Energy Resources; 3rd Ed.; Routledge (2015)
6	Rai, G. D. Non-conventional Energy Sources; Khanna (1988)

7	Arora, C. P. Refrigeration and Air Conditioning; 4th Ed.; McGraw Hill (2021)
8	Rattan, S. S. Theory of Machines; 5th Ed.; McGraw Hill (2019)

Course Outcomes (Students will be able to…..)	
CO1	discuss the steam formation process and its properties (K2)
CO2	understand basics of heat transfer, refrigeration and I. C. Engines (K2)
CO3	understand mechanism of power transfer through belt, rope and gear drives and understand the properties of common engineering materials and apply in engineering industry (K2)
CO4	explain the working principles of power-absorbing devices such as pumps and compressors and explain need and importance of various renewable energy sources (K2)

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

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

	Course Code: FDT 1011	Course Title: SPL1: 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, Organic Chemistry I **(CHT1137)**, Physical Chemistry-I **(CHT1341)**, Analytical Chemistry **(CHT1401)**, Industrial Inorganic Chemistry **(CHT1139**)				
List of Courses where this course will be Prerequisite					
	Food Chemistry **(FDT1032)**, Food additives and ingredients **(FDT 1012)**, Food Microbiology **(FDT 1014)**, Technical Analysis Lab **(FDP1011)**, Food Chemistry Lab **(FDP1015)**				

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

Course objectives

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

Sr. No.	Course Contents (Topics and subtopics)	Required Hours
1	An introduction to food resources and its general composition. proximate analysis of foods, water in food systems – concept of free and bound water, water activity and its impact on food preservation and storage. Basic concept of taste, colour, flavour and texture, sensory analysis, anti-nutritional constituents in foods.	4 (3L+1T)
2	Carbohydrates- classification, structure, properties. Chemical reactions such as caramelization, Maillard reaction, and dehydration; identification and estimations; Sucrose – manufacture from sugar cane and sugar beet; hydrolysis of sucrose (inversion), Starches – isolation from varied sources; amylose/amylopectin, size/shape, gelatinization, gelation, retrogradation, pasting behaviour, functional properties, modification; Commercially important products – glucose, glucose syrup, high fructose corn syrup, maltodextrins. Glycosides in nature; pectin – structure, gelling behaviour of HMP vs. LMP, sources- manufacture and applications; Cellulose and other components of dietary fibre, hydrocolloids (plant/seaweed/ microbial polysaccharides),	16 (12L+4T)

	mucopolysaccharides; chitin and chitosan – sources, structure, manufacture and applications.	
3	Proteins- chemistry of amino acids, structure, classification and their properties (isoelectric pH, solubility profile), special amino acids, non-protein amino acids; Peptides, bioactive peptides; Classification of proteins; protein structure (primary, secondary, tertiary and quaternary); Denaturation of proteins; determination of primary sequence, quantitative estimation of amino acids and proteins in foods; functional properties of proteins, isolation and purification methods for proteins; Isolation of food proteins (soya, fish, whey); Maillard browning; concept of modified proteins; Major food protein systems (milk, egg, wheat, meat)	16 (12L+4T)
4	Chemistry of lipids- fatty acids, mono-, di and triacylglycerols; Classification of lipids- simple, compound and derived; unsaponifiable constituents of lipids such as sterols and hydrocarbons and waxes; Nutritional overview on fats and oils. Rancidity and reversion of fats and oils and thermal stability- its measurement and inhibition; analytical parameters of oils and fats. Extraction, alkali refining, degumming, deodorization, winterization, inter-esterification, hydrogenation etc. of vegetable and animal fats, manufacturing of products such as margarines, hydrogenated vegetable oil and spreads.	12 (9L+3T)
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	12 (9L+3T)
	Total	60

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

CO2	Describe the properties, method of preparation and applications of food constituents (K2)
CO3	Describe the mechanisms and significance of physicochemical reactions involved in food processing and storage (K2)
CO4	Explain the significance of water in food quality, preservation and storage (K2)
CO5	Describe and demonstrate the role of food constituents on nutritional/anti-nutritional and aesthetic quality of raw and processed foods (K3)

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

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

	Course Code: CET1302	Course Title: Material Technology	Credits = 3		
			L	T	P
	Semester: III	Total Contact Hours: 45	2	1	0

List of Prerequisite Courses

Applied Physics – II **(PYT1103)**

List of Courses where this course will be prerequisite

Equipment design, Final Year Project [Project I **(FDP 1027)** & Project II **(FDP 1025)**], Process Development and Engineering, Chemical Project Engineering and Economics **(CET1504)**

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

Selection of Material of Construction for a given application, Maintenance and corrective measures for various Engineering materials, Troubleshooting

Sr. No.	Course Contents (Topics and subtopics)	Required Hours
1	Engineering Materials: Classification, Fundamentals of Engineering properties of materials, Phase diagrams, Study of ferrous and nonferrous materials	12
2	Composite and smart materials	03
3	Structure-Property Relationship: Subatomic to macroscopic level, Modification and control of material properties	10
4	Theory of Failure of Materials: Fracture, creep and fatigue	08
5	Corrosion Engineering: Electrochemical principles, different types of corrosion, Polarization, Mechanisms of corrosion control and prevention, Preventive coatings. Corrosion behavior of industrial materials	08
6.	Criteria for selection of materials in Chemical Process industry	04
	Total	**45**

List of Textbooks

1	The Essence of Materials for Engineers, Robert W. Messler, Jr.
2	Materials Science and Engineering, Raghavan V.
3	Materials Science and Engineering, Van Vlack L.H.
4	Engineering Materials and Applications, Flin R.A., Trojan P.K.

List of Additional Reading Material/Reference Books

1	Material Science and Engg, Callister
2	Mechanical Metallurgy, Dieter

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

CO1	resolve the issues related to mechanical failure (K3)
CO2	troubleshoot corrosion-related industrial problems (K3)
CO3	learn from incidences (LFI) (K2)

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

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

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

	Course Code: BST1102	Course Title: Biochemistry	Credits = 4		
			L	T	P
	Semester: III	Total Contact Hours: 60	3	1	0

List of Prerequisite Courses

Standard XII Biology and Chemistry

List of Courses where this course will be prerequisite

Pharmaceutical and Biochemical Analysis Laboratory, Pharmaceutical Biotechnology, Process Technology and Biotechnology Laboratory or other relevant courses [**Institute Elective – I**: Food Biotechnology **(FDT 1026)**]

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

To train the students with respect to the core chemistry principles involved in functioning of biological systems, structural and chemical biology of macromolecules, including proteins, carbohydrates, lipids, nucleic acid and vitamins , structure, function and kinetic properties of enzymes and their role in metabolism of living cells, major catabolic as well as anabolic pathways involved in cell metabolism and quantitative aspects of biochemical analysis of macromolecules

	Course Contents (Topics and Subtopics)	Required Hours
1	Carbohydrates: Fundamentals of chemistry of carbohydrates, concept of ring structures and straight chain structure of common carbohydrates glucose, fructose, galactose, lactose, maltose, sucrose, polysaccharides, starch, glycogen, cellulose Qualitative tests / colour reaction: phenyl hydrazine, alkali – oxidation reduction with practical significance Metabolic pathways and energy yield for breakdown of carbohydrates: glycolysis, gluconeogenesis, citric acid cycle; pentose phosphate pathway, electron transport chain and coupled oxidative phosphorylation	5 2 5
2	Lipids: Fatly aids, waxes, phospholipids, sphingolipids, terpenoids. With are representative structure and significance Functions & comparative distribution of lipids, lipoproteins B-oxidation of fatly acids, functions of cholesterol & significance Rancidity, sap value, iodine value & hydrogenating	4 4 4
3	Proteins & Amino acids:Amino acids: Structures, pK – isoelectric point, essential & non-essential amino acids, Colour reaction of amino acids Structure of protein: globular, fibrous Structural organization of protein: primary, secondary, tertiary, quaternary Elementary idea about chromatography & electrophoresis	5 4 5 2
4	Nucleic acids and their components:DNA& RNA bases, nucleosides, nucleotides, chemistry of nucleic acids, Structure and functions of RNA & DNA Types of RNA: mRNA, tRNA&rRNA Salient factures of protein biosynthesis & idea of genetic code	5 5
5	Enzymes- definition, function, nomenclature, classification, mechanism of enzyme action, specificity of enzymes,enzyme kinetics, enzyme inhibition and regulation	5
6	Vitamins & Co-enzymes: Structures& function of Nicotinamide, nicotinic acid, riboflavin, lipoic acid, biotin, thiamine, B6, folic acid, B12, pantothenic acid, ascorbic acid, vitamins A, D, K, and E	5
	Total	**60**

List of Textbooks/Reference Books

1	Principles of Biochemistry, Lehninger AL, Nelson DL and Cox MM, 5th Edition, 2008, MacMillan
2	Biochemistry, Stryer L, Berg JM and Tymoczko JL, 5th Edition, 2002, Freeman & Co.
3	Fundamentals of Biochemistry – Voet DJ and Voet JG, Upgrade edition, 2002, John Wiley & Sons

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

CO1	apply of fundamental knowledge of chemistry to biological systems and understand and elucidate structural as well as metabolic role of different macromolecules in the cell (K3)
CO2	apply analytical tests involved in detection of macromolecules in/derived from biological samples (K3)

CO3	understand the role of enzymes in cellular environment and their use in industrial applications for their practical applications and evaluate and elucidate impact of different catalytic reactions involved in metabolic pathway (K4)
CO4	evaluate and explain influence and interactions of different metabolic pathway on each other (K4)

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

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

	Course Code: BST1109	Course Title: Microbiology	Credits = 3		
			L	T	P
	Semester: III	Total Contact Hours: 45	2	1	0

List of Prerequisite Courses

Standard XII Science (Any combination of Physics, Chemistry, Mathematics and Biology)

List of Courses where this course will be prerequisite

Food Microbiology **(FDT1014)**, Principles of Food Preservations **(FDT1031)**

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

To familiarize students with diverse microorganisms in different industries like food, dairy, bio-based fermentation, oil, pharmaceutical industry and bioenergy, with diversity of microorganisms, microbial cell structure and function, microbial growth and metabolism, environmental factors affecting their growth and cultivate/control growth of microbes using physical and chemical technologies; with basics of microbial replication, transcription, translation and mutagenesis and involvement of microorganisms in diseases and role of immune system in defending invading pathogens

	Course Contents (Topics and Subtopics)	Required Hours
1	Introduction to microbiology and its significance (beneficial and harmful) in Foods (Dairy including pre and probiotics, cheese, vitamins, beverages etc.), Pharmaceuticals (Antibiotics, vaccine production, pathogenic organisms etc), Oils (bioremediation, bio-diesel from microorganism etc.), and environ-ment (waste water, nitrification, methanation, green chemicals and biofuels, etc.)	5
2	Prokaryotes and Eukaryotes - morphology, structure and function of microbial cells and their components	5
3	Major groups of microorganisms - Bacteria, Virus, Yeasts and Molds, Rickettsia, Chlamydia and Algae	5
4	Gram character and staining techniques, Isolation, preservation and maintenance of pure cultures	5
5	Nutrient requirements of microorganism, Composition, preparation and sterilization of microbiological media; Classification of media, Methods of sterilization, disinfection, sanitation, asepsis	5
6	Growth studies (lag phase, log phase, stationary phase, death phase); concept of generation time; Physical and chemical factors affecting growth of microbes	5
7	Extremophiles and their applications-Acidophiles, Basophiles, Thermophiles, Hyperthermophiles, Psychrophiles, Osmophiles	5
8	Microscopy (dark, Fluorscence, atomic force, scanning tunnel, confocal etc.); Enumeration of microorganisms (TPC, Yeast and molds count, MPN, turbidometry, rapid methods like flow cytometry, etc.)	5
9	Principles of immunology	5
	Total	**45**

List of Textbooks/Reference Books

1	Microbiology by Prescott, Harley & Klein's 7th Edition, 2008, Mcgraw-Hill
2	Microbiology by Pelczar, 5th edition, 1993, Mcgraw-Hill

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

CO1	Explain the application of diverse microorganisms in different industries like food, dairy, oil, pharmaceutical, bio-based fermentation and bio-energy (K2)
CO2	Describe the cultivation/control methods for diversity of microorganisms, their physiology and metabolism (K2)
CO3	Explain the flow of genetic information from DNA to protein and the mechanisms involved therein (K2)

CO4	Understand and apply the significance of microorganisms in diseases and basic immune system against invading pathogens (K3)

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

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

	Course Code: FDP 1014	Course Title: Pr 1: Biochemistry Lab	Credits = 2		
			L	T	P
	Semester: III	Total Contact Hours: 60	0	0	4

List of Prerequisite Courses	
	None

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

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

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

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

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

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

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

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

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

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

	Course Code: FDP1013	Course Title: Pr 2: Food Microbiology	Credits = 2		
			L	T	P
	Semester: III	Total contact hours: 60	0	0	4
List of Prerequisite Courses					
	Microbiology (BST1109)				
List of Courses where this course will be Prerequisite					
	Food Microbiology **(FDT1014)**, Principle of Food Preservation **(FDT1031)**				

Description of relevance of this course in the B. Tech. (Food Engg. & Tech.) Programme		
1. To understand the principles of different staining techniques used for specific group of microorganism and chemical compounds within the cells 2. To identify and enumerate the contaminating microorganisms in the food samples 3. To identify the microbial resistance towards different types of disinfectants and the effects of physiochemical factors for microbes 4. To develop a specific media and isolate microorganisms from different food samples		
Sr. No.	**Course Contents (Topics and subtopics)**	**Required Hours**
1	Working and handling of common laboratory equipment and materials	4
2	Monochrome staining, Cell wall staining	4
3	Gram staining	4
4	Negative staining. Hanging drop technique	4
5	Capsule staining, Bacterial endospore staining	4
6	Study of Yeast, Mold and Bacteria	4
7	Phenol Coefficient of disinfectant	4
8	Microchemical test for reserve material	4
9	Isolation of Microbes from a food sample	4
10	Composition, preparation, sterilization of routine lab media	4
11	Enumeration, characterization, isolation and maintenance from air and surface	4
12	Effect of physicochemical factors and nutritional requirements on growth of microorganisms	4
13	Isolation and characterization of microbes based on morphological & physiological characteristics	4
14	Evaluations of microbial quality of milk and water samples	4
15	Spread Plate, pour Plate methods for cultivation of microbes, Streaking, and point inoculation methods for bacteria, fungi, and actinomycetes.	4

	Total	**60**

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

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

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

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

Semester IV

	Course Code: GET1117	Course Title: Engineering Mechanics and Strength of Materials	Credits = 3		
			L	T	P
	Semester: IV	Total Contact Hours: 45	2	1	0

List of Prerequisite Courses

Standard XII Physics and Mathematics, Applied Mathematics - I **(MAT1101)** and – II **(MAT1102)**, Applied Physics – I **(PYT1101)**

List of Courses where this course will be Prerequisite

Material Technology **(CET1302)**, Strength of Materials, Environment Science and Technology **(HUT1106)**

Description of relevance of this course in the B. Tech. (Pharm. Chem. Tech.) Programme

This subject will help students to understand use of basics of Applied Mechanics and Strength of Materials. As a practicing Engineer and Technologist, the students will relate different types of forces to be considered along with their quantification during design of equipments. It will also help in understanding the conditions of equilibrium and their application for analysing 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 including in thin cylindrical shells., advantages and disadvantages of various geometric sections available for Engineering design. In addition, the students will be acquainted with different advance fibre polymer composite materials used in industry for various applications and several performance- enhancing construction chemicals. In summary, this is a foundation course for a proficient Design Engineer and Technologist.

Sr. No.	Course Contents (Topics and subtopics)	Required 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.	6
3	Concept of Cetroid and 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.	4
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	6
6	Theory of Bending - Assumptions in derivation of basic equation, Basic equation, Section modulus, Bending stress distribution	3
7	Problems on shear stress - Concept, Derivation of basic formula Shear stress distribution for standard shapes Problems of Shear stress distribution	3
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	Thick and Thin cylinders - Concept of radial, longitudinal stresses, behaviour of thin cylinders Problems on thin cylindrical and spherical shells Behaviour of thick cylinders (Theory only)	4
10	Natural Materials, Manmade Materials	6

	Composite Materials – Types of composite materials and their uses in various industrial applications Different types of performance enhancing and special purpose construction chemicals Plasticizers and super-plasticizers Recycling of waste – value addition Testing of Materials and its relevance	
	Total	**45**

List of Text Books/ Reference Books	
1	Thadani, B. N. Engineering Mechanics; Asia Publishing House (1966)
2	Popov, Egor P. Introduction to Mechanics of Solids; Macdonald (1968)
3	Beer. Mechanics of Materials; 7th Ed.; Mc Graw Hill India (2016)
4	Dadhe, V. G.; Jamdar, M. G.; Walavlkar, Y. N. Fundamentals of Applied Mechanics; Sarita Prakashan (1989)
5	Timoshenko, S.; Young, D. H.; Rao, J. V.; Pati, Sukumar. Engineering Mechanics; 5th Ed.; McGraw Hill Education (2017)
6	Singer, Ferdinand L.; Pytel, Andrew. Strength of Materials; 4th Ed.; Harper Colins Publishers (2012)
7	Kaw, Autar K. Mechanics of Composite Materials; 2nd Ed.; CRC Press (2006)
8	Shetty, M. S.; Concrete Technology: Theory and Practice; S. Chand & Co. Ltd. (2005)

Course Outcomes (Students will be able to…..)	
CO1	quantify the actions and able to find reactions by applying conditions of equilibrium, find out the Centroid and Moment of Inertia for various cross sections used in engineering structures and for plane areas and be able to draw the Shear Force and Bending Moment diagram for different types of beams under simple and complex loading (K3)
CO2	calculate the forces, reactions, stresses, strains in components of the bodies of a complex engineering structure (K3)
CO3	find out the Bending Stresses at different positions and Shear Stress distribution across the cross section at various points and calculate the Slope and Deflection at different points under simple and complex loading (K3)
CO4	explain various materials used in various applications in engineering. cement composite – Concrete, Chemicals used to alter the properties of concrete (K2)

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

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

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

	Course Code: CET1105	Course Title: Transport Phenomena	Credits = 4		
			L	T	P
	Semester: IV	Total Contact Hours: 60	3	1	0

List of Prerequisite Courses

XIIth Standard Physics and Mathematics

List of Courses where this course will be prerequisite

This is a basic course required in special subjects that deal with flow offluids, heat and mass transfer, etc.

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

This basic course introduces concepts of momentum, heat and mass transfer to students. Various other concepts such as pressure, momentum, energy are introduced as well. Laws related to conservation of momentum, energy, mass are taught. Applications of these laws to various engineering and technological situations and process equipments are explained with the help of several problems.

Sr. No.	Course Contents (Topics and subtopics)	Required Hours
1	Fluid Statics and Applications to Engineering importance	4
2	Applications of Bernoulli's Equation, Pressure-drop in pipes and Fittings,Meters, Fluid moving machinery such as pumps	10
3	Particle Dynamics, Flow through fixed and fluidized Beds	4
4	Equations of Continuity and Motion in laminar flows and its applicationsfor simple Couette flow and Poiseuille flow applications	6
5	Heat conduction, Convective heat transfer and concept of heat transfer coefficient	4
6	Design and Constructional Aspects of Exchangers: Types of flows - Concurrent, counter-current and cross flows, Log mean temperature difference, Double-pipe and Shell and tube heat exchangers Introduction to other heat exchangers like, PHE, finned tube heat exchangers, graphite block, etc.	10
7	Heat transfer aspects in agitated tanks, Condensers, Reboilers and evaporators	6
8	Fundamentals of Mass Transfer: Molecular diffusion in fluids, concept ofmass transfer coefficients, and interface mass transfer	4
9	Theories of mass transfer, Analogies for heat and mass transfer, Empirical correlations	4
10	Mass transfer applications in simple 1-D situations	8
	Total	**60**

List of Text Books/ Reference Books

1	Transport Phenomena, Bird R.B., Stewart W.E., Lightfoot E.N.
2	Fluid Mechanics, Kundu Pijush K.
3	Fluid Mechanics, F. W. White
4	Unit Operations of Chemical Engineering, McCabe, Smith

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

CO1	calculate friction factor, pressure drop, power (K3)
CO2	calculate flow and power required for pumps(K3)
CO3	calculate heat transfer coefficients and do basicsizing of double pipe and shell and tube heat exchangers (K3)
CO4	calculate mass transfer coefficients and estimate mass transfer rates in simple situations (K3)

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

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

	Course Code: GET1105	Course Title: Electrical Engineering and Electronics	Credits = 3		
			L	T	P
	Semester: IV	Total Contact Hours: 45	2	1	0

List of Prerequisite Courses

Standard XII Physics and Mathematics courses

List of Courses where this course will be prerequisite

Various Technology Courses and Professional Career

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

In this course, students will get an insight to the importance of Electrical Energy in Chemical Plants. The students will understand basics of electricity alongside basic knowledge about Transformer and selection of different types of drives for a given application process. They will get basic knowledge of electronic devices and their applications in Power supplies, amplifiers and other circuits.

Sr. No.	Course Contents (Topics and Subtopics)	Required Hours
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	3
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	5
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	5
7	Diodes and rectifiers: P-N junction diode characteristics, Zener diode, Half wave and full wave rectifiers, their waveforms, brief introduction to filters	4
8	Bi-polar junction transistor: Current components. Modes of operation, Input and output characteristics, Regions of operation, Transistor as an amplifier, classification of amplifiers	6
9	Introduction to Uni junction transistor, Characteristics, UJT relaxation oscillator	3
10	Silicon controlled rectifier, controlled rectification, characteristics, methods of turning-on. Applications	3
	Total	**45**

List of Textbooks/Reference Books

1	Electrical Engineering Fundamentals by Vincent Deltoro
2	Electronic devices and circuits by Boylstead, Nashelsky
3	Electrical Machines by Nagrath, Kothari
4	Electrical Machines by P.S. Bhimbra
5	Electrical Technology by B. L. Theraja, A.K.Therajavol I,II,IV
6	Thyristors and their applications by M. Ramamurthy
7	Power Electronics by P.S. Bhimbra

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

CO1	Explain the basic concepts of D.C circuits. Solve basic electrical circuit problems (K3)
CO2	Explain the basic concepts of single phase and three phase AC supply and circuits (K2)

CO3	Explain the basic concepts of transformers & motors used as various industrial drives (K2)
CO4	Explain the basic concepts of electronic devices and their applications (K2)

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

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

	Course Code: FDT 1031	Course Title: SPL2: Principles of Food Preservation	Credits = 4		
			L	T	P
	Semester: IV	Total Contact Hours: 60	3	1	0
List of Prerequisite Courses					
	SPL1: Chemistry of Food Constituents **(FDT1011)**, Microbiology **(BST1109)**, Biochemistry **(BST1102)**				
List of Courses where this course will be Prerequisite					
	SPL5: Food Engineering **(FDT1022)**, SPL8: Food Process Engineering **(FDT1027)**, Pr 8: Food Processing and Engineering **(FDP1026)**				

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

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

Sr. No.	Course Contents (Topics and subtopics)	Required Hours
1	**Introduction to food preservation:** Food spoilage; Underlying principles of different modes of food preservation; Preservation methods with emphasis on inactivation, inhibition, and avoiding recontamination.	4
2	**Dehydration and drying of foods:** Drying curve and drying time calculation; Water activity and moisture absorption isotherms; Psychometric chart; Different types of dryers- Conductive, convective, and combined; IMF foods; osmotic dehydration.	10
3	**Thermal processing of food products:** Sterilization and Pasteurization; Canning of food products; Classifications and structure of cans, corrosion, Lacquering; Spoilage in canned foods (1) Thermal death time (TDT) concept; Process time calculation for canned foods; Retort processing; Aseptic packaging.	14
4	**Newer techniques in thermal processing:** Concept of HTST; UHT; Ohmic, Dielectric, Infra-red Heating; Microwave heating; Frying method.	6
5	**Non-thermal processing of food:** High pressure processing; Pulsed electric field processing; Cold extrusion; Plasma processing; Ionizing Radiations; Ultrasound processing; UV and Pulsed light processing; Membrane Technology.	10
6	**Low temperature storage and preservation:** Chilling and Freezing; Freezing curve and water activity; Properties of frozen foods; Enthalpy change during freezing; Plank's equation for freezing time; Cold storage and Refrigeration load; Refrigeration cycle; Cryogenic freezing and IQF; Freeze concentration and freeze drying.	10
7	**Hurdle technology:**	6

	Role of acidity and pH in food preservation; Preservation by fermentation – Curing, Pickling and Smoking; Controlled and modified atmospheric packaging and storage; Chemical and Bio-preservatives; Antimicrobials.	
	Total	**60**

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

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

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

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

	Course Code: 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 **(FDT 1014)**, Principle of Food Preservation **(FDT 1031)**, Food Safety, Quality and Regulations **(FDT 1028)**, Institute Elective – I: Food Biotechnology **(FDT 1026)**

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

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

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

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

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

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

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

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

	Course Code: FDT 1015	Course Title: Nutrition	Credits = 3		
			L	T	P
	Semester: III	Total Contact Hours: 45	2	1	0
List of Prerequisite Courses					
	Biochemistry (BST1102)				
List of Courses where this course will be Prerequisite					
	Food Chemistry (FDT1032), Institute Elective- II: Nutraceuticals and Functional Foods (FDT 1051)				

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

Course objectives

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

Sr. No.	Course Contents (Topics and subtopics)	Required Hours
1	Food composition and nutrients present in foods, terminologies used in nutrition, Food pyramid, my pyramid, my plate, Food exchanges and measures used, Energy value of foods, bomb calorimeter, physiological fuel value, estimation of energy value of foods from proximate composition. Basal Metabolic Energy, factors affecting, and calorie needs for B. M. E., physical activity and diet induced thermogenesis; energy imbalance and body weight regulation; Nutrition through lifecycle.	9 (6L+3T)
2	Role of carbohydrates in human nutrition- nutritionally important carbohydrates, physiological functions, digestion and absorption of available carbohydrates, dietary fiber, non-digestible oligosaccharides, resistant starch and its types, carbohydrates as prebiotics, dental carries and role of sugar, Lactose intolerance and galactosemia, Glycemic index and glycemic load of carbohydrate containing foods. Role of lipids in Human Nutrition- nutritionally important lipid constituents, physiological functions, digestion and absorption of lipids, conjugated linoleic acid, trans fats, medium chain triglycerides, fat replacers and mimetics, keto diet, Cholesterol, Phytosterols, blood lipids (LDL, HDL, VLDL etc), essential fatty acids, their functions and	9 (6L+3T)

	deficiency, omega 3 and omega 6 PUFAs and their dietary sources, eicosanoids.	
3	Role of proteins in Human Nutrition- essential/ non-essential amino acids, complete/ incomplete proteins, limiting amino acid, complementary proteins, physiological functions of proteins, daily protein requirements, digestion absorption and utilization of proteins, common food sources of proteins, protein deficiency (PEM/PCM)- prevalence, causes, effects, remedial measures Concept and estimation of protein quality – *in vitro* (scoring methods, indices, microbiological methods, enzymatic methods) and *in vivo* methods (growth response methods like PER and Nitrogen balance methods like BV), PDCAAS; Anti-nutritional factors present in foods- antiproteins (trypsin inhibitor), antiminerals (phytate), anti- vitamins (ascorbic acid oxidase) and others- their chemistry, occurrence in food sources, mechanism of anti-nutritional action, processing stability, and remedial measures to reduce them	9 (6L+3T)
4	Role of micronutrients (vitamins and minerals) in human health - physiological role, deficiency disease, food sources, factors affecting bioavailability and RDA's; Role of water in nutrition;	9 (6L+3T)
5	Principles of Diet Therapy and Therapeutic Nutrition; Formulation of diets and foods for special needs; Techniques of diet and health surveys; Assessment of nutritional status; Effect of food processing, preservation and storage on nutritional quality of foods; Food nutrification; Sports nutrition; Nutritional labelling of foods; Nutraceuticals and functional foods; Fortification – chemical & biofortification	9 (6L+3T)
	Total	**45**

List of Text Books / Reference Books	
1	Maurice E. Shils, James A. Olson, Moshe Shike, A. Catherine Ross Modern Nutrition in Health & Disease by Young & Shils. Jones & Bartlett Learning; Subsequent edition. 1999. ISBN-10: 068330769X
2	Food, Nutrition and Diet Therapy by Krause and Mahan 1996, Publisher- W.B. Saunders, ISBN: 0721658350
3	Nutritive Value of Indian Foods by C. Gopalan, B. V. Rama Sastri, S. C. Balasubramanian Published by National Institute of Nutrition, Indian Council of Medical Research, 1989
4	Introduction to Human Nutrition by Gibney, Lahnam-New, Cassidy and Vorster, 2009, Nutrition Society Textbook Series, Second Edition, Wiley Blackwell Publisher
5	Molecular Basis of Human Nutrition by Sanders and Emery, 2003, Taylor & Francis Publication, ISBN 0-415-29917-9 (hbk)
6	Principles of Human Nutrition by M. Eastwood, 2003, Blackwell Science. ISBN 0-632-05811-0
Course Outcomes (Students will be able to…..)	
CO1	Explain basic concepts of nutrition, compute energy value of foods and understand body's need for energy (K3)

CO2	Explain the role of different constituents of carbohydrates and lipids in human nutrition (K3)
CO3	Describe the role of proteins in human nutrition, explain concept of protein quality and methods of estimation and identify anti-nutritional factors in food sources (K2)
CO4	Describe the requirements and role of micronutrients (vitamins /minerals) in human health. (K2)
CO5	Explain formulation of diets, techniques of health surveys, nutritional assessment etc. (K3)

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

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

	Course Code: GEP1106	Course Title: Electrical Engineering and Electronics Laboratory	Credits = 2		
			L	T	P
	Semester: IV	Total Contact Hours: 60	0	0	4

List of Prerequisite Courses

Standard XII Physics and Mathematics courses

List of Courses where this course will be prerequisite

Various Technology Courses and Professional Career

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

In this course, students will get an insight to the importance of Electrical Energy in Chemical Plants. The students will understand basics of electricity alongside basic knowledge about Transformer and selection of different types of drives for a given application process. They will get basic knowledge of electronic devices and their applications in Power supplies, amplifiers and other circuits.

	Course Contents (Topics and Subtopics)	Required Hours
	Suitable no of experiments out of the following will be conducted -	
1	Superposition Theorem	5
2	Thevenin's Theorem	5
3	Series RL circuit	4
4	Resonance in Series RLC circuit	5
5	H.W. and F.W. Rectifiers	4
6	Cathode Ray Oscilloscope	5
7	Input and output characteristic of npn transistor in CE mode	4
8	Load Test on Transformer	4
9	Three phase star connection	4
10	Three phase delta connection	4
11	Study of UJT relaxation oscillator	4
12	Design of UJT relaxation oscillator	4
13	Load Test on 3 phase induction motor	4
14	Study of Thermocouple	4
	Total	**60**

List of Textbooks/Reference Books

1	Electrical Engineering Fundamentals by Vincent Deltoro
2	Electronic devices and circuits by Boylstead, Nashelsky
3	Electrical Machines by Nagrath, Kothari
4	Electrical Machines by P.S. Bhimbra
5	Electrical Technology by B. L. Theraja, A.K.Therajavol I,II,IV
6	Thyristors and their applications by M. Ramamurthy
7	Power Electronics by P.S. Bhimbra

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

CO1	Explain concepts of basic working of D.C circuits (K2)
CO2	Explain the basic applications of single phase and three phase AC supply and circuits (K2)
CO3	Explain the working and utility of transformers and motors used as various industrial drives (K2)
CO4	Apply the basic principles in electronic devices and circuits (K3)

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

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

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

	Course Code: MAP 1201	Course Title: Engineering Application of Computers	Credits = 2		
			L	T	P
	Semester: IV	Total Contact Hours: 64	0	0	4

List of Prerequisite Courses

HSC Standard Mathematics, Applied Mathematics – I

List of Courses where this course will be prerequisite

This is a basic Mathematics course. This practical knowledge will be required in several subjects later.

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

Students will understand the basics of Python programming and get exposure to the use of spreadsheet programme and Excel for numerical computations and statistical analysis for engineering applications. The students will also explore R-programming for Regression Analysis, Testing of Hypothesis using of standard statistical inference. B. Tech programme requires students to analyze data and develop computer programmes to solve various problems in Engineering and Technology fields.

	Course Contents (Topics and subtopics)	Hours
1	Introduction to Spreadsheet Programmes, Use of formulae and Plotting Graphs of Function and Data Plotting in Excel	4
2	Exploring Basic Statistics and Hypothesis Testing with Spreadsheet	4
3	Numerical Solution of Linear and Non-Linear Equations in Excel	4
4	Basic Introduction to R and R Studio, Data Management in R	4
5	Plotting Graphs in R, Exploring Probability Distribution Function in R	4
6	Hypothesis Testing in R	4
7	Basic Regression Analysis in R	4
8	Introduction to Python, Installation of Python and jupyter notebook through Anaconda. Variables in Python, Exploring math and cmath modules	4
9	List, Tuples and Dictionaries in Python, if else and elif statements, Creating functions (using def and lambda functions)	4
10	For loops and while loops in Python, Use of break and continue statements with loops, Developing Python programmes using loops	4
11	Writing Python Programme to solve problems in basic numerical analysis such root finding, Numerical solutions of linear equations, Numerical integration, etc.	4
12	Use of Numpy and Scipy to deal with vectors, matrices and their operations	4
13	Use of Numpy and SciPy continued	4
14	Plotting graphs using matplotlib	4
15	Use of Pandas for data processing and analysis	4
16	Linear and multilinear regression using Python	4
	Total	**64**

List of Textbooks/ Reference Books

1	Carlberg, Conrad George. Statistical analysis: Microsoft Excel 2016; Que (2018).
2	Langtangen, Hans Petter. A Primer on Scientific Programming with Python; 5th Ed.; Springer-Verlag Berlin Heidelberg (2016)
3	Thareja, Reema; Python Programming - Using Problem Solving Approach; Oxford University Press (2017)
4	Beazley, David; Jones, Brian K. Python Cookbook: Recipes for Mastering Python 3; O'Reilly Media (2013)
5	VanderPlas, Jack; Python Data Science Handbook: Essential Tools for Working with Data; 1st Ed.; O'Reilly Media (2016)
6	Dalgaard, Peter; Introductory Statistics with R; 2nd Ed.; Springer (2008)
7	Navarro, Daniel; Learning Statistics with R (2013)
8	Dennis, Brian; The R Student Companion; CRC Press (2012)
9	Verzani, John; Using R for Introductory Statistics; 2nd Ed.; CRC Press (2014)

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

CO1	perform descriptive statistical analysis using Excel (K3)
CO2	perform basic statistical tests using R (K3)
CO3	perform linear regression using R (K3)
CO4	write Python programs to implement basic numerical methods (K4)
CO5	perform data processing and regression analysis using Python (K4)

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

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

Semester V

	Course Code: CET1401	Course Title: Chemical Engineering Operations	Credits = 3		
			L	T	P
	Semester: V	Total Contact Hours: 45	2	1	0

List of Prerequisite Courses
Process Calculations **(CET1507)**, Transport Phenomena **(CET1105)**
List of Courses where this course will be prerequisite
This is a basic course. It is required in many other courses that involve physical processes
Description of relevance of this course in the B. Tech. Programme
This is a basic Chemical Engineering course. The principles learnt in this course are required in almost all the forthcoming courses and throughout the professional career of students.

Sr. No.	Course Contents (Topics and Subtopics)	Required Hours
1	Distillation: Fundamentals of flash-, batch- and continuous distillation, Distillation columns internals, Steam and azeotropic distillation	12 – 15
2	Liquid-Liquid Extraction: Solvent selection, Construction of ternary diagrams, Staged calculations, Types of extraction equipment	6
3	Crystallization: Phase diagram (temp/solubility relationship), Evaporative and cooling crystallization, Introduction to different types of crystallizers	5
4	Filtration: Mechanism of filtration, Basic equation, Constant volume, Constant pressure filtration, Rate expressions with cake and filter cloth resistances, Compressible and incompressible cakes, Introduction to various types of filters	5
5	Drying: Drying mechanism, Drying rate curves, Estimation of drying time, ypes of dryers	5
6	Introduction to Other Aspects of Unit Operations: Content will be aimed towards understanding practical and safety aspects of unit operations and/or introducing other separation processes like: adsorption/ion exchange, membrane processes and gas absorption, etc.	9 – 6
7	Industrial Case Studies: Interactive discussion with experienced professionals from industry or equipment vendors with emphasis on applicability, importance and challenges of different unit operations	3
	Total	**45**

List of Text Books/ Reference Books	
1	Richardson, J.F., Coulson, J.M., Harker, J.H., Backhurst, J.R., 2002. Chemical engineering: Particle technology and separation processes. Butterworth-Heinemann, Woburn, MA.
2	Seader, J.D., Henley, E.J., 2005. Separation Process Principles, 2 ed. Wiley, Hoboken, N.J.
3	Svarovsky, L., 2000. Solid-Liquid Separation. Butterworth-Heinemann, Woburn, MA.
4	McCabe, W., Smith, J., Harriott, P., 2004. Unit Operations of Chemical Engineering, 7 ed. McGraw-Hill Science/Engineering/Math, Boston.
5	Green, D., Perry, R., 2007. Perry's Chemical Engineers' Handbook, Eighth Edition, 8 ed. McGraw-Hill Professional, Edinburgh.
6	Dutta, B.K., 2007. Principles of Mass Transfer and Separation Process. Prentice-Hall of India Pvt. Ltd, New Delhi.

Course Outcomes (students will be able to…..)	
1	perform basic sizing of continuous and batch distillation columns (K3)
2	analyze filtration data and select systems based on requirements, estimate filtration area for given requirements, understand filter aids and their usage (K4)
3	describe few industrial crystallization, filtration and drying equipment (K2)

4	describe the need and importance of other separation processes like adsorption, ion exchange and membrane (K2)
5	Apply the concept of unit operation in chemical industries (K3)

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

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

	Course Code: CET1201	Course Title: Chemical Reaction Engineering	Credits = 3		
			L	T	P
	Semester: V	Total Contact Hours: 45	2	1	0

List of Prerequisite Courses

Physical Chemistry – I **(CHT1341)** and – II **(CHT1342)**, Transport Phenomena **(CET1105)**

List of Courses where this course will be prerequisite

Environmental Engineering and Process Safety, Chemical Project Engineering and Economics **(CET1504)**

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

The course is concerned with the utilization of chemical reactions on a commercial scale. This course is very relevant but not limited to the following industries: Inorganic chemicals, organic chemicals, petroleum & petrochemicals, Pulp & paper, Pigments & paints, rubber, plastics, synthetic fibres, Foods, Dyes and intermediates, Oils, oleo chemicals, and surfactants, Minerals, clean sing agents, Polymers and textiles, Biochemicals and biotechnology, Pharmaceuticals and drugs, Microelectronics, energy from conventional and non-conventional resources, Metals

Sr. No.	Course Contents (Topics and Subtopics)	Required Hours
1	Kinetics of homogeneous reactions, Interpretation of batch reactor data, Single ideal reactors including design aspects	10
2	Multiple reactions, Temperature and pressure effects	5
3	Introduction to Non-ideal flow, RTD measurements, Models to predict conversions	5
4	Homogeneous and Heterogeneous Catalysis, Kinetics of Solid Catalyzed Reactions. Design of gas – solid catalytic reactors	15
5	Introduction to multiphase reactors	5
6	Mass Transfer with Chemical Reactions: Regimes of operation and Model contactors	5
	Total	**45**

List of Textbooks

1	Elements of Chemical Reaction Engineering – H. Scott Fogler

List of Additional Reading Material / Reference Books

1	Heterogeneous Reactions, Vol.I and II –L.K. Doraiswamy, M.M.Sharma

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

CO1	describe and apply the principles of various types of reactors (K3)
CO2	calculate rates of reactions based on given reaction scheme (K3)
CO3	design various components of reactors used in industrial practice (K3)
CO4	compare various reactors and select an appropriate reactor for a given situation (K4)

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

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

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

	Course Code: FDT 1022	Course Title: SPL5: Food Engineering	Credits = 4		
			L	T	P
	Semester: V	Total Contact Hours: 60	3	1	0
List of Prerequisite Courses					
	SPL2: Principles of Food Preservation **(FDT1031)**				
List of Courses where this course will be Prerequisite					
	SPL8: Food Process Engineering **(FDT1027)**, Pr 8: Food Processing and Engineering **(FDP1026)**				

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

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

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

List of Text Books / Reference Books

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

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

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

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

	Course Code: FDT 1032	Course Title: SPL6: Food Chemistry	Credits = 3		
			L	T	P
	Semester: V	Total contact hours: 45	2	1	0
List of Prerequisite Courses					
	Basics of Organic, Inorganic, Physical and Analytical Chemistry and SPL 1: Chemistry of Food Constituents **(FDT 1011)**, Organic Chemistry I **(CHT1137)**, Physical Chemistry-I **(CHT1341)**, Analytical Chemistry **(CHT1401)**, Industrial Inorganic Chemistry **(CHT1139)**				
List of Courses where this course will be Prerequisite					
	PR 4: Food chemistry Lab **(FDP1015)**, PR 3: Technical Analysis Lab **(FDP1011)**, SPL 7: Principles of Food Analysis **(FDT1052)**, SPL 14: Food Safety, Quality & Regulations **(FDT 1028)**				

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

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

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

List of Text Books / Reference Books

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

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

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

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

	Course Code: FDT 1052	Course Title: SPL7: Principles of Food Analysis	Credits = 3		
			L	T	P
	Semester: VII	Total contact hours: 60	2	1	0
List of Prerequisite Courses					
	Technical analysis lab (FDP1011) Food analysis Lab				
List of Courses where this course will be Prerequisite					
	SPL 14: Food Safety and Quality Regulations (FDT 1028)				

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

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

Sr. No.	Course Contents (Topics and subtopics)	Required Hours
1	Types of samples analysed, steps in analysis, choice of methods; sampling procedures, considerations and sample preparation; Evaluation of analytical data – accuracy and precision, sources of errors, specificity, sensitivity and detection limits, regression analysis, reporting results	8
2	Analysis of chemical constituents, their characterization and significance- moisture, ash, minerals, lipids, fat, proteins, fibre, titratable acidity, starch, reducing sugars	7
3	Spectroscopic analysis of foods – basic principles, UV, visible, fluorescence, IR, AAS, MS, NMR. Chromatographic analysis of foods – basic principles, HPLC, GC, GLC, principles and applications	14
4	Analysis of vitamins, pigments, flavours, extraneous matter, pesticides and mycotoxins. Microscopic analysis of foods other methods- potentiometry, enzymatic, immunoassays, thermal analysis, and rheological profile. Analysis of genetically modified foods.	13
5	Sensory analysis	3
	Total	**45**

List of Text Books / Reference Books	
1	AOAC International. 2003. Official methods of analysis of AOAC International. 17th Ed. Gaithersburg, MD, USA, Association of Analytical Communities

2	Kirk, RS and Sawyer, R. 1991. Pearson's Chemical Analysis of Foods. 9th Ed. Harlow, UK, Longman Scientific and Technical.
3	Leo ML.2004. Handbook of Food Analysis. 2nd Edition. Vol 1,2 and 3, Marcel Dekker.
4	Linden G. 1996. Analytical Techniques for Foods and Agricultural Products. VCH.
5	Nielsen, S.(Eds) 1994. Introduction to Chemical Analysis of Foods. Jones & Bartlett
6	Pomrenz Y & Meloan CE. 1996. Food Analysis - Theory and Practice. 3rd Ed. CBS.
7	Ranganna, S. 2001. Handbook of Analysis and Quality Control for Fruit and Vegetable Products, 2nd Ed, Tata-McGraw-Hill Publ
8	Cruz RMS, Khmelinskii, I & Vieira MC. 2016. Methods in Food Analysis, CRC Press.
9	Galanakis CM (Editor). 2020. Innovative Food Analysis. Elsevier Science.
10	Gruenwedel. 2017. Food Analysis: Principles and Techniques (4 volumes). CRC Press.
11	Gentili A. & Fanali C. 2019. Advances in Food Analysis. MDPI AG.
Course Outcomes (Students will be able to…..)	
CO1	Describe the basic principles of physical, chemical, biological and instrumental techniques used in food analysis for quality assurance (K2)
CO2	Explain newer and relevant analytical techniques in food systems and design labels for food products on the basis of food analysis (K3)
CO3	Develop analytical techniques for on-line monitoring of food quality during processing and storage (K3)
CO4	Ensure consumer safety through analysis of food contaminants and adulterants and apply them in the light of regulatory requirements (K3)
CO5	Assess the environmental impact of products life from farm to fork (K4)

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

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

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

	Course Code: MAT1106	Course Title: Design and Analysis of Experiments	Credits = 4		
			L	T	P
	Semester: V	Total Contact Hours: 60	3	1	0

List of Prerequisite Courses

HSC Standard Mathematics, Applied Mathematics – I **(MAT1101)**, Computer Applications Laboratory **(MAP1201)**

List of Courses where this course will be prerequisite

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

This course is required for graduating technocrats to function effectively and efficiently in Industry, Academia and other Professional Spheres.

Sr. No.	Course Contents (Topics and subtopics)	Required Hours
	Module I (Statistical Theory of Design of Experiments)	
1	**Fundamental Principles of Classical Design of Experiments:** Strategy of Experimentation, Typical applications of experimental design, Basic principles, Guidelines for designing experiments	2
2	**Review of Probability and Basic Statistical Inference:** Concepts of random variable, Probability, Density function cumulative distribution function, Sample and population, Measure of central tendency, Mean, median and mode, Measures of variability, Concept of confidence level, Statistical Distributions: Normal, Log Normal & Weibull distributions, Hypothesis testing	4
3	**Experiments with a Single Factor: Analysis of Variance -** Fixed effect model and Random effect model, Model adequacy checking, Contrasts, Orthogonal contrasts, Regression Models and ANOVA, Violation of normality assumption: Kruskal-Wallis test Randomized block designs, Latin square designs, Balanced incomplete block designs	8
4	**Factorial Designs:** Definition, Estimating model parameters, Fitting response curves and surfaces	4
	Module II (Data Analysis using Software (R/Python))	
5	The 2^k Factorial design, Blocking and confounding in the 2^k Factorial design, Focus of 2^2 and 2^3 designs, Blocking and confounding in the 2k Factorial Design	8
6	Plackett Burman methods, Central Composite Design (CCD)	4
7	Descriptive Statistics, Probability Distribution and Testing of Hypothesis using R	6
8	Regression techniques, Diagnostic checks, ANOVA using R and implementation of contrasts	6
9	Construction of Balanced Incomplete Block Designs and data analysis using R	6
10	Analysis of factorial designs using R, Understanding output and interpretation	6
11	Factorial designs, Data analysis and interpretation.	6
	Total	**60**

List of Textbooks/ Reference Books

1	Montgomery, Douglas C. Design and Analysis of Experiments; 9th Ed.; John Wiley & Sons, Inc. (2017)
2	Box, G. E.; Hunter, J. S.; Hunter, W. G. Statistics for Experimenters: Design, Innovation, and Discovery; 2nd Ed.; Wiley (2005)
3	Lawson, John. Design and Analysis of Experiments with R; 1st Ed.; CRC Press (2015)
4	Rasch, D.; Pilz, J.; Verdooren, R.; Gebhardt, A. Optimal Experimental Design with R; 1st Ed.; CRC Press (2011)
5	Unpingco, J. Python for Probability, Statistics, and Machine Learning; 2nd Ed.; Springer (2019)
6	Anderson-Cook, Christine M.; Montgomery, Douglas C.; Myers, Raymond H. Response Surface Methodology: Process and Product Optimization using Designed Experiments; 4th Ed.; Wiley (2016)
7	Montgomery, Douglas C. Introduction to Statistical Quality Control; 7th Ed.; Wiley (2009)
8	Lazić, Živorad R. Design of Experiments in Chemical Engineering: A Practical Guide; 1st Ed.; Wiley-VCH (2005)

Course Outcomes (Students will be able to…..)	
CO1	Explain the basic principles of design of experiments (K2)
CO2	perform statistical analysis of single experiments and do post hoc analysis (K3)
CO3	conduct experiment and analyse the data using statistical methods (K4)
CO4	choose an appropriate design given the research problem (K5)
CO5	perform statistical analysis of different designs using R and interpret the results (K5)

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

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

	Course Code: FDP 1011	Course Title: PR3: Technical Analysis	Credits = 4		
			L	T	P
	Semester: V	Total Contact Hours: 120	0	0	8

List of Prerequisite Courses

None

List of Courses where this course will be Prerequisite

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

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

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

Sr. No.	Course Contents (Topics and subtopics)	Required Hours
1	Estimation of Glucose by Lane and Eynon's & Willstatter's Method	4
2	Estimation of Sucrose by Lane and Eynon's Method	4
3	Estimation of Sucrose and Lactose	4
4	Estimation of Reducing Sugar by Bertard's Volumetric Method	4
5	Estimation of Glucose and Maltose by Sichert and Bleyer's Method	4
6	Estimate $\propto$-Amino Nitrogen by Sorenson's Formal Titration	4
7	Qualitative Analysis of Sugar	4
8	Qualitative Analysis of Fats	8
9	Proximate Analysis of Foods	12
10	Identification of Sugars & amino acids by Paper Chromatography	8
11	Protein Precipitation Reaction	4
12	Hardness of Water	4
13	Water Hardness by Soap Titration	4
14	Estimation of Alkalinity of Water	4
15	Estimation of Sulphates in Water	4
16	Estimation of Chloride by Mohr's Method	4
17	Qualitative Analysis of Amino Acid	4
18	Estimation of Copper	4
19	Estimation of Ferric Ions	4
20	Estimation of Zinc	4
21	Estimation of Manganese	4
22	Estimation of Nitrite	4
23	Estimation of Phosphate	4
24	Chemical Oxygen Demand	4
25	Biochemical Oxygen Demand	8
	Total	**120**

List of Text Books / Reference Books

1	Ranganna, S. (1986). *Handbook of analysis and quality control for fruit and vegetable products*. Tata McGraw-Hill Education.
2	Kirk, S., & Sawyer, R. (1991). *Pearson's composition and analysis of foods* (No. Ed. 9). Longman Group Ltd..
Course Outcomes (Students will be able to…..)	
CO1	Perform and demonstrate the analytical techniques associated with sugar & water samples (K3)
CO2	Demonstrate the analytical techniques associated with mineral estimation in food samples (K3)
CO3	Select the appropriate analytical technique when presented with a practical problem (K4)
CO4	Demonstrate practical proficiency in a food analysis laboratory (K3)
CO5	Categorize and recommend suitable analytical technique to find out the properties of foods and food waste samples (K4)

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

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

	Course Code: FDP 1015	Course Title: PR4: Food Chemistry Lab	Credits = 2		
			L	T	P
	Semester: V	Total contact hours: 60			4
List of Prerequisite Courses					
	Technical Analysis **(FDP1011)**, Technical Analysis I, Technical Analysis II, Food Chemistry **(FDT1032)**				
List of Courses where this course will be Prerequisite					
	Food Analysis, Analysis of Foods (Chemical), SPL 7: Principle of Food Analysis **(FDT1052)**, PR5: Food Processing and Product Development **(FDP 1034)**				

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

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

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

	Total	**60**

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

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

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

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

Semester VI

	Course Code: FDT 1027	Course Title: SPL8: Food Process Engineering	Credits = 4		
			L	T	P
	Semester: VI	Total Contact Hours: 60	3	1	0
List of Prerequisite Courses					
	SPL2: Principles of Food Preservation **(FDT1031)**, SPL5: Food Engineering **(FDT1022)**				
List of Courses where this course will be Prerequisite					
	Pr 8: Food Processing and Engineering **(FDP1026)**				

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

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

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

	Total	**60**

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

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

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

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

	Course Code: FDT 1012	Course Title: SPL9: Food Additives and Ingredients	Credits = 4		
			L	T	P
	Semester: VI	Total contact hours: 60	3	1	0
List of Prerequisite Courses					
	SPL 1: Chemistry of Food Constituents **(FDT 1011)**, Introduction to Food Systems				
List of Courses where this course will be Prerequisite					
	Technology of Fruits and Vegetables, SPL10: Technology of Fruits, Vegetables and Tubers **(FDT 1017)**, Technology of Dairy, Animal Products and Plantation Products, SPL13: Technology of Dairy and Animal products **(FDT 1033)**, SPL12: Technology of Cereals, Legumes and Oilseeds **(FDT 1023)** SPL14: Food Safety, Quality and Regulations **(FDT 1028)**				

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

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

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

	Total	**60**

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

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

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

	Course Code: FDT 1017	Course Title: SPL10: Technology of Fruits, Vegetables and Tubers	Credits = 3		
			L	T	P
	Semester: VI	Total Contact Hours: 45	2	1	0

List of Prerequisite Courses

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

List of Courses where this course will be Prerequisite

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

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

Course objectives

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

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

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

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

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

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

	Course Code: HUT1103	Course Title: Industrial Psychology and Human Resource Management	Credits = 3		
			L	T	P
	Semester: VI	Total Contact Hours: 45	2	1	0

List of Prerequisite Courses

None

List of Courses where this course will be prerequisite

Technology Courses in the forthcoming semesters

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

This course equips students with human resource management skills to be able to function effectively in their professional careers.

	Course Contents (Topics and Subtopics)	Required Hours
1	Introduction and Overview	2
2	Management Theories Taylor, Fayol, Weber, Hawthorne; Basic types of structures; Span of Control, Delegation, Authority, Responsibility	4
3	Recruitment Philosophies, Different methods of attracting candidates	3
4	Selection Application blanks, Interviews, Induction	2
5	Performance Management Goal setting process, Performance appraisal methods, Appraisal interviews, Rating errors	3
6	Training & Development Identifying training needs, Training methods (on the job and off the job techniques), Evaluation of training	3
7	Change Management Types of change, Theories of change management, Hurdles to change, Olmosk change strategies	3
8	Knowledge Management Innovation, Importance and benefits of Knowledge Management, Framework	3
9	Motivation Theories Classification of motives, Various theories (Maslow, Herzberg, ERG, Vroom, Equity and Nohria's 4 drive model)	4
10	Leadership Theories Blake Mouton model, Hersey Blanchard Model, Michigan Model	3
11	Organizational Culture Types of cultures, Understanding and influencing cultures	3
12	Conflict Management Stages of conflict, Types of conflict and sources of conflicts, Conflict resolution	3
13	Power &Politics Bases of power, Politicking strategies	3
14	Personality Theories of personality, Behaviour and personality styles	3
15	Perception Perception versus sensation, Perceptual process, Perceptual errors	3
	Total	**45**

List of Textbooks/Reference Books

1	Innovation and Entrepreneurship, Peter Drucker
2	Essentials of organizational Behaviour, Stephen P. Robbins
3	Organizational Behaviour, Luthans
4	Select HBR cases and articles for review
5	Innovation and Entrepreneurship, Peter Drucker

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

CO1	explain the fundamental concepts of industrial psychology and human resource management (K2)
CO2	analyze practical solutions (K4)
CO3	provide applicable solutions (K3)

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

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

	Course Code: HUT1106	Course Title: Environmental Science and Technology	Credits = 3		
			L	T	P
	Semester: VI	Total Contact Hours: 45	2	1	0

List of Prerequisite Courses

Various Technology Courses in previous semesters

List of Courses where this course will be prerequisite

Various Technology Courses in the forthcoming semesters

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

The course is very useful for the future Chemical Engineers and Technologists for assessing and appreciating impact of chemical processes and technologies on the Environment. The students will be exposed to the nitty-gritties of the impact of design principles on the Environment. Thorough understanding of these technology aspects is going to help in innovative solutions with positive impact on the environment.

	Course Contents (Topics and Subtopics)	Required Hours
1	Introduction to all prevailing international standards of Health, Safety, and Environment (HSE); Environmental laws and regulations; Standards (air quality, noise, water), ISO14000+	3
2	Environmental impact assessment, Life cycle assessment (LCA)	3
3	Pollution prevention in chemical manufacturing, effluent valorization	2
4	Air pollution; Air pollutants: sources (specific pollutants), effects, and dispersion modelling, air pollution, air quality, pollutants minimisation and control, fugitive emissions (source and control), Noise pollution	4
5	Wastewater treatment; Groundwater and surface water pollution, removal of specific water contaminants; Solid waste; Hazardous waste	4
6	Inherent safety; Major disasters (e.g. Flixborough, UK; Bhopal, India; Seveso, Italy; Pasadena, Texas; Texas City, Texas; Jacksonville, Florida; Port Wentworth, Georgia)	5
7	Toxicology; Industrial hygiene	2
8	Source models; Toxic release and dispersion models	5
9	Fires and explosions; Concepts to prevent fires and explosions	3
10	Chemical reactivity	2
11	Reliefs and reliefs sizing; Hazard identification; Risk assessment	4
12	Safety procedures and designs	4
13	Some case histories	4
	Total	**45**

List of Textbooks/Reference Books

1	Environmental Studies by R. Rajagopalan, Oxford University Press.
2	Essentials of Environmental Studies by Kurian Joseph & Nagendran, Pearson
3	Education Renewable Energy by Godfrey Boyle, Oxford Publications
4	Perspective of Environmental Studies, by Kaushik and Kaushik, New Age
5	International Environmental Studies by. Anandita Basak, Pearson Education
6	Textbook of Environmental Studies by Dave and Katewa, Cengage Learning
7	Environmental Studies by Benny Joseph, Tata McGraw Hill
8	Textbook of Environmental studies by Erach Books Bharucha, University Press.

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

CO1	Calculate BOD / COD for a given composition of effluent stream, estimation of bio Kinetics (K3)
CO2	Calculate adiabatic lapse rate and determine conditions for suitability of atmospheric dispersion, effective stack height, chimney design (K3)
CO3	Calculate concentrative of pollutant at any point in the neighborhood of emission given atmospheric conditions like wind, dispersion, environmental factors, etc. (K3)
CO4	Calculate size/time/power required for primary clarifier, secondary treatment, tertiary treatment, sizing of different types of Biological treatments etc (K3)
CO5	Identify hazards in a given process and assess the same and provide solutions for operating safely (K4)

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

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

	Course Code: FDT1026	Course Title: Institute Elective I: Food Biotechnology	Credits = 3		
			L	T	P
	Semester: VI	Total Contact Hours: 45	2	1	0
List of Prerequisite Courses					
	Biochemistry (BST 1102), Microbiology (BST 1109)				
List of Courses where this course will be Prerequisite					
	None				

Description of relevance of this course in the B. Tech. (Food Engg. & Tech.) Programme		
Course objectives 1. To describe the fundamentals of molecular biology, chemistry, biology and different mechanisms of DNA, RNA and protein synthesis 2. To explain the regulations in gene expression and recombinant DNA technology in prokaryotes and eukaryotes 3. To describe different techniques and mechanisms involved in industrial fermentation processes 4. To describe tissue culture, microalgae, genetically modified foods and nutritional genomics applied in food biotechnology 5. To describe the various industrial applications of enzymes		
Sr. No.	**Course Contents (Topics and subtopics)**	**Required Hours**
1	Introduction to Food of Biotechnology with applications in Industry, Basics of Molecular Biology - Chemistry and Biology of DNA, RNA and proteins, DNA replication, transcription and translation in prokaryotes and eukaryotes	9 (6L+3T)
2	Regulation of gene expression in prokaryotes and eukaryotes. Recombinant DNA technology with examples	9 (6L+3T)
3	Introductory aspects of biochemical engineering and bioreactor designs; Application of genetic control mechanisms in industrial fermentation processes; Principles of submerged and solid-state fermentations; Fermentation media and sterilization; Basics of strain improvement techniques.	9 (6L+3T)
4	Basic concepts of Plant tissue culture and its applications in Biotechnology; Use of microalgae in biotechnology, Animal tissue culture as a tool of biotechnology; Genetically modified foods – plant and animal origin; Nutritional genomics	9 (6L+3T)
5	Applications of enzymes in industry with case studies	9 (6L+3T)
	Total	**45**
List of Text Books / Reference Books		
1	Basic molecular and Cell Biology 3rd edition Ed. David Latchman. BMJ Publishing Group 1997. 1st Indian reprint 2006.	

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

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

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

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

	Course Code: FDP 1033	Course Title: Seminar	Credits = 2		
			L	T	P
	Semester: VI	Total contact hours: 60	0	1	4

List of Prerequisite Courses

None

List of Courses where this course will be Prerequisite

Project I **(FDP 1027)**, Project II **(FDP 1025)**

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

Course objectives

1. Develop systematic thinking and documenting it effectively on a contemporary topic related to food technology
2. Develop skills for presenting a topic in food science effectively

Sr. No.	Course Contents (Topics and subtopics)	Required Hours
1	Students will be required to prepare a critical review of selected topics in Food Engineering and Technology and submit it in the form of a standard typed report. Typically, the report should contain and will be evaluated based on the following points: (i) Introduction: 2 pages maximum, (ii) Exhaustive review of the literature (including tables and figures): 10 – 12 pages: 50% weightage (iii) Critical analysis of the literature and comments on the analysis (including tables and figures): 10 – 12 pages: 50% weightage. The critical analysis of the literature should include the following points: • Are the papers technically, correct? • Whether the assumptions reasonable and logical? • Are the methods used in the literature appropriate? • Are there any internal contradictions, and are there any loopholes in the observations? If so, please explain. • Critical analysis of papers should also contain a quantitative comparison of observations, results, and conclusions amongst the various papers. Each student will also be required to make an oral presentation of the review. Weightage would be 40% for the presentation and 60% for the report. Additional details and requirements are given to the students every year by the coordinator of this activity.	**60**
	Total	**60**

Course Outcomes (Students will be able to…..)	
CO1	Develop a protocol for literature survey about a certain topic (K4)
CO2	Evaluate the literatures and interpret the scientific content (K5)
CO3	Apply the concept of food technology on a selected topic (K3)
CO4	Develop skills for presenting a scientific topic in food science (K6)
CO5	Develop skills for writing a scientific document (K6)

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

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

	Course Code: FDP 1034	Course Title: PR5: Food Processing and Product Development	Credits = 2		
			L	T	P
	Semester: VI	Total Contact Hours: 60	0	0	4

List of Prerequisite Courses

SPL2: Principles of Food Preservation **(FDT1031)**, SPL5: Food Engineering **(FDT1022)**

List of Courses where this course will be Prerequisite

SPL8: Food Process Engineering **(FDT1027)**

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

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

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

List of Text Books / Reference Books

1	Fuller, G.W. (2011). *New Food Product Development: From Concept to Marketplace*, 3rd ed, CRC Press, UK.
2	Theodoros Varzakas, Constantina Tzia. (2015). *Handbook of Food Processing: Food Safety, Quality, and Manufacturing Processes*, CRC Press, UK.
3	Giridhari Lal, G.S. Siddappa, G.L. Tandon. (1998). *Preservation of Fruits and Vegetables*, ICAR, New Delhi.
4	Khurdia DS. (1995). Preservation of fruits and vegetables. Indian Council of Agriculture Research, New Delhi.
5	Ramaswamy H and Marcott M. (2005). Food Processing Principles and Applications. CRC Press.
6	The Food Safety and Standards Act along with Rules and Regulations (2011). Delhi: Commercial Law Publishers (India) Pvt Ltd.

Course Outcomes (Students will be able to…..)	
CO1	Explain and develop basic flow sheet in food processing operations (K3)
CO2	Analyse the major food processing steps applied during various food preparations (K4)
CO3	Describe and design novel food products (K3)
CO4	Use different food processing equipment for product development (K3)
CO5	Analyse the developed food products (K4)

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

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

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

	Course Code: FDP 1018	Course Title: PR6: Food Analysis - I	Credits = 2		
			L	T	P
	Semester: VI	Total Contact Hours: 60	0	0	4

List of Prerequisite Courses

PR 3: Technical Analysis **(FDP1011)**, PR 4: Food Chemistry **(FDP1015)**

List of Courses where this course will be Prerequisite

PR 7: Food Analysis-II **(FDP1021)**, SPL 14: Food Safety, Quality and Regulations **(FDT1028)**

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

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

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

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

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

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

Semester VII

	Course Code: CET1703	Course Title: Chemical Process Control	Credits = 3		
			L	T	P
	Semester: VII	Total Contact Hours: 45	2	1	0

List of Prerequisite Courses

Material and Energy Balance Calculations, Applied Mathematics, Applied Mathematics-I **(MAT1101)** & II **(MAT1102)**, Chemical Engineering Operations **(CET1401)**, Chemical Reaction Engineering **(CET1212)**

List of Courses where this course will be prerequisite

Chemical Engineering Laboratory **(CEP1714)**, Projects [Project I **(FDP 1027)** & Project II **(FDP 1025)**]

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

Process control plays a very critical role in the context of actual operation of a process plant. Most of the core chemical engineering courses focus on the steady state operation. In the real-life environment, process is continuously subjected to various disturbances which deviates the operation from the designed steady state. This course specifically prepares students to assess the impact of such disturbances and equip them with the tools available to tackle these situations.

Sr. No.	Course Contents (Topics and Subtopics)	Required Hours
1	Instrumentation: Principles of measurement; Pressure, Temperature, Level, Flow and composition measuring devices; Introduction to controllers (PLC, digital control, DCS), Introduction to control valves, Types of control valves, Control valve characteristics	9
2	Introduction to system dynamics, Concept of dynamic response, Linear systems, First, second and higher order system, Systems with dead-time, Definition of terms such as transfer function, Time constant, Gain of the process with practical examples Response of processes to standard inputs	9
3	Introduction to Process Control: Set point, disturbance, closed loop and open loop control, Feedback and feed-forward configurations, Poles and zeros of the transfer functions Basic control actions (ON/OFF, P, I and D), Effects of controller action on process response: Offset, closed-loop gain, controller gain effect of controller parameters	6
4	Stability analysis of feedback systems, Notion of stability, Criteria for stability	6
5	Control System Design: Introduction to controller design Identification of controlled, manipulated and disturbance variables, Pairing of inputs and outputs Controller selection for pressure, flow, temperature, level and composition control Criteria-based controller design, heuristic controller design, controller tuning	9
6	Multiple Loop and Traditional Advanced Control Systems: Cascade control, Ratio control, Feed-forward control, Selective control, Split-range control, Inferential control	6
	Total	**45**

List of Text Books/ Reference Books

1	Chemical Process Control: An Introduction to Theory and Practice, Stephanopolous G.
2	Process Modeling, Simulation, and Control for Chemical Engineers, Luyben W.L.
3	Process Dynamics and Control, Seborg, D.E. and Mellichamp, D.A. and Edgar, T.F. and Doyle, F.J.
4	Process Control: Modeling, Design, and Simulation, Bequette, B.W.
5	Process Control Instrumentation Technology, Johnson, C.D.

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

1	Specify the required instrumentation and control elements for a particular process (K3)
2	Develop input-output transfer function models for dynamics of processes (K4)
3	Characterize the dynamics and stability of processes based on mathematical analysis (K5)
4	Design and tune process controllers (K6)
5	Specify the required instrumentation and control elements for a particular process (K3)

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

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

	Course Code: FDT 1024	Course Title: SPL11: Technology of Plantation Products	Credits = 3		
			L	T	P
	Semester: VII	Total Contact Hours: 45	2	1	0
List of Prerequisite Courses					
	SPL 1: Chemistry of Food Constituents **(FDT 1011)**. SPL 6: Food Chemistry **(FDT1032)**				
List of Courses where this course will be Prerequisite					
	PR8: Food processing and Engineering **(FDP 1026)**				

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

Course objectives

1. To understand the process of cocoa fermentation and unit operations involved in extracting cocoa butter and producing cocoa powder
2. To describe cocoa butter replacement fats and the method of manufacture of chocolate-based confectionery
3. To understand tea/coffee cultivation, composition, processing, products and analysis
4. To describe spices, their chemical constituents and post-harvest handling and processing
5. To describe different types of sugar-based confections including manufacturing process, equipment used and physico-chemical analysis

Sr. No.	Course Contents (Topics and subtopics)	Required Hours
1	Cultivation of cocoa, microbiology/biochemistry of cocoa bean fermentation, development of cocoa flavour precursors, drying, roasting, alkalization (Dutching), NARS process, winnowing, nib grinding, liquor processing, expeller pressing, cocoa cake grinding, cocoa products, analysis of cocoa powder, cocoa butter-chemistry and properties,	9 (6L+3T)
2	Cocoa butter replacement fats (CBS and CBE fats and other fats), antibloom fat, lecithin as emulsifier in chocolate; Chocolate based confectionery-Bulk chocolate manufacture: raw materials, milk chocolate process including milk crumb process, melangeuring, refining, pasting, conching; tempering, moulding, enrobing, panning.	9 (6L+3T)
3	Tea cultivation, constituents of tea leaf, fermentation and black tea manufacture, characteristics and quality of tea beverage, types of tea- black tea, green tea, oolong tea, speciality teas, herbal teas; analysis of tea Coffee varieties, cultivation, coffee bean composition, processing of berries (wet and dry process), roasting, grinding, brewing, instant coffee manufacture, decaffeination; analysis of coffee and chicory	9 (6L+3T)
4	Varieties of spices/condiments grown and consumed in various countries including India, nomenclature, properties and culinary uses, preservative action, medicinal uses, analysis of spices, post-harvest handling/ storage/ preservation/ processing of spices, spice-based products, major individual spices- turmeric, cardamom, asafoetida, cinnamon, cloves, nutmeg, capsicum, pepper, ginger, saffron, anise, ajwain, coriander, cumin, celery, caraway, dill, fenugreek, fennel etc.	9 (6L+3T)
5	Sugar based confectionery- ingredients used including sugar and alternative sweeteners, description of types of confections like HBC, toffee, fudge, gums and jellies, aerated confectionery, sugar panned confections, chewing gum etc,	9 (6L+3T)

	manufacturing process and equipment, structure of sugar confection, chemical analysis and quality assurance. Indian confectionery- types, description of characteristics, method of preparation	
	Total	**45**

List of Text Books / Reference Books	
1	Chocolate, cocoa and confectionery: Science and Technology – 3rd Edition 1989 Minifie B.W.
2	Industrial Chocolate Manufacture and Use, Edited by Stephen Beckett, 4th Edition Publisher Wiley Blackwell, ISBN: 978-1-4051-3949-6
3	Science of Tea Technology by PS Ahuja, A Gulati, RD Singh, RK Sud & RC Boruah. Scientific Publishers (2013). ISBN-13: 978-8172338312
4	Coffee: planting, production and processing by S K Mangal. Gene-Tech Books. 1st Edition (2007). ISBN: 9781441653093
5	Handbook of herbs and spices by KV Peter. Woodhead Publishing Limited. 2nd Edition, Vol II (2012)
6	Spices by JW Purseglove, EG Brown, CL Green & SRJ Robbins. Longman Group Ltd. Vol. 2 (1981) (pp. 447-813).
7	Sugar Confectionery and Chocolate Manufacture by R. Lees and E. B. Jackson. Springer US. 1st Edition (1995). ISBN: 9781468414950
Course Outcomes (Students will be able to…..)	
CO1	Explain the process of cocoa fermentation and unit operations involved in extracting cocoa butter and producing cocoa powder (K2)
CO2	Describe cocoa butter replacement fats and analyse the method of manufacture of chocolate-based confectionery (K4)
CO3	Explain tea/coffee cultivation, composition, processing, products and analysis (K2)
CO4	Describe spices, their chemical constituents and solve the problems related to post-harvest handling and processing (K3)
CO5	Describe different types of sugar-based confections including manufacturing process, equipment used and analysis (K2)

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

CO4	K3	3	3	2	2	2	3	3	3	3	3	3	2	3	3
CO5	K2	3	2	1	2	1	3	3	3	3	3	3	1	3	2
Course	K4	3	3	2	3	2	3	3	3	3	3	3	2	3	3

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

	Course Code: FDT 1023	Course Title: SPL12: Technology of Cereals, Legumes and Oilseeds	Credits = 3		
			L	T	P
	Semester: VII	Total Contact Hours: 45	2	1	0

List of Prerequisite Courses

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

List of Courses where this course will be Prerequisite

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

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

Course objectives

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

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

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

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

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

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

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

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

Course objectives

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

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

List of Text Books / Reference Books

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

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

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

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

	Course Code: FDP 1035	Course Title: In-plant Training	Credits = 6		
			L	T	P
	Semester: VII	Total duration: 12 weeks	0	0	0

List of Prerequisite Courses

None

List of Courses where this course will be Prerequisite

Project I **(FDP 1027)**, Project II **(FDP 1025)**

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

Course objectives

1. Develop a systematic thinking about an industrial problem
2. Develop skills for communication, networking, personal grooming & professional conduct within an industrial environment
3. Develop the attitude for individual and teamwork

Sr. No.	Course Contents (Topics and subtopics)	Required weeks
1	-Each Student will be involved in R & D/ manufacturing (QA / QC / Plant Engineering /Stores and Purchase)/ marketing / finance/ consultancy/ Technical services/ Engineering / Projects, etc. -Oral presentation & written report of the in-plant training will be evaluated along with industry feedback.	**12**
	Total	**12**

Course Outcomes (Students will be able to…..)	
CO1	Apply the concept of project & production management in further planning (K3)
CO2	Develop critical thinking regarding the various operations involved in food industry (K4)
CO3	Solve certain industrial challenges in food processes (K6)
CO4	Present and communicate an industrial problem effectively (K6)
CO5	Write a scientific report on the training (K6)

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

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

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

	Course Code: HUT1105	Course Title: Industrial Management	Credits = 4		
			L	T	P
	Semester: VII	Total Contact Hours: 60	3	1	0

List of Prerequisite Courses
None

List of Courses where this course will be prerequisite
None

Description of relevance of this course in the B. Tech. Program
This course is required for effective and holistic functioning of students in their professional career.

	Course Contents (Topics and Subtopics)	Required Hours
1	Greiner's Model of Organization Life Cycle Organic and mechanistic structures	3
2	Marketing Management Introduction, Porter's value chain, Porter's five forces, Porter's generic strategies	7
3	Introduction to the 4Ps of Marketing Product, Price, Place, Promotion	11
4	Production and Operations Management Concept of productivity, World class manufacturing, Business process reengineering, Kanban, JIT, Poka Yoke system, Maintenance practices	10
5	Quality Management The concept of quality, Quality control, acceptance sampling and SQC Deing's 14 points, TQM, Insights into ISO-9000, ISO -14000, ISO-50000	6
6	Financial Management Accounting system, Balance-sheet evaluation, Fund-flow analysis, financial ratios an insight, Costing	15
7	Materials Management Value analysis, Purchasing and vendor development, Warehousing and inventory control methods	4
8	Maintenance Management Classifications, Equipment and plant reliability and availability, Management of shut downs and turnarounds	4
	Total	**60**

List of Textbooks/Reference Books	
1	Industrial Management–I, Jhamb L. C. and Jhamb S.
2	Industrial Management, Spriegel U.S.
3	Operations Management for Competitive Advantage, Richard B. Chase, F. Robert Jacobs, Nicholas Acquilano
4	World Class Manufacturing - A strategic Perspective, B.S. Sahay, K.B.C. Saxena, Ashish Kumar
5	Management Finance, Varanasay Murthy
6	Essentials of Management,Koontz
7	Principles of Marketing, Kotler
8	Quality Planning and Analysis, Juran
9	Financial Management, Prasanna Chandra
10	Financial Management, R. M. Srivastava
11	Select HBR cases and articles for review

Course Outcomes (Students will be able to…..)	
CO1	explain the fundamental concepts of Marketing management and the various aspects therein (K2)
CO2	describe the fundamental concepts of Finance and analyse the balance sheet (K4)

CO3	explain various productivity techniques that when combined with engineering knowledge can be applied successfully in the industry (K2)
CO4	study real life practical problems, constraints and will be able to think in terms of various alternative solutions (K3)

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

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

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

	Course Code: CEP1714	Course Title: Chemical Engineering Laboratory	Credits = 2		
			L	T	P
	Semester: VII	Total Contact Hours: 60	0	0	4

List of Prerequisite Courses

Process Calculations **(CET1507)**, Transport Phenomena **(CET1105)**, Chemical Engineering Operations **(CET1401)**, Chemical Reaction Engineering **(CET1212)**

List of Courses where this course will be prerequisite

Other B. Tech. courses in this and the last semester

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

This course provides students the first-hand experience of verifying various theoretical concepts learnt in theory courses. It also exposes them to practical versions of typical chemical engineering equipments and servers as a bridge between theory and practice. This particular lab focuses on fluid dynamics, distillation, filtration, drying and sedimentation.

Sr. No.	Course Contents (Topics and Subtopics)	Required Hours
1	4 - 6 Experiments on fluid dynamics and heat transfer	24
2	3 - 5 Experiments on Chemical Engineering Operations	16
3	2 – 4 Experiments on Reaction Engineering	12
4	1 – 3 Experiments on process dynamics and control	8
	Total	**60**

List of Text Books/ Reference Books

1	McCabe W.L., Smith J.C., and Harriott P. Unit Operations in Chemical Engineering, 2014
2	Bird R.B., Stewart W.E., and Lightfoot, E.N. Transport Phenomena, 2007
3	Coulson J.M., Richardson J.F., and Sinnott, R.K. Coulson & Richardson's Chemical Engineering: Chemical engineering design, 1996.
4	Green D. and Perry R. Perry's Chemical Engineers' Handbook, Eighth Edition, 2007.

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

CO1	Learn how to experimentally verify various theoretical principles (K3)
CO2	Visualize practical implementation of chemical engineering equipment (K4)
CO3	Develop experimental skills (K4)

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

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

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

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

List of Prerequisite Courses

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

List of Courses where this course will be Prerequisite

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

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

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

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

List of Text Books / Reference Books

1	Neilsen Suzanne S., Food Analysis, Fourth Edition, Springer; 2010.

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

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

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

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

	Course Code: FDP 1027	Course Title: Project -I	Credits = 2		
			L	T	P
	Semester: VII	Total contact hours: 60	0	1	4

List of Prerequisite Courses

	Seminar **(FDP 1033) and all the courses up to Semester VI**

List of Courses where this course will be Prerequisite

	Project II **(FDP 1025)**

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

1. Develop skills to execute & solve ideas on new products/processes in food technology for possible commercialization
2. Develop skills for presenting research work effectively

Sr. No.	Course Contents (Topics and subtopics)	Required Hours
1	-Teachers will communicate various research project topics to all the students based on interest and facilities available, and relevance to the area of Food Engineering and Technology. - Each student, based on his/her interest and merit, selects the research topic and is allotted a supervisor. -The literature search will have to be submitted in the form of a standard typed report - Review of literature, formulation of the research project, hypothesis, objectives, methodology, possible expected outcomes, planning for experimentation, experimental trials, data generation, and analysis. Every student will be orally examined. The student will be assessed based on the progress made during the semester. There would be (i) submission of report and (ii) PowerPoint presentation. The PowerPoint will be presented to a panel of faculty members/examiners, and they will also evaluate the submitted report. There will be a weightage of 60% for the report submission and 40% for the presentation. Additional details may be given to the students from time to time by the coordinator.	**60**
	Total	**60**

Course Outcomes (Students will be able to…..)	
CO1	Develop critical thinking to identify the research gap for the project (K5)
CO2	Formulate a scientific question and approach to solve it (K6)
CO3	Plan the experimental methodology for the project (K5)
CO4	Develop skills to communicate the research plan effectively (K6)
CO5	Develop skills for writing a scientific document on the research work (K6)

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

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

CO5	K6	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Course	K6	3	3	3	3	3	3	3	3	3	3	3	3	3	3

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

Semester VIII

	Course Code: CET1504	Course Title: Chemical Project Engineering and Economics	Credits = 3		
			L	T	P
	Semester: VIII	Total Contact Hours: 45	2	1	0

List of Prerequisite Courses

Material and Energy Balance Calculations, Equip Design and Drawing I, Energy Engineering, Industrial Engineering Chemistry

List of Courses where this course will be prerequisite

Home Papers I and II

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

This course is required for the future professional career.

Sr. No.	Course Contents (Topics and Subtopics)	Required Hours
1	Introduction to the green field projects and global nature of the projects Impact of currency fluctuations on Project justification and cash flows Concepts of 'Quality by Design' including typical design deliverables Understanding constructability, operability and maintainability during all stages of project execution Meaning of Project Engineering, various stages of project implementation	6
2	Relationship between price of a product and project cost and cost of production, EV Analysis. Elements of cost of production, monitoring of the same in a plant Meaning of Administrative expenses, sales expenses, etc. Introduction to various components of project cost and their estimation Introduction to concept of inflation, location index and their use in estimating plant and machinery cost Various cost indices	8
4	Project financing, debt:equity ratio, promoters, contributors, shareholders contribution, source of finance, time value of money Concept of interest, time value of money, selection of various alternative equipment or system based on this concept, Indian norms, EMI calculations Depreciation concept, Indian norms and their utility in estimate of working results of project. Working capital concept and its relevance to project	7
5	Estimate of working results of proposed project. Capacity utilization, Gross profit, operating profit, profit before tax, Corporate tax, dividend, Net cash accruals. Project evaluation: Cumulative cash flow analysis Break-Even analysis, incremental analysis, various ratios analysis, Discounted cash flow analysis	7
6	Process Selection, Site Selection, Feasibility Report	4
7	Project: Conception to Commissioning: milestones, Project execution as conglomeration of technical and nontechnical activities, contractual details. Contract: Meaning, contents, Types of contract. Lump- sum Turnkey (LSTK),Eng, Procurement and Construction(EPC),Eng, Procurement and Construction Management (EPCM).Mergers and Acquisitions	6
8	Reading of balance sheets and evaluation of techno-commercial project reports	3
9	PERT, CPM, Bar-charts and network diagrams	4
	Total	**45**

List of Text Books/ Reference Books

1	Chemical Project Economics,MahajaniV.V.andMokashi SM.
2	Plant Designand Economics for Chemical Engineers,Peters M.S.,TimmerhausK.D.
3	Process Plant and Equipment Cost Estimation, Kharbanda O.P.

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

CO1	calculate working capital requirement for a given project (K3)
CO2	calculate cost of equipment used in a plant total project cost (K3)
CO3	calculate cash-flow from a given project (K3)
CO4	select a site for the project from given alternatives (K4)

CO5	list out various milestones related to project concept to commissioning (K2)

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

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

	Course Code: FDT 1033	Course Title: SPL13: Technology of Dairy and Animal Products	Credits = 4		
			L	T	P
	Semester: VI	Total contact hours: 60	3	1	0
List of Prerequisite Courses					
	SPL1: Chemistry of Food Constituents **(FDT 1011)**. SPL6: Food Chemistry **(FDT1032)**				
List of Courses where this course will be Prerequisite					
	PR8: Food Processing and Engineering **(FDP 1026)**				

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

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

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

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

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

12	Aberele ED, Forrest JC, Gerrard, D. E., & Mills, E. W. Principles of Meat Science, Kendll Hunt (2001).
13	**Warris, PD. Meat Science- An Introductory Text. CABI Publsihing, 2nd Edition (2010)**
14	**Kinsman, DM, Kotula DW & Btendstein BC. Muscle Food.** destein, Marcel Dekker Inc. (1994)
15	**Ockerman HW & Hansen CL. Animal By-product Processing and Utilization.** CRC Press, 1st Edition (1999).
16	**Toldra F. Handbook of Meat Processing, Wiley Blackwell (2010)**
17	**Gracey G, Collins DS & Huey R. Meat Hygiene,** W.B. Saunders Company Ltd., CRC Press (1999).
18	**Mountney GJ & Parkhurst CR. Poultry Products Technology.** Haworth Press, 3rd edition (1995).
19	**Feiner G. Meat Products Handbook,** Woodhead Publishing (2006).
20	**Lawrie RA. Lawrie's Meat Science,** CRC Press, 8th edition (2017)
21	Meilgaard, M, Civille GV & Thomas Carr **B. Sensory Evaluation Technique,** , CRC Press (2016)
Course Outcomes (Students will be able to…..)	
CO1	Explain fundamental knowledge on dairy-based and animal-based products (K2)
CO2	Explain the facts and unit operations/flow sheet of manufacture and technologies involved in the processing/food plant sanitation of different animal products/milk and dairy products (K2)
CO3	Apply techniques suitable for the extraction/isolation of high value compounds from milk/animal products (K3)
CO4	Develop/design/modify new products/processes for value-addition of dairy/animal products (K3)
CO5	Explain the causes related to any aspect of quality/spoilage and processing of dairy/animal based products and do troubleshooting (K3)

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

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

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

	Course Code: FDT 1028	Course Title: SPL14: Food Safety and Quality Regulations	Credits = 3		
			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 Engg. & Tech.) Programme		
1. To explain the functional role and safety issues of food contaminants, food adulteration, 2. To describe the hygiene and sanitation in food processing plant, equipment, storage and handling 3. To explain the various quality attributes of food and emphasizing on microbial quality control in food and water quality 4. To conduct a food safety-based risk assessment at different stages of production of food and thereby designing the HACCP, VACCP and TACCP system 5. To explain the role, standard and law set by Indian and global regulatory authorities with respect to food quality control		
Sr. No.	**Course Contents (Topics and subtopics)**	**Required Hours**
1	**India Regulations** Overview of FSSAI. Detail of FSS Regulations relevant to products and labelling. (FSS Licensing & Registration including Schedule IV, Product Standards & Additives, Labelling & Display, Advertisement & Claims) Introduction to food safety and security: Hygienic design of food plants and equipment,	15
2	**Food quality**: Various Quality attributes of food, Instrumental, chemical and microbial Quality control. Sensory evaluation of food and statistical analysis. Water quality and other utilities.	8
3	**Food Safety Management System**: Food Safety, Threat and Fraud Management based on international standards (HACCP / VACCP / TACCP)?	14
4	**Global regulations:** FAO, Technical Cooperation programmes, Bio-security in Food and Agriculture, World Health Organization (WHO), World Animal Health Organization (OIE), International Plant Protection, Convention (IPPC) Codex Alimentarius Commission - Codex India – Role of Codex Contact point, National Codex contact point (NCCP), National Codex Committee of India – ToR, Functions, Shadow Committees etc. **Overview of US and EU regulations for food**	8
	Total	**45**

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

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

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

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

	Course Code: FDT 1019	Course Title: SPL15: Food Packaging	Credits = 3		
			L	T	P
	Semester: VIII	Total Contact Hours: 45	2	1	0
List of Prerequisite Courses					
	SPL1: Chemistry of Food Constituents **(FDT 1011)**, SPL3: Food Microbiology **(FDT 1014)**				
List of Courses where this course will be Prerequisite					
	SPL2: Principles of Food Preservation **(FDT 1031)**				

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

Course objectives:

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

Sr. No.	Course Contents (Topics and subtopics)	Required Hours
1	Introduction to food packaging; Causes of food spoilage; Factors affecting food spoilage; Packaging as a method for preservation of foods; Functions of food packaging including new packaging technologies; Levels of packaging; Food labelling	9 (6L+3T)
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	9 (6L+3T)
3	Testing of various packaging materials and packages for evaluation of quality, for identification, for evaluation of barrier and strength properties for transport-worthiness, for biodegradability, for migration etc; Criteria for selection of packaging materials; Shelf-life testing of packaged foods	9 (6L+3T)
4	Food and Packaging material interactions including migration, scalping of flavour; biodegradable packaging; application of nanotechnology in food packaging; environmental concerns and lifecycle assessment Packaging of various food commodities including fresh produce (fruits and vegetables), meat, fish, poultry, milk, cereals and processed foods.	9 (6L+3T)
5	Newer packaging technologies- CAP/MAP packaging; aseptic processing and packaging; irradiated packaging; retort pouch; microwaveable packaging; packaging for high pressure processing; active packaging; intelligent packaging	9 (6L+3T)
	Total	**45**

List of Text Books / Reference Books

1	Packaging Media by Paine F.A. Publisher: Blackie and son Ltd., Bishop Briggs (1977)
2	Food and Packaging Interactions by Risch.S.H. Publisher American chemical society, Washington (1991).
3	Handbook of Food Packaging by F.A. Paine and H.Y. Paine Publisher: Blackie and Son Ltd. London. (1983)
4	Food Packaging Technology by G Bureau and JL Multon, VCH, New York (Vol.1 & 2) (1996). ISBN: 1560819324, 9781560819325
5	Food Packaging and Shelf Life: A Practical Guide by Gordon L. Robertson. CRC Publication. Edition 1 (2009). ISBN: 9781420078442
6	Food Packaging - Principles and Practice (3rd Edition) by Gordon L. Robertson. Taylor & Francis. Edition 3 (2013). ISBN: 9781628706529
7	Innovations in Food Packaging by Jung H. Han. Academic Press- Food Science and Technology International Series. Edn 1 (2005. ISBN: 9780123116321)
Course Outcomes (Students will be able to…..)	
CO1	Discuss and analyze the role of food packaging in food preservation (K4)
CO2	Describe different food packaging materials, properties, and interactions (K2)
CO3	Apply the concept of packaging with respect to various food commodities (K3)
CO4	Explain and interpret various tests used in evaluating quality and safety of food packaging materials (K2)
CO5	Describe newer food packaging technologies (K2)

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

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

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

	Course Code: FDT 1053	Course Title: Program Elective: Waste Management in Food Processing	Credits = 3		
			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 Engg. & Tech.) Programme

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

Sr. No.	Course Contents (Topics and subtopics)	Required Hours
1	Water quality, treatment and recycle. BOD, COD and definitions, Discharge limits for effluents. Primary treatment, secondary and tertiary treatments by physical, chemical and biological methods.	10
2	Effluent and solid waste utilization food processing industry by biological methods – for SCP, biogas and other products	9
3	Waste management strategies and value-added products from of agri-food processing industry	9
4	Recovery of biological from dairy, meat, fish and poultry processing industry	8
5	Case studies: Cane Sugar waste, molasses for alcohol, bagasse for paper pulp, chemicals, bioethanol, cogeneration. Other processes including vermiculture.	9
	Total	**45**

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

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

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

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

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

	Course Code: FDP 1026	Course Title: PR8: Food Processing and Engineering	Credits = 4		
			L	T	P
	Semester: VIII	Total Contact Hours: 60	0	0	8
List of Prerequisite Courses					
	SPL2: Principles of Food Preservation **(FDT1031)**, SPL5: Food Engineering **(FDT1022)**, SPL8: Food Process Engineering **(FDT1027)**.				
List of Courses where this course will be Prerequisite					

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

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

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

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

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

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

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

	Course Code: FDP 1025	Course Title: Project -II	Credits = 4		
			L	T	P
	Semester: VIII	Total contact hours: 120	0	0	8

List of Prerequisite Courses

	Project I **(FDP 1027)**

List of Courses where this course will be Prerequisite

	None

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

1. Develop skills to execute & solve ideas on new product/process in food technology for possible commercialization
2. Develop skills for presenting research outcomes effectively

Sr. No.	Course Contents (Topics and subtopics)	Required Hours
1	Work done in Semester VII (Project I) will be studied in detail by extrapolating further. The topic of the research with defined objectives and hypotheses should be explored by scientifically planned rational experiments. Students should have actual experimental data collected on the chosen research topic. Should be able to address relevant matters such as quality assurance, packaging, costing, plant layout, and regulatory as well as marketing aspects of the product(s) developed.	**80**
2	Every student will be orally examined. The student will be assessed based on (i) submission of report and (ii) Presentation and Viva-voce. The student will present his/her work to a panel of faculty members/examiners, and they will also evaluate the submitted report. Final report of Project -II would be given a weightage of 50 marks. There will be a viva-voce after the presentation. The weightage for the viva-voce would be 50 marks. Additional details may be given to the students from time to time by the coordinator.	**40**
	Total	**120**

Course Outcomes (Students will be able to…..)	
CO1	Perform experiments & troubleshoot to generate reliable data (K5)
CO2	Apply different statistical tools for scientific data analysis (K4)
CO3	Evaluate critically the experimental data and draw meaningful inferences (K5)
CO4	Develop skills to communicate the research outcome effectively (K6)
CO5	Develop skills for writing a complete document on the project work (K6)

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

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

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