KONGU ENGINEERING COLLEGE
PERUNDURAI ERODE – 638 052
(Autonomous)

VISION

To be a centre of excellence for development and dissemination of knowledge in Applied Sciences, Technology, Engineering and Management for the Nation and beyond.

MISSION

We are committed to value based Education, Research and Consultancy in Engineering and Management and to bring out technically competent, ethically strong and quality professionals to keep our Nation ahead in the competitive knowledge intensive world.

QUALITY POLICY

We are committed to

- Providing value based quality education for the development of students as competent and responsible citizens.
- Contributing to the nation and beyond through research and development
- Continuously improving our services

DEPARTMENT OF FOOD TECHNOLOGY

VISION

To be a centre of excellence for development and dissemination of knowledge in the field of Food Technology for the nation and beyond.

MISSION

Department of Food Technology is committed to:

MS1: Develop vibrant, competent and ethical food engineers who can promote technical advancements in the field of Food Technology

MS2: Foster the research activities of faculty and students to explore the state-of- the-art techniques to meet the industrial and societal needs

MS3: Endeavour for constant upgradation of technical expertise to support continuous learning

2014 REGULATIONS

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

Graduates of Food Technology will

PEO1: Apply principles of basic sciences, and engineering to succeed in their professional career

PEO2: Analyze, design and develop food processes/products that are technically feasible, economically viable and socially relevant

PEO3: Exhibit professional and ethical codes of conduct and an aptitude for continuous learning for catering to the ever changing needs of the society

MAPPING OF MISSION STATEMENTS (MS) WITH PEOs

MS\PEO	PEO1	PEO2	PEO3
MS1	3	2	3
MS2	3	3	2
MS3	2	2	3

1 – Slight, 2 – Moderate, 3 – Substantial

PROGRAM OUTCOMES (POs)

Engineering Graduates will be able to:

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.

PROGRAM SPECIFIC OUTCOMES (PSOs)

PSO1 Explore the ideas and methodologies in developing innovative food processing techniques and food products

PSO2 Adapt multidisciplinary approach to solve food industry problems and ensure food quality and safety

MAPPING OF PEOs WITH POs AND PSOs

PEO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
PEO1	3	3	3	2	2	2	1	1	1	1	1	2	3	3
PEO2	3	3	3	3	3	3	2	2	1	1	2	3	3	3
PEO3	1	1	1	1	1	3	3	3	2	2	1	3	2	2

1 – Slight, 2 – Moderate, 3 – Substantial

CURRICULUM BREAKDOWN STRUCTURE UNDER REGULATION 2014

Curriculum Breakdown Structure(CBS)	**Curriculum Content (% of total number of credits of the program)**	**Total number of contact hours**	**Total number of credits**
Basic Sciences(BS)	16.67	510	30
Engineering Sciences(ES)	8.33	285	15
Humanities and Social Sciences(HS)	9.44	315	17
Program Core(PC)	45	1575	81
Program Electives(PE)	10	270	18
Open Electives(OE)	5	135	09
Project(s)/Internships(PR)	5	270	09
Industrial Training (IT)	0.56	120	01
Total			**180**

KONGU ENGINEERING COLLEGE, PERUNDURAI, ERODE – 638 052
(Autonomous)

B.TECH. DEGREE IN FOOD TECHNOLOGY

CURRICULUM

(For the candidates admitted from academic year 2014 – 15 onwards)

SEMESTER – I

Course Code	Course Title	Hours / Week			Credit	Maximum Marks			CBS
		L	T	P		CA	ESE	Total	
	THEORY								
14EGT11	Communicative English I	3	0	0	3	40	60	100	HS
14MAT11	Mathematics I	3	1	0	4	40	60	100	BS
14PHT11	Applied Physics	3	0	0	3	40	60	100	BS
14CYT11	Applied Chemistry	3	0	0	3	40	60	100	BS
14MET11	Basics of Civil and Mechanical Engineering	3	0	0	3	40	60	100	ES
14MEC11	Engineering Drawing	2	0	3	3	40	60	100	ES
14VEC11	Value Education	0	2	1	1	100	0	100	HS
	PRACTICAL								
14PHL11	Physical Sciences Laboratory I	0	0	3	1	100	0	100	BS
14MEL11	Basics of Civil and Mechanical Engineering Laboratory	0	0	3	1	100	0	100	ES
				Total	**22**				

CA – Continuous Assessment, ESE – End Semester Examination
CBS - Curriculum Breakdown Structure

KONGU ENGINEERING COLLEGE, PERUNDURAI, ERODE – 638 052
(Autonomous)

B.TECH. DEGREE IN FOOD TECHNOLOGY

CURRICULUM

(For the candidates admitted from academic year 2014 – 15 onwards)

SEMESTER – II

Course Code	Course Title	Hours / Week			Credit	Maximum Marks			CBS
		L	T	P		CA	ESE	Total	
	THEORY								
14EGT21	Communicative English II	3	0	0	3	40	60	100	HS
14MAT21	Mathematics II	3	1	0	4	40	60	100	BS
14PHT21	Materials Science	3	0	0	3	40	60	100	BS
14CYT21	Environmental Science	3	0	0	3	40	60	100	BS
14CSC11	Problem Solving and Programming	3	0	3	4	40	60	100	ES
14EET11	Basics of Electrical and Electronics Engineering	3	0	0	3	40	60	100	ES
	PRACTICAL								
14PHL21	Physical Sciences Laboratory-II	0	0	3	1	100	0	100	BS
14EEL11	Basics of Electrical and Electronics Engineering Laboratory	0	0	3	1	100	0	100	ES
				Total	**22**				

CA – Continuous Assessment, ESE – End Semester Examination
CBS - Curriculum Breakdown Structure

KONGU ENGINEERING COLLEGE, PERUNDURAI, ERODE – 638 052
(Autonomous)

B.TECH. DEGREE IN FOOD TECHNOLOGY

CURRICULUM

(For the candidates admitted from academic year 2014 – 15 onwards)

SEMESTER – III

Course Code	Course Title	Hours / Week			Credit	Maximum Marks			CBS
		L	T	P		CA	ESE	Total	
	THEORY								
14MAT31	Mathematics III	3	1	0	4	40	60	100	BS
14FTT31	Fluid Mechanics in Food Processing Operations	3	1	0	4	40	60	100	PC
14FTT32	Food Process Calculations	3	1	0	4	40	60	100	PC
14FTT33	Thermodynamics	3	1	0	4	40	60	100	PC
14FTT34	Food Biochemistry	3	0	0	3	40	60	100	PC
14FTT35	Principles of Microbiology	3	0	0	3	40	60	100	PC
	PRACTICAL								
14FTL31	Unit Operations Laboratory I	0	0	3	1	100	0	100	PC
14FTL32	Biochemistry Laboratory	0	0	3	1	100	0	100	PC
14FTL33	Microbiology Laboratory	0	0	3	1	100	0	100	PC
				Total	**25**				

CA – Continuous Assessment, ESE – End Semester Examination
CBS - Curriculum Breakdown Structure

KONGU ENGINEERING COLLEGE, PERUNDURAI, ERODE – 638 052
(Autonomous)

B.TECH. DEGREE IN FOOD TECHNOLOGY

CURRICULUM

(For the candidates admitted from academic year 2014 – 15 onwards)

SEMESTER – IV

Course Code	Course Title	Hours / Week			Credit	Maximum Marks			CBS
		L	T	P		CA	ESE	Total	
	THEORY								
14MAT41	Numerical Methods	3	1	0	4	40	60	100	BS
14FTT41	Heat Transfer in Food Processing Operations	3	1	0	4	40	60	100	PC
14FTT42	Mass Transfer in Food Processing Operations	3	1	0	4	40	60	100	PC
14FTT43	Food Chemistry	3	0	0	3	40	60	100	PC
14FTT44	Food Microbiology	3	0	0	3	40	60	100	PC
14FTT45	Engineering Properties of Food Materials	3	0	0	3	40	60	100	PC
	PRACTICAL								
14FTL41	Unit Operations Laboratory -II	0	0	3	1	100	0	100	PC
14FTL42	Food Chemistry Laboratory	0	0	3	1	100	0	100	PC
14FTL43	Food Microbiology Laboratory	0	0	3	1	100	0	100	PC
				Total	**24**				

CA – Continuous Assessment, ESE – End Semester Examination
CBS - Curriculum Breakdown Structure

KONGU ENGINEERING COLLEGE, PERUNDURAI, ERODE – 638 052
(Autonomous)

B.TECH. DEGREE IN FOOD TECHNOLOGY

CURRICULUM

(For the candidates admitted from academic year 2014 – 15 onwards)

SEMESTER – V

Course Code	Course Title	Hours / Week			Credit	Maximum Marks			CBS
		L	T	P		CA	ESE	Total	
	THEORY								
14FTT51	Food Process Engineering - I	3	1	0	4	40	60	100	PSC
14FTT52	Refrigeration and Cold Chain Management	3	1	0	4	40	60	100	PC
14FTT53	Dairy Engineering	3	0	0	3	40	60	100	PC
14FTT54	Process Instrumentation and Control	3	1	0	4	40	60	100	PC
14FTT55	Baking and Confectionery Technology	3	0	0	3	40	60	100	PC
	Elective - I (Professional)	3	0	0	3	40	60	100	PE
	PRACTICAL								
14FTL51	Dairy Engineering Laboratory	0	0	3	1	100	0	100	PC
14FTL52	Baking and Confectionery Laboratory	0	0	3	1	100	0	100	PC
14GL41	Communication Skills Laboratory	0	0	3	1	100	0	100	HS
				Total	**24**				

CA – Continuous Assessment, ESE – End Semester Examination
CBS - Curriculum Breakdown Structure

KONGU ENGINEERING COLLEGE, PERUNDURAI, ERODE – 638 052
(Autonomous)

B.TECH. DEGREE IN FOOD TECHNOLOGY

CURRICULUM

(For the candidates admitted from academic year 2014 – 15 onwards)

SEMESTER – VI

Course Code	Course Title	Hours / Week			Credit	Maximum Marks			CBS
		L	T	P		CA	ESE	Total	
	THEORY								
14GET61	Economics and Management for Engineers	3	0	0	3	40	60	100	HS
14FTT61	Fruits and Vegetables Processing Technology	3	0	0	3	40	60	100	PC
14FTT62	Food Process Engineering - II	3	1	0	4	40	60	100	PC
14FTT63	Food Packaging Technology	3	0	0	3	40	60	100	PC
	Elective - II (Professional)	3	0	0	3	40	60	100	PE
	Elective - III (Open)	3	0	0	3	40	60	100	OE
	PRACTICAL								
14FTL61	Food Process Engineering Laboratory	0	0	3	1	100	0	100	PC
14FTL62	Fruits, Vegetables Processing and Food Packaging Laboratory	0	0	3	1	100	0	100	PC
				Total	**21**				

CA – Continuous Assessment, ESE – End Semester Examination
CBS - Curriculum Breakdown Structure

KONGU ENGINEERING COLLEGE, PERUNDURAI, ERODE – 638 052
(Autonomous)

B.TECH. DEGREE IN FOOD TECHNOLOGY

CURRICULUM

(For the candidates admitted from academic year 2014 – 15 onwards)

SEMESTER – VII

Course Code	Course Title	Hours / Week			Credit	Maximum Marks			CBS
		L	T	P		CA	ESE	Total	
	THEORY								
14GET71	Total Quality Management	3	0	0	3	40	60	100	HS
14FTT71	Food Quality Assurance and Control	3	0	0	3	40	60	100	PC
14FTT72	Meat, Fish and Poultry Process Technology	3	0	0	3	40	60	100	PC
	Elective - IV (Professional)	3	0	0	3	40	60	100	PE
	Elective - V (Open)	3	0	0	3	40	60	100	OE
	Elective - VI (Open)	3	0	0	3	40	60	100	OE
	PRACTICAL								
14FTL71	Food Analysis and Quality Control Laboratory	0	0	3	1	100	0	100	PC
14FTL72	Food Process Equipment Design and Drawing Laboratory	0	0	3	1	100	0	100	PC
14FTI71	Industrial Training	0	0	0	1	0	100	100	IT
				Total	**21**				

CA – Continuous Assessment, ESE – End Semester Examination
CBS - Curriculum Breakdown Structure

KONGU ENGINEERING COLLEGE, PERUNDURAI, ERODE – 638 052
(Autonomous)

B.TECH. DEGREE IN FOOD TECHNOLOGY

CURRICULUM

(For the candidates admitted from academic year 2014 – 15 onwards)

SEMESTER – VIII

Course Code	Course Title	Hours / Week			Credit	Maximum Marks			CBS
		L	T	P		CA	ESE	Total	
	THEORY								
14GET81	Professional Ethics and Human Values	3	0	0	3	40	60	100	HS
	Elective VII (Professional)	3	0	0	3	40	60	100	PE
	Elective VIII (Professional)	3	0	0	3	40	60	100	PE
	Elective IX (Professional)	3	0	0	3	40	60	100	PE
	PRACTICAL								
14FTP81	Project Work	0	0	18	9	100	100	200	PR
				Total	**21**				

CA – Continuous Assessment, ESE – End Semester Examination
CBS - Curriculum Breakdown Structure

LIST OF PROFESSIONAL ELECTIVES						
Course Code	**Course Title**	**Hours/Week**			**Credit**	**CBS**
		L	**T**	**P**		
SEMESTER V						
14FTE01	Food Science And Nutrition	3	0	0	3	PE
14FTE02	Milling Technology	3	0	0	3	PE
14FTE03	Technology Of Fats And Oils	3	0	0	3	PE
SEMESTER VI						
14FTE04	Bioprocess Engineering	3	0	0	3	PE
14FTE05	Food Additives And Nutraceuticals	3	0	0	3	PE
14FTE06	Technology Of Snack And Extruded Foods	3	0	0	3	PE
SEMESTER VII						
14FTE07	Fermentation Technology	3	0	0	3	PE
14FTE08	Plantation And Spices Products Technology	3	0	0	3	PE
14FTE09	Food Allergens And Toxicology	3	0	0	3	PE
14FTE10	Food Storage And Infestation Control	3	0	0	3	PE
SEMESTER VIII						
14FTE11	Beverage Technology	3	0	0	3	PE
14FTE12	Cane Sugar Technology	3	0	0	3	PE
14FTE13	Drying Technology	3	0	0	3	PE
14FTE14	Emerging Technologies In Food Processing	3	0	0	3	PE
14FTE15	Modeling, Simulation And Soft Tools For Food Technologists	3	0	0	3	PE
14FTE16	Analytical Instruments In Food Industries	3	0	0	3	PE
14FTE17	Separation Techniques In Food Processing	3	0	0	3	PE
14FTE18	Waste Management And By-Product Utilization In Food Industries	3	0	0	3	PE
14GEE81	Entrepreneurship Development	3	0	0	3	HS

LIST OF OPEN ELECTIVES						
Course Code	**Course Title**	**Hours/Week**			**Credit**	**CBS**
		L	**T**	**P**		
SEMESTER VI						
14FTO01	Energy Management In Process Industries	3	0	0	3	OE
14FTO02	Design Of Experiments	3	0	0	3	OE
SEMESTER VII						
14FTO03	Food Process Plant Layout And Safety	3	0	0	3	OE
14FTO04	Fundamentals And Applications Nanotechnology	3	0	0	3	OE
14FTO05	Computational Fluid Dynamics For Food Processing	3	0	0	3	OE
14FTO06	Industrial Waste Water Treatment	3	0	0	3	OE

14EGT11 COMMUNICATIVE ENGLISH I

(Common to all Engineering and Technology branches)

3 0 0 3

UNIT – I **9**

Functional Grammar: Basics of Vocabulary - Parts of speech or Word Classes including Determiners - Prefixes and Suffixes - Homonyms and Homophones - Connectives - Compound Nouns. **Listening:** Introduction to Listening / Types of Listening – Extensive / Intensive Listening - Listening Activities. **Speaking:** Verbal and non verbal communication – An introduction to speech sounds, syllables & word stress – Speaking Activities. **Reading:** Introduction to Skimming and scanning as reading techniques - understanding discourse coherence – sequencing of sentences – Reading activities. **Writing:** Introduction to aspects of technical writing – writing definitions and descriptions- Letter Writing – Informal letters-Punctuation in Letter Writing

UNIT – II **9**

Functional Grammar: Concord - Tenses - Voice - Use of Articles and prepositions. **Listening:** Listening Comprehension – Cloze Test - Extensive listening – listening for general information. **Speaking:** Role Play – Situational Conversations. **Reading:** Reading newspaper articles – global understanding skills and ability to infer, extract gist and understand main ideas. **Writing:** Letter Writing - Formal letters, Writing a Profile about an organization—Punctuation (General).

UNIT – III **9**

Functional Grammar: Phrasal verbs - Clauses - Simple, Compound and Complex Sentences - Synonyms and Antonyms. **Listening:** Listening Comprehension – Cloze Text - Intensive listening – listening for specific information. **Speaking:** Describing Places, People, Technical Processes. **Reading:** Reading different types of texts – Understanding general and specific information. **Writing:** Paragraph Writing – Writing reviews on short films and videos - Offering suggestions and recommendations

UNIT – IV **9**

Functional Grammar: Conditional clauses (If clause) - Adjectives, Compound Adjectives and Degrees of Comparison. **Listening:** Listening to different accents, listening to speeches / presentations. **Speaking:** Describing Technical Processes and Machines and Gadgets - Telephone Skills. **Reading:** Reading Texts with focus on use of verbs and verb phrases. **Writing:** Writing e-mails –Transcoding - Using Charts, pictures and tables for interpretations.

UNIT – V **9**

Functional Grammar: Modals – Types of Sentences – Idioms and Phrases and proverbs - identifying odd words. **Listening:** Retrieval of factual information – listening to identify topic, context, function, speaker's opinion, attitude, etc. **Speaking:** Interviews - Personal and Telephonic - Giving impromptu talks, making presentations on given topics. **Reading:** Reading for structure and detail – finding key information in a given text and finding topic sentences. **Writing:** Designing and Making Posters – Writing Advertisements-Free writing on any given topic (Technical and topics on current affairs)

TOTAL : 45

TEXT BOOKS :

1. "Learn English – A Fun Book of Functional Language, Grammar and Vocabulary", McGraw Hill Education [India] Pvt. Ltd., Santanu Sinha Chaudhuri, 2013.

REFERENCE BOOKS :

1. Raman, Meenakshi and Sangeetha Sharma, "Technical Communication: Principles and Practice", Oxford University Press, New Delhi, 2011.
2. Regional Institute of English, "English for Engineers", Cambridge University Press, New Delhi, 2006.
3. Rizvi, Ashraf M., "Effective Technical Communication", Tata McGrawHill, New Delhi. 2009.

COURSE OUTCOMES

On completion of the course the students will be able to

CO1: speak clearly, confidently, comprehensibly, and communicate with others using appropriate communicative strategies

CO2: write cohesively and coherently and flawlessly avoiding grammatical errors, using a wide range of vocabulary, organizing their ideas logically on a topic

CO3: read different genres of texts adopting various reading strategies

CO4: listen/view and comprehend different spoken discourses / excerpts in different accents

CO5: use language effectively and accurately acquiring vocabulary from real-life context

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1						1			2	3		2		
CO2						1			1	3		1		
CO3						1			1	3		2		
CO4						1			2	3		2		
CO5						2			2	3		2		

1 – Slight, 2 – Moderate, 3 – Substantial

14MAT11 MATHEMATICS I

(Common to all Engineering and Technology branches)

3 1 0 4

Pre-requisites: Basics concepts of matrices, Basic idea of differentiation, Knowledge of differential equations

UNIT – I **9**

Matrices: Eigenvalues and Eigenvectors of a real matrix – Properties of Eigenvalues and Eigenvectors (without proof) – Cayley-Hamilton Theorem (Statement and Applications) - Similarity transformation (concept only) – Orthogonal matrices – Orthogonal transformation of a symmetric matrix to diagonal form – Quadratic form – Nature of quadratic forms – Reduction of a quadratic form to canonical form by orthogonal transformation.

UNIT – II **9**

Functions of Several Variables: Functions of two variables – Partial derivatives – Total differential – Taylor's Series expansion –Maxima and Minima – Constrained maxima and minima – Lagrange's multiplier method – Jacobians – Properties.

UNIT – III **9**

Ordinary Differential Equations of First Order: Solutions of equations in separable form – Exact differential equations – Integrating factors – Linear first order differential equations – Bernoulli's equation – Clairaut's equation.

UNIT – IV **9**

Ordinary Differential Equations of Higher Order: Linear differential equations of second and higher order with constant coefficients – Particular Integrals for the types: e^{ax} – cos(ax) / sin(ax) – x^n – $e^{ax}x^n$, e^{ax}sin(bx) and e^{ax}cos(bx) – x^nsin(ax) and x^ncos(ax) – Linear differential equations with variable coefficients: Euler-Cauchy's equation – Legendre's equation.

UNIT – V **9**

Applications of Ordinary Differential Equations: Method of variation of parameters – Simultaneous first order linear equations with constant coefficients – Simple harmonic motion – Deflection of beams – Electric circuits (Differential equations and associated conditions need to be given).

Lecture: 45, Tutorial: 15, TOTAL: 60

TEXT BOOKS:

1. Kandasamy P., Thilagavathy K. and Gunavathy K., "Engineering Mathematics For First Year B.E/B.Tech", Reprint Edition 2014, S.Chand and Co., New Delhi.
2. Veerarajan T., "Engineering Mathematics, (for first year)", Reprint Edition 2013, Tata McGraw-Hill, New Delhi.

REFERENCE BOOKS:

1. Grewal B.S., "Higher Engineering Mathematics", 42nd Edition, Khanna Publications, New Delhi, 2011.
2. Jain R.K. and Iyengar S.R.K., "Advanced Engineering Mathematics", 4th Edition, Narosa Publishing House, New Delhi, Reprint 2014.
3. Bali N.P. and Manish Goyal, "Text Book of Engineering Mathematics", 8th Edition, Laxmi Publications, New Delhi, 2011.
4. Ramana B.V., "Higher Engineering Mathematics", Tata McGraw Hill Publishing Company, New Delhi, 2011.
5. Kreyszig E., "Advanced Engineering Mathematics", 10th Edition, John Wiley Sons, 2010.

COURSE OUTCOMES

On completion of the course the students will be able to

CO1: solve engineering problems which needs matrix computations.
CO2: solve extremal problems which arise in function of several variables.
CO3: identify the appropriate method for solving first order ordinary differential equations.
CO4: classify and find the solution of ordinary differential equations of higher order.
CO5: apply the concept of ordinary differential equations for modeling and finding solutions to engineering problems.

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	1								1		
CO2	3											1		
CO3	3	3	1	1								1		
CO4	3	3	1	1								1		
CO5	3	3	2	1								1		

1 – Slight, 2 – Moderate, 3 – Substantial

14PHT11 APPLIED PHYSICS

(Common to all Engineering and Technology branches)

3 0 0 3

UNIT – I **9**

Properties of Matter: Elasticity – Hooke's law – Modulus of elasticity (qualitative) – Stress-strain diagram – Poisson's ratio – Bending moment – Depression of a cantilever (theory) – Derivation of Young's modulus of the material of the beam – Uniform and non-uniform bending – I-shaped girders. **Thermal Physics:** Modes of heat transfer – Thermal conductivity – Derivation of rectilinear flow of heat along a bar – Radial and cylindrical heat flow – Conduction through compound media (series and parallel).

UNIT – II **9**

Acoustics: Classification of sound – Weber–Fechner law – Sabine's formula- derivation using growth and decay method – Absorption coefficient and its determination –Factors affecting acoustics of buildings and their remedies. **Ultrasonics:** Production – Magnetostrictive generator – Piezoelectric generator – Determination of velocity using acoustic grating – Cavitation – Industrial applications – Drilling, welding, soldering and cleaning – Non destructive testing – Ultrasonic pulse echo system.

UNIT – III **9**

Laser and Applications: Spontaneous emission and stimulated emission – Population inversion – Pumping methods – Derivation of Einstein's coefficients (A&B) – Types of lasers – Nd:YAG laser, CO_2 laser, Semiconductor lasers: homojunction and heterojunction – Laser Applications – Industrial applications: laser welding, laser cutting, laser drilling – Holography – Construction and reconstruction of images.

UNIT – IV **9**

Fiber Optics and Applications: Principle and propagation of light through optical fibers – Derivation of numerical aperture and acceptance angle – Classification of optical fibers (based on refractive index, modes and materials) – Crucible-crucible technique for fiber fabrication – Sources (LED and LASER) and detectors (p-i-n photodiode and avalanche photodiode) for fiber optics - Fiber optical communication links – Losses in optical fibers – Fiber optic sensors – Temperature and displacement sensors.

UNIT – V **9**

Quantum Physics and Applications: Black body radiation – Planck's theory (derivation) – Compton effect (theory) – Matter waves – Uncertainty principle (qualitative) – Schroedinger's wave equations – Time independent and time dependent wave equations – Physical significance of wave function – Particle in a box (One dimensional) – Electron microscopes – Scanning electron microscope – Transmission electron microscope.

TOTAL : 45

TEXT BOOKS:

1. Tamilarasan K and Prabu K, "Engineering Physics-I", Tata McGraw Hill Education Private Limited, New Delhi, 2014.

REFERENCE BOOKS:

1. Gaur R.K. and Gupta S.L., "Engineering Physics", Dhanpat Rai and Sons, New Delhi, 2009.
2. Uma Mukherji, "Engineering Physics", Narosa Publishing House, New Delhi, 2011.
3. Laud B.B., "Lasers and non- linear optics", New Age International (p) Limited Publishers, New Delhi, 1996.
4. Ajoy Ghatak and Thyagarajan K., "Introduction to Fiber Optics", Cambridge University Press, New York, USA, 2000
5. Mehta and Neeraj, "Applied Physics for Engineers", Prentice-Hall of India Private Limited, New Delhi, 2011.
6. Douglas Brandt and Douglas C. Giancoli, "Physics for Scientists and Engineers", Prentice-Hall of India Private Limited, New Delhi, 2000.

COURSE OUTCOMES

On completion of the course the students will be able to

CO1: Infer the extensive properties of matter and heat conduction in metal.
CO2: Demonstrate acoustically good buildings and non-destructive testing using ultrasonic waves.
CO3: Employ the laser in engineering and technology.
CO4: Sketch the principle of fiber optics and fiber optic communication link.
CO5: Interpret the concepts of quantum physics to optical phenomena and electrons in a metal.

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3			2	2		2		1					
CO2	3			2	2		2		1					
CO3	3			2	2		2		1					
CO4	3			2	2		2		1					
CO5	3			2	2		2		1					

1 – Slight, 2 – Moderate, 3 – Substantial

14CYT11 APPLIED CHEMISTRY

(Common to all Engineering and Technology branches)

3 0 0 3

UNIT – I **9**

Water: Introduction - Sources of water - Impurities in water - Types of water - Water quality standards - Water quality parameters (Brief discussion only) - Hardness of water- Expression of hardness - Units of hardness –Estimation of Hardness of water by EDTA method – Determination of alkalinity - Disadvantages of using hard water - Boiler troubles due to hard water - scale and sludge formation – boiler corrosion – caustic embrittlement- priming and foaming- Softening of water- External treatment methods - zeolite and demineralization process (principle, process, advantages and disadvantages only) - Internal treatment process - colloidal, carbonate, calgon and phosphate conditioning (brief discussion only) - desalination by reverse osmosis method

UNIT – II **9**

Electrochemistry: Introduction – Electrolytic and Electrochemical Cells – Representation of a galvanic cell - Reversible and Irreversible cells - EMF and its determinations – Electrode potential - Nernst Equation – Reference electrodes (hydrogen and calomel electrodes) – Electrochemical series and its applications – Conductometric titrations (strong acid vs strong base only) - Batteries (Lead Acid battery, NICAD, Lithium battery, Lithium Sulphur battery) – Proton exchange membrane cells.

UNIT – III **9**

Corrosion and Its Control: Introduction – Mechanism of chemical and electrochemical corrosion – galvanic corrosion - concentration cell corrosion – Galvanic series - Factors influencing rate of corrosion – corrosion control methods - Sacrificial anode and impressed current cathodic protection methods – Corrosion inhibitors - Protective coatings - classifications - Pretreatment of metal surface - Metallic coating -electroplating and electrolessplating (General discussion) - Hot dipping (Tinning and galvanising) - Non-metallic coating - surface conversion coating (phosphate coating and anodized coating) - Organic coating - paints – constituents and their function – Special paints (Fire retardant, temperature indicating, water repellant and luminescent paints)

UNIT – IV **9**

Fuels: Coal and its varieties – proximate and ultimate analysis – their significance – metallurgical coke - Otto-Hoffman byproduct method - Liquid fuel - refining of petroleum – Manufacture of synthetic petrol – Cracking - Polymerization - Hydrogenation of coal (Fisher Tropsch and Bergius methods) - knocking - octane number – improving octane number by additives – Diesel – cetane number – Gaseous fuels (Water gas and LPG).

Combustion: Introduction – Calorific Values – Gross and Net Calorific Values – Dulong's formula (simple problems)- Flue gas analysis by Orsat's method - Explosive range and Spontaneous Ignition Temperature

UNIT – V **9**

Polymers: Introduction – Nomenclature of polymers – functionality – polymerization - types – addition, condensation and co-polymerization with examples – Effect of polymer structure on properties (strength, plastic deformation, glass transition temperature and melting point of polymers (Tg and Tm), crystallinity and chemical resistance) - plastics – types (thermo and thermosetting plastics) - individual polymers - Polyethylene, Polypropylene, PVC, Teflon and Bakelite (preparation, properties and uses only) - Compounding of plastics- Fabrication of plastics (compression, injection and extrusion moulding methods) – conducting polymers

TOTAL : 45

TEXT BOOKS:

1. Palanisamy P.N, Geetha A, Manjula Rani K, "Applied Chemistry", 2nd Edition, Tata McGraw Hill Education Private Limited, New Delhi, 2013.
2. Jain P C and Monica Jain, "Engineering Chemistry", 15th Edition, Dhanpat Rai Publication Co., New Delhi, 2008.

REFERENCE BOOKS:

1. Sharma B.K., "Engineering Chemistry", Krishna Prakasan Media (P) Ltd., Meerut, 2001.
2. Sivasankar B., "Engineering Chemistry", Tata McGraw-Hill, New Delhi, 2008.
3. Krishnamurthy N., "Engineering Chemistry", 2nd Edition, PHI Learning Private Limited, New Delhi, 2008.

COURSE OUTCOMES

On completion of the course the students will be able to

CO1: Get the basic knowledge of water quality parameters and treatment methods
CO2: Obtain the principles of electrochemical cells, EMF series and energy storing devices
CO3: Acquire the knowledge of the types and prevention methods of corrosion
CO4: Know the concepts and developments in combustion and various types of fuels.
CO5: Understand the knowledge about the types of polymers, plastics and moulding methods

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2		2	2		2	3	3	1	1		
CO2	3	2		2	2		2	3	3	1	1		
CO3	3	2		2	2		2	3	3	1	1		
CO4	3	2		2	2		2	3	3	1	1		
CO5	3	2		2	2		2	3	3	1	1		

1 – Slight, 2 – Moderate, 3 – Substantial

14MET11 BASICS OF CIVIL AND MECHANICAL ENGINEERING

(Common to all Engineering and Technology branches)

3 0 0 3

PART-A: CIVIL ENGINEERING

UNIT – I **5**

Introduction: History of civil engineering - Role and Functions of civil engineer - Fields of civil engineering

UNIT– II **5**

Building Materials: Introduction – Properties and applications of Construction Materials – bricks – stones – sand – cement – mortar- concrete – steel – glass-wood –plastics- ceramics -rubber- FRP – Non ferrous materials - Geosynthetics – Smart materials.

UNIT – III **4**

Sub Structure: Soil **–** classification- bearing capacity- foundation -function- requirements- types-failures -remedial measures- machine foundation

UNIT – IV **4**

Super Structures: Brick masonry – stone masonry – beams – columns – lintels – roofing – flooring – plastering- damp proofing- weathering course

UNIT – V **4**

Interior design and Landscaping: History of Interior design-Importance of Interior design- Basic elements of Interior design. Landscape Architecture-Elements of Landscaping- Green Engineering

PART-B: MECHANICAL ENGINEERING

UNIT – I **5**

Thermal Science: Laws of thermodynamics and their applications – Principle of operation of Steam, Diesel, Hydro-electric and Nuclear power plants - Classification of internal combustion engines and their working principles – Components of basic Vapour Compression Refrigeration system.

UNIT – II **4**

Fluid Science: Properties of fluids – Classification of hydraulic turbines, working principle of Pelton turbine – Applications of steam and gas turbines. Classification of pumps, working principle of centrifugal and reciprocating pump

UNIT – III **4**

Mechanics and Materials: Classification of engineering materials - Mechanical properties of engineering materials- Definition and importance of stress and strain - Definition and importance of centre of gravity and moment of inertia.

UNIT – IV **5**

Mechanical Components And Their Applications: Basic principles and applications of power transmission systems such as belt, rope, chain and gear drives – Function and principles of coupling, clutch, brake, flywheel and governor

UNIT – V **5**

Manufacturing Technology: Principle and applications of Metal forming process – Foundry, Forging. Principle and applications of Metal Joining process – Welding, Soldering and Brazing, Basics of CAD/CAM/CIM.

TOTAL : 45

TEXT BOOKS:

1. Palanichamy M.S., "Basic Civil Engineering", Tata McGraw-Hill, New Delhi, 2006.
2. Pravin Kumar, "Basic Mechanical Engineering", Pearson Publishers, New Delhi, 2013.

REFERENCE BOOKS:

1. Rangawala S.C., "Engineering Materials" Charotor Publishing House(P) Ltd., Anand, 2013.
2. Punmia B.C., Ashok Kumar Jain, Arun Kumar Jain, "Building Construction," Laximi Publications (P) Ltd., NewDelhi, 2005.
3. Shanmugam G., "Basic Mechanical Engineering", Tata McGraw-Hill, New Delhi, 2005.
4. Venugopal K. and Prabhu Raja V., "Basic Mechanical Engineering", 6th Edition, Anuradha Publishers, Kumbakonam, 2005.

COURSE OUTCOMES

On completion of the course the students will be able to

CO1: select the suitable materials and components required for building construction

CO2: demonstrate an understanding of basic concepts in thermal engineering

CO3: demonstrate an understanding of basic concepts in fluid mechanics and fluid machines

CO4: demonstrate an understanding of basic concepts in engineering mechanics and materials

CO5: demonstrate an understanding of principles and applications of different mechanical components.

CO6: demonstrate an understanding of principles and applications of various manufacturing process

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2		2	1	2			2		2
CO2	3	2	2		2	1	2			2		2
CO3	3	2	2		2	1	2			2		2
CO4	3	2	2		2	1	2			2		2
CO5	3	2	2		2	1	2			2		2
CO6	3	2	2		2	1	2			2		2

1 – Slight, 2 – Moderate, 3 – Substantial

14MEC11 ENGINEERING DRAWING

(Common to all Engineering and Technology branches)

2 0 3 3

Pre-requisites: Basic knowledge in practical geometry construction and mathematics

UNIT – I **9**

General Principles of Orthographic Projection: Importance of graphics in engineering applications – Use of drafting instruments – BIS conventions and specifications – Size, layout and folding of drawing sheets – Lettering and dimensioning. Projections of Points, Lines and Planes. General principles of orthographic projection – First angle projection – Layout of views – Projection of points, located in all quadrant and straight lines located in the first quadrant – Determination of true lengths and true inclinations and location of traces – Projection of polygonal surface and circular lamina inclined to both reference planes.

UNIT – II **9**

Projections of Solid: Projections of simple solids like prisms, pyramids, cylinder and cone when the axis is inclined to one reference plane by change of position method.

UNIT – III **9**

Sectioning of Solids: Sectioning of solids- prisms, pyramids, cylinder and cone in simple vertical position by cutting planes inclined to one reference plane and perpendicular to the other – Obtaining true shape of section.

UNIT – IV **9**

Development of Surfaces: Development of lateral surfaces of simple and truncated solids – prisms, pyramids, cylinders and cone with cutout, perpendicular and inclined to the horizontal axis.

UNIT – V **9**

Isometric and Perspective Projection: Principles of isometric projection – isometric scale – isometric projections of simple solids, truncated prisms, pyramids, cylinders and cones Conversion of isometric projection into orthographic projection. Perspective projection of prisms, pyramids and cylinders by visual ray method.

TOTAL : 45

TEXT BOOKS:

1. Basant Agarwal and Agarwal C.M., "Engineering Drawing", Tata McGraw-Hill, New Delhi, 2008.
2. Venugopal K. and Prabhu Raja V., "Engineering Graphics", New Age International (P) Limited, New Delhi, 2008.

REFERENCE BOOKS:

1. Bhatt N.D., "Engineering Drawing", 46th Edition, Charotar Publishing House, Anand, 2003.
2. Gopalakrishnana K.R., "Engineering Drawing", Volume. I & II, Subhas Publications, Bangaluru, 2006.
3. Dhananjay A. Jolhe, "Engineering Drawing with an introduction to AutoCAD", Tata McGraw Hill, New Delhi, 2008.

COURSE OUTCOMES

On completion of the course the students will be able to

CO1: gain knowledge on international standards of drawings and to draw the different types of projections for points, lines and planes

CO2: draw the different positions of 3D primitive objects like cube, cone, cylinder, etc.

CO3: draw sections of solids including prisms, pyramids, cylinders and cones

CO4: understand the concepts of development of surfaces of simple and truncated solids

CO5: draw the isometric and perspective projections for the given object

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	3		2	1				2		2
CO2	3	2	3		2	1				2		2
CO3	3	2	3		2	1				2		2
CO4	3	2	3		2	1				2		2
CO5	3	2	3		2	1				2		2

1 – Slight, 2 – Moderate, 3 – Substantial

14VEC11 VALUE EDUCATION

(Common to all Engineering and Technology branches)

0 2 1 1

UNIT – I **6**

Philosophy of Life Science: Life – Purpose of life (four stages of life) – Philosophy of life (who am 'I') – Law of nature (cause of the life and body) – Content of the Life (five sheaths) – Goal of life. Five duties in life.
Methodology: Life and messages of spiritual and national leaders– The forgotten hero, etc.
Project report: Complementing with happiness - Every soul is potentially divine

UNIT – II **6**

Human Values-Moral foundation: Truth, forgiveness, compassion, endurance, humility, non violence, moderate diet, non stealing, self purification, self discipline, self study, content, cleanliness, honesty, and totality in faith– Good habits – Attitude forming for Individual peace.
Practical Methods: Personal experience with above characters, Puranic Stories - Self resolve diary maintenance

UNIT – III **6**

Social Values: Family – Family System - Greatness of women – World brotherhood (vasudeiva kudumbagam) – Glorious Bharath - Bharathian systems - Past –Present – Future - Team spirit - Goal setting – Economics – Education – Politics – Responsibilities of people – Preserving natural resources.
Methodology: Preparing an album on glorious Bharath Past, Present and Future Plans. Goal setting - Management Games. Team Spirit - Yogic Games.

UNIT – IV **6**

Development of Mental Prosperity: Prosperity of mind – Functions of mind - Obstacles of mind - Practical method to perfect mind is yoga – Types – Uses – Precaution – Contradiction – Kriyas - Asanas – Pranayamas – Meditative techniques.
Methodology: Asana - Pranayama – Cyclic meditation – Nada anu sandhana – Meditation – Yogic games for memory. Album on asanas , pranayama and mantra.

UNIT – V **6**

Maintenance of Physical Health: Human body – Structure - Ten Systems of the body as per modern science. Five elements - Harmonious relationship – Life force – Conserving vitality & health through natural life – Pranic food and its importance – Uses of herbs - Right way of cooking to preserve nutrients - Cause of the disease – Acute and chronic - Disease - Life and death.
Methodology: Natural food making, traditional millet dishes. Asanas, pranayamas, cleansing procedures, Quiz on healthy living, Uses of herbs or kitchen garden.

TOTAL : 30

TEXT BOOK:

1. "Value Education", compiled by Vethathiri Maharishi Institute for Spiritual and Intuitional Education, Aliyar, Pollachi, for Kongu Engineering College.

COURSE OUTCOMES

On completion of the course the students will be able to

CO1: understand the purpose and value of life
CO2: exhibit positive human values
CO3: understand social values
CO4: take steps to develop mental and physical health

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1						3		3				3		
CO2						3		3				3		
CO3						3		3				3		
CO4						3		3				3		

1 – Slight, 2 – Moderate, 3 – Substantial

14PHL11 PHYSICAL SCIENCES LABORATORY I

(Common to all Engineering and Technology branches)

0 0 3 1

PART-A: APPLIED PHYSICS LABORATORY
(Any five experiments)

LIST OF EXPERIMENTS:

1. Determination of Young's modulus of a given material using uniform bending.
2. Determination of thermal conductivity of bad conductor using Lee's disc arrangement.
3. Determination of velocity of ultrasonic waves in liquid and compressibility of liquid using ultrasonic interferometer.
4. (a) Particle size determination using diode laser.

   (b) Determination of wavelength of laser
5. Determination of specific resistance of a given coil of wire using Carey Foster bridge.
6. Determination of wavelength of Hg spectrum using spectrometer and grating.

Demonstration

1. Measurement of efficiency of a solar cell
2. Non destructive testing
3. Tyndall effect

PART-B: APPLIED CHEMISTRY LABORATORY
(Any five experiments)

LIST OF EXPERIMENTS:

1. Estimation of Total, Temporary and Permanent hardness of water by EDTA method.
2. Estimation of Ca^{2+} and Mg^{2+} hardness separately by EDTA method.
3. Estimation of Alkalinity of the given water sample.
4. Conductometric titration - Mixture of acids.
5. Estimation of Hydrochloric acid using pH meter.
6. Estimation of Ferrous ion by potentiometric titration.

Demonstration

1. Distillation system
2. RO water treatment system
3. UV Spectrophotometer

REFERENCES / MANUALS / SOFTWARE:

1. Physics Laboratory Manual –Dr.K.Tamilarasan and Dr.K.Prabu
2. Chemistry Laboratory Manual- Dr.P.N.Palanisamy, P.Manikandan, A.Geetha and K.Manjularani

TOTAL : 45

COURSE OUTCOMES

On completion of the course the students will be able to

CO1: Describe the basics of modulus of elasticity, thermal conductivity, ultrasonics and compressibility of water, laser parameters, specific resistance of electrical conductors, and interference and diffraction of light waves.

CO2: Operate thebasic measuring devices, travelling microscope, Lee's disc arrangement, ultrasonic interferometer, Carrey Foster bridge and spectrometer, and to measure the related physical parameters.

CO3: Analyze the hardness, amount of Ca^{2+} and Mg^{2+} ions, and presence of alkalinity in water.

CO4: Employ the instruments like pH meter, conductivity meter and potentiometer for the estimation of unknown concentration of acids and ferrous ion.

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3		2	1		2		2				
CO2	3	3		2	1		2		2				
CO3	3	3		2	1		2		2				
CO4	3	3		2	1		2		2				

1 – Slight, 2 – Moderate, 3 – Substantial

14MEL11 BASICS OF CIVIL AND MECHANICAL ENGINEERING LABORATORY

(Common to all Engineering and Technology branches)

0 0 3 1

LIST OF EXPERIMENTS:

1. To prepare a square or rectangular shaped two identical MS plates by cutting and filing operations
2. To prepare a square/rectangular/circular/trapezoidal/Vshaped projection and its counterpart formating from the given square or rectangular MS plates.
3. To carryout drilling, tapping and assembly on the given MS plates.
4. To carryout thread forming on a GI and PVC pipes and cut to the required length.
5. To use various pipe fitting accessories and prepare water leak proof water line from overhead tank.
6. To prepare a T/L/Lap joint from the given wooden work pieces.
7. To prepare a plywood box/tray to the given dimensions.
8. To prepare a leak proof sheet metal tray/box/funnel to the given dimensions.
9. Cutting of MS plates by gas cutting method and arc weld joining by Lap/Butt/T joint method
10. Preparing a simple PVC window/door frame assembly.
11. Preparing a simple memento or similar articles using wood/sheet metal
12. Preparing innovative articles involving waste metals.

TOTAL : 45

REFERENCES / MANUALS / SOFTWARE:

1. Introduction to basic manufacturing processes and workshop technology by Rajender Singh, New Age International (P) Limited, 2006.
2. Elements of Workshop Technology by S.K.Hajra Choudhury, Media Promoters, 2009.

COURSE OUTCOMES:

On completion of the course the students will be able to

CO1: demonstrate knowledge on safety and adhere to safety features

CO2: mark the given dimensions accurately and execute cutting and joining operations

CO3: select methods and tools and execute the given experiments

CO4: finish the job to the requirements and quantify the accuracy

CO5: plan and complete simple and innovative articles

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	1	2		2	2	1		2	2		2
CO2	3	1	2		2	2	1		2	2		2
CO3	3	1	2		2	2	1		2	2		2
CO4	3	1	2		2	2	1		2	2		2
CO5	3	1	2		2	2	1		2	2		2

1 – Slight, 2 – Moderate, 3 – Substantial 1

14EGT21 COMMUNICATIVE ENGLISH II

(Common to all Engineering and Technology branches)

3 0 0 3

UNIT – I **9**

Functional Grammar: Sentences – Affirmative / Negative – Asking questions in the simple present – Using reference words - Cause and Effect expressions. **Listening:** Listening practice - listening to different types of conversation and answering questions - listening to Audio texts and completing cloze exercises. **Speaking:** Opening a conversation and getting acquainted with people. **Reading:** Reading excerpts from a novel, itinerary, magazine and news paper articles. **Writing:** Formal Letter writing – Job Application Letter – CV and Resume – Writing Instructions

UNIT – II **9**

Functional Grammar: Sentences – Interrogative & WH questions - SI units – Numerical Adjectives

Listening: Listening to situation based dialogues – listening to short and long conversations in different domains of activity. **Speaking** : Conversation practice in real life situations, describing places, narration, introducing ideas. **Reading:** Reading historic writing – biographical writing – Non fictional book extracts and news feeds. **Writing:** Filling Forms – Academic Writing - Basics of Business Writing – Calling for Quotation, Placing Orders, Letter of Complaint

UNIT – III **9**

Functional Grammar: Sentences – Imperative – Gerunds & Infinitives - Commonly confused words. **Listening:** Understanding the structure of conversations - Listening to academic lectures and live speech – advertisements and announcements. **Speaking:** Giving and Justifying opinions – apologizing – extempore. **Reading:** Reading Blogs - Website articles – e-mails. **Writing:** e-mails – Tweets – Texting and SMS language

UNIT – IV **9**

Functional Grammar: Transformation of Sentences – Simple, Compound and Complex - Vocabulary (single word substitute) – conjunctions - reporting verbs – Direct and Indirect speech. **Listening:** Listening to a telephone conversation, viewing of model interviews (face–to–face, telephonic and video conferencing). **Speaking:** Giving instructions – Role play – Interviews. **Reading:** Reading job advertisements and profile of the company concerned **Writing:** Writing Reports - Preparing a Check list

UNIT – V **9**

Grammar: Analyzing sentence structures in a given short passage - Identifying parts of speech in a given short passage. **Listening:** Viewing a model group discussion and reviewing the performance of each participant – identifying the characteristics of a good listener – casual conversation. **Speaking:** Group discussion skills – initiating, turn taking and concluding the discussion. **Reading:** Making notes from long passages or any form of written materials – providing a suitable title – identifying main points, supporting points. **Writing:** Email writing – Effective use of email.

TOTAL: 45

TEXT BOOKS :

1. Dr. Elango et al. "Resonance: English for Engineers and Technologists", Foundation, Chennai, 2013.

REFERENCE BOOKS:

1. Anderson, Paul V., " Technical Communication **:** A Reader–Centered Approach", Cengage.
2. Muralikrishna and Sunita Mishra, "Communication Skills for Engineers", Pearson, New Delhi, 2011.
3. Sharma, Sangeetha and Binod Mishra, "Communication Skills for Engineers and Scientists", PHI Learning, New Delhi, 2009.

COURSE OUTCOMES

On completion of the course the students will be able to

CO1: speak effectively, express their opinions clearly, initiate and sustain a discussion and also negotiate using appropriate communicative strategies

CO2: write effectively and persuasively and produce different types of writing such as narration, description, exposition and argument as well as creative, critical, analytical and evaluative writing

CO3: read different genres of texts, infer implied meanings and critically analyze and evaluate them for ideas as well as for method of presentation

CO4: listen and comprehend different spoken excerpts critically and infer unspoken and implied meanings

CO5: use functional grammar for improving employment oriented skills

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1						2			2	3		2		
CO2						1			1	3		1		
CO3						2			1	3		2		
CO4						1			2	3		2		
CO5						1			1	3		1		

1 – Slight, 2 – Moderate, 3 – Substantial

14MAT21 MATHEMATICS II

(Common to all Engineering and Technology branches)

3 1 0 4

Pre-requisites: Basic ideas of integration, Basic ideas of vectors and complex numbers

UNIT – I **9**

Multiple Integrals: Double integration in Cartesian coordinates – Change of order of integration – Area between two curves – Triple integration in Cartesian coordinates –Volume as Triple integrals (Simple problems only).

UNIT – II **9**

Vector Calculus: Gradient of a scalar point function – Directional derivative – Divergence of a vector point function – Curl of a vector – Irrotational and Solenoidal vectors – Line Integral, Surface integral and Volume integral (Concept only) – Green's, Stoke's and Gauss divergence theorems (Statement only) – Verification of the above theorems and evaluation of integrals using them (Simple problems only).

UNIT – III **9**

Analytic Functions: Functions of a complex variable – Analytic functions – Necessary conditions and Sufficient conditions (excluding proofs) – Cauchy– Riemann equations (Statement only) – Properties of analytic function (Statement only) – Harmonic functions – Construction of Analytic functions – Conformal mapping: $w = z + a$, az, $1/z$ – Bilinear transformation.

UNIT – IV **9**

Complex Integration: Cauchy's theorem and Cauchy's integral formula (Statement and applications) – Taylor's and Laurent series – Singularities – Classification – Cauchy's Residue theorem (Statement only) – Contour integration – circular and semi-circular contours (excluding poles on real axis).

UNIT – V **9**

Laplace Transform: Conditions for existence – Transform of elementary functions – Basic properties – Derivatives and integrals of transforms – Transforms of derivatives and integrals – Initial and final value theorems – Transform of unit step function – Transform of periodic functions - Inverse Laplace transform of elementary functions – Partial fraction method – Convolution theorem (Statement only) – Solution of linear ODE of second order with constant coefficients.

Lecture: 45, Tutorial: 15, TOTAL: 60

TEXT BOOKS:

1. Kandasamy P., Thilagavathy K. and Gunavathy K., "Engineering Mathematics For First Year B.E/B.Tech", Reprint Edition 2014, S.Chand and Co., New Delhi.
2. Veerarajan T., "Engineering Mathematics", (for first year), Reprint Edition 2013, Tata McGraw-Hill, New Delhi.

REFERENCE BOOKS:

1. Grewal B.S., "Higher Engineering Mathematics", 42nd Edition, Khanna Publications, New Delhi, 2011.
2. Jain R.K. and Iyengar S.R.K., "Advanced Engineering Mathematics", 4th Edition, Narosa Publishing House, New Delhi, Reprint 2014.
3. Bali N.P. and Manish Goyal, "Text Book of Engineering Mathematics", 8th Edition, Laxmi Publications, New Delhi, 2011.
4. Ramana B.V., "Higher Engineering Mathematics", Tata McGraw Hill Publishing Company, New Delhi, 2011.
5. Kreyszig E., "Advanced Engineering Mathematics", 10th Edition, John Wiley Sons, 2010.

COURSE OUTCOMES

On completion of the course the students will be able to

CO1: Solve problems involving double and triple integrals.
CO2: Apply the concept of vectors in engineering problems.
CO3: Have a clear idea about functions of complex variables and analytic function which are widely used in study of fluid and heat flow problems.
CO4: Evaluate complex integrals which is extensively applied in engineering.
CO5: Handle Laplace transforms to solve practical problems.

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	1	1								1		
CO2	3	3	1	1								1		
CO3	3	3										1		
CO4	3	3	1	1								1		
CO5	3	3	1	1								1		

1 – Slight, 2 – Moderate, 3 – Substantial

14PHT21 MATERIALS SCIENCE

(Common to all Engineering and Technology branches)

3 0 0 3

UNIT – I **9**

Crystal Physics: Crystalline and amorphous solids – Lattice – Unit cell – Crystal systems – Bravais lattice – Lattice planes – Miller indices – Derivation of '*d*' spacing in cubic lattice – Atomic radius – Coordination number– Packing factor for SC, BCC, FCC and HCP structures – Crystal imperfections: Point and line imperfections.

UNIT – II **9**

Conducting Materials: Conductors – Classical free electron theory of metals – Electrical and thermal conductivities – Wiedemann–Franz law – Lorentz number – Draw backs of classical theory – Quantum theory – Fermi distribution function – Effect of temperature on Fermi function – Density of energy states – Carrier concentration in metals.

UNIT – III **9**

Semiconducting Materials: Intrinsic semiconductor – Carrier concentration derivation – Electrical conductivity and band gap (theory) – Extrinsic semiconductors – Carrier concentration derivation in n-type and p-type semiconductors – Hall effect – Determination of Hall coefficient – Applications –Solar cell – LDR.

UNIT – IV **9**

Magnetic and Superconducting Materials: Magnetic materials - Types of magnetic materials (qualitative) – Domain theory – Hysteresis – Soft and hard magnetic materials – Applications - Transformer core – Magneto optical recording – Superconductors – Properties – Types of superconductors – BCS theory of superconductivity (qualitative) – Josephson effect - Applications of superconductors – SQUID – Cryotron – Magnetic levitation. **Dielectric Materials:** Dielectric constant – Qualitative study of polarization – Frequency and temperature dependence of polarization – Dielectric loss – Dielectric breakdown – Uses of dielectric materials (capacitor) – Ferro electric materials (qualitative).

UNIT – V **9**

Smart Materials: Metallic glasses: Preparation (Melt spinning method only), properties and applications – Shape memory alloys (SMA): Characteristics and applications. **Nano Materials:** Low dimensional structures (quantum dot, wire and well) – Features of nano materials – Synthesis: top down and bottom up approaches – Ball milling and lithographic methods – Physical and chemical vapor phase depositions – Sol gel method – Carbon nanotubes: Structures – Properties – Fabrication by laser ablation – Applications.

TOTAL : 45

TEXT BOOKS:

1. Tamilarasan K. and Prabu K., "Engineering Physics-II", Tata McGraw Hill Education Private Limited, New Delhi, 2014.

REFERENCE BOOKS:

1. Mehta and Neeraj, "Applied Physics for Engineers", Prentice-Hall of India Private Limited, New Delhi, 2011.
2. Raghavan V., "Materials Science and Engineering: A first course", 5th Edition, Prentice-Hall of India, New Delhi, 2009.
3. Poole Charles P. and Ownen Frank J., "Introduction to Nanotechnology", Wiley India, 2007.
4. William Fortune Smith and Javad Hashemi, "Foundations of Materials Science and Engineering", McGraw-Hill Education, 2006, New Delhi.
5. Pillai S.O., "Solid State Physics", 5th Edition, New Age International, New Delhi, 2003.

COURSE OUTCOMES

On completion of the course the students will be able to

CO1: Explain the various crystal systems and crystal defects.
CO2: Comprehend the theory of conducting materials.
CO3: Classify the types of semiconducting materials and to illustrate the device applications.
CO4: Summarize the theory and applications of magnetic, superconducting and dielectric materials.
CO5: Outline the properties and applications of smart materials and nano materials.

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3			2	2		2		1					
CO2	3			2	2		2		1					
CO3	3			2	2		2		1					
CO4	3			2	2		2		1					
CO5	3			2	2		2		1					

1 – Slight, 2 – Moderate, 3 – Substantial

14CYT21 ENVIRONMENTAL SCIENCE

(Common to all Engineering and Technology branches)

3 0 0 3

UNIT – I **9**

Introduction to Environmental Studies and Natural Resources: Introduction to Environmental Science – Forest resources: Use and over-exploitation, deforestation, case studies. – Water resources: Use and over-utilization of surface and ground water, dams - benefits and problems – Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies – Food resources: World food problems, changes caused by agriculture - effects of modern agriculture, fertilizer and pesticide problems, water logging, salinity, case studies – Energy resources: Growing energy needs, renewable and non-renewable energy sources, use of alternate energy sources, case studies – Land resources: Land as a resource – Conservation Practices - Role of an individual in conservation of natural resources.

UNIT – II **9**

Ecosystems: Concept of an ecosystem – Components of an ecosystem - Structural and functional features – Functional attributes (Food chain and Food web only) –Ecological Succession- Introduction, types, characteristic features, structure and functions of the (a) Forest ecosystem (b) Aquatic ecosystems (ponds, rivers and oceans). **Biodiversity:** Introduction – Classification: genetic, species and ecosystem diversity – Bio geographical classification of India- Value of biodiversity: consumptive use, productive use, social, ethical, aesthetic, option values and ecosystem service value – Biodiversity at global, national and local level- Hotspots of biodiversity – Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts – Endangered and endemic species of India – In-situ and Ex-situ conservation of biodiversity.

UNIT – III **9**

Environmental Pollution: Definition – Causes, effects and control measures of: (a) Air pollution - Climate change, global warming, acid rain, ozone layer depletion (b)Water pollution (c) Soil pollution - Solid waste Management - Disaster management: floods, earthquake, cyclones and landslides - Role of an individual in prevention of pollution - Case studies. **Water Treatment methods:** Treatment of Water for Domestic Supply (Screening, Aeration, Sedimentation with Coagulation, Filtration and Disinfection methods) - Break point chlorination- Estimation of dissolved oxygen, BOD and COD - Sewage treatment (Primary, Secondary & Tertiary methods) – Introduction to industrial wastewater treatment using Reverse Osmosis Technology- Membrane Technology for wastewater treatment - Activated carbon in pollution abatement of wastewater.

UNIT – IV **9**

Social Issues and the Environment: From Unsustainable to Sustainable development – Urban problems related to energy – Water conservation– Environmental ethics - Wasteland reclamation – Environment Production Act – Air (Prevention and control of pollution) Act – Water (Prevention and control of pollution) Act – Wildlife protection Act – Forest conservation Act – Issues involved in enforcement of environmental legislation – Public awareness. **Human Population and the Environment:** Introduction - Population growth - Variation of population based on age structure - Variation among nations – Population explosion – Family welfare programme – Value Education – HIV / AIDS – Women and Child welfare – Role of Information Technology in Environment and human health – Case studies.

UNIT – V **9**

Green Chemistry for Sustainable Future: Water the greenest solvent – Role of catalyst – Biopolymers – Biofertilizers – Principle and applications of green chemistry. **Food and Human Health:** Introduction – Classification and applications of carbohydrates, amino acids, proteins, lipids and vitamins – Food additives – Balanced food – Minerals rich, carbohydrates rich and proteins rich – Chemistry of soft drinks – Oils and fats – Simple tests for identification of adulterants in food stuffs – Impacts of fluoride and arsenic on human health – Fluoride and arsenic removal methods – Significance of iodine, iron and calcium content in human health.

TOTAL : 45

TEXT BOOKS:

1. Palanisamy P.N., Manikandan P., Geetha A., Manjula Rani K., "Environmental Science", Pearson Education, New Delhi, Revised Edition 2014.
2. Anubha Kaushik, and Kaushik C.P., "Environmental Science and Engineering", 4th multicolour Edition, New Age International (P) Ltd., New Delhi, 2014.

REFERENCE BOOKS:

1. Erach Bharucha, "Textbook of Environmental Studies for Undergraduate Courses", 2005, University Grands Commission, Universities Press India Private Limited, Hyderguda, Hyderabad.
2. Uppal M.M. revised by Bhatia S.C., "Environmental Chemistry", 6th Edition, Khanna Publishers, New Delhi, 2002.
3. Bahl B.S. and Arun Bahl, "Advanced Organic Chemistry", 3rd Edition, S. Chand & Co., New Delhi, 2005.

COURSE OUTCOMES

On completion of the course the students will be able to

CO1: Know the types of natural resources and the individual role in conserving the resources
CO2: Understand the ecological balance and the preservation of biodiversity
CO3: Gain the knowledge of the various types of pollution and the waste water treatment methods
CO4: Attain the knowledge of various social issues and impact of population explosion on environment
CO5: Know about the green chemistry for sustainable future, food and human health

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2			3	2	3	2	1	1			
CO2	3	2			3	2	3	2	1	1			
CO3	3	2			3	2	3	2	1	1			
CO4	3	2			3	2	3	2	1	1			
CO5	3	2			3	2	3	2	1	1			

1 – Slight, 2 – Moderate, 3 – Substantial

14CSC11 PROBLEM SOLVING AND PROGRAMMING

(Common to all Engineering and Technology branches)

3 0 3 4

UNIT – I **9**

Introduction to Computer and Problem Solving: Overview of computers – Applications of computers-Characteristics of computer - Basic computer Organization – Number System - Problem solving: Planning the computer program – Algorithms - Flowcharts – Pseudo codes – Structuring the logic - Top-Down design.

UNIT – II **9**

Case Study on Problem Solving: Algorithm, Flowchart and Pseudo code for the problems: Exchanging the values of two variables – Finding the biggest number - Counting – Summation of numbers – Factorial computation – Generation of Fibonacci Sequence - Summation of series – Base Conversion - Reversing the digits of an Integer.

UNIT – III **9**

Introduction to C and Control Statements: Overview of C – Basic structure of a C Program – Executing a C Program – C Character set – Tokens – Keywords and Identifiers – Constants – Variables – Data types - Storage classes - Managing Input and Output operations – Operators and Expressions - Decision making and Branching - Looping – break and continue statements.

UNIT – IV **9**

Arrays, Strings and Functions: Arrays – One dimensional and Two dimensional arrays - Handling of character strings: Declaring and initializing string variables – String handling functions - Library functions – User defined functions: Elements of User defined Functions – nesting of functions – passing arrays to function – passing strings to functions - recursion.

UNIT – V **9**

Structures, Unions and Pointers: Structure definition – Structure declaration – Accessing a structure member- Structure initialization – Array of Structures - Arrays within structures –Structures within Structures – Structures and Functions , Unions. Understanding pointers – Accessing address of a variable – Declaring pointer variables – Initialization of pointer variables – accessing a variable through its pointer – Pass by value vs. Pass by pointers.

Lecture: 45, Practical: 45, TOTAL: 90

REFERENCE BOOKS:

1. Dromey R.G., "How to Solve it by Computer", Pearson Education, 2009.
2. Balagurusamy E., "Fundamentals of Computing and Programming", Tata McGraw-Hill Education Pvt. Ltd, 2010.
3. Stephen G. Kochan, "Programming in C", 3rd Edition, Pearson Education, 2005.
4. Yashavant P. Kanetkar, " Let Us C", BPB Publications, 2011.

COURSE OUTCOMES

On completion of the course the students will be able to

CO1: apply fundamental principles of problem solving techniques
CO2: develop algorithm, flowchart and pseudo code to provide solutions to problems
CO3: develop programs using basic programming principles of C language
CO4: implement modular programming concepts using functions
CO5: design simple applications using arrays, structures and pointers

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3		2							2		
CO2	3	3	1		2							2		
CO3	3	3	2	1	2							2		
CO4	3	3	3	2								2		
CO5	3	3	3	2	2							2		

1 – Slight, 2 – Moderate, 3 – Substantial

14EET11 BASICS OF ELECTRICAL AND ELECTRONICS ENGINEERING

(Common to all Engineering and Technology branches)

3 0 0 3

UNIT- I **9**

Introduction to Power Systems: Introduction: Electric Potential, Current, Power and Energy. Generation of Electrical Energy: Sources of Energy - Renewable and Non Renewable - Power Generation: Thermal, Hydro and Nuclear Power plants - Solar and Wind (schematic arrangement and operation) Power plants - Structure of Electric Power System - Transmission and Distribution Voltages. Electrical Safety Aspects - Phase-Neutral - Earthing: Need for Earthing and Types - Domestic Wiring (Simple and staircase) - Energy Conservation and Sustainability.

UNIT - II **9**

DC Circuits and AC Circuits: Resistance: Resistors in Series and Parallel - Network Reduction - Voltage and Current Division Rule - Ohm's Law- Kirchhoff's Laws - Mesh Analysis of Simple Resistive Networks.

Single phase systems: Alternating (Sinusoidal) Voltage and Current, R.M.S and Average Value, Power Factor, Form Factor and Peak Factor - AC Series Circuits (RL, RC & RLC). Three phase Systems (Qualitative only): Star and Delta Connected Systems - Line and Phase Voltage/Current - Three Phase Power Measurement by Two Wattmeter Method.

UNIT - III **9**

Electrical Machines: DC Machines: Construction, Principle of Operation of DC Motor-Torque Equation, Types and Applications. AC Machines: Construction and Working Principle of AC Generator , Single Phase Transformer, Three Phase Induction Motor and Single Phase Induction Motor (Split Phase and Capacitor Start Induction Motor) - Applications.

UNIT - IV **9**

Basic Electronics: PN Junction Diode - Operation of Rectifiers (Half wave, Full wave - Bridge Rectifiers with waveforms) and Filters - Zener Diodes - Zener Diode as Voltage Regulator - IC Voltage Regulators (78XX & 79XX) - Transistors: Types - Operation of NPN Transistor - Transistor as an Amplifier - Operation and Characteristics of SCR - UPS and SMPS (Block Diagram approach).

UNIT - V **9**

Digital Electronics: Introduction – Binary Number Systems and Conversions - Binary Addition and Subtraction - Logic Gates and Truth tables - Boolean Algebra - Basic Laws and Demorgan's theorem - Simplification of Boolean Functions - Full Adder and Full Subtractor - Flip Flops - Counters: Asynchronous Binary Ripple Counter .

TOTAL: 45

TEXT BOOKS:

1. Prasad P.V., Sivanagaraju S. and Prasad R., "Basics of Electrical and Electronics Engineering", 1st Edition, Cengage Learning, 2013.
2. Muthusubramanian R. and Salivahanan S., "Basics of Electrical and Electronics Engineering", 1st Edition ,Tata McGraw Hill, 2009.

REFERENCE BOOKS:

1. Jegathesan V., Vinoth Kumar K. and Saravanakumar R., "Basic Electrical and Electronics Engineering", 1st Edition, Wiley India, 2011.
2. Sukhija M.S. and Nagsarkar T.K., "Basics of Electrical and Electronics Engineering", 1st Edition ,Oxford University Press, 2012.
3. Smarajit Ghosh, "Fundamentals of Electrical and Electronics Engineering", 2nd Edition, PHI Learning, 2007.
4. Edward Hughes, Ian McKenzie Smith, Dr. John Hiley and Keith Brown, "Electrical and Electronics Technology", 8th Edition, Pearson Education, 2012.

COURSE OUTCOMES

On completion of the course the students will be able to

CO1: develop a basic understanding of the concept of electrical systems
CO2: analyze the DC and AC circuits
CO3: interpret the construction and working of different types of electric machines
CO4: discuss the basic electronic components
CO5: distinguish analog and digital electronics

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3									1		
CO2	3	3	3									1		
CO3	3	3	3									1		
CO4	3	3	3									1		
CO5	3	3	3									1		

1 – Slight, 2 – Moderate, 3 – Substantial

14PHL21 PHYSICAL SCIENCES LABORATORY II

(Common to all Engineering and Technology branches)

0 0 3 1

PART-A: APPLIED PHYSICS LABORATORY

(Any five experiments)

LIST OF EXPERIMENTS:

1. Determination of band gap of a semiconductor material using post office box.
2. Determination of dispersive power of a prism using spectrometer.
3. Determination of viscosity of liquid - Poiseuille's method.
4. Determination of thickness of a thin wire – air wedge method.
5. Determination of AC frequency using Melde's string experiment.
6. Determination of hysteresis loss in a ferromagnetic material.

Demonstration

1. Thin film deposition using RF magnetron sputtering technique
2. Synthesis of nano-particles
3. Phase change memory materials - RW CD / DVD

PART - B: APPLIED CHEMISTRY LABORATORY

(Any five experiments)

LIST OF EXPERIMENTS:

1. Estimation of Chloride in the given water sample.
2. Determination of Dissolved Oxygen in the given wastewater sample.
3. Estimation of Ferrous ion in the given solution.
4. Estimation of Copper in the given solution by Iodometric method.
5. Estimation of Chromium (Cr^{6+}) in the wastewater.
6. Estimation of copper content of the given solution by EDTA method.

Demonstration

1. Turbidity measurement using Nephelometer
2. COD analyzer
3. Dissolved Oxygen measurement using DO analyzer

TOTAL : 45

REFERENCES / MANUALS / SOFTWARE:

1. Physics Laboratory Manual –Dr.K.Tamilarasan and Dr.K.Prabu
2. Chemistry Laboratory Manual- Dr.P.N.Palanisamy, P.Manikandan, A.Geetha and K.Manjularani

COURSE OUTCOMES

On completion of the course the students will be able to

CO1: Describe **t**he basics of band gap of semiconductors, dispersive power of a prism, viscosity of liquids, interference of light, AC frequency and hysteresis of ferromagnetic materials.

CO2: Operate the instruments like post office box, air wedge arrangement, Melde's string apparatus and hysteresis arrangement, and to measure the related parameters

CO3: Estimate the amount of DO and chloride in a given water sample

CO4: Determine the amount of chromium, ferrous ion and copper in waste water

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3		2	1		2		2				
CO2	3	3		2	1		2		2				
CO3	3	3		2	1		2		2				
CO4	3	3		2	1		2		2				

1 – Slight, 2 – Moderate, 3 – Substantial

14EEL11 BASICS OF ELECTRICAL AND ELECTRONICS ENGINEERING LABORATORY

(Common to all Engineering and Technology branches)

0 0 3 1

LIST OF EXPERIMENTS:

1. Control of incandescent and fluorescent lamp by simple and stair-case wiring
2. Resistor color coding and verification of Ohm's Law and Kirchhoff's Laws
3. Measurement of real power, reactive power, power factor and impedance of RC, RL and RLC circuits.
4. Measurement of Earth's resistance
5. Load test on DC shunt motor
6. Performance characteristics of single phase Transformer
7. Load test on single phase induction motor.
8. Verification of basic logic gates and their truth tables.
9. Implementation of Half wave and Full wave Rectifier with simple Capacitor Filter
10. Study of Mixie, Ceiling Fan and Vacuum Cleaner

TOTAL : 45

REFERENCES / MANUALS / SOFTWARE:

- Lab Manuals

COURSE OUTCOMES

On completion of the course the students will be able to

CO1: create a basic electrical connections for domestic applications
CO2: test basic electrical machines like transformer and DC motors
CO3: construct and analyze basic electronic circuits
CO4: measure the various electrical parameters of the circuit
CO5: explain the working of various domestic appliances

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3									2		
CO2	3	3	3									2		
CO3	3	3	3						2			2		
CO4	3	3	3									2		
CO5	3	3	3					1				2		

1 – Slight, 2 – Moderate, 3 – Substantial

14MAT31 MATHEMATICS III

(Common to all Engineering and Technology Branches)

3 1 0 4

UNIT – I **9**

Fourier Series: Dirichlet's conditions – General Fourier series – Change of interval - Odd and even functions – Half range Sine series – Half range Cosine series – Harmonic analysis.

UNIT – II **9**

Partial Differential Equations: Formation of partial differential equations by elimination of arbitrary constants and arbitrary functions – Lagrange's linear equation – Homogeneous linear partial differential equations of higher order with constant coefficients.

UNIT – III **9**

Applications of Partial Differential Equations: Classification of second order quasi linear partial differential equations – Solutions of one dimensional wave equation – One dimensional heat equation – Steady state solution of two dimensional heat equation (excluding insulated edges).

UNIT – IV **9**

Fourier Transform: Fourier Integral theorem (without proof) – Fourier transform pair – Properties – Transforms of simple functions – Fourier Sine and Cosine transforms – Convolution theorem and Parseval's identity (Statement and applications only).

UNIT – V **9**

Z - Transform: Definition – Elementary properties – Z-transform of some basic functions – Inverse Z-transform – Partial fraction method – Residue method – Convolution theorem – Applications of Z-transforms – Solution of difference equations.

Lecture: 45, Tutorial: 15, TOTAL: 60

TEXT BOOKS:

1. Kandasamy P., Thilagavathy K. and Gunavathy K., "Engineering Mathematics, Volume - III", Reprint Edition, S.Chand & Co., New Delhi, 2014.
2. Veerarajan T., "Transforms and Partial Differential Equations", 3rd Reprint, Tata McGraw Hill Education Pvt. Ltd., New Delhi, 2013.

REFERENCE BOOKS:

1. Grewal B.S., "Higher Engineering Mathematics", 43rd Edition, Khanna Publishers, Delhi, 2014.
2. Jain R.K. and Iyengar S.R.K., "Advanced Engineering Mathematics", Reprint Edition, Narosa Publishing House, New Delhi, 2014.
3. Bali N.P. and Manish Goyal, "A Text Book of Engineering Mathematics", 9th Edition, Laxmi Publications, New Delhi, 2014.
4. Ramana B.V., "Higher Engineering Mathematics", 11th Reprint, Tata McGraw Hill Publishing Company, New Delhi, 2010.
5. Erwin Kreyzig, "Advanced Engineering Mathematics", 10th Edition, Wiley & Co, 2011.

COURSE OUTCOMES

On completion of the course the students will be able to

CO1: Expand a function in terms of Fourier series and apply it for solving engineering problems

CO2: Model and solve higher order partial differential equations

CO3: Apply the methods of solving PDE in practical problems

CO4: Gain knowledge on Fourier transforms

CO5: Handle problems in Z transforms and apply it to solve difference equations

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	1	1								1		
CO2	3	3	1	1								1	1	
CO3	3	3	1	1								1	1	
CO4	3	3	1	1								1		
CO5	3	3	1	1								1		

1 – Slight, 2 – Moderate, 3 – Substantial

14FTT31 FLUID MECHANICS IN FOOD PROCESSING OPERATIONS

3 1 0 4

UNIT – I **9**

Fluid Statics and Dimensional Analysis: Nature of fluids – physical properties of fluids, Compressible and incompressible. Types of fluids – Newtonian and Non – Newtonian fluids. Fluid static: Hydrostatic equilibrium. Application of fluid statics: manometers, continuous gravity decanter. Basics of dimensional analysis: Rayleigh's method and Bukingham's π method.

UNIT – II **9**

Basic Equations of Fluid Flow: Bernoulli equation. Correction of Bernoulli equation for fluid friction. Application of Bernoulli equation for pump work. Shear stress and skin friction in pipes. Laminar and turbulent flow of fluids through closed conduits. Velocity profiles and friction factor for smooth and rough pipes. Friction loss due to sudden enlargement, contraction. Friction loss in fittings, valves and coils.

UNIT – III **9**

Flow Past Immersed Bodies: Pressure drop for flow of liquids through porous media. Motion of particles through fluids: Equation for one dimensional motion of spherical particle through fluid, terminal velocity, Hindered settling. **Agitation of liquids:** Types of impellers, Flow pattern in agitated vessel. Power consumption in agitated vessels, blending and mixing.

UNIT – IV **9**

Transportation of Fluids: Fluid moving machinery. Performance – selection and specification. Positive displacement, centrifugal pump - characteristics. Gear pump, diaphragm pumps, vacuum pump, metering pump, peristaltic pump – working principle and application. Fans, blowers and compressors – Selection, types and applications.

UNIT – V **9**

Metering of Fluids: Variable head meter: Orifice meter, Venturimeter, Pitot tube. Variable area meter: Rota meter. Calibration of flow meters. Principles and applications of Doppler Effect in flow measurement. Principle of Magnetic flow meters, V-Notch, Turbine flow meters, and Thermal flow meters. Valves – Types, applications.

Lecture: 45, Tutorial: 15, TOTAL: 60

TEXT BOOKS:

1. McCabe W.L., Smith J.C. and Harriot P., "Unit Operations of Chemical Engineering", 7th Edition, McGraw Hill, New York, 2005.
2. Gavhane K.A., "Unit Operations – I", 8th Edition, Nirali Prakashan Publications, Pune, 2000.

REFERENCE BOOKS:

1. Coulson J.M. and Richardson J.F., "Chemical Engineering", Volume I, Pergamon Press, New York, 1977.
2. Noel de Nevers, "Fluid Mechanics for Chemical Engineers", 2nd Edition, McGraw Hill, New York, 1991.
3. Cengel, Yunus and Cimbala John M., "Fluid Mechanics Fundamentals and Applications", 2nd Edition, Tata McGraw Hill Publishing Company, New Delhi, 2006.
4. http://www.msubbu.in/ln/fm/
5. http://nptel.ac.in/downloads/103104043/

COURSE OUTCOMES

On completion of the course the students will be able to

CO1: classify fluids, apply hydrostatic equilibrium and dimensional analysis in fluid flow behaviour

CO2: derive and apply basic equations of fluid flow

CO3: analyze fluid flow through porous media and select suitable mixing equipment used in food industries

CO4: select and evaluate the performance of pumps

CO5: illustrate the principle and application of different flow measuring devices and valves

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	2	2							1	2	1
CO2	3	2	3	2	2							1	2	1
CO3	3	2	3	2	1							1	3	2
CO4	3	2	2	1	1							1	3	1
CO5	3	1	1	1	1							1	3	1

1 – Slight, 2 – Moderate, 3 – Substantial

14FTT32 FOOD PROCESS CALCULATIONS

3 1 0 4

UNIT – I **9**

Units and Dimensions, Fundamental Calculations: Basic and derived units, unit conversions, use of model units in calculations, methods of expression, compositions of mixture and solutions. Ideal and real gas laws – gas constant - calculations of pressure, volume and temperature using ideal gas law, Use of partial pressure and pure component volume in gas calculations, applications of real gas relationship in gas calculation.

UNIT – II **9**

Material Balance: Stoichiometric principles, material balance without chemical reaction- application of material balance to unit operations like distillation, evaporation, crystallization, drying and extraction.

UNIT – III **9**

Recycle Operations: Recycle stream**,** block diagram, purging operations, purge ratio, recycle ratio and purge stream. **Humidity and Saturation:** Calculation of absolute humidity, molal humidity, relative humidity and percentage humidity, wet and dry bulb temperature, dew point - Humidity chart usage.

UNIT – IV **9**

Energy Balance: Heat capacity of solids, liquids, gases and solutions, use of mean heat capacity in heat calculations, problems involving sensible heat and latent heats, evaluation of enthalpy. Standard heat of reaction, heats of formation, combustion, solution, mixing etc., calculation of standard heat of reaction - Effect of pressure and temperature on heat of reaction - Energy balance for systems without chemical reaction.

UNIT – V **9**

Combustion: Combustion of solids, liquid and gas, determination of NHV and GHV. Determination of composition by Orsat analysis - Calculation of excess air, theoretical oxygen requirement.

Lecture: 45, Tutorial: 15, TOTAL: 60

TEXT BOOKS:

1. Gavhane K.A., "Introduction to Process Calculations (Stoichiometery)", 22nd Edition, Nirali Prakashan Publications, Pune, 2009.
2. Venkataramani V. and Anantharaman N., "Process Calculations", Prentice Hall of India, New Delhi, 2003.

REFERENCE BOOKS:

1. Bhatt B.L. and Vora S.M., "Stoichiometry", 4th Edition, Tata McGraw Hill Publishing Company, New Delhi, 2004.
2. Himmelblau D.M., "Basic Principles and Calculations in Chemical Engineering", 6th Edition, Prentice Hall of India, New Delhi, 2003.
3. Narayanan K.V. and Lakshmikutty B., "Stoichiometry and Process Calculations", Prentice Hall of India, New Delhi, 2006.
4. http://nptel.ac.in/syllabus/103102017/
5. http://www.nzifst.org.nz/unitoperations/httrapps2.htm

COURSE OUTCOMES

On completion of the course the students will be able to

CO1: apply different systems of units and dimensions, estimate compositions of mixtures and solutions

CO2: apply material balance for different unit operations

CO3: apply material balance for recycle operations and perform humidification calculations

CO4: perform energy balance calculations

CO5: determine the GHV, NHV and composition of fuels

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	1	1								1	1	1
CO2	3	3	2	2	1							1	3	3
CO3	3	3	2	2	1							1	3	3
CO4	3	3	2	2	1							1	2	1
CO5	3	3	2	1	1							1	1	1

1 – Slight, 2 – Moderate, 3 – Substantial

14FTT33 THERMODYNAMICS

3 1 0 4

Pre-requisites: Engineering Mathematics I & II

UNIT – I **9**

Basic Concepts and First Law: Fundamental concepts of thermodynamics- microscopic and macroscopic approach – systems, properties, process, functions, units, energy, heat and work, zeroth law. First law - statement of first law for flow and non - flow process, internal energy, enthalpy, heat capacities (C_V and C_P) – steady state flow processes with reference to various thermal equipments - nozzle, throat, throttling process and compressors.

UNIT – II **9**

Second Law: Second Law of thermodynamics: Kelvin-Plank, Clausius statements and its equivalence, reversible cycle – Carnot cycle and theorem – thermodynamic temperature scale. Entropy, Clausius theorem, Clausius inequality, Entropy changes during processes – available and unavailable energies.

UNIT – III **9**

PVT Behavior of Pure Fluids: PVT surfaces: P-V, P-T, T-S and H-S Diagrams. Equation of state and the concept of ideal gas - Process involving ideal gases: constant volume, constant pressure, constant temperature, adiabatic and polytrophic process. Equation of state for real gases – Vander Waals equation, Redllich Kwong equation, Virial equation of state. Principle of corresponding states – generalized compressibility charts.

UNIT – IV **9**

Steam Properties: Properties of steam, usage of steam tables. Determination of dryness fraction of steam. Calorimeters – Tank or barrel type, throttling, separating, separating and throttling. Steam distribution systems. Types of steam traps and their characteristics. Application of steam in food process industries.

UNIT – V **9**

Boilers: Types and classification of boilers - Cochran Boiler, Lancashire boiler, Locomotive Boiler, Fluidized Bed Boiler. Boiler mountings and Accessories. Performance and energy efficiency of boilers. Simple calculation of Boiler efficiency. Importance of boiler water treatment and blow down.

Lecture: 45, Tutorial: 15, TOTAL: 60

TEXT BOOKS:

1. Narayanan K.V., "A Text Book of Chemical Engineering Thermodynamic", Prentice Hall of India, New Delhi, 2003.
2. Kothandaraman C.P., Khajuria P.R., Arora S.C. and Domkundwar S.A., "Course in Thermodynamics and Heat Engines", 3rd Edition, Dhanpat Rai & Sons, New Delhi, 1990.

REFERENCE BOOKS:

1. Ballaney P.L., "Thermal Engineering", 23rd Edition, Khanna Publishers, New Delhi, 2005.
2. Smith J.M., Van Ness H.C. and Abbott M.M., "Introduction to Chemical Engineering Thermodynamics", 7th Edition, McGraw Hill, New York, 2005.
3. Rao Y.V.C., "An Introduction to Thermodynamics", Universities Press, 2004.
4. http://www.nptel.ac.in/downloads/112108148/
5. http://mes2005.tripod.com/Steam_and_its_properties.pdf

COURSE OUTCOMES

On completion of the course the students will be able to

CO1: outline the basic concepts and apply the first law of thermodynamics in selected processes

CO2: understand the principle of second law of thermodynamics and concepts of Carnot cycle

CO3: interpret the second law of thermodynamics and relate the properties of pure substance

CO4: estimate the properties of steam and measurement of quality of steam using calorimeters

CO5: integrate the use of simple calculation in gaining the working knowledge of different boilers

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	1	1	2							1	1	
CO2	3	2	1	1	2							1	1	
CO3	3	2	1	1	2							1	1	
CO4	3	2	1		2							1	2	2
CO5	3	2			2							1	2	1

1 – Slight, 2 – Moderate, 3 – Substantial

14FTT34 FOOD BIOCHEMISTRY

3 0 0 3

UNIT – I **9**

Carbohydrates: Classification; Simple Sugars: mono and disaccharides, Hygroscopicity and solubility, optical rotation, mutarotation; Sweetness: structure-activity relationship and sweetness index; Dextrose Equivalent, Degree of polymerisation; Sugar alcohols; Oligosaccharides: structure and occurrence. Polysaccharides: Starch-amylose and amylopectin- properties. Cellulose. Pectins, gums and seaweeds – structure & properties. Dietary fibres - Food sources, functional role and uses in foods.

UNIT – II **9**

Lipids: Structure, classification and composition of fats. Physical properties of fats and oils: crystal formation, polymorphism, melting point, plasticity, radiolysis. Shortening power of fats, emulsification, smoke point and polymerization. Chemical properties of fats – Hydrolysis, saponification, halogenation. Hydrolytic rancidity and oxidative rancidity.

UNIT – III **9**

Proteins: Amino acids - Definition, structure and classification. Protein - structure and conformation, Food sources and biological role. Properties of proteins in food systems: Dissociation, optical activity, solubility, hydration, swelling, foam formation and stabilization, gel formation, emulsifying effect. Denaturation.

UNIT – IV **9**

Enzymes as food processing aids: Introduction, Nature, classification and nomenclature of enzymes. Specificity. Enzyme kinetics – Michelis - Menten equation, Factors affecting enzyme action, mechanism of enzyme action; active site. Immobilization methods.

UNIT – V **9**

Nucleic Acids: Composition and structure of DNA and RNA. **Metabolism**: Metabolism - Glycolysis; TCA cycle; substrate level phosphorylation. Protein metabolism – urea cycle. Cellular respiration - electron transport chain. Lipid metabolism – lipases and phospholipases. Fatty acid metabolism – beta oxidation and fatty acid synthesis. Inter relationship of metabolic pathways.

TOTAL: 45

TEXT BOOKS:

1. Belitz H. D., Grosch W., and Schieberle P., "Food Chemistry", 3rd Edition, Springer Verley, Berlin, 2008.
2. Jain J.L., Sunjay Jain and Nitin Jain, "Fundamentals of Biochemistry", S. Chand & Co., New Delhi, 2008.

REFERENCE BOOKS:

1. Alais C. and Linden G., "Food Biochemistry", Ellis Horwood Series in Food Science and Technology, Springer, 1991.
2. Rastogi S.C., "Biochemistry", 3rd Edition, Tata McGraw Hill Publishing Company, New Delhi, 2010.
3. John. M. DeMan, "Principles of Food Chemistry", An Aspen Publication, Maryland, 1999.
4. http://freevideolectures.com/Course/2524/BioChemistry/3
5. http://freevideolectures.com/Course/2524/BioChemistry/20

COURSE OUTCOMES

On completion of the course the students will be able to

CO1: interpret the structure and properties of carbohydrates

CO2: recall the structure and properties of lipids

CO3: recognize the structural and functional role of proteins

CO4: classify the enzymes and interpret the enzyme action and their immobilization

CO5: infer the structure of nucleic acids and illustrate the basics of energy metabolism

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	2		1						1	2	2
CO2	3	2	2	2		1						1	2	2
CO3	3	2	2	2		1						1	2	2
CO4	3	2	1	2								1	2	2
CO5	3	1	1	1		1						1	2	1

1 – Slight, 2 – Moderate, 3 – Substantial

14FTT35 PRINCIPLES OF MICROBIOLOGY

3 0 0 3

UNIT – I **9**

Introduction: Development and Scope of Microbiology, History of Microbiology - Spontaneous generation theory, Biogenesis, Germ theory of diseases. Contributions by Anton Van Leeuwenhoek, Louis Pasteur, John Tyndall, Robert Koch, Joseph Lister, Edward Jenner, Alexander Fleming and Waksman.

UNIT – II **9**

Classification and Structure of Microorganisms: Classification and Groups of microorganisms - Prokaryotes and Eukaryotes. Whittaker's five kingdom and three kingdom concept of living organisms. Microbial cell: Bacteria, Virus, Algae, Fungi- structure, reproduction and economic importance. Bacteriophage – structure, importance and life cycle (lytic and lysogenic cycle).

UNIT – III **9**

Microscopy and Staining Techniques- Principle, resolution, numerical aperture, magnification. Different types of microscopes – Light, UV, dark field, phase contrast and Electron microscope (Scanning and Transmission type). Stains – Auxochrome, chromophores, acidic and basic dyes. Staining techniques – Simple staining, Gram's staining, acid fast staining, endospore staining, capsule staining and flagella staining.

UNIT – IV **9**

Microbial Nutrition and Growth: Primary nutritional requirements and nutritional classification – Phototrophs, autotrophs, organotrophs, lithotrophs, chemotrophs. Culture Media – components of media, design and preparation of media using common ingredients. Types of media - natural, synthetic, complex, selective, differential, enriched, assay, enumeration, transport and enrichment media. Growth curve – batch culture, continuous culture, synchronous culture. Physical factors influencing the growth – Temperature, pH, osmotic pressure and salt concentration.

UNIT – V **9**

Isolation and Control of Microbes: Pure culture technique – Serial dilution and plating methods; cultivation, maintenance and preservation of pure cultures. Control of microorganisms: Physical agents – heat, radiation and filtration; Chemical agents and their mode of action – Aldehydes, halogens, Quaternary ammonium compounds, phenol and phenolic compounds, heavy metals, alcohol, detergents and surfactants; Antibiotics and their mode of action – Pencillin, streptomycin, tetracycline and chloramphenicol.

TOTAL: 45

TEXT BOOKS:

1. Pelczar M.J., Chan E.C.S. and Krieg N.R., "Microbiology", McGraw Hill, New York, 2004.
2. Powar C.B. and Daginawala H.F., "General Microbiology", Volume I and II, Himalaya Publishing House, New Delhi, 2005.

REFERENCE BOOKS:

1. Wiley J., Sherwood L., and Woolverton C., "Prescott's Microbiology", McGraw Hill, New York, 2013.
2. Harvey R.A., Cornelissen C.N. and Fisher B.D., "Microbiology", 3rd Edition, Lippincott Williams & Wlakins, Philidelphia, 2013.
3. Black J.G., "Microbiology – Principles and Explorations", Wiley Publications, USA, 2008.
4. http://www.grsmu.by/files/file/university/cafedry/microbiologii-virysologiiimmynologii/files/essential_microbiology.pdf
5. https://archive.org/details/in.ernet.dli.2015.146167

COURSE OUTCOMES

On completion of the course the students will be able to

- CO1: acquire knowledge on historical developments in microbiology
- CO2: classify and identify the structure of microorganisms
- CO3: interpret the different types of microscopes and staining techniques
- CO4: formulate media for microbial growth
- CO5: identify the technique used for isolation and control of microorganisms

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2											1	
CO2	3	3		1	1							1	2	1
CO3	3	3		1	1							1	2	2
CO4	3	3	2	1	2							2	1	2
CO5	3	3	2	1	2							2	2	3

1 – Slight, 2 – Moderate, 3 – Substantial

14FTL31 UNIT OPERATIONS LABORATORY I

0 0 3 1

LIST OF EXPERIMENTS / EXERCISES:

1. Flow through venturimeter
2. Flow through orficemeter
3. Flow through coils
4. Characteristic curves of centrifugal pumps
5. Flow through square duct pipes
6. Flow through circular pipes
7. Calibration of V- Notch
8. Flow through annular pipes
9. Flow through valves and pipe fittings
10. Pressure drop studies in packed beds
11. Open drum with orifice
12. Flow through fluidized bed

TOTAL : 45

REFERENCES / MANUALS / SOFTWARE:

1. McCabe W.L., Smith J.C., and Harriot P., "Unit Operations of Chemical Engineering", 7th Edition, McGraw Hill, New York, 2005.
2. Perry Robert, "Perry's Chemical Engineers Hand book", 8th Edition, McGraw Hill, New York, 2007.

COURSE OUTCOMES

On completion of the course the students will be able to

CO1: determine the discharge coefficient using variable area flow meters and variable head flow meters

CO2: assess the flow of fluids through closed conduits, open channels, valves and pipe fitting

CO3: select and evaluate the performance of pumps

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1		3					3	*12		1	3	1
CO2	2	1		3					3			1	3	1
CO3	2	1		3					3			1	3	2

1 – Slight, 2 – Moderate, 3 – Substantial

14FTL32 BIOCHEMISTRY LABORATORY

0 0 3 1

LIST OF EXPERIMENTS / EXERCISES:

1. Qualitative tests for monosaccharide, disaccharides, polysaccharides
2. Estimation of reducing sugar by dinitrosalicylic acid method
3. Estimation of starch by anthrone method
4. Estimation of amylase
5. Determination of iodine number
6. Extraction and estimation of oil content
7. Determination of saponification number
8. Estimation of moisture content, total ash and acid insoluble ash
9. Estimation of vitamins
10. Estimation of protein by biuret method
11. Estimation of minerals

TOTAL : 45

REFERENCES / MANUALS / SOFTWARE:

1. Sadasivam S., and Manickam A., "Biochemical Methods", 3rd Edition, New Age International, Delhi, 1996.
2. Ranganna S., "Handbook of Analysis and Quality Control for Fruit and Vegetable Products", 2nd Edition, Tata McGraw Hill.

COURSE OUTCOMES

On completion of the course the students will be able to

CO1: analyze and estimate carbohydrates in food samples

CO2: estimate protein, vitamins, minerals and moisture content in food products

CO3: extract oil and determine its properties

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	3		3	1	1			3			1	2	2
CO2	2	3		3	1	2			3			1	2	2
CO3	2	3		3	1	3			3			1	2	2

1 – Slight, 2 – Moderate, 3 – Substantial

14FTL33 MICROBIOLOGY LABORATORY

0 0 3 1

LIST OF EXPERIMENTS / EXERCISES:

1. Study experiment on lab equipments and practices
2. Identification of microorganisms by simple staining technique
3. Identification of microorganisms by Gram's staining technique
4. Observation of microorganisms by wet mount preparation and hanging drop technique
5. Preparation of different culture media
6. Techniques for isolation of microorganisms using serial dilution method
7. Cultivation and enumeration of microorganisms using spread plate method
8. Isolation of microorganisms by pour plate method
9. Isolation of microorganisms by streak plate method
10. Cultivation and enumeration of microorganisms in nature (air/soil/water)
11. Biochemical characteristics of microorganisms using IMViC test
12. Antibiotic sensitivity test for microorganisms

TOTAL : 45

REFERENCES / MANUALS / SOFTWARE:

1. Gunasekaran P., "Laboratory Manual in Microbiology", 1st Edition, New Age International Publications, New Delhi, 2005.

COURSE OUTCOMES

On completion of the course the students will be able to

CO1: identify the morphology of microorganisms

CO2: prepare different types of media and plating techniques to grow the microorganisms

CO3: cultivate, isolate and characterize the microorganisms

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	3		3	1				3			1	2	2
CO2	2	3		3	1				3			2	2	2
CO3	2	3		3	1				3			2	2	2

1 – Slight, 2 – Moderate, 3 – Substantial

14MAT41 NUMERICAL METHODS

(Common to Civil, EEE, EIE, Chemical & Food Technology)

3 1 0 4

UNIT – I **9**

Solution to Algebraic and Transcendental Equations: Iteration method – Method of false position – Newton-Raphson method – Solution of linear system of equations – Direct methods: Gauss elimination method and Gauss - Jordan method – Iterative methods: Gauss Jacobi and Gauss – Seidel methods.

UNIT – II **9**

Interpolation: Interpolation with equal intervals: Newton's forward and backward difference formulae – Central difference interpolation formulae: Gauss forward and backward interpolation formulae – Interpolation with unequal intervals: Lagrange's interpolation formula – Newton's divided difference formula.

UNIT – III **9**

Numerical Differentiation and Integration: Differentiation using Newton's forward, backward and divided difference formulae – Numerical integration: Trapezoidal rule – Simpsons $1/3^{rd}$ rule – Double integrals using Trapezoidal and Simpson's rules.

UNIT – IV **9**

Numerical Solution of First order Ordinary Differential Equations: Single step methods**:** Taylor series method – Euler method – Modified Euler method – Fourth order Runge-Kutta method – Multi step methods: Milne's predictor corrector method – Adam's Bashforth method.

UNIT – V **9**

Solutions of Boundary Value Problems in PDE: Solution of one dimensional heat equation – Bender -Schmidt recurrence relation – Crank - Nicolson method – One dimensional wave equation – Solution of two dimensional Laplace equations – Solution of Poisson equation.

Lecture: 45, Tutorial: 15, TOTAL: 60

TEXT BOOKS:

1. Kandasamy. P, Thilakavathy.K, and Gunavathy. K, "Numerical Methods", Reprint Edition, S.Chand & Co, New Delhi, 2014.
2. Veerarajan. T, Ramachandran.T, "Numerical Methods with Programming C", 2^{nd} Edition, Tata McGraw-Hill Publishing Company Ltd., New Delhi, 2008.

REFERENCE BOOKS:

1. Balagurusamy.E, "Numerical Methods", Reprint Edition, Tata McGraw-Hill Publishing Company Ltd., New Delhi, 2007.
2. Jain.M.K, Iyengar,S.R.K and Jain.R.K, "Numerical Methods for Scientific and Engineering Computation", 6^{th} Reprint, New Age International Pvt. Ltd., New Delhi, 2014.
3. Sankara Rao. K, "Numerical methods for Scientists and Engineers", 3^{rd} Edition, Prentice Hall of India Pvt. Ltd., New Delhi, 2008.
4. Gerald. C. F and Wheatley. P. O, "Applied Numerical Analysis", 7^{th} Edition, Pearson Education, Asia, New Delhi, 2006.
5. Grewal.B.S, "Numerical Methods in Engineering and Science", 9^{th} Edition, Khanna Publishers, 2007.

COURSE OUTCOMES

On completion of the course the students will be able to

CO1: know the various methods of solving algebraic and transcendental equations numerically

CO2: understand the concept of interpolation

CO3: gain knowledge on the concepts of numerical differentiation and integration

CO4: obtain the solution of ordinary differential equations numerically

CO5: apply various numerical techniques in solving complex partial differential equations

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	1	1								1		
CO2	3	3										1		
CO3	3	3	1	1								1		
CO4	3	3	1	1								1	1	
CO5	3	3	1	1								1	1	

1 – Slight, 2 – Moderate, 3 – Substantial

14FTT41 HEAT TRANSFER IN FOOD PROCESSING OPERATIONS

3 1 0 4

UNIT – I **9**

Conduction: Concept of heat conduction - Fourier's law of heat conduction - One dimensional steady state heat conduction equation for flat plate, hollow cylinder - Heat conduction through a series of resistances. Thermal Conductivity - effect of temperature on thermal conductivity.

UNIT – II **9**

Convection: Concept of heat transfer by convection - Natural and forced convection – Combined natural and forced convection - Application of dimensional analysis for convection - Equations for forced and natural convection under laminar, transition and turbulent conditions. **Film Coefficients:** Individual and overall heat transfer coefficients and its relationship between them. Extended surface heat transfer.

UNIT – III **9**

Radiation: Concept of thermal radiations - Black body concept - Radiation Properties – Stefan Boltzman's law, emissivity and absorptivity. Concept of grey body – radiation between surfaces – radiation shields.

UNIT – IV **9**

Heat Exchangers: Parallel and counter flow heat exchangers - LMTD - Heat exchangers effectiveness; number of transfer unit – use of correction factor charts, Chart for different configurations - Fouling factor. Types of heat exchanger- Single pass, multi pass heat exchangers, shell and tube heat exchanger, Compact heat exchangers: plate and spiral heat exchangers – working principles and applications.

UNIT – V **9**

Evaporators: Steam economy, capacity, boiling point elevation. Types of evaporators - Open pan evaporator, horizontal tube evaporator, vertical tube evaporator, long tube evaporator, forced circulation evaporator, Film type evaporators – working principle and applications. Multiple effect evaporators: Feed forward and feed backward operations.

Lecture:45, Tutorial:15, TOTAL: 60

TEXT BOOKS:

1. Dutta. Binay K., "Heat Transfer: Principles and Applications", Prentice Hall of India, New Delhi, 2001.
2. Gavhane K.A., "Heat Transfer SI Units", 13th Edition, Nirali Prakashan Publications, Pune, 2012.

REFERENCE BOOKS:

1. Kern D.Q., "Process Heat Transfer", McGraw Hill, New York, 1999.
2. McCabe W.L., Smith J.C., and Harriot P., "Unit Operations of Chemical Engineering", 7th Edition, McGraw Hill, New York, 2005.
3. Cengel Yunus A., "Heat Transfer: A Practical Approach", 2nd Edition, WCB / McGraw Hill, New Delhi, 2003.
4. http://nptel.ac.in/courses/103103032/21
5. http://www.nzifst.org.nz/unitoperations/httrapps.htm

COURSE OUTCOMES

On completion of the course the students will be able to

CO1: infer the fundamental concept of heat conduction

CO2: make use of dimensional analysis for solving convective heat transfer coefficient

CO3: apply the concepts of radiation in solving heat transfer problems

CO4: select a suitable heat exchangers and analyze the performance

CO5: paraphrase the types of evaporators along with its applications

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3		2	1							1	1	1
CO2	3	3		2	2							1	2	1
CO3	3	3		2	1							1	1	1
CO4	3	3	2	2	2							1	3	2
CO5	3	3	2	2	2							1	3	2

1 – Slight, 2 – Moderate, 3 – Substantial

14FTT42 MASS TRANSFER IN FOOD PROCESSING OPERATIONS

3 1 0 4

UNIT – I **9**

Diffusion: Types of mass transfer operations, Ficks law of diffusion. Steady state molecular and eddy diffusion in gases and liquids, steady state diffusion under stagnant and laminar flow conditions. Measurement and prediction of diffusivity of gas and liquids, diffusion in solids.

UNIT – II **9**

Interphase mass Transfer: Individual and over all mass transfer co-efficient - Theories of mass transfer: Two Film, penetration, surface renewal. Analogy between heat, mass and momentum transfers. **Humidification:** Basic concepts and terminologies, Adiabatic saturation process and theory of wet bulb temperature - Measurement of humidity - Cooling towers: Principle and operation.

UNIT – III **9**

Distillation: Vapour-liquid equilibria, Raoult's law and deviations from ideality. Methods of distillation: Simple distillation- calculations using Rayleigh equation, Flash vaporization, steam distillation. Design of multistage tray towers for binary systems using McCabe-Thiele method.

UNIT – IV **9**

Liquid-Liquid Extraction: Equilibrium in ternary systems; Solvent selection criteria; equilibrium stage wise contact – Single stage extraction, Multi stage cross current and counter current operations. Extractors – mixer settlers, packed tower, spray towers, perforated plate, rotating disc contactors, pulse column - working principles and applications.

UNIT – V **9**

Leaching: Solid-liquid equilibrium, single stage leaching, multi stage cross current and counter current leaching operations. Leaching equipments – Bollman extractor, Rotocel extractor, Pachuca tank, Dorr agitator – working principle and applications.

Lecture:45, Tutorial:15, TOTAL: 60

TEXT BOOKS:

1. Gavhane K.A., "Mass Transfer - II", 5th Edition, Nirali Prakashan Publications, Pune, 2006.
2. Anantharaman N., Begum K. M. and MeeraSheriffa, "Mass Transfer: Theory and Practice", Prentice Hall of India, 2011.

REFERENCE BOOKS:

1. Treybal R.E., "Mass Transfer Operations", 3rd Edition, McGraw Hill, New York, 1981.
2. Coulson J.M. and Richardson J.F., "Chemical Engineering", Volume - III, Pergamon Press, New York, 1977.
3. McCabe W.L., Smith J.C. and Harriot P., "Unit Operations of Chemical Engineering", 7th Edition, McGraw Hill, New York, 2005.
4. http://nptel.ac.in/courses/103103035/
5. http://www.ifh.uni-karlsruhe.de/lehre/envflu_i/lecture_notes/lecture_notes.htm

COURSE OUTCOMES

On completion of the course the students will be able to

CO1: classify and quantify the diffusion in gas, liquid and solid
CO2: estimate the mass transfer coefficient and apply the concepts of humidification
CO3: summarize various distillation processes and design a multistage distillation tower
CO4: select suitable solvent and extraction equipments
CO5: perform leaching calculations and illustrate the principle and operation of leaching equipments

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	2	1								1	1
CO2	3	3	2	2	1							1	2	2
CO3	3	3	3	3	3							1	3	2
CO4	3	3	3	3	2		1					1	3	2
CO5	3	3	3	3	2		1					1	3	2

1 – Slight, 2 – Moderate, 3 – Substantial

14FTT43 FOOD CHEMISTRY

3 0 0 3

Pre-requisites: Food Biochemistry

UNIT – I **9**

Food Groups - Definition. Major food groups (basic 4, 5, 7) and their characterization. Food as a source of energy, Energy value of foods, energy requirement of the body - estimation. Water balance and recommended intakes; fluid/electrolyte balance, acid-base balance; Concept of water activity – Water binding in foods. **Nutrition:** Definitions – Malnutrition, obesity, balanced diets, Recommended Dietary Allowances (RDA).

UNIT – II **9**

Minerals: Major minerals – Calcium, Potassium, Sodium, Phosphorus. Minor minerals – Iron, Zinc, Iodine, Copper, Selenium. Functional role and deficiency. **Vitamins:** Definition, water soluble and fat soluble vitamins, sources, functions and deficiency symptoms.

UNIT – III **9**

Changes during Cooking: Cooking – objectives, methods – moist heat, dry heat and combination. Loss of nutrients and prevention, biochemical changes in carbohydrates - Gelatinization and retrogradation of starch, proteins and lipids; parboiling of rice; enzymatic browning reactions; non enzymatic browning reactions - caramelization, Maillard reaction.

UNIT – IV **9**

Modification of Biomolecules: Modified starches, resistant starch. Starch hydrolysates – Maltodextrins and dextrins. Modification of proteins – chemical and enzymatic methods. Modification of fats - Hydrogenation - cis and trans isomers, interesterification, winterization. Biochemical changes during processing of foods - pickling, malting, drying and baking.

UNIT – V **9**

Food Preservation: principles of food preservation. Preservation by high temperature – sterilization, pasteurization, blanching. Preservation by low temperature – Refrigeration and freezing – factors affecting the process and characteristics of foods. Preservation by irradiation, drying and chemicals. Biochemical changes during preservation.

TOTAL: 45

TEXT BOOKS:

1. Belitz H.D., Grosch W. and Schieberle P., "Food Chemistry", 3rd Edition, Springer-Verley, Berlin, 2004.
2. Sivasankar B., "Food Processing and Preservation", Prentice Hall of India, New Delhi, 2005.

REFERENCE BOOKS:

1. Miller Dennis D., "Food Chemistry", John Wiley & Sons, New York, 1993.
2. Srilakshmi B., "Nutrition Science", 3rd Edition, New Age International Ltd., New Delhi, 2011.
3. Eskin N.A. and Henderson H.M., "Biochemistry of Foods", Harcourt Publishers Ltd., Singapore, 1990.
4. http://freevideolectures.com/Course/2524/BioChemistry/18
5. https://www.youtube.com/watch?v=yL8ejNmJII4

COURSE OUTCOMES

On completion of the course the students will be able to

CO1: interpret the nutritional importance of foods and water

CO2: summarize the nutritional importance of vitamins and minerals

CO3: recognize the changes in food components during cooking, processing and storage

CO4: modify the carbohydrates, proteins and fats based on its functional properties

CO5: apply the different methods of food preservation

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	1	1	3						1	2	1
CO2	3	3	2	1		3						1	1	2
CO3	3	2	1	1	2	2						1	2	1
CO4	3	3	2	1	2	3						1	3	3
CO5	3	3	2	1	2	3						2	3	3

1 – Slight, 2 – Moderate, 3 – Substantial

14FTT44 FOOD MICROBIOLOGY

3 0 0 3

Pre-requisites: Principles of Microbiology

UNIT – I **9**

Incidence of Microorganisms in Food: Importance of microorganisms in food, primary sources of microorganisms in food, Intrinsic and Extrinsic parameters of food affecting / influencing microbial growth. Types of microorganisms in foods like meats, poultry, seafood, vegetables, dairy products, fruits and vegetables.

UNIT – II **9**

Microbial Load Assessment: Sampling methods, SPC, MPN, spiral platter, DEFT, microcolony HGMF, DMC, Dye reduction, swab/swab-rinse method, impedance, microcalorimetry, flow cytometry, ATP measurement, PCR, Fluorescent antibody, RIA, ELISA.

UNIT – III **9**

Fermented Foods: Fermentation– Introduction, batch, fed batch and continuous fermentation. Fermented foods – Sauerkraut, Cheese, Beer, Vinegar and Tempeh. Single cell protein – Introduction, nutritive value, advantages over plant and animal proteins. Production process – BEL, SYMBA, PEKILO, BIOPROTEIN, QUORN and PRUTEEN process. Probiotics.

UNIT – IV **9**

Microbial Spoilage: principles and types of spoilage, microbial spoilage of different types of foods– fruits and vegetables, meat, poultry, sea foods, cereals products, bakery products, dairy products, fermented foods and canned foods.

UNIT – V **9**

Food Borne Diseases and Quality Control: Gastroenteritis, Listeriosis, Salmonellosis, Shigellosis, Vibriosis, Campylobacteriosis. Food toxins – Aflatoxin and Botulin. Food sanitation – indicators of food safety, Coliform bacteria. Food processing plant sanitation. Microbiological standards and guidelines –Microbiological criteria for foods, Enforcement and control agencies.

TOTAL: 45

TEXT BOOKS:

1. Frazier W.C., Westhoff D.C. and Vanitha N.M., "Food Microbiology", 5th Edition, Tata McGraw Hill Publishing Company, New Delhi, 2014.
2. Jay J.M., "Modern Food Microbiology", 6th Edition, Aspen Publications, Maryland, USA, 2000.

REFERENCE BOOKS:

1. Adams M.R. and Moss M.O., "Food Microbiology", RSC Publishing, 2008.
2. Ray B. and Bhunia A., "Fundamental Food Microbiology", 5th Edition, CRC Press, 2013.
3. Montville T.J., Matthews K.R., and Kniel K.E., "Food Microbiology: An Introduction", ASM Press, USA, 2012.
4. http://www.angrau.ac.in/media/9301/fdim142.pdf
5. http://www.nptel.ac.in/courses/102103015/pdf/mod5.pdf

COURSE OUTCOMES

On completion of the course the students will be able to

CO1: recognize the sources and factors influencing the microbial growth

CO2: identify the techniques used to assess the microbial load

CO3: apply the knowledge of microorganisms in fermentation process

CO4: interpret microbial spoilage of different foods

CO5: distinguish food borne diseases and intoxication caused by microorganisms

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1									1	2	1
CO2	3	3	3	1	2	2						1	2	3
CO3	3	3	2	1	2							1	3	1
CO4	3	3	3	1		2						1	1	3
CO5	3	3	3	1	1	2						1	1	3

1 – Slight, 2 – Moderate, 3 – Substantial

14FTT45 ENGINEERING PROPERTIES OF FOOD MATERIALS

3 0 0 3

Pre-requisites: Material Science

UNIT – I **9**

Physical Properties: Physical properties of food materials- size, shape, density, porosity and surface area – definitions and measurements, moisture content and its determination, direct and indirect methods, units, Frictional properties – friction – types, coefficient of friction, angle of repose – types and its determination.

UNIT – II **9**

Thermal Properties: Thermal properties, Definition of specific heat, enthalpy, conductivity and diffusivity, surface heat transfer coefficient. Measurement of specific heat, thermal conductivity, thermal diffusivity. Cryogenics, Calorific value of food, Bomb calorimeter. Applications of thermal properties.

UNIT – III **9**

Optical Properties: Refractive index of food items, Abbe's refractometer, Sorting of food material using optical properties , Optical activity, Polarimeter, Spectrophotometer, Gloss, color, translucency – Definitions, measurement and applications. **Electromagnetic Properties:** Electrical properties, dielectric heating, electrical conductivity, dielectric measurements, microwave heating and other Applications.

UNIT – IV **9**

Rheological Properties: Stress Strain behaviour of Newtonian and Non- Newtonian fluids- Bingham and Non Bingham. Stress-strain relationships in solids, liquids and viscoelastic behaviour- stress relaxation test, creep test and dynamic test, stress-strain diagrams, Emulsions and Colloids. Viscosity – Principle, Types- Capillary, Orifice, Falling and Rotational viscometers.

UNIT – V **9**

Textural Properties: Types of food textures, Texture measuring instruments- Compression, Snap Bending, Cutting Shear, Puncture, Penetration and TPA, Properties of food powders. **Colour**: Interaction of object with light, Colorimeter- Color order systems- Munsel color system, CIE color system, Hunter lab color space, Loviebond system.

TOTAL: 45

TEXT BOOKS:

1. Rao M. A. and Rizvi S.S.H., "Engineering Properties of Foods", Mercel Dekker Inc., New York, 1998.
2. Mohesnin N.N., "Physical Properties of Plant and Animal Materials", Volume I, Gordon and Breach Science Publishers, New York, 1970.

REFERENCE BOOKS:

1. Stroshine R., "Physical Properties of Agricultural Materials and Food Products", West Lafayette, IN., Purdue University, 2000.
2. Mathur D.S., "Properties of Matter", S. Chand & Co, New Delhi, 1997.
3. Singh R. Paul and Heldman Dennis R., "Introduction to Food Engineering", 3rd Edition, Gulf Publishing USA, 2001.
4. https://kuliahpangan77.files.wordpress.com/2016/02/physical-properties-of-foods-038730780x.pdf
5. https://www.asabe.org/media/207160/selections_from_food_proc._eng._tech.pdf

COURSE OUTCOMES

On completion of the course the students will be able to

CO1: interpret the physical properties of agricultural materials

CO2: elaborate the thermal properties and its application

CO3: outline the optical and electromagnetic properties

CO4: recognize the rheological properties of food materials

CO5: infer textural properties and color measurements of food materials

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2		1	3							1	2	1
CO2	3	2		2	3							1	2	1
CO3	3	2		2	3							1	2	1
CO4	3	2		2	3							1	2	3
CO5	3	2		2	3							1	2	3

1 – Slight, 2 – Moderate, 3 – Substantial

14FTL41 UNIT OPERATIONS LABORATORY II

0 0 3 1

LIST OF EXPERIMENTS / EXERCISES:

1. Heat transfer in natural convection/ forced convection
2. Determination of Stefan Boltzman constant
3. Estimation of thermal conductivity of a material
4. Shell and tube heat exchangers
5. Heat transfer in an agitated vessel
6. Heat transfer in bare and fin tubes
7. Verifying the Raleigh's equation for the given system using simple distillation setup
8. Determination of vaporization efficiency (E_v) and thermal efficiency (E_t) of the given system using steam distillation setup
9. Determination of the diffusivity of given liquid to air
10. Determination of the activity coefficients by vapor liquid equilibrium
11. Studying the theoretical and actual recovery of solvent using leaching
12. Studying the concept of surface evaporation

TOTAL : 45

REFERENCES / MANUALS / SOFTWARE:

1. McCabe W.L., Smith J.C. and Harriot P., "Unit Operations of Chemical Engineering", 7th Edition, McGraw Hill, New York, 2005.
2. Perry Robert, "Perry's Chemical Engineers Hand Book", 8th Edition, McGraw Hill, New York, 2007.
3. Treybal R.E., "Mass Transfer Operations", 3rd Edition, McGraw Hill, New York, 1981.

COURSE OUTCOMES

On completion of the course the students will be able to

CO1: evaluate the process/performance parameters for mass transfer operations(distillation column, leaching)

CO2: determine diffusivity and Stefan Boltzman constant using fundamental principles

CO3: calculate the individual and overall heat transfer coefficient of heat exchangers

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	1	3					3	111		1	3	2
CO2	2	1		3					3			1	1	1
CO3	2	2	1	3					3			1	3	2

1 – Slight, 2 – Moderate, 3 – Substantial

14FTL42 FOOD CHEMISTRY LABORATORY

0 0 3 1

LIST OF EXPERIMENTS / EXERCISES:

1. Extraction and estimation of starch
2. Determination of dextrose equivalent
3. Estimation of crude fibre
4. Estimation of non-enzymatic browning in foods
5. Extraction and estimation of chlorophyll
6. Extraction and estimation of carotenoids and lycopene
7. Isolation of protein from milk and egg
8. Determination of peroxide value of oil
9. Determination of TBA value of oil
10. Extraction and estimation of polyphenols
11. Extraction and estimation of flavonoids
12. Determination of titratable acidity, sugar acid ratio and pH of food products

TOTAL : 45

REFERENCES / MANUALS / SOFTWARE:

1. Sadasivam S. and Manickam A., "Biochemical Methods", 3rd Edition, New Age International, New Delhi, 1996.
2. Ranganna S., "Handbook of Analysis and Quality Control for Fruit and Vegetable Products", 2nd Edition, Tata McGraw Hill, New Delhi, 2008.

COURSE OUTCOMES

On completion of the course the students will be able to

CO1: estimate the biomolecules in food samples

CO2: interpret the changes during storage of oil

CO3: extract and estimate pigments and bioactive compounds

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2		3	2				3			1	3	2
CO2	2	2		3	2				3			1	3	2
CO3	2	2		3	2				3			1	3	2

1 – Slight, 2 – Moderate, 3 – Substantial

14FTL43 FOOD MICROBIOLOGY LABORATORY

0 0 3 1

LIST OF EXPERIMENTS / EXERCISES:

1. Enumeration of microorganisms in spoiled fruits/vegetables
2. Examination of microorganisms in egg/egg products
3. Examination of microorganisms in spoiled bakery and confectionery products
4. Microbial examination of blanched/pasteurized/sterilized foods
5. Microbial examination of refrigerated/frozen foods
6. Microbial examination of RTE/RTS/RTC foods
7. Assessing the load of coliform bacteria as an indicator microorganisms
8. Examination of microorganisms in food utensils and processing plants
9. Examination of microorganisms in meat/meat products
10. Isolation of Proteus sp. in powder foods
11. Isolation of E.coli in water
12. Construction of growth curve for microorganisms

TOTAL : 45

REFERENCES / MANUALS / SOFTWARE:

1. Yousef A.E. and Carlstrom C., "Food Microbiology: A Laboratory Manual", Wiley Interscience Publications, 2003.
2. McLandsborough L., "Food Microbiology Laboratory", CRC Press, 2004.

COURSE OUTCOMES

On completion of the course the students will be able to

CO1: examine the microorganisms present in fresh and spoiled food products

CO2: enumerate the microorganisms present in different food products

CO3: identify the microorganism present in different food materials

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1									1	1	3
CO2	3	3	3	1	2	2						1	1	3
CO3	3	3	2	1	2							1	1	3

1 – Slight, 2 – Moderate, 3 – Substantial

14FTT51 FOOD PROCESS ENGINEERING I

3 1 0 4

Pre-requisites: Heat Transfer in Food Processing Operations, Engineering Properties of Food Materials

UNIT – I **9**

Processing Operations: Post-harvest losses in field crops – Cleaning - Wet and Dry cleaning, Screen Cleaners, Air Screen Cleaners. Peeling - Flash steam, Knife, Abrasion, Caustic and Flame peeling. Grading and Sorting - Principles, types and equipments. Moisture content – free moisture, bound and unbound moisture. Equilibrium moisture content - determination methods, models, Importance and hysteresis effect. Water activity and its importance.

UNIT – II **9**

Drying: Theory and mechanism of drying - Drying characteristics of materials. Psychrometric chart – applications. Thin layer and deep bed drying. Methods of drying agricultural materials - batch and continuous drying. Drying equipment design and performance of various drying equipments.

UNIT– III **9**

Types of Dryers: Tunnel Dryer, Belt Dryer, Drum Dryer, Spray Dryer, Fluidized Bed Dryer, Spouted bed dryer, Pneumatic Dryer, Rotary Dryer, Vacuum Drying, Freeze Drying, Heat Pump drying, Di-electric drying and Micro wave drying.

UNIT – IV **9**

Preservation by Heating: Methods of applying heat to food - Blanching, Pasteurization, Sterilization. Thermal death time relationships (D, Z and F values). Process calculations: General method, Ball's formula method. Sterilization – methods and equipments. UHT sterilization.

UNIT – V **9**

Preservation by Cooling: Chilling - Equipments, Cold storage. Freezing - Thermodynamics of food freezing, Phase diagrams, Ice crystals formation, Properties of frozen foods. Freezing time calculations, Freezing equipments. Freeze concentration.

Lecture:45, Tutorial:15, TOTAL: 60

TEXT BOOKS:

1. Fellows P.J., "Food processing Technology: Principles and Practice", 3rd Edition, Wood Head Publishing Limited, New Delhi, 2009.
2. Sahay K.M. and Singh K. K., "Unit Operations of Agricultural Processing", 2nd Edition, Vikas Publishing House Pvt. Ltd., New Delhi, 2012.

REFERENCE BOOKS:

1. Earle R.L., "Unit Operations in Food Processing", Web Edition, Pergamon Press, U.K., 2004.
2. Paul Singh R. and Dennis R. Heldman, "Introduction to Food Process Engineering", 5th Edition, Academic Press, USA, 2014.
3. James G Brennan, "Food Processing Handbook", 2nd Edition, Wiley VCH, Weinheim, 2011.
4. http://www.nzifst.org.nz/unitoperations/
5. http://rpaulsingh.com/lectures/lecturelist.html

COURSE OUTCOMES

On completion of the course the students will be able to

CO1: choose the pre-processing operations and estimate the moisture content of food materials

CO2: illustrate the concept of drying process

CO3: demonstrate the dryers and apply for food processing

CO4: appraise the techniques of preservation by heating

CO5: appraise the techniques of preservation by cooling.

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3			2	1							2	2
CO2	3	3	2	1	2	1						1	3	2
CO3	3	3	2	1	2	1						1	3	2
CO4	3	3	2	1	2	1						1	3	3
CO5	3	3	2	1	2	1						1	3	3

1 – Slight, 2 – Moderate, 3 – Substantial

14FTT52 REFRIGERATION AND COLD CHAIN MANAGEMENT

3 1 0 4

UNIT – I **9**

Introduction: Introduction to refrigeration, unit of refrigeration capacity. Review of Second law of thermodynamics and interpretation. Production of low temperatures - principles and process. Refrigerants - classification and thermodynamic properties. Ozone depletion potential. Reversed Carnot cycle. Limitations of reversed Carnot systems.

UNIT – II **9**

Refrigeration Systems: Refrigeration cycle – simple vapour compression, vapour absorption cycle, p-h and T-s diagrams, COP. Energy ratios and Power consumption of a refrigerating machine. Standard rating cycle and effect of operating conditions. Air refrigeration system – reversed Brayton cycle.

UNIT – III **9**

Components of A Refrigeration System: Evaporator- dry and flooded type, liquid cooling evaporator. Condenser- water cooled, air cooled and evaporative condenser. Compressor - Reciprocating type compressors. Expansion valve - thermostatic expansion valve.

UNIT – IV **9**

Low Temperature Storage Systems: Pre-cooling systems, Cold storage- construction, insulation and operation. Design of cold storage unit. Calculation of refrigeration load in cold store. Prefabricated systems, walk-in-coolers. Frozen storage, Cryogenics – Linde and Claude system for liquefaction of air.

UNIT – V **9**

Cold Chain: Introduction, Components of cold chain. Refrigerated distribution and transport systems, Cold chain in retail, Traceability- Application of RFID in cold chain. Role of refrigeration in food production - candy manufacture, beverage processing, bakery products, meat products, poultry products, fishery products, fruit /vegetables and dairy products.

Lecture:45, Tutorial:15, TOTAL: 60

TEXT BOOKS:

1. Rajput R.K., "Refrigeration And Air-conditioning", 3rd Edition, S.K. Kataria and Sons (Publishers), Delhi, 2012.
2. Dellino C.V.J., "Cold and Chilled Storage Technology", 2nd Edition, Springer, US, 2011.

REFERENCE BOOKS:

1. Arora C.P., "Refrigeration and Air Conditioning", 2nd Edition, Tata McGraw-HillPublishing Company Ltd., Delhi, 2008.
2. Khurmi R.S. and Gupta J.K., "Textbook of Refrigeration and Air Conditioning", 5th Edition, S. Chand Publishers, New Delhi, 2006.
3. Narayanan K.V., "A Textbook of Chemical Engineering Thermodynamics", 2nd Edition, PHI Learning Pvt. Ltd., New Delhi, 2013.
4. http://nptel.ac.in/courses/112105128/1
5. ftp://doc.nit.ac.ir/mec/a.ramiar/Refrigeration/ASHRAE%202010%20-%20Refrigeration%20(SI).pdf

COURSE OUTCOMES

On completion of the course the students will be able to

CO1: interpret the basics of refrigeration with thermodynamic principles and Carnot cycle

CO2: make use of the concept of refrigeration cycles

CO3: identify various components of refrigeration system and its types

CO4: adapt low temperature storage systems for foods

CO5: apply cold chain and refrigeration for food products

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1		1							1		1
CO2	3	2	1	1	1							1	1	2
CO3	3	2	1		1							1	1	2
CO4	3	2	2		1	2	2					2	2	3
CO5	3	2	2			2	2					2	3	3

1 – Slight, 2 – Moderate, 3 – Substantial

14FTT53 DAIRY ENGINEERING

3 0 0 3

Pre-requisites: Principles of Microbiology, Heat Transfer in Food Processing Operations

UNIT – I **9**

Milk: Indian Dairy industry, Milk - Definition, types of market milk, Composition of milk, Factors affecting composition of milk, System of pricing of milk, Nutritive value of milk, Physico-chemical properties of milk: Color, Flavour, Specific Gravity, Boiling point, Freezing point, Refractive Index, Acidity and pH, Viscosity, Surface Tension.

UNIT – II **9**

Raw Milk Collection, Transportation and Reception: Raw milk collection system, Cooling and Transportation of milk, Platform tests of milk: Smell, Appearance, Temperature, Sediment, Acidity, Lactometer Reading, Fat, Solids-Not-Fat, Dye Reduction Test: MBRT test, Resazurin tests, Mastitis test, Filtration/Clarification of raw milk, Bactofugation of milk, Cooling and storage of raw milk, Bulk transportation technologies – carbondioxide impregnation.

UNIT – III **9**

Fluid Milk Processing: Milk Standardization, Cream separation, Homogenization, Milk Pasteurization: HTST and Batch Pasteurization, Milk Sterilization, Bottling/Packaging of milk, Liquid milk filling, Aseptic filling of milk. **Milk Products:** Manufacture of cheese, ice-cream, yoghurt, condensed milk, milk powder.

UNIT – IV **9**

Design of Equipments: Selection of Accessories - Pipes, Aseptic valves, Filters, Pumps, Blenders, Storage Tank. Design of dairy equipments – Heat exchangers, Homogenizer, Spray dryer, Bulk coolers, Evaporators, Butter churner, Separators. Calculation of Refrigeration Load. Process Automation.

UNIT – V **9**

Cleaning and Sanitization of Dairy Equipments: Basic principles, Cleaning and Sanitizing – agents and methods. Can washer - Rotary type and Straight through type. Selection and maintenance of can washers, CIP - Types of CIP system, Design of CIP system, CIP of dairy equipments.

TOTAL : 45

TEXT BOOKS:

1. Sukumar De, "Outlines of Dairy Technology", Royal Oxford University Press, Delhi, 2010.
2. Tufail Ahmed, "Dairy Plant Engineering and Management", Kitab Mahal, New Delhi, 2012.

REFERENCE BOOKS:

1. Jane Selia dos Reis Coimbra, Jose A. Teixeira, "Engineering Aspects of Milk and Dairy Products", CRC Press, New York, 2010.
2. Robinson R.K., "Modern Dairy Technology: Advances in Milk Products", Volume 2, Springer London Ltd., 2012.
3. Hui,Y.H,, "Dairy Science and Technology Handbook: Applications Science, Technology and Engineering", Volume 3, Wiley, New Delhi, 2014.
4. http://www.agrimoon.com/wp-content/uploads/Dairy-Engineering-1.0.pdf
5. http://nptel.ac.in/courses/103107088/module30/lecture1/lecture1.pdf

COURSE OUTCOMES

On completion of the course the students will be able to

CO1: identify the physico-chemical properties of milk

CO2: apply the acquired knowledge on raw milk collection, transportation and reception

CO3: infer the technical aspects of fluid milk processing and production of milk products

CO4: select and design appropriate dairy processing equipments

CO5: choose suitable cleaning operations in dairy industry

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1										1	1	1
CO2	3	1	2			1						2	1	3
CO3	3	1	3		2	1						2	2	3
CO4	3		3	1	1							2	2	
CO5	3		2		2	2						1	1	3

1 – Slight, 2 – Moderate, 3 – Substantial

14FTT54 PROCESS INSTRUMENTATION AND CONTROL

3 1 0 4

Pre-requisites: Mathematics II

UNIT – I **9**

Laplace Transform and First Order System: Laplace transformation, transform of standard functions, derivatives and integrals, inversion, theorems in Laplace transformation, application. Open-loop systems, first order systems and their transient response for standard input functions, Linearization and its application in process control.

UNIT – II **9**

Second Order System: Second order systems - Interacting system and non-interacting system, manometer, damped oscillator, dynamic response of second order system, Closed loop control systems, development of block diagram for feed-back control systems, servo and regulator problems.

UNIT – III **9**

Controllers and Dynamic Response: Controllers - Proportional, Proportional Integral, Proportional Derivative and Proportional Integral Derivative (PID). Dynamic behavior of feedback controlled processes. Effect of proportional, Integral, Derivative and composite control actions on the response of controlled processes. **Automation:** Control components of SCADA, working of SCADA, comparison of SCADA with DCS, comparison of PLC with RTU.

UNIT – IV **9**

Stability Analysis and Frequency Response: Stability for linear systems, Routh stability criterion and its limitations. Introduction to frequency response of closed-loop systems, control system design by frequency, Bode diagram, Bode stability criterion, phase and gain margin, Ziegler- Nichols optimum controller settings and its limitations.

UNIT – V **9**

Process Instruments: Principles of measurements - Static and dynamic response of instruments, Temperature measurements – Expansion Thermometer, filled system thermometers, thermocouple, thermistors, optical pyrometers, radiation pyrometers. Pressure measurements - Manometers, bourdon gauge and bellow gauge, pressure transducers, pressure measurement by vacuum. Level measurement – sight glass level indicator, float and tape liquid level gauge.

Lecture:45, Tutorial:15, TOTAL: 60

TEXT BOOKS:

1. Vyas R.P., "Process Control and Instrumentation", 6th Edition, Central Techno Publications, Nagpur, 2011.
2. Eckman D.P., "Industrial Instrumentation", Wiley Eastern Ltd, New Delhi, 2004.

REFERENCE BOOKS:

1. Stephanopoulos S.G., "Chemical Process Control: An introduction to Theory and Practice", Prentice Hall of India, New Delhi, 1997.
2. Coughanowr Donald R., "Process Systems Analysis and Control", 3rd Edition, McGraw Hill, New York, 2009.
3. Singh S.K., "Industrial Instrumentation and Control", 2nd Edition, Tata McGraw-Hill, New Delhi, 2006.
4. http://nptel.ac.in/courses/103103037/14
5. https://www.btechguru.com/courses--nptel--chemical-engineering--process-control-and-instrumentation-video-lecture--CME--CH1001037W.html

COURSE OUTCOMES

On completion of the course the students will be able to

CO1: make use of Laplace Transformation for first order systems

CO2: apply Laplace Transformation for Second order systems and determine its dynamic response

CO3: infer the concepts of feedback controller, its dynamic response and automation

CO4: examine the stability criteria for various controllers

CO5: select temperature and pressure measuring instruments

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2		1	2							1	1	2
CO2	3	2		1	2							1	2	2
CO3	3	2	1	2	3							2	3	3
CO4	3	2	1	2	3							1	2	2
CO5	3	2			1							2	2	3

1 – Slight, 2 – Moderate, 3 – Substantial

14FTT55 BAKING AND CONFECTIONERY TECHNOLOGY

3 0 0 3

Pre-requisites: Food Biochemistry, Food Chemistry

UNIT – I **9**

Science Behind Baking: Classification of bakery products. Bakery ingredients and their functions- flour, yeast, sugar, fat, egg, water, salt, coloring agents, flavoring agents, milk, milk powder, emulsifiers, leaveners, antioxidants and improvers.

UNIT – II **9**

Equipments: Handling of ingredients- dough mixers, dividers, rounder, sheeter, laminating equipments, fermentation enclosures and brew equipment, ovens and slicers. Rheology of dough- Farinograph, Amylograph, Alveograph, and Extensiograph.

UNIT – III **9**

Bread Making Process: Chemistry of Dough Development. Bread making methods- Straight dough/bulk fermentation, Sponge and dough, Activated dough development, Chorleywood bread process, No time process. Characteristics of good bread- Internal and external characters. Bread defects/faults and remedies. Spoilage of bread-Causes, detection and prevention.

UNIT – IV **9**

Bakery Products: Biscuit making – Ingredients and their functions. Types of biscuit dough – Developed dough, short dough's, semi-sweet, enzyme modified dough's and batters. Methods of biscuit manufacturing. Cake making- Ingredients and their function. Methods for different types of cakes manufacture. Miscellaneous bakery products production - Wafers, puff pastry, chemically leavened bakery products. Problems of baking.

UNIT – V **9**

Confectionery Products: Definition, importance of sugar confectionery, ingredients, Formulation and Processing methods. Industrial sugar confectionery manufacture - compositional effects, prevention of re-crystallization and stickiness. Manufacturing of Caramel, Toffee and Fudge. Aerated confectionery- Methods of aeration and Manufacturing processes. Confectionery product quality parameters, faults and corrective measures. Spoilage of confectionery products.

TOTAL : 45

TEXT BOOKS:

1. Samuel A. Matz, "Bakery Technology and Engineering", 3rd Edition, Chapman and Hall, London, 2005.
2. Cauvain, Stanley, P. and Young, Linda S., "Technology of Bread Making", 2nd Edition, Aspen Publication, Maryland, 1999.

REFERENCE BOOKS:

1. Servet Gulum Sumnu and Serpil Sahin, "Food Engineering Aspects of Baking Sweet Goods", CRC Press, USA, 2008.
2. Samuel A. Matz, "Equipment for Bakers", Pan Tech International Publication, 1988.
3. Ferenc A. Mohos, "Confectionery and Chocolate Engineering: Principles and Applications", Wiley Blackwell, UK, 2010.
4. http://eacharya.inflibnet.ac.in/index.php/content/index/594515d68007bef81d3c4dfb

COURSE OUTCOMES

On completion of the course the students will be able to

CO1: choose the ingredients for production of bakery products

CO2: select appropriate equipments for baking process

CO3: adapt bread making process and identify defects in bread

CO4: formulate various bakery products

CO5: develop confectionery products and identify cause for defects

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	1	1		1						1	2	2
CO2	3	2										1	3	1
CO3	3	3	1	1		1						1	3	1
CO4	3	3	1	1		1						1	3	1
CO5	3	3	1	1		1						1	3	1

1 – Slight, 2 – Moderate, 3 – Substantial

14FTL51 DAIRY ENGINEERING LABORATORY

0 0 3 1

LIST OF EXPERIMENTS /EXERCISES:

1. Studies on milk sampling, judging and grading of milk.
2. Determination of acidity, specific gravity and clot-on-boil test of milk.
3. Determination of fat, SNF and total solids content in milk.
4. Determination of MBRT and alcohol index test of milk.
5. Determination of pasteurization efficiency of milk.
6. Estimation of homogenization efficiency
7. Detection of adulterants in milk.
8. Estimation of surface tension of milk.
9. Determination of total milk protein content in milk.
10. Determination of churning efficiency of butter churner.
11. Determination of efficiency of spray dryer
12. Determination of separation efficiency of cream separator.

TOTAL : 45

REFERENCES / MANUALS / SOFTWARE:

1. Sukumar De, "Outlines of Dairy Technology", Royal Oxford University Press, New Delhi, 2010.
2. Tufail Ahmed, "Dairy Plant Engineering and Management", Kitab Mahal, New Delhi, 2012.
3. Manual of Methods of Analysis of Foods (Milk And Milk Products), Directorate General of Health Services, Ministry of Health and Family Welfare, 2005.

COURSE OUTCOMES

On completion of the course the students will be able to

CO1: analyze the physico-chemical properties of milk

CO2: apply platform tests for assessing milk quality

CO3: estimate the efficiency of dairy processing equipments

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1				1			3			1	2	2
CO2	3	2				1			3			1	2	2
CO3	3	2				1			3			1	2	2

1 – Slight, 2 – Moderate, 3 – Substantial

14FTL52 BAKING AND CONFECTIONERY LABORATORY

0 0 3 1

LIST OF EXPERIMENTS / EXERCISES:

1. Estimation of wet and dry gluten content of wheat flour
2. Estimation of water absorption power of wheat flour
3. Determination of sedimentation value of wheat flour
4. Determination of dough rising capacity of wet and dry yeast
5. Estimation of quality parameters of bakery ingredients
6. Experiment on leavening power of baking powder, sodium-bicarbonate and ammonium-bicarbonate
7. Preparation and analysis of bread
8. Preparation and analysis of biscuits and cookies
9. Preparation and analysis of cake
10. Preparation and analysis of candy
11. Preparation and analysis of toffee
12. Preparation and analysis of cocoa based confectionery

TOTAL : 45

REFERENCES / MANUALS / SOFTWARE:

1. Duncan Manley,"Biscuit, Cracker and Cookie Recipes for the Food Industry", Woodhead Publishing, England, 2001.
2. Yogambal Ashokkumar, "Text book of Bakery and Confectionery", 2nd Edition, PHI Learning Pvt. Ltd., New Delhi, 2012.
3. Samuel A. Matz, "Bakery Technology and Engineering", 3rd Edition, Chapman and Hall, London, 2005.

COURSE OUTCOMES

On completion of the course the students will be able to

CO1: analyze the quality of ingredients used in bakery products

CO2: develop different bakery products

CO3: formulate various confectioneries

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2		3	2				3			1	3	2
CO2	2	2		3	2				3			1	3	2
CO3	2	2		3	2				3			1	3	2

1 – Slight, 2 – Moderate, 3 – Substantial

14EGL41 COMMUNICATION SKILLS LABORATORY

(Common to all Engineering and Technology branches)

0 0 3 1

LIST OF EXPERIMENTS:

1. Listening Skills: Listening activity using software package in the communication laboratory - Listening to native speakers - Developing oral communication by imitating the model dialogues. Listening for specific information – Listening to improve pronunciation – Listening and typing – Filling the blanks–TV programmes and News.

Audio Visual Lab: Activity based learning

2. Activity based Reading Skills: Reading for getting information and understanding; scanning, skimming and identifying topic sentences – Reading for gaining knowledge-Group activity.

3. Activity based Writing Skills: Preparing a draft – Word editing features, editing and proof reading; Writing a short essay using the draft prepared - Group activity.

4. Speaking Skills: Verbal and Non-Verbal Communication; Introducing oneself -Describing a place, Expressing views and opinions; Giving a presentation on a Topic - eye contact, speaking audibly, clearly and with confidence; Group discussion.Conversations – Face-to-Face conversation – Simulated Telephonic Conversation.

Career Lab

5. Interview Skills: Introducing oneself – Answering other FAQ's. Presentation Skills: Elements and structure of effective presentation – Presentation Tools – Voice modulation – Body language –Video samples. Group Discussion: Structure of Group Discussion – Strategies in group discussion - Team work – Video Samples. Soft Skills: Fundamentals of Soft Skills – Work Place Culture and Inter-Personal Relationships.

TOTAL : 45

REFERENCES / MANUALS / SOFTWARE:

1. Orell Digital Language Lab Software

COURSE OUTCOMES

On completion of the course the students will be able to

CO1: communicate efficiently in real life and career related situations

CO2: demonstrate good Presentation skills and team skills

CO3: familiarize in using modern communication software packages to enhance their soft skills

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1				2					2	3		1		
CO2				2					2	3		1		
CO3				2					2	3		1		

1 – Slight, 2 – Moderate, 3 – Substantial

14GET61 ECONOMICS AND MANAGEMENT FOR ENGINEERS

(Common to all Engineering and Technology branches)

3 0 0 3

UNIT – I **9**

Economics – Basics Concepts and Principles – Demand and Supply – Law of demand and Supply – Determinants – Market Equilibrium – Circular Flow of Economic activities and Income.

UNIT – II **9**

National Income and its measurement techniques. Inflation - Causes of Inflation – Controlling Inflation – Business Cycle. Forms of business – Management Functions: Planning, Organizing, Staffing, Leading and Controlling - Managerial Skills - Levels of Management - Roles of manager.

UNIT – III **9**

Marketing - Core Concepts of Marketing - Four P's of Marketing - New product development - Product Life Cycle - Pricing Strategies and Decisions.

UNIT – IV **9**

Operations Management - Resources - Types of Production system - Site selection, Plant Layout, Steps in Production Planning and Control - Inventory - EOQ Determination.

UNIT – V **9**

Accounting Principles – Financial Statements and its uses – Depreciation: Straight Line and Diminishing Balance Method – Break Even Analysis – Capital Budgeting: Meaning – Types of decisions – Methods (Theory).

TOTAL : 45

TEXT BOOK:

1. "Economics and Management for Engineers", Compiled by Department of Management Studies, Kongu Engineering College, McGraw-Hill Education, India, 2013.

REFERENCE BOOKS:

1. Geetika, Piyali Ghosh and Purba Roy Choudhury, "Managerial Economics", 1st Edition, Tata McGraw-Hill, New Delhi, 2008.
2. Jeff Madura, "Fundamentals of Business", Cengage Learning Inc., India, 2007.
3. Stanley L. Brue and Campbell R. Mcconnell, "Essentials of Economics", Tata McGraw-Hill, New Delhi, 2007.
4. Jain S.P., Narang K.L. and Simi Agrawal, "Accounting for Management", 1st Edition, Tata McGraw-Hill, New Delhi, 2009.

COURSE OUTCOMES

On completion of the course the students will be able to

CO1: estimate market equilibrium and interpret national income calculation and inflation issues

CO2: categorize the forms of business and analyse the functions of management

CO3: appraise marketing management decisions

CO4: apply appropriate operation management concept in business situations

CO5: interpret financial and accounting statements

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	1	2			3		2	2	2	3	2		2
CO2		1	2			2	2	2	2	2	3	2		2
CO3	1	2	1			2		2	2	2	3	2	1	2
CO4	1	2	1			2		2	2	2	3	2		2
CO5	2	2				2		2	2	2	3	2		2

1 – Slight, 2 – Moderate, 3 – Substantial

14FTT61 FRUITS AND VEGETABLES PROCESSING TECHNOLOGY

3 0 0 3

Pre-Requisites: Food Chemistry

UNIT – I **9**

Physiological Development: Classification of fruits and vegetables. General structure, composition and nutritional aspects. Physiological Development - maturation, ripening, senescence. Harvesting – methods and tools. Deterioration factors - physical, chemical and biological. Changes during deterioration. Methods of reducing deterioration.

UNIT – II **9**

Preservation and Storage Methods: Pre-cooling and evaporative cooling. Preparatory operations and related equipments - washing, cleaning, grading, peeling and blanching methods. Storage of fruit and vegetables - under ambient conditions, low temperature storage. Freezing –Air blast, Fluidized bed and immersion freezer. Controlled and modified atmosphere storage - concepts and methods. Irradiation. Waxing.

UNIT– III **9**

Processing of Fruits and Vegetables: Juice and pulp extraction equipment –Juice, Squash, cordial, concentrated juice, nectar, RTS. Clarification and concentration by membranes. Production of IMF - jam, jellies and marmalades - Defects in jam and jelly. Candies and preserves. Fermented vegetable products - Sauerkraut and Pickle. Fermented fruit beverages- Wine and vinegar production.

UNIT – IV **9**

Specialty Products: Fresh cut fruit and vegetables – processing, quality parameters, physiological and biochemical changes. Production of Fruit powders and Fruit bar. Osmotic dehydration - Tutti fruiti. Edible coating of fruits – Processing, quality parameters, physiological and biochemical changes.

UNIT – V **9**

Canning and Waste Utilization of Fruits and Vegetables: Types of cans and materials, preparation of fruits and vegetables for canning, Filling, closing and sterilization operation. Precautions in canning operations. Spoilage of canned products. Utilization of waste from fruit and vegetable processing – pectin, oil and enzymes.

TOTAL : 45

TEXT BOOKS:

1. Hui Y.H., "Handbook of fruits and fruit processing",1st Edition, Blackwell Publishing, USA, 2006.
2. Desrosier N.W., "The Technology of Food Preservation", 4th Edition, CBS Publisher and Distributions, New Delhi, 2006.

REFERENCE BOOKS:

1. Wim Jongen, "Fruit and Vegetable Processing- Improving Quality", Wood Head Publishing Ltd, England, 2002.
2. Thompson A.K., "Fruits and Vegetable - Harvesting, Handling and Storage", Blackwell Publishing, USA, 2003.
3. Lal G., Siddappa G. and Tondon G.L., "Preservation of Fruits and Vegetables", Indian Council of Agricultural Research, New Delhi, 1986.
4. http://nptel.ac.in/courses/103107088/module20/lecture1/lecture1.pdf
5. http://www.angrau.ac.in/media/10841/fdst215.pdf

COURSE OUTCOMES

On completion of the course the students will be able to

- CO1: interpret physiological development of fruit and deterioration factors
- CO2: identify different preprocessing methods, preservation and storage
- CO3: select suitable processing methods for fruits and vegetables
- CO4: elaborate the techniques involved in processing of specialty products
- CO5: perform canning operations and utilize fruits /vegetable waste

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3		2	1								1	1	1
CO2	3	2	3	1		2						1	3	3
CO3	3	3	2	2		2						1	3	2
CO4	3	3	2	2		2						1	3	2
CO5	3	2	2	1		2						1	3	2

1 – Slight, 2 – Moderate, 3 – Substantial

14FTT62 FOOD PROCESS ENGINEERING II

3 1 0 4

Pre-requisites: Heat Transfer in Food Processing Operations, Engineering Properties of Food Materials

UNIT – I **9**

Size reduction: Fibrous foods, Dry foods and Liquid foods – Energy Used in Grinding. New Surface Formed by Grinding. Grinding and Cutting equipments - Crushers, Hammer mills, Fixed head mills, Ball mills, Plate mills and Roller mills. Cutters - Slicers, Dicers, Shredder and Pulper. Size reduction in liquids

UNIT – II **9**

Mechanical Separation: Sedimentation in liquids - Gravitational sedimentation – Floatation - Sedimentation of particles in gas. Centrifugal separation – Velocity of particles – Radius of neutral zone – Equipments. Filtration – Constant rate and Constant pressure filtration - Equipments, Sieving effectiveness and Applications.

UNIT – III **9**

Crystallization: Crystallization Equilibrium – Nucleation – Meta stable region – Seed Crystals. Heat of Crystallization - Rate of crystal growth. Stage equilibrium crystallization. Equipments - Types – Applications.

UNIT – IV **9**

Mixing: Characteristics of mixtures. Measurement of mixing - sample size, sample composition. Particle mixing and Liquid Mixing - mixing index. Mixing of different quantities. Rate of Mixing and Energy Input in Mixing. Mixing equipments - Liquid Mixers, Powder and Particle Mixers, Dough and Paste Mixers.

UNIT – V **9**

Extrusion: Theory - Rheological properties and Operating Characteristics. Single and Twin screw extruders - Ancillary Equipments. Applications and Effects on Foods. **Material handling**: Types of handling and conveying system for food products - Belt conveyor, screw conveyor, bucket elevator and pneumatic conveyor.

Lecture:45, Tutorial:15, TOTAL: 60

TEXT BOOKS:

1. Fellows P.J., "Food processing Technology: Principles and Practice", 3rd Edition, Woodhead Publishing Ltd., New Delhi, 2009.
2. Earle R.L., "Unit Operations in Food Processing", Web Edition, Pergamon Press, UK, 2004.

REFERENCE BOOKS:

1. James G Brennan, "Food Processing Handbook", 2nd Edition, Wiley VCH, Weinheim, 2011.
2. Paul Singh R and Dennis R. Heldman, "Introduction to Food Process Engineering", 5th Edition, Academic Press, USA, 2014.
3. Sahay K.M. and Singh K.K., "Unit Operations of Agricultural Processing", 2nd Edition, Vikas Publishing House Pvt. Ltd., New Delhi, 2012.
4. http://www.nzifst.org.nz/unitoperations/
5. http://rpaulsingh.com/lectures/lecturelist.html

COURSE OUTCOMES

On completion of the course the students will be able to

CO1: apply the concept of size reduction

CO2: choose mechanical separation techniques for food processing

CO3: elaborate the crystallization process and its equipments

CO4: analyze the mixing process and demonstrate the mixing equipments

CO5: outline the extrusion process and material handling systems.

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3		1	2							1	3	1
CO2	3	3	1	1	2							1	3	1
CO3	3	3	2	1	2							1	3	3
CO4	3	3	2	1	2							1	3	3
CO5	3	3	2	1	2							1	3	3

1 – Slight, 2 – Moderate, 3 – Substantial

14FTT63 FOOD PACKAGING TECHNOLOGY

3 0 0 3

UNIT – I **9**

Basics in Food Packaging: Definitions and basic functions of a food package. Food package design and development. Packaged product quality and shelf life. Current status in food packaging in India. Package standards and regulation. Labelling, Bar coding.

UNIT – II **9**

Metal cans: Raw materials for can making – steel, aluminium. Can making processes - three piece welded cans, DWI, DRD cans – end making processes – coating. Film laminates and inks, metal packages – corrosion and sulphur staining. Application of metal containers in food industries. **Glass containers:** Definition and composition. Glass container manufacture – melting, forming, surface treatments. Closure selection. Glass bottle design and specification. Application of glass containers in food industries

UNIT– III **9**

Plastic Packaging: Types of plastics used in packaging – PE, PP, PET, PVC, EVOH, PVA. Secondary conversion techniques – film, extrusion and thermal lamination. Printing of plastic films and rigid plastic containers. Food contact and barrier properties. Sealability and closure. Application of plastics for food packaging.

UNIT – IV **9**

Paper and Paperboard Packaging: Properties of paper and paperboard. Paper and paperboard manufacture - SBB, SUB, FBB, WLC. Package types – paper, pouches, sachets, cartons, boxes, tubes, tubs, containers, drums, tapes, cushion, cap liners and diaphragm. Application of paper and paperboards for food packaging.

UNIT – V **9**

Trends in Food Packaging: Active packaging, modified atmosphere packaging - vacuum and Inert gas Packaging, Biodegradable and edible packaging, Aseptic packaging, Shrink wrapping, Nano packaging, Antimicrobial packaging, self-heating and cooling cans.

TOTAL : 45

TEXT BOOKS:

1. Richard Coles and Mark J. Kirwan, "Food and Beverage Packaging Technology", 2nd Edition, Blackwell Publishing Asia Pty Ltd, CRC press, USA, 2011.
2. Robertson Gordon L., "Food Packaging: Principles and Practice", 3rd Edition, Marcel Dekker Inc, USA, 2012.

REFERENCE BOOKS:

1. Han Jung H., "Innovations in Food Packaging", 2nd Edition, Academic Press, USA 2013.
2. Dong Sun Lee, Kit L. Yam and Luciano Piergiovanni, "Food Packaging Science and Technology", CRC press, USA, 2008.
3. Otto G. Piringer and A.L. Baner, "Plastic Packaging Materials for Food", 1st Edition, Wiley-VCH, Germany, 2008.
4. http://www.sustainableplastics.net/about
5. https://www.micvac.com/retail-solutions/packaging/

COURSE OUTCOMES

On completion of the course the students will be able to

CO1: infer basic concepts in food packaging

CO2: choose appropriate metal and glass containers for food packaging

CO3: classify plastics and elaborate their properties

CO4: make use of paper and paperboards for various food applications

CO5: adapt recent trends in food packaging

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1									1	1	1
CO2	3	3	2	1								1	3	2
CO3	3	3	2	1								1	3	2
CO4	3	3	2	1								1	3	2
CO5	3	3	2	1								2	3	2

1 – Slight, 2 – Moderate, 3 – Substantial

14FTL61 FOOD PROCESS ENGINEERING LABORATORY

0 0 3 1

LIST OF EXPERIMENTS /EXERCISES:

1. Determination of size, roundness, sphericity and 1000 grain weight of food grains
2. Determination of bulk density, true density and porosity
3. Determination of angle of repose for grain sample
4. Determination of co efficient of friction for grain sample
5. Experiment on drying characteristics of food material using tray dryer
6. Determination of fineness modulus for ground material using ball mill
7. Determination of separation efficiency of inclined belt separator
8. Determination of conveying efficiency and power requirement of screw conveyor
9. Experiment on analysis of particle size distribution using hammer mill
10. Experiment on paddy dehusker to determine the shelling efficiency
11. Experiment on terminal velocity apparatus
12. Experiment on drying characteristics of food material using fluidized bed dryer

TOTAL: 45

REFERENCES / MANUALS / SOFTWARE:

1. Sharma Shri K., Mulvaney Steven J. and Rizvi Syed S. H., "Food Process Engineering: Theory and Laboratory Experiments", 1st Edition, Wiley Inter-science, New Jersey, 1999.
2. Rao M., Syed. S.H. Rizvi and Ashim K. Datta, "Engineering Properties of Foods", 4th Edition, CRC Press, Florida, 2005.

COURSE OUTCOMES

On completion of the course the students will be able to

CO1: estimate engineering properties of agricultural produce.

CO2: evaluate the performance of agro processing equipments.

CO3: evaluate the effectiveness of size reduction equipments.

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	3					3			1	3	2
CO2	3	2	1	3					3			1	3	2
CO3	3	2	1	3					3			1	3	2

1 – Slight, 2 – Moderate, 3 – Substantial

14FTL62 FRUITS, VEGETABLES PROCESSING AND FOOD PACKAGING LABORATORY

0 0 3 1

LIST OF EXPERIMENTS /EXERCISES:

1. Experiment on juice extractor and pulper
2. Experiment on osmotic dehydration of fruits and vegetables
3. Preparation and analysis of jam/jelly
4. Preparation and analysis of squash
5. Preparation and analysis of sauce
6. Preparation and analysis of fruit bar
7. Experiment on canning of fruits and vegetables
8. Estimation of bursting strength of packaging materials
9. Determination of tear / puncture resistance of packaging materials
10. Determination of tensile strength of different packaging materials
11. Estimation of water absorption capacity of paper based packaging materials
12. Estimation of water vapour permeability of different packaging materials
13. Determination of overall migration of different plastic packaging materials
14. Determination of shelf life of modified atmospheric packed food

TOTAL: 45

REFERENCES / MANUALS / SOFTWARE:

1. Ranganna S., "Handbook of Analysis and Quality Control for Fruit and Vegetable", Tata McGraw-Hill, 2001.
2. Gordon L. Robertson, "Food Packaging and Shelf Life: A Practical Guide", CRC Press, USA, 2009.

COURSE OUTCOMES

On completion of the course the students will be able to

CO1: Demonstrate knowledge on extraction, pulping, dehydration and prepare fruit/vegetable based products

CO2: Evaluate mechanical properties of packaging materials

CO3: Estimate water barrier properties of packaging materials

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2		3	2				3			1	3	2
CO2	3	2		3	2				3			1	3	2
CO3	3	2		3	2				3			1	3	2

1 – Slight, 2 – Moderate, 3 – Substantial

14GET71 TOTAL QUALITY MANAGEMENT

(Common to all Engineering and Technology branches)

3 0 0 3

UNIT – I **9**

Quality (Basic concepts and principles) : Definition of Quality, Dimensions of Quality, Quality Planning, Quality costs, Basic concepts of Total Quality Management, Historical Review. Principles of TQM, Leadership – Concepts, Quality Council, Quality Statements, Strategic Planning, Deming Philosophy, Barriers to TQM Implementation.

UNIT – II **9**

TQM Principles and strategies : Customer satisfaction – Customer Perception of Quality, Customer Complaints, Customer Retention, Employee Involvement – Motivation, Empowerment, Teams, Recognition and Reward, Performance Appraisal, Benefits. Continuous Process Improvement – Juran Trilogy, PDSA Cycle, 5S, Kaizen, Supplier Partnership – Partnering, sourcing, Supplier Selection, Supplier Rating, Relationship Development

UNIT – III **9**

TQM Tools (Process Control): The seven tools of quality, Statistical Fundamentals – Measures of central Tendency and Dispersion, Population and Sample, Normal Curve, Control Charts for variables and attributes, Process capability, Concept of six sigma, New seven Management tools.

UNIT – IV **9**

TQM Tools: Benchmarking – Reasons to Benchmark, Benchmarking Process, Quality Function Deployment (QFD) – House of Quality, QFD Process, Benefits, Taguchi Quality Loss Function, Total Productive Maintenance (TPM) – Concept, Improvement Needs, FMEA – Stages of FMEA, Poka Yoke.

UNIT – V **9**

Quality Systems -Need for ISO 9000 and Other Quality Systems, ISO 9000:2008 Quality System – Elements, Implementation of Quality System, Documentation, Quality Auditing, Introduction to TS 16949, QS 9000, ISO 14000, ISO 18000, ISO 20000, ISO 22000.

TOTAL : 45

TEXT BOOKS:

1. Besterfield, Dale H. et al., "Total Quality Management", 3rd Edition (Revised), Pearson Education, 2011.
2. Subburaj Ramasamy, "Total Quality Management", Tata McGraw Hill, New Delhi, 2008.

REFERENCE BOOKS:

1. Feigenbaum A.V., "Total Quality Management", 4th Edition, Tata McGraw Hill, New Delhi, 2004.
2. Suganthi L. and Samuel A. Anand, "Total Quality Management", PHI Learning, New Delhi, 2011.
3. Evans James R. and Lindsay William M., "The Management and Control of Quality", 7th Edition, South-Western (Thomson Learning), 2011.

COURSE OUTCOMES

On completion of the course the students will be able to

CO1: understand the meaning of quality and its importance

CO2: know the principles of total quality management and peculiarities of their implementation

CO3: develop in-depth knowledge on various tools and techniques of quality management

CO4: learn the applications of quality tools and techniques in both manufacturing and service industry

CO5: develop analytical skills for investigating and analyzing quality management issues in the industry and suggest implement able solutions to those

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1						2	2	3	2	2	2	3		3
CO2						3	2	3	3	3	2	3		3
CO3	3	2	2	2	2	2		1	2	2	3	2		3
CO4	2	2	2	2	2	2		1	2	2	3	2		3
CO5						3	3	2	3	2	2	2		3

1 – Slight, 2 – Moderate, 3 – Substantial

14FTT71 FOOD QUALITY ASSURANCE AND CONTROL

3 0 0 3

UNIT – I **9**

Food quality and standards: Quality of Foods, Quality Standards - mandatory and optional standards, Food Safety Systems - ISO 9000, ISO 14000, ISO 22000, Mechanism of developing and fixing food standards, Good Manufacturing Practice, HACCP, Standards of Weights and Measures.

UNIT – II **9**

Quality Assurance in Food industry: Objectives, importance and functions of quality control, Concept of Quality Assurance and Quality Control, Quality Control procedures, Quality Assurance procedures, International organizations: ISO, CAC, WTO, USFDA, Codex, EIC. National organizations: BIS, CCFS, Agmark, MMPO and APEDA, Good Laboratory Practices.

UNIT – III **9**

Regulations for Food Business Operator: Food adulteration and food safety, Food laws - Food Safety and Standards Act (FSSAI), Prevention of Food Adulteration Act, Packaged Commodities Rules, Functions of Food Business Operator, QA Audit, IPR and Patents, Issues affecting consumers and industry - Genetically Modified Foods, Fortification, Pesticide Residues, Organic Foods, Food Additives.

UNIT – IV **9**

Sampling and Statistical Quality Control: Sampling- concept, methods and importance. Statistical Process and Quality Control - concept, importance and tools. Control charts: importance, types, design process, Control limits and errors, Process Capability.

UNIT – V **9**

Sensory evaluation: Introduction, sensory panel - screening and selection methods, training of sensory panel, Physiological factors affecting sensory panel, Hedonic rating of food. Sensory Evaluation tests - Difference - Paired Comparison, Triangle, Duo-trio Test, Quantitative - Grading, scaling and ranking.

TOTAL : 45

TEXT BOOKS:

1. Inteaz Alli, "Food Quality Assurance: Principles and Practices", 2nd Edition, Taylor and Francis, UK, 2014.
2. Andres Vasconcellos J, "Quality Assurance for the Food Industry: A Practical Approach", CRC Press, New York, 2004.

REFERENCE BOOKS:

1. David Kilcast, "Sensory Analysis for Food and Beverage Quality Control: A Practial Guide", Woodhead Publishing Ltd, Cambridge, 2010.
2. Singh, S. P., "Food Safety, Quality Assurance, and Global Trade: Concerns and Strategies", International Book Distributing Company, Lucknow, 2009.
3. "Manuals of Food Quality Control: Quality Assurance in Food Control Chemical Laboratory", FAO, Itlay, 1993.
4. http://www.thanut-swu.com/images/BOT331/food%20quality%20assurance.pdf
5. http://www.fao.org/3/a-t0451e.pdf

COURSE OUTCOMES

On completion of the course the students will be able to

CO1: identify suitable food quality standards

CO2: apply principles of quality assurance and quality management systems in food industries

CO3: appraise various regulations for food business operator

CO4: adapt and interpret sampling and statistical quality control techniques

CO5: take part in sensory analysis of foods

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1	2			2		1				1	1	3
CO2	3	1	2			3		1				1	1	3
CO3	3	1	2			3		1				1	2	3
CO4	3	2	2	2	2	1						1	2	3
CO5	3	2	2	2	2	1						1	3	3

1 – Slight, 2 – Moderate, 3 – Substantial

14FTT72 MEAT, FISH AND POULTRY PROCESS TECHNOLOGY

3 0 0 3

Pre-requisites: Food Chemistry, Food Microbiology

UNIT – I **9**

Meat Processing: Types of Meat and its sources, composition, structure of meat. Ante mortem handling, slaughtering of animals, inspection and grading of meat. Introduction to Halal. Post-mortem changes of meat. Meat -Tenderization, Aging. Meat quality evaluation. Wholesale and retail cuts. Preservation of meat- curing, smoking, drying, freezing. Processed meat products- Hamburgers, sausages and meat balls.

UNIT – II **9**

Fish Processing: Types of fish, composition and nutritive value of fish. Harvesting of fish. Spoilage factors of fish. Post-mortem changes in fish. Preservation- Freezing and Individual quick freezing, Canning and smoking operations, Salting and drying of fish, pickling.

UNIT – III **9**

Poultry Processing: Types and characteristics of poultry products. Unit operation in poultry processing. Pre-slaughter factors affecting poultry meat quality. Types of poultry cuts. Factors affecting the shelf-life of poultry meat. Sensory quality of poultry meat- color, texture and flavor. Preservation techniques: chemical treatments, heating, drying and irradiation.

UNIT – IV **9**

Egg Processing: Structure, composition, nutritive value of egg. Functional properties of eggs, Factors affecting egg quality and measures of egg quality. Preservation of egg by different methods. Egg powder processing-spray drying, Foam mat drying

UNIT – V **9**

Hygiene and Sanitation: Handling and maintenance of tools and core equipment. Meat plant layout. Meat processing hygiene. Cleaning and sanitation in meat plants. Food safety measures –GMP and GHP.

TOTAL : 45

TEXT BOOKS:

1. Panada P.C., "Text book on Egg and Poultry Technology", 1st Edition, Vikas Publishing House Pvt. Ltd., New Delhi, 1996.
2. Gunter Heinz and Peter Hautzinger, "Meat Processing Technology", 1st Edition, Rap Publication, Monteplier, 2007.

REFERENCE BOOKS:

1. Ionnis S. Boziaris, "Seafood Handbook: Technology, Quality and Safety", Wiley Blackwell, UK, 2014.
2. Mead G.C., "Poultry Meat Processing and Quality", 1st Edition, CRC Press, London, 2004.
3. Alan R. Sams, "Poultry Meat Processing", 1st Edition, CRC Press, London, 2001.
4. http://msue.anr.msu.edu/program/smprv/proper_amount_of_nitrite
5. https://meathaccp.wisc.edu/

COURSE OUTCOMES

On completion of the course the students will be able to

CO1: elaborate handling and processing of meat

CO2: recommend fish processing and preservation techniques

CO3: categorize poultry products and apply suitable processing techniques

CO4: select appropriate techniques for egg processing

CO5: adapt hygiene and sanitation procedures in meat industry

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	1		2							1	3	2
CO2	3	3	1		2							1	3	2
CO3	3	3	1		2							1	3	2
CO4	3	3	1		2							1	3	2
CO5	3	3	1		2							1	2	3

1 – Slight, 2 – Moderate, 3 – Substantial

14FTL71 FOOD ANALYSIS AND QUALITY CONTROL LABORATORY

0 0 3 1

LIST OF EXPERIMENTS:

1. Estimation of saccharin present in the given sample
2. Determination of pectin present in the given sample
3. Detection of adulterants in food materials
4. Determination of viscosity of food samples
5. Estimation of iodine and purity of salt samples
6. Estimation of sucrose present in table sugar
7. Detection and estimation of additives in food materials
8. Determination of lactose in milk samples
9. Estimation of sulphurdioxide in foods
10. Determination of antioxidant activity
11. Extraction and determination of curcumin from turmeric
12. Familiarization on working of analytical instruments like HPLC, UV visible spectrophotometer, flame photometer

TOTAL: 45

REFERENCES / MANUALS / SOFTWARE:

1. Sadasivam S., and Manickam A., "Biochemical Methods", 3rd Edition, New Age International, Delhi, 1996.
2. Suzanne Nielsen S., "Food Analysis Laboratory Manual", Springer, New York, 2010.
3. "Manual of Methods of Analysis of Foods – Food Additives", FSSAI, New Delhi, 2012.

COURSE OUTCOMES

On completion of the course the students will be able to

CO1: analyze the components present in food materials

CO2: detect the adulterants in food products

CO3: estimate the additives present in food products

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	3		3	1	1			3			1	1	3
CO2	2	3		3	1	2			3			1	2	3
CO3	2	3		3	1	2			3			1	2	3

1 – Slight, 2 – Moderate, 3 – Substantial

14FTL72 FOOD PROCESS EQUIPMENT DESIGN AND DRAWING LABORATORY

0 0 3 1

LIST OF EXPERIMENTS:

1. Studies of symbols and materials used for design and drawing
2. Design and drawing of pipes and fittings
3. Design and drawing of storage tanks
4. Design and drawing of agitated vessel
5. Design and drawing of double pipe heat exchangers
6. Design and drawing of shell and tube heat exchangers
7. Design and drawing of plate heat exchanger
8. Design and drawing of single effect evaporator
9. Design and drawing of cyclone separators
10. Design and drawing of rotary drier
11. Design and drawing of spray drier
12. Design and drawing of vessel supports

TOTAL: 45

REFERENCES / MANUALS / SOFTWARE:

1. Joshi M.V. and Mahajan V.V., "Process Equipment Design", 4th Edition, MacMillan India, New Delhi, 2009.
2. Dawande S.D., "Process Equipment Design Volume 1 and 2", 5th Edition, Denett and Company, India, 2015.
3. Perry R.H. and Green D.W., "Chemical Engineers Handbook", 8th Edition, McGraw-Hill, New York, 2007.

COURSE OUTCOMES

On completion of the course the students will be able to

CO1: adopt symbols in plant layout and design

CO2: design and draw pipe accessories and vessels.

CO3: design and draw heat transfer equipments and separators.

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1			1						3					1
CO2	3	3	3	3	1				3			1	2	2
CO3	3	3	3	3	1				3			1	3	3

1 – Slight, 2 – Moderate, 3 – Substantial

14FTI71 INDUSTRIAL TRAINING

0 0 0 1

COURSE OUTCOMES

On completion of the course the students will be able to

CO1: take part in real time practices in food industries

CO2: apply the gained technical knowledge and skills to solve issues in food industry

CO3: work as an individual or lead a team independently in exhibiting managerial skills

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	3	3	3	2	2	3	3	3	3	3	3
CO2	3	3	3	3	3	3	2	2	3	3	3	3	3	3
CO3							1	3	3	3	3	3	1	2

1 – Slight, 2 – Moderate, 3 – Substantial

14GET81 PROFESSIONAL ETHICS AND HUMAN VALUES

(Common to all Engineering and Technology branches)

3 0 0 3

UNIT – I **9**

Understanding: Morals – Values-Ethics– Honesty – Integrity – Work Ethic – Service Learning – Civic Virtue – caring – Sharing – Courage – Valuing Time – Co-operation – Commitment – Empathy –Self-Confidence – Character – Spirituality- Senses of 'Engineering Ethics' - variety of moral issues - types of inquiry.

UNIT – II **9**

Moral dilemmas – moral autonomy – Kohlberg's theory – Gilligan's theory – consensus and controversy – Models of Professional Roles – theories about right action – Self-interest – customs and religion- uses of ethical theories. Meaning of Engineering experimentation - engineers as responsible experimenters.

UNIT – III **9**

Codes of ethics for engineers - a balanced outlook on law - the challenger case study. Safety and risk - assessment of safety and risk - risk benefit analysis and reducing risk, Bhobal Gas Tragedy and Chernobyl case studies.

UNIT – IV **9**

Collegiality and loyalty – respect for authority – collective bargaining – confidentiality – conflicts of interest – occupational crime – professional rights – employee rights – discrimination – Intellectual Property Rights (IPR) – Multinational corporations.

UNIT – V **9**

Environmental ethics - Computer ethics – weapons development-engineers as managers-consulting engineers-engineers as expert witnesses and advisors -moral leadership-sample code of Ethics like ASME, ASCE, IEEE, Institution of Engineers (India), Indian Institute of Materials Management, Institution of Electronics and Telecommunication Engineers(IETE).

TOTAL : 45

TEXT BOOKS:

1. Martin Mike and Schinzinger Roland, "Ethics in Engineering", 4th Edtion, Tata McGraw-Hill, New Delhi, 2014.
2. Govindarajan M., Natarajan S., and Senthil Kumar V.S., "Engineering Ethics", Prentice Hall of India, New Delhi, Reprint 2013.

REFERENCE BOOKS:

1. Fleddermann Charles D., "Engineering Ethics", 4th Edition, Pearson Education/Prentice Hall, New Jersey, 2014.
2. Harris Charles E., Protchard Michael S. and Rabins Michael J., "Engineering Ethics: Concepts and Cases", 4th Edition Wadsworth Thompson Learning, United States, 2008.
3. Seebauer Edmund G. and Barry Robert L., "Fundamentals of Ethics for Scientists and Engineers", Oxford University Press, Oxford, 2008.

COURSE OUTCOMES

On completion of the course the students will be able to

CO1: understand the components of ethics and values

CO2: understand the knowledge interpersonal and organizational issues in ethics

CO3: acquire knowledge on ethical theories and their application

CO4: highlight ethical issues in risky situation

CO5: understand the role of professional bodies

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1						3		3	2	2		2		2
CO2						3		3	2	3		2		2
CO3						3	2	3	2	1		2		2
CO4						3	3	3	2	3		2		2
CO5						2	2	3	2	2		2		2

1 – Slight, 2 – Moderate, 3 – Substantial

14FTP81 PROJECT WORK

0 0 18 9

COURSE OUTCOMES

On completion of the course the students will be able to

CO1: apply the acquired technical knowledge and skills to solve real time problems

CO2: design and fabricate food processing equipments

CO3: formulate and develop value added food products

CO4: apply scientific research tools for design and optimization of food processing operations.

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	3	3	2	3	2	3	3	3	3	2	3
CO2	3	3	3	3	3	2	2	2	3	3	3	3	3	2
CO3	3	3	3	3	2	3	3	3	3	3	3	3	3	3
CO4	3	3	3	3	3	2	2	2	3	3	3	3	3	2

1 – Slight, 2 – Moderate, 3 – Substantial

14FTE01 FOOD SCIENCE AND NUTRITION

3 0 0 3

Prerequisites: Food Biochemistry

UNIT – I **9**

An Overview of Nutrition: Definition, six classes of nutrients, RDA, nutritional status and its assessment, nutritional requirement, malnutrition – over nutrition and under nutrition.Anatomy and physiology of the digestive tract, mechanical and chemical digestion, absorption and transport of nutrients.

UNIT – II **9**

Carbohydrates - Sugars, Starch and Fiber: Digestion and absorption of carbohydrates, lactose intolerance; Glycemic and Non-glycemic carbohydrates, recommendations of sugar intake for health, health effects of fiber and starch intake, artificial sweeteners; Nutrition and Diabetes, GTT.

UNIT – III **9**

Lipids and Proteins: Food Sources, Lipid digestion, absorption and transport; Functions of the triglycerides; essential fatty acids - n-3 and n-6 fatty acids; trans fatty acids, Medium Chain Triglycerides, phospholipids and sterols; Health effects and recommended intakes of lipids. Digestion and absorption of proteins; Functions of proteins; amino acids; Protein quality, methods of assessing protein quality; Recommended intakes of proteins; protein and amino acid supplements; Protein Energy Malnutrition - Marasmus and Kwashiorkor.

UNIT – IV **9**

Energy Balance and Body Composition: Calorific value of foods: Definition, units, bomb calorimeter; Energy requirements: basal metabolism, specific dynamic action of foods, energy balance, direct and indirect calorimetry, physiological energy value of foods. Energy Balance and Body Composition: Energy balance; body weight and body composition; health implications; obesity, BMR and BMI calculations; Weight Control: Fat cell development; hunger, satiety and satiation; dangers of weight loss; how to identify unsafe weight loss schemes; treatment of obesity; attitudes and behaviours toward weight control.

UNIT – V **9**

Nutrition for Different Age Groups: Factors to be considered in meal/menu planning. Pregnancy - nutrition requirements and food selection. Lactation - nutritional requirements. Infancy - nutritional requirements, breast feeding, infant formula. Introduction of supplementary foods. Early childhood. (Toddlers and Preschoolers) - Growth and nutrient needs, nutritional related problems, Feeding Pattern. School children - Nutritional requirements, Importance of snacks, school lunch. Adolescence - Growth, Nutrient needs, food choice, eating habits, factors influencing. Geriatic Nutrition - Factors affecting food intake and nutrients use, nutrient needs, nutrition related problems.

TOTAL : 45

TEXT BOOKS:

1. Mann Jim and Stewart Truswell, "Essentials of Human Nutrition", 3rd Edition, Oxford University Press, Oxford, 2007.
2. Michael J. Gibney, Susan A. Lanham-New, Aedin Cassidy and Hester H. Vorster, "Introduction to Human Nutrition", 2nd Edition, Wiley Blackwell, UK, 2009.

REFERENCE BOOKS:

1. Gropper, Sareen S. and Jack L. Smith, "Advanced Nutrition and Human Metabolism", 5th Edition, Wadsworth Cengage Learning Publishing, US, 2008.
2. Srilakshmi B., "Nutrition Science", 3rd Edition, New Age International Publishers, New Delhi, 2011.
3. Shubangini A Joshi, "Nutrition and Dietetics", Tata Mc Graw Hill Pub. Co. Ltd., New Delhi, 1998.
4. Mahan L.K. and Escott-Stump S.,"Krause's Food, Nutrition and Diet Therapy", 10th Edition, W.B. Saunders Company, London, 2000.
5. http://nptel.ac.in/courses/126104004/2
6. Michael J. Gibney, Susan A. Lanham-New, Aedin Cassidy and Hester H. Vorster, Introduction to Human Nutrition‖, 2nd Edition, Wiley Blackwell, UK, 2009 (ebook)

COURSE OUTCOMES

On completion of the course the students will be able to

CO1: interpret the physiological and metabolic functions of nutrients
CO2: select appropriate carbohydrate diet based on their health effects
CO3: recommend the intake of lipids and proteins based on their nutritional value
CO4: assess energy balance and body composition
CO5: identify nutrition requirement based on different age groups

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	1	3		1							3	1
CO2	3	3	1	1		3						1	1	3
CO3	3	3	1			3						1	1	3
CO4	3	3	1	3		2						1	3	2
CO5	3	3	1	3		3						1	3	2

1 – Slight, 2 – Moderate, 3 – Substantial

14FTE02 MILLING TECHNOLOGY

3 0 0 3

Pre-requisites: Engineering properties of Food materials

UNIT – I **9**

Structure, Storage and Pest Management of Grains: Grains - Definition. Importance. Physical properties of grains. Structure, Composition and Nutritional value – paddy, wheat, maize, oat, sorghum. Grain storage systems - farm level storage, bagged storage, bulk storage, hermetic storage, outdoor storage. Losses during storage, Grain protection methods – physical and chemical methods. Integrated stored grain pest management.

UNIT – II **9**

Milling of Paddy: Rice milling flow sheet. Cleaning. Parboiling- traditional and improved methods, Physio–chemical changes during parboiling, Effect of parboiling on rice quality. Husking- Methods of husking, Huskers/Shellers – impact type, centrifugal dehusker, under runner disc huller, rubber roll sheller. Separation – indented tray and compartment type separator. Whitening – friction type and abrasive type whiteners. Color sorter. New quality control instruments. Byproducts from rice milling.

UNIT – III **9**

Milling of Wheat: Types of wheat. Wheat milling – Simple and detailed flow sheet. Preparation of Wheat for Milling – wheat blending, tempering or conditioning, Roller milling – break rolls and reduction rolls, operation and corrugation specification, Sifting – Plan sifters, Purifying - purifier. Milling performance evaluation. Functional properties of flour. Flour treatment – Enrichment, Enhancement of flour appearance, Improvement of functional properties. By products from wheat milling.

UNIT – IV **9**

Milling of Corn and Pulses: Types of corn. Dry milling – Tempering, dehulling, degermination and milling. Wet milling – Steeping, Germ, fiber, starch and gluten separation, starch refinement. By products from corn milling. Legumes – Structure, Types, Nutritional and Anti-nutritional factors. Pulse Milling – Conditioning, Pitting, Oil/water treatment, drying, dehuskers – Tangential Abrasive Dehulling Device (TADD), Central Institute of Agricultural Engineering (CIAE) design, Schule design, CFTRI mini dhal mill, Husk separation and grading, Splitting – Equipments. Milling - Dry and wet milling, Dehulling efficiency.

UNIT – V **9**

Milling of Oil Seeds: Types of Oil seeds. Oil seed processing - Mechanical extraction – Hydraulic press, Screw press, Filter press. Mechanical extraction of coconut oil and palm oil. Cold pressing and Hot Pressing. Solvent extraction – Flow sheet. Factors influencing extraction. Refining of oil – Degumming, Dewaxing, Neutralization, Bleaching, Filtration and Deodorization. Hydrogenation. Winterization. Oil seed flour concentrates and isolate.

TOTAL : 45

TEXT BOOKS:

1. Chakraverty A., "Post-Harvest Technology of Cereals, Pulses and Oil Seeds", 3rd Edition, Oxford IBH Publishing Co. Pvt. Ltd., New Delhi, 2008.
2. Sahay K.M. and Singh K.K., "Unit Operations of Agricultural Processing", 2nd Edition, Vikas Publishing House, New Delhi, 2008.

REFERENCE BOOKS:

1. Chakraverty A., Mujumdar A.S., VijayaRaghavan G.S. and Ramaswamy H.S., "Handbook of Postharvest Technology - Cereals, Fruits, Vegetables, Tea, and Spices", Marcel Dekker, Inc., New York, 2003.
2. Kulp K. and Pont J.G., "Handbook of Cereal Science and Technology", 2nd Edition, Marcel Dekker, Inc., New York, 2000.
3. Richard D. O'Brien, "Fats and Oils: Formulating and Processing for Applications", 3rd Edition, CRC Press, London, 2008.
4. http://www.knowledgebank.irri.org/step-by-step-production/postharvest/milling
5. http://www.namamillers.org/education/wheat-milling-process/

COURSE OUTCOMES

On completion of the course the students will be able to

CO1: identify grain properties and recommend suitable storage structures against pest infestation
CO2: adapt suitable parboiling and milling methods for paddy
CO3: apply wheat milling process
CO4: elaborate the process involved in corn and pulse milling
CO5: choose suitable technologies for extraction and refining of oil

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1	2		2		2					1	2	2
CO2	3	1	2		2		1					2	3	
CO3	3	1	2		2		1					2	3	
CO4	3	1	2		2		1					1	3	
CO5	3	1	2		2		1					1	3	

1 – Slight, 2 – Moderate, 3 – Substantial

14FTE03 TECHNOLOGY OF FATS AND OILS

3 0 0 3

Pre-requisites: Food Biochemistry, Food Chemistry

UNIT – I **9**

Properties of Oils and Fats: Oils and fats – sources, composition. Nutritional importance of fats and oils. Physical properties of fats and oils - color, odour, consistency, melting point, flash point, smoke point. Chemical properties of fats and oils - iodine value, saponification value, free fatty acids, peroxide value.

UNIT – II **9**

Vegetable Oil and Animal Fat Production: Industrial production of oils- seed handling and storage. Preparation of seed for extraction of oil. Processing- peanut oil, rice bran oil, sunflower oil and soy bean oil. Production of cod liver oil. Method of extraction- cold pressing and hot pressing, Equipments- Filter press, hydraulic press. Production of margarine. Production of Lard.

UNIT – III **9**

Solvent Extraction and Refining of Oils: Solvent extraction – prepress and direct extraction, removal and recovery of solvent from miscella and extracted residue. Physical refining, Chemical Refining, Degumming - types, dewaxing/winterization, bleaching – deodorizing, hydrogenation.

UNIT – IV **9**

Edible Oil, Fat Products and Modification of Oils: Modification of oils - Refined oil – fractionation- Blending – Interesterification – Types – Chemical and Enzymatic, Applications. Margarines, spreads, mayonnaise. Shortenings in bakery products and confectionery lipids. Fat substitutes and its types.

UNIT – V **9**

Packaging and Storage of Oil: Changes during storage of oil. Role of fat or oil in frying .Selection of frying oil. Applications of frying oil .Rancidity - atmospheric oxidation and enzyme action. Quality standards of oil - Packaging of oils and fats.

TOTAL : 45

TEXT BOOKS:

1. Fereidoon Shahidi, "Bailey's Industrial Oil and Fat Products", 6th Edition, Wiley - Interscience, New Jersey, 2005.
2. Richard D. O'Brien, "Fats and Oils: Formulating and Processing for Applications", 3rd Edition, CRC Press, London, 2010.

REFERENCE BOOKS:

1. Casimir C. Akoh and David B. Min, "Food Lipids: Chemistry, Nutrition and Biotechnology", CRC Press, USA, 2008.
2. Wolf Hamm and Richard J. Hamilton, "Edible Oil Processing", Wiley - Blackwell, UK, 2013.
3. Kanes K. Rajah, "Fats in Food Technology", Sheffield Academic Press, UK, 2002.
4. http://www.mpoc.org.my/upload/Understanding-Oils-Fats-Processing-aspects-practice-KimJongGil-POTS-Korea-2015-P1.pdf
5. http://www.fao.org/docrep/v4700e/v4700e0a.htm

COURSE OUTCOMES

On completion of the course the students will be able to

CO1: assess the physical and chemical properties of fats and oils

CO2: recommend suitable mechanical methods for oil extraction

CO3: apply solvent extraction and refining of oils

CO4: develop edible oil, fat products and modified oil

CO5: choose an appropriate package and storage for oils

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1		2									1	3
CO2	3				3							2	3	
CO3	3				3							2	3	
CO4	3				3							2	3	
CO5	3	1			1							2	3	2

1 – Slight, 2 – Moderate, 3 – Substantial

14FTE04 BIOPROCESS ENGINEERING

3 0 0 3

UNIT – I **9**

Enzyme: Introduction, Single and Multi-substrate reactions - mechanisms and kinetics; turnover number; Enzyme Inhibition and Kinetics- competitive, non-competitive and uncompetitive; Enzyme Immobilization – Physical and chemical methods.

UNIT – II **9**

Microbial Strain Improvement: Media – composition, design, formulation and optimization. Microbial Strains: Isolation, cultivation and preservation techniques; strain selection and improvement - Recombinant DNA Techniques and Cloning Strategies.

UNIT – III **9**

Stoichiometry of Cell Growth and Product Formation: Elemental balances, degrees of reduction of substrate and biomass, available electron balances, yield coefficients of biomass and product formation, maintenance coefficients, energetic analysis of microbial growth and product formation.

UNIT – IV **9**

Fermentation and Sterilization: Batch, fed batch and continuous fermentation. Main parameters to be monitored and controlled in fermentation processes. Microbial growth kinetics model - Simple unstructured and Monod model. Sterilization methods, Thermal death kinetics of microorganisms, batch and continuous heat sterilization, filter sterilization.

UNIT – V **9**

Bioreactors: Basic configuration of bioreactor and ancillaries. Types of reactor- Air Lift Reactor, Bubble Column Reactor, Immobilized enzyme reactors- packed bed, fluidized bed and membrane reactors.

TOTAL : 45

TEXT BOOKS:

1. Trevor Palmer and Philip L.R. Bonner, "Enzymes: Biochemistry, Biotechnology, Clinical Chemistry", 2nd Edition, Woodhead Publishing, Cambridge, 2007.
2. Stanbury P.F., Whitaker A. and Hall S.J., "Principles of Fermentation Technology", 2nd Edition, Pergamon, USA, 1995.

REFERENCE BOOKS:

1. Shuler M.L. and Kargi F., "Bioprocess Engineering: Basic Concepts", 2nd Edition, PHI, New Delhi, 2002.
2. Najafpour, D. Ghasem, "Biochemical Engineering and Biotechnology", Elsevier, USA, 2007.
3. Michael J. Waites, Neil L. Morgan and Gary Higton, "Industrial Microbiology: An Introduction", Wiley-Blackwell, UK, 2001.
4. https://lecturesug3.files.wordpress.com/2012/09/lecture-2.pptx
5. http://nptel.ac.in/courses/104105040/Lecture%2023.pdf

COURSE OUTCOMES

On completion of the course the students will be able to

CO1: interpret the kinetics of enzymatic reactions, enzyme inhibition and enzyme immobilization

CO2: demonstrate the microbial strain preservation and improvement techniques

CO3: perform the stoichiometric calculation of microbial growth and product formation

CO4: choose appropriate fermentation process and sterilization methods

CO5: classify and appraise the working of bioreactors

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	3	2							1	2	2
CO2	3	3	3	2	3							1	3	3
CO3	3	3	3	3	3							1	1	2
CO4	3	3	3	2	3							1	2	2
CO5	3	3	2	2	3							1	3	3

1 – Slight, 2 – Moderate, 3 – Substantial

14FTE05 FOOD ADDITIVES AND NUTRACEUTICALS

3 0 0 3

UNIT – I **9**

Food Additives: Definition; their function in food processing and preservation; Preservatives –definition; natural preservatives; chemical preservatives;acidulants and low pH –organic acids and esters; sulphur dioxide and its salts; nitrites; antibiotics; surface preservation; Permitted preservatives in foods –Antioxidants; natural and chemical antioxidants; mechanism of antioxidant function; primary and secondary antioxidants; sequestrants; selection and application of antioxidants in foods; evaluation of antioxidant effectiveness –permitted antioxidants in foods.

UNIT – II **9**

Food Colors, Emulsifiers and Stabilizers: Natural and synthetic colors; fake colors; inorganic pigments; application of colors in food industry; restriction on the use of colors in foods. Flavoring agents –concept of flavors in foods; natural flavors; nature identical flavors; artificial flavoring substances; restrictions on the use of flavoring agents in Foods. Definition, properties of HLB value; function of emulsifiers and stabilizers in foods; permitted emulsifiers and stabilizers used in foods; polyols–physical and chemical properties of polyols, application in food industry, permitted polyols in foods.

UNIT – III **9**

Safety, Regulation and Quality Standards: Safety limits of Food additives; Risk assessment and risk benefit Indices of human exposure, acute toxicity, mutagenicity and carcinogenicity, reproductive and developmental toxicity, teratogenicity, neurotoxicity and behavioral effect, immunotoxicity. Determination of the limit for addition – NOEL – Method of determining toxicity – LD50. FSSAI regulations and GRAS additives.

UNIT – IV **9**

Nutraceuticals: Introduction, definition and difference from nutrients. Plant and animal based nutraceuticals. Health benefits of antioxidants, Flavonoids, Omega-3 Fatty Acids, Carotenoids.Technologies to recover Nutraceuticals compounds: Distillation, ultrahydrostatic pressure treatment, dense carbon-di-oxide treatment, encapsulation of nutraceuticals – materials, mechanical processes and chemical based processes, nano encapsulation.

UNIT – V **9**

Role in Health Promotion and Disease Prevention: Nutraceuticals in prevention and treatment of gastrointestinal disorder, Cardiovascular and Chronic Diseases. End User Market Products - supplements forms- tablets, capsules, powders, soft gels, gel caps, liquids; Nutraceuticals currently available in the market, regulation for nutraceuticals.

TOTAL : 45

TEXT BOOKS:

1. Belitz H.D., Grosch W. and Schieberle P., "Food Chemistry", 3rd Edition, Springer-Verley, Berlin, 2004.
2. Wildman, Robert E.C., "Handbook of Nutraceuticals and Functional Foods", 2nd Edition, CRC Press, New York, 2006.

REFERENCE BOOKS:

1. Clare M. Hasler, "Regulation of Functional Foods and Nutraceuticals: A Global Perspective", 1st Edition, Wiley, Chicago, 2008.
2. Yashwant Pathak, "Hand Book of Nutraceuticals", Volume 1, 1st Edition, CRC Press, USA, 2011.
3. Lockwood, Brian, and Rapport, Lisa, "Nutraceuticals: A Guide for Healthcare Professionals", 2nd Edition, Pharmaceutical Press, London, 2007.
4. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3257668/
5. http://content.inflibnet.ac.in/index.php/content/index/594515cd8007bef81d3c4cf1

COURSE OUTCOMES

On completion of the course the students will be able to

CO1: acquire insight on various food additives
CO2: choose suitable food colours, emulsifiers and stabilizers
CO3: identify the safety, regulations and quality standards of food additives
CO4: develop nutraceuticals products
CO5: infer the effect of nutraceuticals in health promotion and disease prevention

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1									1	2	3
CO2	3	2	1									1	2	3
CO3	3	2	2		1	1						1	1	3
CO4	3	2	1		1	2						1	2	3
CO5	3	2	2		1	2						1	2	3

1 – Slight, 2 – Moderate, 3 – Substantial

14FTE06 TECHNOLOGY OF SNACK AND EXTRUDED FOODS

3 0 0 3

UNIT – I **9**

Introduction: Current status of snack food industry in India. Types of snack food – Raw Vegetable Snack, Formed dough products from potato and maize derivatives, Half Products, Directly expanded extruded snack, Puffed Snacks and other. Types and Functions of ingredients – structure forming materials, dispersed phase/filling materials, plasticizers/lubricants, soluble solids, nucleating substances, coloring and flavouring substances.

UNIT – II **9**

Potato and Rice Based Snacks: Potato Chip - Pre cleaning and peeling, slicing, drying/frying, salting and seasoning, quality control. Fabricated potato snacks – potato flakes, potato granules, potato starch, ground and crushed dehydrated potato. Rice based Snacks – Products using whole grains – Gun puffed rice. Products using flours.

UNIT – III **9**

Corn Based Snacks: Tortilla chip – Corn soaking and smoking, Grinding, Masa flour, Sheeting and Cutting, Baking and Frying. Popcorn – Popping methods, oil popping and dry popping. Commercial and industrial popcorn process. Flavorings and Applicators.

UNIT – IV **9**

Extrusion Based Snacks: Extruder components – Single and Twin screw, Single and Multiple die extruders. Second generation and Third generation snacks, Co extruded snacks, Masa based snacks, Flat bread, Crisp bread.

UNIT – V **9**

Pasta Products: Raw materials. Preparation of raw materials for extrusion. Spaghetti, noodles, macaroni and similar products. Dry and frozen pasta products. Pretzel – Types – Formulation and Processing - mixing, extrusion, proofing, cooking, surface salting, baking and drying. Problems in pretzel manufacture.

TOTAL: 45

TEXT BOOKS:

1. Edmund W. Lusas and Lloyd W. Rooney, "Snack Food Processing", 1st Edition, CRC Press, Florida, 2001.
2. Robin Guy, "Extrusion cooking: Technologies and Applications", 1st Edition, CRC Press, Florida, 2001.

REFERENCE BOOKS:

1. Panda H., "The Complete Technology Book on Snack Foods", National Institute of Industrial Research, New Delhi, 2003.
2. Sergio O. Serna-Saldivar, "Industrial Manufacture of Snack Food", Woodhead Publishing, New Delhi, 2008.
3. Mian N. Riaz., "Extruders in Food Application", CRC Press, Florida, 2000.
4. http://jakraya.com/journal/pdf/7-jrefArticle_1.pdf
5. https://link.springer.com/chapter/10.1007/978-1-4615-2135-8_4

COURSE OUTCOMES

On completion of the course the students will be able to

CO1: make use of specific ingredient based on their functionality.

CO2: appraise the concepts involved in potato and rice based snack manufacturing

CO3: elaborate the steps involved in corn based snacks manufacturing

CO4: explain the working of equipment used for production of snack and extruded foods.

CO5: categorize and formulate the pasta products

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3		2		1							1	3	1
CO2	3	2	3		1							1	3	1
CO3	3	2	3		1							1	3	1
CO4	3	1	3		1							1	3	1
CO5	3	2	3		1							1	3	1

1 – Slight, 2 – Moderate, 3 – Substantial

14FTE07 FERMENTATION TECHNOLOGY

3 0 0 3

UNIT – I **9**

Food Fermentation: Origin and history of food fermentation, Micro-organisms for fermentation, Starter Cultures and fermented Products, Manufacture of fermented products, Quality and flavour of fermented products.

UNIT – II **9**

Types of Fermentation: Types of fermentation submerged/solid state. Sterilization-air sterilization, media sterilization. Batch/continuous fermentation, scale up in fermentation. Maintenance of aseptic conditions.

UNIT – III **9**

Aeration and agitation in fermentation: Aeration and agitation in fermentation: Oxygen requirement, measurement of adsorption coefficients, bubble aeration, mechanical agitation, correlation between mass-transfer coefficient and operating variables.

UNIT – IV **9**

Production of Fermented products: Semi solid cultured dairy products- principles and applications- packaging quality assurance and sanitation. Meat fermentation- principles and application. Fermented cereal food and beverages.

UNIT – V **9**

Production of Fermented products: Production of vitamins, amino acids, organic acids, enzymes and antibiotics, alcohols. Industrial production of beer, wine, enzymes-amylase, pectinase, proteases, vitamins, antibiotics, baker's yeast, single cell protein. Fermented foods: Sauerkraut, yoghurt, cheese, miso, tempeh, tofu, idli, dosa.

TOTAL : 45

TEXT BOOKS:

1. Y. H. Hui, Lisbeth Meunier-Goddik, JytteJosephsen, Wai-Kit Nip and Peggy S. Stanfield., "Handbook of Food and Beverage Fermentation Technology", CRC Press, UK, 2004.
2. Robert W. Hutkins., "Microbiology and Technology of Fermented Foods", CRC Press, UK, 2004.

REFERENCE BOOKS:

1. Gutierre, Gustavo F., “Food Science and Food Biotechnology”, CRC Press, New York, 2003.
2. Crueger W. and Crueger A., “Biotechnology: A Textbook of Industrial Microbiology”, Science Tech. Madison, USA, 1984.
3. Stanbury P.F., and Whitake S.A., “Principles of Fermentation Technology”, Pergamon Press, Oxford, UK, 1984.
4. http://nptel.ac.in/courses/103107082/module5/lecture1/lecture1.pdf
5. https://www.ifsc.usp.br/~ilanacamargo/FFI0740/4.pdf

COURSE OUTCOMES

On completion of the course the students will be able to

CO1: apply the principles of microbiology in the production of fermented foods

CO2: classify fermentation process and maintain aseptic conditions in a fermentation process

CO3: relate the process parameters in aeration and agitation of a fermentation operation

CO4: make use of concepts of fermentation in dairy, meat, cereal and beverage products

CO5: identify processes involved in production of various fermented products

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	1		2							1	3	1
CO2	3	1	2		2							1	2	2
CO3	3	3	3		2							1	2	1
CO4	3	3	3	3	2							1	3	2
CO5	3	3	3	3	2							1	3	2

1 – Slight, 2 – Moderate, 3 – Substantial

14FTE08 PLANTATION AND SPICES PRODUCTS TECHNOLOGY

3 0 0 3

UNIT – I **9**

Processing of Plantation Crops: Importance of plantation crops – cashew –harvesting – uses of cashew – cashew nut processing. Coconut – harvesting – Processing. Cocoa bean - Occurrence – Chemistry of the cocoa bean –Processing of cocoa bean – cocoa powder – cocoa liquor.

UNIT – II **9**

Processing of Tea and Coffee: Types of tea – green, oolong and CTC – Chemistry and technology of CTC tea – Manufacturing process - Grading of tea**.** Coffee – Occurrence – chemical constituents– fermentation of coffee beans – Process flow sheet for the manufacture of coffee powder. Export and Import Duties of plantation crops.

UNIT – III **9**

Processing of Spices: Importance of Spices- Processing of Spices- Pepper, cardamom, ginger and turmeric, cumin, coriander, cinnamon, fenugreek, garlic, clove and vanilla –method of manufacture of oleoresins and essential oils.

UNIT – IV **9**

Processing of Tuber Crops: Chemical composition and processing of tuber crops - tapioca, sugar beet, potato and yam - starch and sago production- Grades. Other by-products-Applications and Processing.

UNIT – V **9**

Biosynthesis of Flavours: Chemistry of volatiles –enzymatic synthesis of flavour identical, micro-organisms and plant suspension cultures- Present trends in synthesis of volatiles.

TOTAL : 45

TEXT BOOKS:

1. Pandey P.H., "Post-Harvest Engineering of Horticultural Crops through Objectives", Saroj Prakasam, Allahabad, 2003.
2. Kumar K., Md Abdul Kadar JBM., Rangaswamyi P. and Irulappan I., "Introduction to Spices, Plantation Crops, Medicinal and Aromatic Plants", Oxford and IBH Publishing, 2006.

REFERENCE BOOKS:

1. Minifie Bernard W., "Chocolate, Cocoa and Confectionery Technology", 3rd Edition, Springer Netherlands, 2012.
2. Shanmugavelu K.G., Kumar N. and Peter K.V., "Production Technology of Spices and Plantation Crops", Jodhpur Agrobios (India) Agro House, 2005.
3. National Institute of Industrial Research (NIIR) Board, "Handbook on Spices", Asia Pacific Business Press Inc., New Delhi, 2004.
4. http://agritech.tnau.ac.in/horticulture/horti_plantation%20crops_cocoa.html
5. https://answers.practicalaction.org/our-resources/community/food-processing-1-2

COURSE OUTCOMES

On completion of the course the students will be able to

CO1: illustrate the steps involved in processing of plantation crops

CO2: elaborate the processing of tea and coffee

CO3: apply appropriate techniques for processing of spices

CO4: make use of the food processing operations in the processing of tuber crops

CO5: take part in the biosynthesis of flavors

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1			2	1						1	2	
CO2	3	1			2	1						1	2	
CO3	3	1			2	1						1	2	
CO4	3	1			2	1						1	2	
CO5	3	2	2		2		1					2		2

1 – Slight, 2 – Moderate, 3 – Substantial

14FTE09 FOOD ALLERGENS AND TOXICOLOGY

3 0 0 3

Pre-requisites: Food Biochemistry, Food Chemistry, FoodMicrobiology

UNIT – I **9**

Introduction to Food Toxicology: Definition and need for understanding food toxicology; Hazards -Microbiological, nutritional and environmental. Basics of immune response - humoral and cell mediated response. Allergen and mechanism of allergic response.

UNIT – II **9**

Natural Toxins, Food Allergy and Sensitivity: Toxins – Natural toxin and poison, difference between toxin, poison and natural toxin, toxin foods, unsafe food, bio-toxin, toxin characteristics, classification of natural toxin. Chemistry of food allergens, food disorders associated with metabolism, biotransformation and Elimination of Toxicants, lactose intolerance, celiac disease and asthma.

UNIT – III **9**

Toxicants Formed During Food Processing: Intentional direct additives, preservatives, nitrate, nitrite, and N-nitroso compound flavour enhancers, food colors, indirect additives, residues and contaminants, heavy metals, other organic residues and packaging materials. Toxicity of heated and processed foods, food carcinogens and mutagens - Polycyclic aromatic hydrocarbons, N - nitrosamines, Acrylamide and their mode of action.

UNIT – IV **9**

Assessment of Toxicants in Food Sampling: Quantitative and qualitative analysis of toxicants in foods; Biological determination of toxicants. Assessment of food safety – Risk assessment and risk benefit indices of human exposure, acute toxicity, mutagenicity and carcinogenicity, reproductive and developmental toxicity, neurotoxicity and behavioural effect, immunotoxicity.

UNIT – V **9**

Instrumentation Techniques to Detect Toxins: Chromatography, Principles, procedure and applications of Thin layer chromatography, Gas chromatography column chromatography, Ion exchange chromatography and High performance liquid chromatography**,** PCR Techniques, ELISA. Spectrophotometry, Principles, instrumentation and applications of atomic absorption spectrophotometry (AAS) and atomic emission spectrophotometry (AES), Centrifugation; Principles, instrumentation and applications of preparative and ultracentrifuge.

TOTAL : 45

TEXT BOOKS:

1. Helferich, William and Carl K.Winter, "Food Toxicology", CRC Press, 2001.
2. Alluwalia, Vikas, "Food Hygiene and Toxicology", Paragon International Publishers, 2007.

REFERENCE BOOKS:

1. Labbe, Ronald G. and Santos Garcia "Guide to Food Borne Pathogens", John Wiley and Sons, 2001.
2. Cliver, Dean O., and Hans P. Riemann, "Food Borne Diseases" 2nd Edition, Academic Press/Elsevier, 2002.
3. Maleki, Soheila J. A., Wesley Burks, and Ricki M.Helm, "Food Allergy", ASM Press, 2006.
4. Shibamoto, Taka yuki and Leonard F. BjeldAnzes, "Introduction to Food Toxicology", 2nd Edition, Academic Press, 2009.
5. http://pubweb.carnet.hr/htdr/wp-content/uploads/sites/414/2016/04/Lecture_Food-Toxicology_Ritieni.pdf
6. http://www.123foodscience.com/food_microbiology/Toxicants_Formed_during_Food_Processing.pdf

COURSE OUTCOMES

On completion of the course the students will be able to

- CO1: Infer the concepts of food toxicology
- CO2: Categorize toxins, allergens and interpret its sensitivity in human food chain
- CO3: Identify toxicants formed during food processing
- CO4: Assess the toxicants and risks involved in human exposure
- CO5: Adapt suitable method for detection of toxins

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3		1			1								3
CO2	3		2			3						1		3
CO3	3	1	3	3	3	3	2					1	2	3
CO4	3		3	3		3	2					1	2	3
CO5	3		3	2	3							1		3

1 – Slight, 2 – Moderate, 3 – Substantial

14FTE10 FOOD STORAGE AND INFESTATION CONTROL

3 0 0 3

UNIT – I **9**

Fundamentals of Storage Infestation: Introduction, history of storage entomology, concepts of storage entomology and significance of insect pests. Post-harvest losses - total production of food grains in India. Scientific and socio-economic factors responsible for grain losses. Important pests namely insects, mites, rodents, birds and microorganisms associated with stored grain and field conditions including agricultural products.

UNIT – II **9**

Ecology of Insects and Storage Losses: Ecology of insect pests of stored commodities/grains with special emphasis on role of moisture, temperature and humidity in safe storage of food grains and commodities. Stored grain deterioration process, physical and biochemical changes and consequences; traditional storage structures; association of stored grain insects with fungi and mites, their systematic position, identification, distribution, nature and extent of damage, role of field and cross infestations and natural enemies, type of losses in stored grains and their effect on quality including biochemical changes.

UNIT – III **9**

Grain Storage and Management: Grain storage types of storage structures - traditional, improved and modern storage structures in current usage. Ideal seeds and commodities storage conditions. Important rodent pests associated with stored grains and their non-chemical and chemical control including fumigation of rat burrows. Pest Birds – role and its management. Control of infestation by insect pests, mites and microorganisms. Preventive measures- Hygiene/sanitation, disinfestations of stores/receptacles, legal methods.

UNIT – IV **9**

Pest Control Measures: Non-chemical control measures- ecological, mechanical, physical, cultural, biological and engineering. Chemical control- prophylactic and curative. Pesticides – characteristics, uses and precautions in handling. Integrated approaches to stored grain pest management.

UNIT – V **9**

Quality Control in Grains: Detection of insect infestation in stored food grains, losses in stored food grains – weveiled and unweveiled grains, determination of moisture content in stored food grains, Quality control aspects in FCI godowns, central warehouse. Demonstration of preventive and curative measures including fumigation techniques; treatment of packing materials and their effect on seed quality.

TOTAL : 45

TEXT BOOKS:

1. Mohan and Awaknavar J.S., "Pest Management in Store Grains", Satish Serial Publishing House, New Delhi, 2009.
2. Nair K.R., "Integrated Production and Pest Management", DK Publishers and Distributors, Delhi, 2007.

REFERENCE BOOKS:

1. Hagstrum D.W., and Subramanyam B., "Fundamentals of Stored Product Entomology" American Association of Cereal Chemists Inc., 2006.
2. Subramanyam B., "Integrated Management of Insects in Stored Products", CRC Press, 1995.
3. Slansky Jr. F., and Rodriguez J.G., "Nutritional Ecology of insects, mites, spiders and related invertebrates", John Wiley, 1987.
4. http://nptel.ac.in/courses/103107088/module4/lecture2/lecture2.pdf
5. https://www.extension.umn.edu/agriculture/small-grains/harvest/management-of-stored-grain-with-aeration/

COURSE OUTCOMES

On completion of the course the students will be able to

- CO1: identify possible sources of pest infestation in storage
- CO2: interpret ecology of region specific insects and its impact on storage
- CO3: recommend appropriate storage structures and preventive measures for pests
- CO4: select integrated pest management approach and curative measures in grain storage
- CO5: adapt suitable quality control techniques in grain storage

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1			2			1						1		1
CO2	3	2	2			1	2					1	1	3
CO3	3	2	3		3	2	3					1	1	3
CO4	3	1	3		3	2	3					1	1	3
CO5	3		3		3	3	3					2	2	3

1 – Slight, 2 – Moderate, 3 – Substantial

14FTE11 BEVERAGE TECHNOLOGY

3 0 0 3

Pre-requisites: Fruits and vegetables processing Technology

UNIT – I **9**

Introduction: Current status of beverage industry in India - Types of beverages- Alcoholic and non-alcoholic. Nutritional and therapeutic benefits. Raw materials - Water, sweeteners, bulking agents, acidulants, emulsifiers, stabilizers. Flavoring and Coloring agents.

UNIT – II **9**

Non Alcoholic Beverages: Natural Fruit based beverages, Synthetic/Artificial beverages. Carbonated beverages- Properties of carbon dioxide, carbonation – carbonators. Preparation of syrup, filling and packaging. Measurement of carbonation. Dairy based beverages – whey based beverages and flavored milk.

UNIT – III **9**

Alcoholic Beverages: Types of alcoholic beverages. Wine – types – red and white, production, wine defects. Beer – Types – Production and defects. Distilled beverages – Brandy, Whiskey, Rum, Gin – Production and defects.

UNIT – IV **9**

Speciality Beverages: Coffee – decaffeination, Instant coffee. Tea – black and green tea. Probiotics as ingredient in functional beverage- production – health benefits. Fortification of beverages – nutrients. Sport beverages – Physiological needs and formulation.

UNIT – V **9**

Quality Control: Sanitation and Hygiene in Beverage industries. Quality control in soft drink industries – water quality, Threshold limits of ingredients. Requirements of Soluble solids and titratable acidity in beverages – Standards and regulation in India.

TOTAL : 45

TEXT BOOKS:

1. Philip R. Ashurst, "Chemistry and Technology of Soft Drinks and Fruit Juices", 2nd Edition, Blackwell Publishing Ltd., 2005.
2. Paquin P., "Functional and Speciality Beverage Technology", 1st Edition, Wood Head Publishing in Food Science Technology and Nutrition, 2009.

REFERENCE BOOKS:

1. Bamforth, "Brewing: New Technologies", Woodhead Publishing Limited, England, 2006.
2. Varnam A.H., and Sutherland J.P., "Beverages: Technology, Chemistry and Microbiology", Aspen Publishers, Maryland, 1999.
3. Mitchell A.J., "Formulation and Production Carbonated Soft Drinks", Blackie and Sons Ltd., USA, 1990.
4. http://www.agrimoon.com/wp-content/uploads/FOOD-TECHNOLOGY.pdf
5. https://www.researchgate.net/publication/227191780_Alcoholic_Beverages

COURSE OUTCOMES

On completion of the course the students will be able to

CO1: identify the ingredients for production of beverages

CO2: apply suitable techniques for development of non-alcoholic beverages

CO3: recommend appropriate process for production of alcoholic beverages

CO4: develop speciality beverages

CO5: apply the acquired knowledge on quality control for beverage industry

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3		1	1							1	1	1
CO2	3	3		1	2							1	3	2
CO3	3	3		1	2							1	3	2
CO4	3	3		1	2							1	3	2
CO5	3	3		1	1							1	3	2

1 – Slight, 2 – Moderate, 3 – Substantial

14FTE12 CANE SUGAR TECHNOLOGY

3 0 0 3

Pre-requisites: Heat Transfer in Food Processing Operations, Food Process Engineering – II

UNIT – I **9**

Introduction and Preprocessing Operation: Brief account of sugar industry- composition of sugar cane, manufacturing process of sugarcane juice, types of cane sugar, terminology. Harvesting indices, Cane cutting – Manual and Mechanical, Transportation, Cane conveyor, Washing, Shredding.

UNIT – II **9**

Juice Extraction and Juice Concentration: Crushing –Types of crushers, crushing efficiency. Extraction of juice – methods. Accumulators – types. Maceration. Theory of cane diffusivity. Types of diffusers. Weighing of juice - Maxwell Boulogne Scale and Magnetic Flow Meters. Concentration - Importance- types of heaters- construction and working of tubular heater, Direct Contact Heater (DCH), Plate Heater (PHE), advantages and disadvantages. Evaporator- types- performance measures.

UNIT – III **9**

Clarification: Clarification – importance, methods, clarifying agent, bleaching agent. Role of pH, non-sugars, colloids and gums in cane juice clarification. Lime - specification, storage. Preparation of milk of lime, rotary lime slacker, classifier, MOL tanks, lime pumps, use of hydrated lime powder. Sulphur -specification and storage, production of sulphur dioxide gas, construction and working of sulphur burner, film type sulphur burner.

UNIT – IV **9**

Crystallization and Refining: Sugar boiling, Nucleation and crystal growth, super saturation and meta stable stage, seeding – shock seeding, true seeding. Crystallizers. Refining - Brown sugar, importance of refining, Affination, clarification, carbonation, sulphitation, phosphitation, decolorization, centrifugation - dewatering of sugar. Drying.Bagging and storage. Factors affecting sugar refining process.

UNIT – V **9**

Manufacturing of Jaggery/ Gur and other by products: Extraction of Juice, Clarification of Gur, Concentration of Juice, Drying and grading of Gur, Storage of Gur. Byproducts - Drying and uses of Bagasse - Back strap Molasses - Characteristics of Molasses. Direct Utilization of Molasses - Distilling Industries - Applications in animal feed – Biogas – Biofertilizers production- Inverted syrup.

TOTAL : 45

TEXT BOOKS:

1. Paturau J.M., "By-Products of the Cane Sugar Industry", 2nd Edition, Elsevier Publishing Company, New York, 1989.
2. Baikow V.E., "Manufacturing and Refining of Raw Cane Sugar", 2nd Edition, Volume - I and II, Elsevier Publishing Company, New York, 1967.

REFERENCE BOOKS:

1. Heriot T, H. P., "The Manufacture of Sugar From The Cane and Beet", Read Books, New York, 2007.
2. Ram BehariLal and Mathur, "Hand Book of Cane Sugar Technology", Oxford and IBH Publishing Company, New Delhi, 1995.
3. Chung Chi Chou, "Handbook of Sugar Refining: A Manual for the Design and Operation of Sugar Refining Facilities", John Wiley and Sons, 2000.
4. http://www.in.kpmg.com/pdf/indian_sugar_industry.pdf
5. https://www.britannica.com/topic/sugar-chemical-compound/Crystallization

COURSE OUTCOMES

On completion of the course the students will be able to

- CO1: identify sugar cane constituents and apply preprocessing operations
- CO2: recommend suitable cane juice extraction and concentration method
- CO3: choose appropriate clarification methods for sugarcane juice
- CO4: adapt crystallization and refining techniques
- CO5: apply the acquired knowledge for manufacturing of cane sugar by-products

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3											1	1	
CO2	3				3							1	1	
CO3	3				3							1	1	
CO4	3				2							1	1	2
CO5	3		1		2		1					1	3	1

1 – Slight, 2 – Moderate, 3 – Substantial

14FTE13 DRYING TECHNOLOGY

3 0 0 3

Pre-requisites: Heat transfer in Food Processing Operations, Mass Transfer in Food Processing Operations

UNIT – I **9**

Fundamentals of Drying: Drying and dehydration – Basics and principles. Mechanism of drying – Drying curves, Drying rate periods – constant and falling rate periods. Drying and Food Quality – Post-drying problems and In-drying problems. Effect of drying on Water activity, EMC, Sorption isotherms. Moisture diffusivities in food. Quality changes in food - Browning, color loss, shrinkage, solubility, texture and rehydration.

UNIT – II **9**

Types of Dryers: Classification of dryers – Based on mode of operation, mode of heat transfer – conduction, convection and radiation. Based on feed properties. Selection of dryers - energy costs, safety, and environmental factors. Conventional versus innovative drying techniques. Tray dryer – principle operational aspects and design.

UNIT – III **9**

Low Cost Drying methods: Solar drying. Types of solar dryers – Direct, Indirect and mixed mode. Green house solar dryers. Osmotic dehydration – Principal. Osmotic agents, Factors affecting osmotic dehydration. Effect of water activity. Osmo convective drying. Applications, Advantages and Limitations.

UNIT – IV **9**

Drying of Solids: Rotary dryer – Principle, Types, Applications. Freeze drying – Phase diagram of water, Principle – Freezing, Primary and Secondary drying stage. Fluidized bed drying - Principles of fluidization, Types of fluidized bed dryers. Pneumatic drying – Principle, Working mechanism, Applications.

UNIT – V **9**

Drying of Liquids and Slurries: Drum drying – principle. Types of drum driers – Single and double drum driers. Types of Feeding system. Foam mat drying – Principles, Foaming agents, Foaming Properties, Continuous foam mat dryer. Spray drying – Principle. Components of spray dryer -Atomizer types. Single stage and double stage spray dryer. Design aspects. Advantages and limitations.

TOTAL : 45

TEXT BOOKS:

1. Mujumdar A.S., "Handbook of Industrial drying", 3rd Edition, CRC press, Taylor and Francis group.UK.2007.
2. Xiao Dong Chen and Mujumdar A.S, "Drying Technologies in Food Processing", 1st Edition, Wiley-Blackwell, 2008.

REFERENCE BOOKS:

1. Jangam S.V., Chung Lim Law and Mujumdar A.S., "Drying of Foods, Vegetables and Fruits", Volume 1, Electronic Version, 2010.
2. Hii, C.L., Jangam S.V., SzePhengOng and Mujumdar, A.S., "Solar Drying: Fundamentals, Applications and Innovations", Electronic Version, 2012.
3. Toledo R.T., "Fundamentals of Food Process Engineering", Springer, 2007.
4. https://www.arunmujumdar.com/e-books.htm
5. https://www.asabe.org/media/184966/chapter_10_in_wilhelm_food_proc._eng._tech.pdf

COURSE OUTCOMES

On completion of the course the students will be able to

CO1: infer the mechanism and quality changes during drying
CO2: select suitable dryers for food products based on requirement
CO3: identify appropriate low cost drying methods
CO4: choose suitable dryers for solid food materials
CO5: recommend appropriate dryers for liquid food materials

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3											1		
CO2	3		2		3							2	3	1
CO3	3		3		3							2	3	1
CO4	3		2		3							2	3	1
CO5	3		3		3							2	3	1

1 – Slight, 2 – Moderate, 3 – Substantial

14FTE14 EMERGING TECHNOLOGIES IN FOOD PROCESSING

3 0 0 3

UNIT – I **9**

High Pressure Processing of Foods: High Pressure Processing – Principle - Description, Packaging requirements, Uses and Effects on food quality. High Pressure Regulations. Other applications of high pressure - High pressure freezing, High Pressure thawing, High Pressure non-frozen storage. **Pulsed Electric Field Processing:** Principle - Mechanism of action. PEF treatment systems - processing parameters. Applications. Safety aspects, Problems and challenges in PEF.

UNIT – II **9**

High Intensity Pulsed Light Technology: Principles of Pulsed Light Technology, Effect of Pulsed Light Technology on food products, enzymes and food properties. Systems for Pulsed Light Technology. **Irradiation of Foods:** Fundamentals of food irradiation - Definition, Doses of Irradiation. Biological effects of irradiation – effect on micro-organisms, parasites and insects, viruses, ripening and sprouting inhibition.

UNIT – III **9**

Ultrasound: Fundamentals of ultrasound, ultrasonic processing equipment, Inactivation of micro-organisms and enzymes. Application- mixing and homogenization, foam formation and destruction, precipitation of airborne powders, filtration and drying, extraction. **Ozonation**: Solubility, stability and reactivity of ozone. Antimicrobial properties of ozone. Ozone Treatment System. Food applications.

UNIT – IV **9**

Ohmic Heating: Ohmic Heating - fundamentals, electrical conductivity. Generic Configurations - Batch Configuration, Transverse Ohmic heating and Collinear Ohmic heating. Product suitability for thermal treatments. **Di-electrical Heating:** Dielectric properties of foods. Dielectric heating, difference between MW and RF. Microwave heating – working principle. Microwave processing of foods – baking, thawing, drying, pasteurization and sterilization. Radio-frequency heating – material properties, adopting RF technology, heating and drying application.

UNIT – V **9**

Novel Hybrid Drying Technologies: Need for hybrid drying systems. Hybrid systems - Heat pump drying, fluidized bed drying, combined microwave and vacuum drying, infra-red drying, superheated steam drying, pressure regulating drying, rotating jet spouted bed drying. **Automation:** Automation process control for food industry – introduction. Recent trends in tools of automation – Computer vision systems, On-line sensors, Expert systems, Robot Technology, Computer Integrated manufacturing.

TOTAL: 45

TEXT BOOKS:

1. Da-Wen Sun, "Emerging Technologies for Food Processing", 2nd Edition, Elsevier Academic Press, London, 2014.
2. Howard Q. Zhang, Gustavo V. Barbosa-Canovas, Balasubramaniam V.M., Dunne C. P., Farkas D.F. and Yuan J.T.C., "Non-thermal Processing Technologies for Food", 1st Edition, John Wiley and Sons Ltd., UK, 2011.

REFERENCE BOOKS:

1. Han, Jung H., "Packaging for Non-thermal Processing of Food", Wiley-Blackwell, Oxford, 2007.
2. Mujumdar A.S., "Handbook of Industrial drying", 4th Edition, CRC Press, UK, 2014.
3. Lelieveld H.L.M., "Food Preservation by pulsed electric fields: From research to application", Wood Head Publishing Ltd., England, 2007.
4. http://www.fao.org/3/a-x7133m/x7133m03.pdf
5. https://youtu.be/1jlX98QHQFs

COURSE OUTCOMES

On completion of the course the students will be able to

CO1: perceive the concepts and effects of high pressure processing
CO2: experiment with pulsed electric field and pulsed light technology for foods
CO3: adapt ultrasound and ozone techniques for foods
CO4: apply ohmic heating principle in food processing
CO5: choose novel drying techniques and adapt automation in food processing

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3		2		3	1						2	3	3
CO2	3		2		3	1						2	3	3
CO3	3		2		3	1						2	3	3
CO4	3		2		3	1						2	3	3
CO5	3		2		3	1						2	3	3

1 – Slight, 2 – Moderate, 3 – Substantial

14FTE15 MODELING, SIMULATION AND SOFT TOOLS FOR FOOD TECHNOLOGISTS

3 0 0 3

UNIT – I **9**

Introduction to Modeling: Physical, Mathematical and Chemical Systems. Modeling - Principles of model Formulation, Representation of Model, Fundamental Laws, Types of Modeling Equations, Black Box Principles, Boundary Condition, Validation of model. Benefits of modeling in food process.

UNIT – II **9**

Models in Fermentation: Introduction, Biological models - Genetic models, growth models, killing-off models and productions models. Technological models - heat transfer models, oxygen transfer models and mixing models. Economic models and mixed models. **Models in MAP:** Principle and methods, macro, micro and meso level models.

UNIT – III **9**

Modeling of Cooling and Freezing Processes: Introduction, modeling product heat load during cooling - single tank model and tank network model. Modeling product heat load during freezing. Numerical solution of heat conduction equation with phase change. Finite different models and element model. Modeling of combined heat and mass transfer - porous, non-porous foods, foods with impermeable skin and frozen foods.

UNIT – IV **9**

Modeling of Thermal Process: Types, basic equations - Microbiological and quality kinetics, thermal transport equations. Conduction equations, complex models for non-uniformity and convective flows, sterilization of liquids foods and foods containing particulates. Models for microwave and ohmic heating.

UNIT – V **9**

Soft Tools for Modeling of Food Processes: Soft tools for Sensory analysis, Mathematical analysis, data treatment tools, design tools, Simcad Pro simulation software, COMSOL, gPROMS.

TOTAL: 45

TEXT BOOKS:

1. Luyben W.L., "Process Modeling, Simulation and Control for Chemical Engineers", 2nd Edition, McGraw Hill Book Co., New York, 1990.
2. Tijskens L.M.M., Hertog T.M. and Nicolai B.M., "Food Process Modeling", CRC Press, 2001.

REFERENCE BOOKS:

1. Babu B.V., "Process Plant Simulation", Oxford University Press, New Delhi, 2004.
2. Farid M.M., "Mathematical Modeling of Food Processing", CRC Press, 2010.
3. Jun S. and Irudayaraj J.M., "Food Processing Operations modeling: Design and analysis", CRC Press, 2009.
4. https://www.iseki-food.net/sites/iseki-food.net/.../WebSeminar%202012-02-01.pdf
5. http://www.agrojournal.org/19/03-18.pdf

COURSE OUTCOMES

On completion of the course the students will be able to

CO1: apply the concepts of modeling in food processing

CO2: adapt suitable mathematical models in fermentation and MAP

CO3: illustrate the modeling concepts in cooling and freezing processes of foods

CO4: infer the models used in thermal processing of foods

CO5: make use of appropriate software for modeling processes

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	1	3							1	1	1
CO2	3	3	3	1	3							1	3	1
CO3	3	3	3	1	3							1	3	1
CO4	3	3	3	1	3							1	3	1
CO5	3	3	3	3	3							1	3	1

1 – Slight, 2 – Moderate, 3 – Substantial

14FTE16 ANALYTICAL INSTRUMENTS IN FOOD INDUSTRIES

3 0 0 3

Pre-requisites: Food Biochemistry, Food Chemistry

UNIT – I **9**

Spectrometry: Classification of Instrumental methods– Electromagnetic radiation – electromagnetic spectrum, Interaction of electromagnetic radiation with matter. Visible spectrometry and Colorimetry – Theory, Instrumentation (Line diagram alone) and applications. Ultra violet spectroscopy – Theory, instrumentation - Single and Double beam, applications. Infra-red spectroscopy – Theory, Fundamental Vibrations, Instrumentation, Applications.

UNIT – II **9**

Atomic Absorption and NMR Spectroscopy: AAS - Principle, Instrumentation and applications. NMR spectroscopy – Principle, Instrumentation, Chemical shift and applications. **Thermal methods:**Thermogravimetry, Differential thermal analysis, Differential Scanning Calorimetry – Principle, Instrumentation and Applications.

UNIT – III **9**

X-Ray and Flame Photometer: X-ray diffraction - Principle, instrumentation, detectors and applications. Flame photometer - Theory, Instrumentation and applications.Polarimetry - specific rotation, optical activity, Principle and instrumentation. Saccharimetery- Analysis of Sugar.

UNIT – IV **9**

Conductance and Potential Measurements: Definitions, conductance measurements, applications, Types, advantages and disadvantages of Conductometric titrations. Potential measurements, pH determination, Potentiometric Titrations. Basic principles of electrophoresis, theory and application of paper and gel.

UNIT – V **9**

Chromatographic Techniques: Introduction**,** Paper chromatography, Thin Layer Chromatography, Column Chromatography - Gas chromatography,HPLC – reverse phase and normal phase - Principle, Instrumentation and Applications.

TOTAL : 45

TEXT BOOKS:

1. Chatwal, Gurdeep R., and Anand, Sham K., "Instrumentation Methods of Chemical Analysis", 2nd Edition, Himalaya Publications, Bombay, 2003.
2. Willard H.H, Merritt L.L, Dean J.A, and Settle F.A., "Instrumental Methods of Analysis", 7th Edition, CBS Publishers and Distributors, New Delhi, 1988.

REFERENCE BOOKS:

1. Skoog Douglas A., West Donald M., Holler F James, and Crouch Stanley R., "Analytical Chemistry: An Introduction", 7th Edition, South-Western, Australia, 2000.
2. Rouessac F., "Chemical Analysis: Modern International Method and Techniques", 3rd Edition, Wiley, New Delhi, 1999.
3. Banwell G.C., "Fundamentals of Molecular Spectroscopy", 2nd Edition, Tata McGraw-Hill, New Delhi, 1992.
4. https://www.youtube.com/watch?v=J-wao0O0_qM
5. **https://www.**nptel.ac.in/courses/104108078/

COURSE OUTCOMES

On completion of the course the students will be able to

CO1: interpret the application of UV-Visible and IR spectroscopy in food analysis

CO2: make use of AAS, NMR and thermal methods to analyze different food materials

CO3: apply X-ray diffraction, flame photometers and polarimetry in food analysis

CO4: recognize the usage of conductance and potential measurements for analysis of components

CO5: infer the chromatographic principles to separate and analyze materials

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3		3	2							1	3	2
CO2	3	3		2	2							1	3	2
CO3	3	3		3	2							1	3	1
CO4	3	3		2	2							1	3	2
CO5	3	3		3	2							1	3	3

1 – Slight, 2 – Moderate, 3 – Substantial

14FTE17 SEPARATION TECHNIQUES IN FOOD PROCESSING

3 0 0 3

Pre-requisites: Food Process Engineering II

UNIT – I **9**

Mechanism of Separation and Filtration Processes: Review of conventional processes. Recent advances in separation techniques based on size, surface properties, ionic properties and other special characteristics of substances. Process concept, theory and equipment used in cross flow filtration, cross flow electro filtration, dual functional filter, Surface based solid – liquid separations involving a second liquid, Sirofloc filter.

UNIT – II **9**

Membrane Separation: Types and choice of membranes, membrane module- Plate and frame, tubular, spiral wound and hollow fibre. Membrane processes - dialysis, reverse osmosis, Nanofiltration, ultrafiltration, Microfiltration and Donnan dialysis. Membrane fouling – cleaning techniques.

UNIT – III **9**

Adsorption and Chromatography: Mechanism, Types and choice of adsorbents, adsorption techniques – pressure swing and temperature swing cycles. Affinity and Immuno-chromatography. Large scale chromatography – theory and general system.

UNIT – IV **9**

Ionic Separation and Permeation: Controlling factors, Applications, Types of equipment employed for electrophoresis, Dielectrophoresis, ion exchange chromatography and electrodialysis. Separations involving pervaporation and permeation techniques for solids, liquids and gases.

UNIT – V **9**

Other Separation Processes: Zone melting, Adductive crystallization, Supercritical fluid extraction, Oil spill Management, Industrial effluent treatment by modern techniques.

TOTAL : 45

TEXT BOOKS:

1. Seader J.D., Ernest J. Henley and Keith Roper D., "Separation Process Principles", 3rd Edition, John Wiley and Sons Inc., New York, 2011.
2. Roussel Ronald W., "Handbook of Separation Process Technology", John Wiley, New York, 2008.

REFERENCE BOOKS:

1. Scott K. and Hughe R., " Industrial Membrane Separation Technology", Blackie Academic and Professional Publications, Glasgow, 1996.
2. Schoen H.M., "New Chemical Engineering Separation Techniques", Inter-science Publishers, New York, 1972.
3. Humphrey Jimmy L., George E. Keller II., "Separation Process Technology", McGraw-Hill Publishing Company Ltd., USA, 1997.
4. http://www.internetchemistry.com/chemistry/separation-processes.htm
5. http://nptel.ac.in/downloads/103105060/

COURSE OUTCOMES

On completion of the course the students will be able to

CO1: infer the concepts of separation and filtration techniques
CO2: select suitable membrane process and cleaning techniques
CO3: classify and adapt appropriate adsorption techniques
CO4: apply the concepts of ionic separation and permeation
CO5: elaborate other separation processes and effluent treatment

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2			1	2					1	2	1
CO2	3	2	2		3	1	2					2	3	2
CO3	3	2	3		3	1	2					1	2	2
CO4	3	2	3		3	1	2					1	2	1
CO5	3	2	2			2	3					2	3	2

1 – Slight, 2 – Moderate, 3 – Substantial

14FTE18 WASTE MANAGEMENT AND BY-PRODUCT UTILIZATION IN FOOD INDUSTRIES

3 0 0 3

Pre-requisites: Fruits and Vegetable Processing Technology, Dairy Engineering, Meat, Fish and Poultry process Technology

UNIT – I **9**

Importance and Characteristics of Industrial Waste: Classification of waste, characterization of waste, magnitude of waste generation in different food processing industries, importance of waste management, Economical aspects of waste treatment and disposal, Strategies for minimizing waste, Application of 3R's and life cycle assessment (LCA).

UNIT – II **9**

Waste Treatment Methods: Membrane separation, advanced oxidation/reduction, electrolytic methods, up-flow anaerobic sludge blanket (UASB), aerobic and anaerobic methods, activated sludge treatment, sludge thickening, sludge conditioning, sludge dewatering, composting and incineration, land filling, vermicomposting.

UNIT – III **9**

By Products from Oil Seed and Tuber Processing Industries: Oil processing industries – Introduction, De-oiled cake, animal feed, fertilizer, bio sorbents, waxes, soap stock, cocoa butter replacer. Tuber processing industries- Introduction, enzyme production, biogas, bakers yeast, bio-ethanol, animal feed, corn syrup, organic acids, nutraceuticals.

UNIT – IV **9**

By Products from Animal Product based Industries: Dairy industry - Introduction- opportunities – whey, bio surfactants, bacteriocin. Meat, fish, poultry processing industries- bio active peptide, protein extract, gelatin, heparin, pepsin, bio molecule from bone and blood, keratin form animal hair, bone meal, meat meal,chondroitin sulfate, squalene, fish oil, micro nutrients- vitamins and minerals, pigments.

UNIT – V **9**

By Products from Milling, Fruits and Vegetables Processing Industries: Milling industries- introduction, bran utilization-dietary fibre, substrate for mushroom cultivation and enzyme production, briquettes, edible oils. Fruits and vegetable processing industries- current scenario in waste generation- anti oxidants, natural colorants and flavors, pectin and other poly saccharides, organic acids, adsorbent, phyto chemicals.

TOTAL : 45

TEXT BOOKS:

1. Chandrasekaran M., "Valorization of Food Processing By-Products", CRC Press, 2013.
2. Vasso Oreopoulou and Winfried Russ, "Utilization of By-Products and Treatment of Waste in the Food Industry", Springer Science Business Media, USA, 2007.

REFERENCE BOOKS:

1. Keith Waldron, "Handbook of waste management and co-product recovery in food processing", Wood head Publishing Ltd., England, 2007.
2. Green J.H. and Kramer A., "Food Processing Waste Management", AVI Publishing Company, Malaysia,1981.
3. Nelson L. Nemerow and Franklin J. Agardy, "Strategies of Industrial and Hazardous Waste Management", John Wiley and Sons, 1998.
4. http://nptel.ac.in/courses/120108005/module6/lecture6.pdf
5. http://nptel.ac.in/courses/120108005/module8/lecture8.pdf

COURSE OUTCOMES

On completion of the course the students will be able to

CO1: classify food waste and recommend the strategies for waste minimization
CO2: identify the method for treatment of liquid and solid waste
CO3: utilize residues from oil seed and tuber processing industries
CO4: elaborate by-product production from animal product based industries
CO5: develop by-products from grain, fruits and vegetables processing

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3		1			3						1		1
CO2	3		2		1	2	3					1		2
CO3	3	2	3		1	3	3					1	3	
CO4	3	2			1	2	3					1	3	
CO5	3	2	3		1	3	3					1	3	

1 – Slight, 2 – Moderate, 3 – Substantial

14GEE81 ENTREPRENEURSHIP DEVELOPMENT

(Common to all Engineering and Technology branches except Civil and Chemical Engg.)

3 0 0 3

UNIT – I **9**

Entrepreneurship Concepts: Meaning and concept of entrepreneurship, Role of Entrepreneurship in Economic Development. Factors affecting Entrepreneurship – Creativity, Innovation and Entrepreneurship, Intrapreneurship

UNIT – II **9**

Entrepreneur: Definition, Entrepreneurial Motivation, Characteristics of Entrepreneurs, Distinction between an Entrepreneur and a Manager.

UNIT – III **9**

Business Plan: Objectives of a Business Plan, Business Planning Process, Opportunity Identification and Selection, Contents of a Business Plan, Functional Plans.

UNIT – IV **9**

Entrepreneurial Eco System: Forms of Business Ownership, Sources of Finance, Institutional Support to Entrepreneurs.

UNIT – V **9**

Small Business Management: Definition of Small Scale Industries, Strengths and Weaknesses of Small Business, Growth Strategies in Small Scale Enterprises, Sickness in Small Enterprises – Symptoms, Causes and Consequences.

TOTAL : 45

TEXT BOOK:

1. S.S.Khanka, "Entrepreneurial Development", 4th Edition, S.Chand & Company Ltd., 2012.
2. Madhurima Lall and Shikha Sahai, "Entrepreneurship", 2nd Edition, Excel Books, New Delhi, 2008.

REFERENCE BOOKS:

1. Raj Shankar, "Entrepreneurship, Theory and Practice", Vijay Nicole Imprints Pvt. Ltd., Chennai 2012.
2. Barringer and Ireland, "Entrepreneurship", 3rd Edition, Pearson Education, 2012.
3. Zimmer and Scarborough, "Essentials of Entrepreneurship and Small Business Management", 5th Edition, PHI Learning Pvt. Ltd., 2009.

COURSE OUTCOMES

On completion of the course the students will be able to

CO1: understand the concepts of entrepreneurship and its importance

CO2: understand the traits of an entrepreneur and the sources of his motivation

CO3: understand the components of a business plan

CO4: demonstrate knowledge of various sources of finance and institutions supporting entrepreneurship

CO5: understand the nature of small business and causes of industrial sickness

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1						1	3	2	3		3	2	1	1
CO2						1	3	2	3		3	2	1	1
CO3				2		1	3	2	3		3	2	1	1
CO4				1		1	3	2	3		3	2	1	1
CO5		2		2		1	3	2	3		3	2	1	1

1 – Slight, 2 – Moderate, 3 – Substantial

14FTO01 ENERGY MANAGEMENT IN PROCESS INDUSTRIES

3 0 0 3

UNIT – I **9**

Energy and Energy Analysis: Energy, unit of energy, energy consumption and GDP, energy and environment – carbon dioxide emission, depletion of ozone layer. Energy supply: Primary energy, delivered energy, electricity supply, natural gas, fuel oils, renewable energy. Energy analysis - Annual Energy Consumption, Normalized Performance Indicators, Time-Dependent Energy Analysis. Energy Management - Organizational Structure, Energy Policy and Planning.

UNIT – II **9**

Energy Audits and Surveys: Energy Audit - types, Preliminary Energy Audits, Comprehensive, Energy Surveys and Audit report. Energy Monitoring, Targeting and Waste Avoidance - Concept of monitoring and targeting, Computer-Based M and T, Monitoring and Data Collection, Energy Targets, reporting techniques, Diagnosing Changes in Energy Performance, waste avoidance, Prioritizing.

UNIT – III **9**

Energy Conservation in Thermal Systems: Energy conservation in steam generation –energy analysis, energy recovery - through optimal design, from flue gas, from blow down water. Steam distribution system – heat loss, energy efficiency and energy conservation. Waste heat recovery - heat pumps, heat exchangers. Thermal energy storage- storage systems, storage materials, hot thermal energy and cooling energy storage.

UNIT – IV **9**

Energy Conservation in Power, Electrical and Mechanical Systems: Sources of energy loss – low power factor, improper motor load, poor control. Energy conservation - Power Factor Improvement, Replacement with High-Efficiency Motors and electronic adjustable speed motors. Energy Conservation in Mechanical systems**:** Compressed air system **–** sources of energy losses. Energy conservation – high efficiency motor, repairing of air leaks, reduced air pressure and air inlet temperature. Localized air delivery system.

UNIT – V **9**

Energy Conservation in Food Processing Units: Dairy Processing - Potential Energy Conservation measures in pasteurization, cooling, concentration and drying. Fruit and Vegetable Processing – energy flow in canned products, energy conservation measures in blanching, pasteurization, sterilization. Energy conservation in Baking and confectionery units. Thermochemical Conversion of Food Processing Wastes for Energy Utilization – pyrolysis, gasification and liquefaction.

TOTAL : 45

TEXT BOOKS:

1. Beggs Clive, "Energy: Management Supply and Conservation", 2nd Edition, Butterworth-Heinemann, USA, 2002.
2. Lijun Wang, "Energy Efficiency and Management in Food Processing Facilities", CRC Press, 2008.

REFERENCE BOOKS:

1. Wayne C. Turner, "Energy Management Handbook", 4th Edition, The Fairmont Press, Inc, 2001.
2. Klemes J, R. Smith, Santa Barbara, J-K Kim, "Handbook of Water and Energy Management in Food Processing", 1st Edition, Woodhead Publishing, 2008.
3. Chakrabarti Allan, "Energy Engineering and Management", PHI Learning Pvt. Ltd., 2011.
4. https://www.beeindia.gov.in/content/energy-auditors
5. http://www.em-ea.org/download.asp

COURSE OUTCOMES

On completion of the course the students will be able to

- CO1: identify energy sources and analyze the energy consumption
- CO2: plan and perform energy audits and survey
- CO3: achieve energy conservation in thermal systems
- CO4: recommend energy conservation measures in power, electrical and mechanical systems
- CO5: apply energy conservation practices in food industries

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	2			1					1	1	
CO2	3	2		2								1	1	
CO3	3	2		2								1	1	2
CO4	3	2		2								1	1	2
CO5	3	2		2		3							1	2

1 – Slight, 2 – Moderate, 3 – Substantial

14FTO02 DESIGN OF EXPERIMENTS

3 0 0 3

UNIT – I **9**

Introduction: Definition and Basic Principles of design of experiments (DOE) – Randomization, replication and blocking. Purpose of experimental design. Guidelines for designing experiments- defining research problem, selection of factors, levels and range, selection of the response variable, choice of experimental design, performing the experiment, statistical analysis of the data, conclusion and recommendation.

UNIT – II **9**

Experimental Designs: Introduction, elimination of extraneous variables, handling many factors simultaneously, single factor design, full factorial design, fractional factorial design, RSM, composite design, central composite design, Box-Behnken design, Taguchi design, application of various designs in food processing research.

UNIT – III **9**

Statistical Analysis: Simple discrete and continuous distributions, statistical inference, hypothesis and estimation, Point and interval estimates, control charts, analysis of variance. Regression analysis – linear, multiple, polynomial and nonlinear regression. Correlation analysis – linear and multiple linear regressions.

UNIT – IV **9**

Data Analysis and Modeling: Concept of cluster analysis, factor analysis, principal component analysis, mathematical and statistical modeling, interpretation of model parameters and selection criteria for best models, validation of models. Application of software's in data processing – Spread sheet, MatLab – curve fitting tools, Statistical analysis of data – Design expert and Minitab. Graphical representations of data analysis – Spread sheet and OriginPro.

UNIT – V **9**

Optimization: optimization of first order models –new region exploration, steepest ascent/descent methods. Optimization of unconstrained functions – Newton's method, Quasi-Newton methods, polynomial approximation methods. Unconstrained optimization of second order models – Canonical analysis and Ridge analysis. Optimization of multi response analysis – regressional desirability approach. Nonlinear programming approaches.

TOTAL : 45

TEXT BOOKS:

1. Montgomery D.C., "Design and Analysis of Experiments", 5th Edition, John and Wiley Sons Inc., New York, 2001.
2. Lazic Z.R., "Design of Experiments in Chemical Engineering – A Practical Guide", Wiley-VCH Verlag GmbH and Co., Weinheim, 2004.

REFERENCE BOOKS:

1. Castillo E.D., "Process Optimization – A Statistical Approach", Springer Science Business Media, USA, 2007.
2. Antony J., "Design of Experiments for Engineers and Scientists", Butterwoth-Heinemann an imprint of Elsevier, USA, 2003.
3. Hoshmand A.R., "Design of Experiments for Agriculture and the Natural Sciences", CRC Press, 2006.
4. http://www.ift.org/~/media/Knowledge%20Center/Publications/Books/Samples/IFTPressBoook_MathematicalAndStatisticalMethods_PreviewChapter.pdf
5. http://www.scielo.br/scielo.php?script=sci_arttext&pid=S0101-74382011000300008

COURSE OUTCOMES

On completion of the course the students will be able to

- CO1: infer the basics concepts in designing experiments
- CO2: propose a suitable experimental design
- CO3: analyze the data statistically
- CO4: utilize appropriate software in data analysis and modeling
- CO5: solve research problem through optimization techniques

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3		3	2							1	3	1
CO2	3	3		3	3							1	3	1
CO3	3	3		3	3							1	3	1
CO4	3	3		3	3							1	3	1
CO5	3	3		3	3							1	3	1

1 – Slight, 2 – Moderate, 3 – Substantial

14FTO03 FOOD PROCESS PLANT LAYOUT AND SAFETY

3 0 0 3

UNIT – I **9**

Selection of Plant Layout: Introduction and classification of food plants, Site selection of plant. Plant location factors plant lay out advantages types of layout-characteristics of an efficient layout. Techniques of plant layout. General requirements and considerations for construction, materials and floors. Drains and drain layout. Ventilation, fly control, mould prevention, illumination in food plants.

UNIT – II **9**

Industrial Safety: Process industries, potential hazards, toxic chemicals and physical safety analysis, high pressure, high temperature operation, radioactive materials, safe handling and operation of machineries.

UNIT – III **9**

Safety Performance: Safety Appraisal, effective steps to implement safety procedures, periodic inspection and safety procedures; proper selection and replacement of handling equipments, personal protective equipments.

UNIT – IV **9**

Accidents: Industrial accidents – accident costs – identification of accident spots, remedial measures, identification and analysis of causes of injury to men and machines – accident prevention – accident proneness – vocational guidance, fault free analysis. Fire prevention and fire protection.

UNIT – V **9**

Health Hazards and Legal Aspects: Health hazards – occupational – industrial health hazards – health standards, and rules – safe working environments – parliamentary legislations – factories act – labour welfare act – ESI Act – Workmen Compensation Act.

TOTAL : 45

TEXT BOOKS:

1. Handley William, "Industrial Safety Hand Book", 2nd Edition, McGraw Hill, New York, 1969.
2. Fawatt H.H. and Wood W.S., "Safety and Accident Prevention in Chemical Operation", 2nd Edition, Inter-science, New York, 1984.

REFERENCE BOOKS:

1. Heinrich H.W., Dan Peterson P.E. and Nester Rood, "Industrial Accident Prevention", 2nd Edition, McGraw-Hill Book Co., 1980.
2. Blake R.P., "Industrial Safety", 3rd Edition, Prentice Hall Inc., New Jersey, 1993.
3. Amit Gupta, 'Industrial Safety and Environment", 2nd Edition, Laxmi Publications Pvt. Ltd., New Delhi, 2006.
4. www.kopykitab.com/Industrial-Safety-And-Environment-by-Er-A-K-Gupta
5. https://www.eolss.net/sample-chapters/C10/E5-10-05.pdf

COURSE OUTCOMES

On completion of the course the students will be able to

CO1: design the plant layout

CO2: identify different industrial hazards

CO3: appraise the industrial safety performance and safety procedures

CO4: apply the acquired knowledge for prevention of industrial accidents

CO5: perceive the health hazards and legal aspects in industries

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	3			1	2					1	1	2
CO2	1	1	3			2	2					1	1	3
CO3	1	2	3			3	2					1	1	3
CO4	1	1	3			3	2					1	1	3
CO5	1	1	3			3	2					2	1	2

1 – Slight, 2 – Moderate, 3 – Substantial

14FTO04 FUNDAMENTALS AND APPLICATIONS OF NANOTECHNOLOGY

3 0 0 3

UNIT – I **9**

Classification and Properties: Introduction,Classifications of nanostructured materials: Zero, One, Two and Three dimensional structure, Size control of metal Nanoparticles and their properties: Optical, Electronic, Magnetic properties. Surface plasma Resonance, Change of band gap.

UNIT – II **9**

Synthesis of Nano Materials: Introduction to synthesis of nanostructure materials, Bottom-up approach and Top-down approach. Physical methods - ball milling, sputtering, evaporation. Chemical methods - photochemical synthesis, electrochemical synthesis, co-precipitation method. Thermolysis route - spray pyrolysis. Biological methods – bacteria, fungi and actinomycetes

UNIT– III **9**

Characterization Techniques: Structural Characterization techniques - X-ray Photoelectron Spectroscopy (XPS), Energy Dispersive X-ray analysis (EDAX). Spectroscopic Techniques - UV- Visible Spectroscopy, Fourier Transform infrared (FTIR) spectroscopy. Microscopy Techniques - Scanning electron microscopy (SEM), Transmission electron microscopy (TEM), Atomic force microscopy (AFM).

UNIT – IV **9**

Applications of Nano Particles: Applications of nanoparticles as delivery systems for improved natural colorant solubility, improved vitamin bioavailability, improved flavour retention and improved antimicrobial activity. Nano polymers in water purification.

UNIT – V **9**

Nanotechnology in Food Processing: Nanoencapsulation – controlled release, consecutive delivery of multiple active ingredients. Food safety and biosecurity – Contaminant detection. Nano Packaging – Nano composite films, nano fillers, nano coatings, nano barriers.

TOTAL : 45

TEXT BOOKS:

1. Guozhong Cao and Ying Wang, "Nanostructures and Nanomaterials: Synthesis, Properties, and Applications", 2nd Edition, World Scientific Publishing Co., Singapore, 2011.
2. Rai M., Ribeiro C., Mattoso L., and Duran N., "Nanotechnologies in Food and Agriculture", Springer International Publishing, Switzerland, 2015.

REFERENCE BOOKS:

1. Charles P. and Frank J. Owens, "Introduction to Nanotechnology", John Wiley and Sons, USA, 2003.
2. Akhlesh Lakhtakia, "The Handbook of Nanotechnology. Nanometer Structures: Theory, Modeling, and Simulation", SPIE Publications, USA, 2004.
3. Qingrong Huang, "Nanotechnology in the Food, Beverage and Nutraceutical Industries", 1st Edition, Woodhead Publishing, 2012.
4. http://www.ift.org/knowledge-center/read-ift-publications/science-reports/scientific-status-summaries/functional-materials-in-food-nanotechnology.aspx
5. http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.469.30&rep=rep1&type=pdf

COURSE OUTCOMES

On completion of the course the students will be able to

CO1: classify nanomaterials and identify its properties
CO2: Develop nanoparticles using different methods
CO3: Apply instrumental techniques for characterization of nanoparticles
CO4: improve food quality by employing nanoparticles
CO5: adapt nanotechnology in food processing

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3										1	1	1
CO2	2	3	3	1								2	3	1
CO3	3	3		3								2	2	1
CO4	3	3	2	3								2	3	2
CO5	3	3	3	3								2	3	2

1 – Slight, 2 – Moderate, 3 – Substantial

14FTO05 COMPUTATIONAL FLUID DYNAMICS FOR FOOD PROCESSING

3 0 0 3

UNIT – I **9**

Introduction to CFD: Introduction to CFD - Theory of CFD modeling - Conservation of mass, Momentum Equation, Energy Equation, Navier Stokes Equation. Classification of simple PDEs and fluid flow equations.

UNIT – II **9**

Turbulence and Modeling: Transition from laminar to turbulent flow, Effect of turbulence on time-averaged Navier-Stokes equations, Characteristics of simple turbulent flows - Free turbulence models, turbulent flow calculations, Direct numerical simulation.

UNIT– III **9**

The Finite Volume Method for Diffusion Problems: Introduction - One dimensional steady state diffusion, two dimensional and three dimensional diffusions. The central differencing scheme, The upwind differencing scheme, the hybrid differencing scheme, the power-law scheme, higher order differencing schemes.

UNIT – IV **9**

CFD Analysis: CFD Applications in Food Processing, Spray Drying-Air Flow Pattern, Atomization, air-particle interaction, Residence time of the particle, Particle deposition and position. Modeling in Bread Baking Process.

UNIT – V **9**

Applications of CFD: Canning of foods, Canned solid liquid food mixtures, Bacterial Deactivation kinetics, analysis of fluid flow pattern during sterilization, Thermal processing of canned foods, Other applications in food processing.

TOTAL : 45

TEXT BOOKS:

1. Anandharamakrishnan C., "Computational Fluid Dynamics Applications in Food Processing", Springer Science and Business Media, Germany, 2013.
2. Da-Wen Sun, "Computational Fluid Dynamics in Food Processing", CRC Press, New York, 2007.

REFERENCE BOOKS:

1. Versteeg H.K. and Malalasekara W., "An Introduction to Computational Fluid Dynamics", 2nd Edition, Pearson Education Ltd., England, 2007.
2. Anderson John, "Computational Fluid Dynamics – The Basics with Applications", McGraw Hill, 1995.
3. Lomax H., Pulliam T.H. and Zingg D.W., "Fundamentals of Computational Fluid Dynamics", 1st Edition, Springer Science and Business Media, Germany, 2004.
4. https://www3.nd.edu/~gtryggva/CFD-Intro.pdf
5. http://nptel.ac.in/courses/103106073/1

COURSE OUTCOMES

On completion of the course the students will be able to

CO1: apply the knowledge of fluid dynamics in developing fluid flow models

CO2: make use of the models to study the effect of turbulence and its characteristics

CO3: apply finite volume method for developing solution of steady state diffusion processes

CO4: analyze the spray drying and baking processes using the basic theories of fluid dynamics

CO5: gain knowledge on applications of CFD in food processing operations

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1	1		2							1		1
CO2	3	2	1	3	3							1		1
CO3	3	2	3	3	3							1		1
CO4	3	3	3	3	3							2	3	
CO5	3	3	3	2	3							2	3	

1 – Slight, 2 – Moderate, 3 – Substantial

14FTO06 INDUSTRIAL WASTE WATER TREATMENT

3 0 0 3

UNIT – I **9**

Physical Methods: Principles of Screening – Mixing, Equalization – Sedimentation - Filtration, back washing – Accelerated gravity separation – Evaporation- Adsorption– Principles, - Membrane separation - Reverse Osmosis, nanofiltration, ultrafiltration – electrodialysis.

UNIT – II **9**

Chemical Methods: Principles of Chemical treatment – Coagulation, flocculation - Precipitation – floatation – Disinfection. Ion exchange, Electrolytic methods, Solvent extraction – ozonation, advances oxidation/reduction.

UNIT – III **9**

Biological Treatment-Aerobic: Objectives of biological treatment – significance – kinetics of biological growth – Biological treatment process – aerobic suspended growth treatment process-activated sludge process, aerated lagoons, stabilization ponds, oxidation ditch - aerobic attached growth treatment process-trickling filters.

UNIT – IV **9**

Biological Treatment-Anaerobic: Rotating biological contactors - anaerobic suspended growth treatment process-anaerobic digestion, USAB - anaerobic attached growth treatment process-anaerobic filter process expanded bed.

UNIT – V **9**

Solid Waste Management and Design Aspects: Sludge treatment process, sludge thickening, sludge digestion, sludge conditioning, sludge dewatering, composting, – incineration -thermal reduction and disposal of sludge. Selection of unit operations and processes - Design of water treatment plant units – aerators, flocculation, clarifier, filters, chlorinators and thickeners.

TOTAL : 45

TEXT BOOKS:

1. Metcalf and Eddy, "Waste water Engineering, Treatment and Reuse", 4th Edition, Tata McGraw-Hill, New Delhi, 2003.
2. Qasim S.R., Motley E.M. and Zhu G., "Water Works Engineering: Planning, Design and Operation", Prentice Hall, New Delhi, 2002.

REFERENCE BOOKS:

1. Punmia B.C. and Ashok Jain, "Waste water Engineering", Arihant Publications, Jodhpur, 1996.
2. McCabe Warren L, Smith Julian C and Harriott Peter, "Unit operations of Chemical Engineering", 6th Edition, McGraw-Hill, New York, 2005.
3. Eckenfelder W.W., "Industrial Water Pollution Control", McGraw-Hill, 1999.
4. http://www.nptelvideos.com/video.php?id=1118
5. http://freevideolectures.com/Course/99/Water-and-Wastewater-Engineering/36

COURSE OUTCOMES

On completion of the course the students will be able to

CO1: adapt appropriate physical method for treating waste water

CO2: recommend suitable chemical method for waste water treatment

CO3: elaborate waste water treatment by aerobic method

CO4: make use of anaerobic treatment for industrial effluent

CO5: plan a wastewater treatment unit and manage solid waste

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1	1	1	2	2	3					1	1	2
CO2	3	1	1	1	2	2	3					1	1	2
CO3	3	2	1	1	2	2	3					1	1	2
CO4	3	2	1	1	2	2	3					1	1	2
CO5	3	1	2	2	2	3	3					1	1	2

1 – Slight, 2 – Moderate, 3 – Substantial