BIRLA INSTITUTE OF TECHNOLOGY

NEP-2020 CURRICULUM BOOK
(Effective from Academic Session: Monsoon 2024)

Bachelor of Technology

CENTRE FOR FOOD ENGINEERING AND TECHNOLOGY

Institute Vision

To become a Globally Recognized Academic Institution in consonance with the social, economic and ecological environment, striving continuously for excellence in education, research, and technological service to the National needs.

Institute Mission

- To educate students at Undergraduate, Postgraduate, Doctoral, and Post-Doctoral levels to perform challenging engineering and managerial jobs in industry.
- To provide excellent research and development facilities to take up Ph.D. programmes and research projects.
- To develop effective teaching learning skills and state of art research potential of the faculty.
- To build national capabilities in technology, education, and research in emerging areas.
- To provide excellent technological services to satisfy the requirements of the industry and overall academic needs of society.

Centre Vision:

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

Centre Mission

1. To improve food especially Indian traditional food in terms of nutrition, safety and functionality employing fundamental and applied sciences.
2. To produce trained personnel of highest standards for the benefit of the industry and society in the field of Food Engineering & Technology.
3. To provide leadership qualities in areas of education, research, innovations and solutions in food technology, and engineering in order to direct overall activity towards economic growth of India.

Graduate Attributes

1.Engineering Knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to develop to the solution of complex engineering problems.

2. Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4)

3. Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society
and environment as required. (WK5)

4. Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8).

5. Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems. (WK2 and WK6)

6. The Engineer and The World: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment. (WK1, WK5, and WK7).

7. Ethics: Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws. (WK9)

8. Individual and Collaborative Team work: Function effectively as an individual, and as a member or leader in diverse/multi-disciplinary teams.

9. Communication: Communicate effectively and inclusively within the engineering community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language, and learning differences

10. Project Management and Finance: Apply knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, and to manage projects and in multidisciplinary environments.

11. Life-Long Learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change. (WK8)

Programme Educational Objectives (PEOs)

PEO 1: To develop knowledge and understanding about systems in the production, processing and consumption of food and an appreciation of their impact on society.

PEO 2: To impart knowledge about the nature of food and human nutrition and an appreciation of the importance of food to health.

PEO 3: To build up skills in researching, analyzing and communicating issues related to food preservation, processing, storage and packaging.

PEO 4: To enhance skills in experimenting with and development of food products and equipment by applying theoretical concepts.

PEO 5: To develop skills in designing, implementing and evaluating solutions to food industry situations.

(A) Programme Outcomes (POs)

Engineering Graduates will be able to:

1.Engineering Knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to develop to the solution of complex engineering problems.

2. Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4)

3. Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society
and environment as required. (WK5)

4. Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8).

5. Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems. (WK2 and WK6)

6. The Engineer and The World: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment. (WK1, WK5, and WK7).

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8. Individual and Collaborative Team work: Function effectively as an individual, and as a member or leader in diverse/multi-disciplinary teams.

9. Communication: Communicate effectively and inclusively within the engineering community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language, and learning differences

10. Project Management and Finance: Apply knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, and to manage projects and in multidisciplinary environments.

11. Life-Long Learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change. (WK8)

(B) Programme Specific Outcomes (PSOs)

PSO 1: Students will develop ability to evaluate the impact and apply good manufacturing practices in food industry on the individual, society & environment with success skills in interpretation, communication, critical thinking, interaction, information acquisition, organization, professionalism, leadership, auto-didactics and life-long-learning.

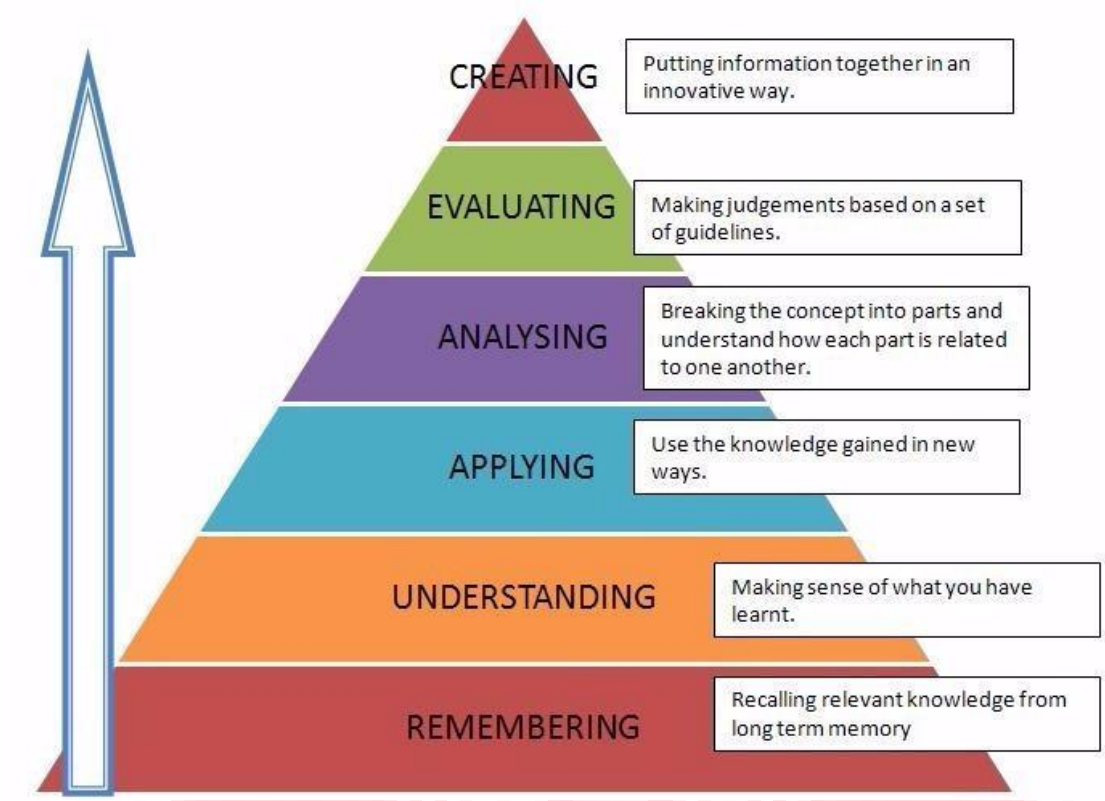
PSO 2: Students will develop ability to explain the role of nutrients in human health and develop, prepare and present food products using modern processing, preservation and packaging techniques, and lean to analyze them in quality perspective.

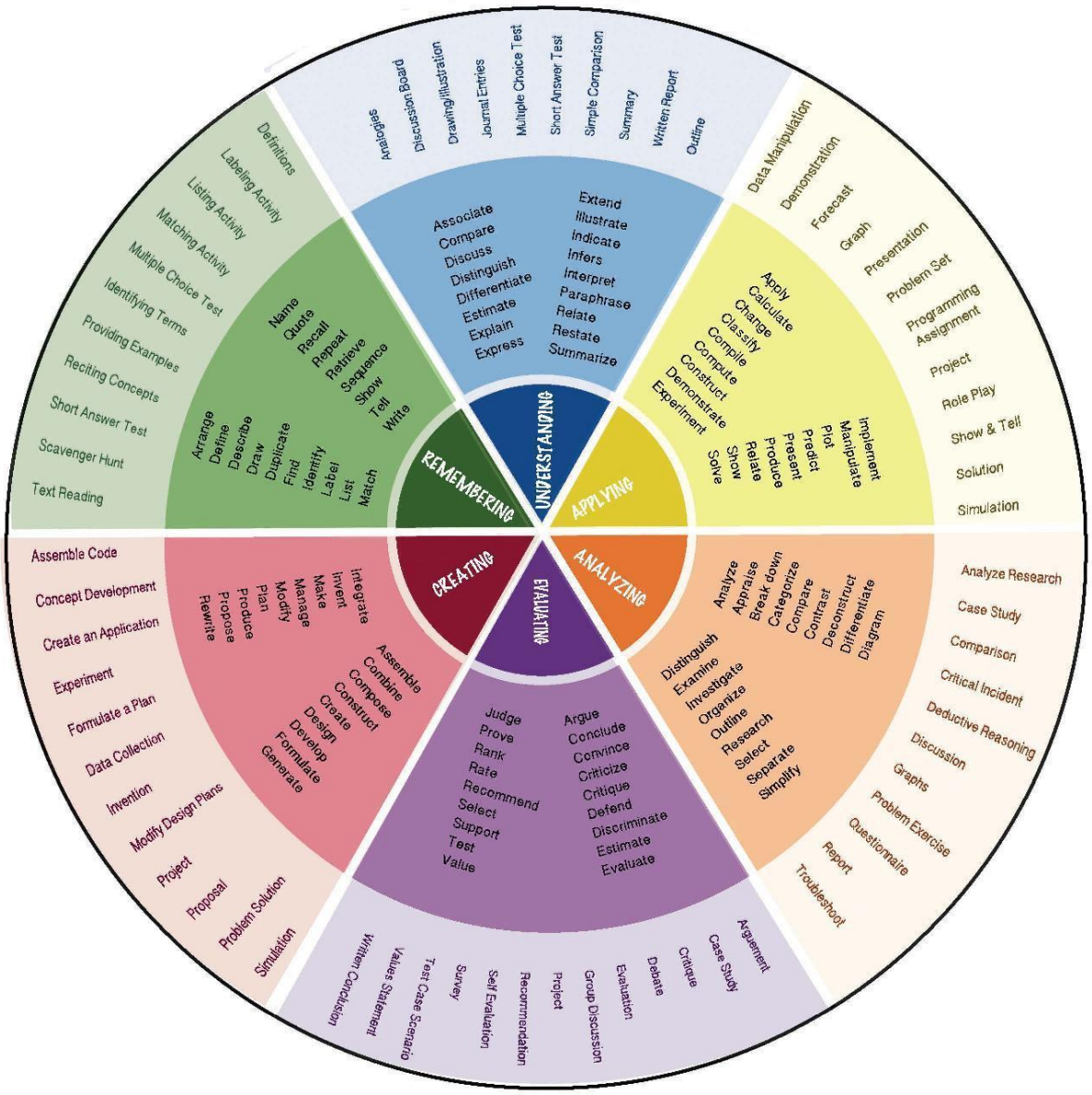
PSO 3: Students will be prepared to be professionals with the skills and know-how that will enable them to explain and understand manufacturing processes and technologies used in the production of food products, examine the nature and extent of the food industry, justify processes of food product manufacturing and equipment design in terms of market, technological and environmental considerations.

BLOOM'S TAXONOMY FOR CURRICULUM DESIGN AND ASSESSMENT:

Preamble

The design of curriculum and assessment is based on Bloom's Taxonomy. A comprehensive guideline for using Bloom's Taxonomy is given below for reference.




REMEMBERING
UNDERSTANDING
APPLYING
ANALYZING
EVALUATING
CREATING
Name
Quote
Recall
Repeat
Retrieve
Sequence
Show
Tell
Write
Arrange
Define
Describe
Draw
Duplicate
Find
Identify
Label
List
Match
Definitions
Labeling Activity
Listing Activity
Matching Activity
Multiple Choice Test
Identifying Terms
Providing Examples
Reciting Concepts
Short Answer Test
Scavenger Hunt
Text Reading
Associate
Compare
Discuss
Distinguish
Differentiate
Estimate
Explain
Express
Extend
Illustrate
Indicate
Infers
Interpret
Paraphrase
Relate
Restate
Summarize
Analogies
Discussion Board
Drawing/Illustration
Journal Entries
Multiple Choice Test
Short Answer Test
Simple Comparison
Summary
Written Report
Outline
Apply
Calculate
Change
Classify
Compile
Compute
Construct
Demonstrate
Experiment
Implement
Manipulate
Pilot
Predict
Present
Produce
Relate
Show
Solve
Data Manipulation
Demonstration
Forecast
Graph
Presentation
Problem Set
Programming Assignment
Project
Role Play
Show & Tell
Solution
Simulation
Analyze
Appraise
Break down
Categorize
Compare
Contrast
Deconstruct
Differentiate
Diagram
Distinguish
Examine
Investigate
Organize
Outline
Research
Select
Separate
Simplify
Analyze Research
Case Study
Comparison
Critical Incident
Deductive Reasoning
Discussion
Graphs
Problem Exercise
Questionnaire
Report
Troubleshoot
Argue
Conclude
Convince
Criticize
Critique
Defend
Discriminate
Estimate
Evaluate
Judge
Prove
Rank
Rate
Recommend
Select
Support
Test
Value
Argument
Case Study
Critique
Debate
Evaluation
Group Discussion
Project
Recommendation
Self Evaluation
Survey
Test Case Scenario
Values Statement
Written Conclusion
Integrate
Invent
Make
Manage
Modify
Plan
Produce
Propose
Rewrite
Assemble
Combine
Compose
Construct
Create
Design
Develop
Formulate
Generate
Assemble Code
Concept Development
Create an Application
Experiment
Formulate a Plan
Data Collection
Invention
Modify Design Plans
Project
Proposal
Problem Solution
Simulation

Birla Institute of Technology, Mesra, Ranchi

Course Structure for B.Tech. (Food Engineering)

Based on NEP-2020, CBCS and OBE, Effective from 2024-2025

Sr. No.	Semester of Study (Recommended)	Category of Course	Course Code	Subjects	Mode of Delivery & Credits *L-Lecture; T-Tutorial; P-Practical*			Total Credits
					L (*Periods / Week*)	T (*Periods/ Week*)	P (*Periods/ Week*)	
	FIRST	**THEORY**						
I.1		FS	MA24101	Mathematics - I	3	1	0	4
I.2			PH24101	Physics	3	1	0	4
I.3			BE24101	Biological Science for Engineers	2	0	0	2
I.4		GE	CS24101	Programming for Problem Solving	3	1	0	4
I.5			EE24101	Basics of Electrical Engineering	2	1	0	3
		LABORATORIES						
I.6		FS	PH24102	Physics Laboratory	0	0	2	1
I.7		GE	CS24102	Programming for Problem Solving Laboratory	0	0	2	1
I.8			EE24102	Electrical Engineering Laboratory	0	0	2	1
I.9		HSS	HS24131	Communication Skill - I	0	0	3	1.5
I.10		MC	MC24 101/102/103 /104/105	Choice of : NCC/NSS/ PT & Games/ Creative Arts (CA) /Entrepreneurship	0	0	2	1
TOTAL (Theory + Labs)								**22.5**
	SECOND	**THEORY**						
II.1		FS	MA24103	Mathematics - II	3	1	0	4
II.2			CH24101	Chemistry	3	1	0	4
II.3		GE	EC24101	Basic Electronics	2	1	0	3
II.4			ME24101	Basics of Mechanical Engineering	2	1	0	3
II.5		FS	CE24101	Environmental Science	2	0	0	2
		LABORATORIES						
II.6		FS	CH24102	Chemistry Laboratory	0	0	2	1
II.7		GE	EC24102	Basic Electronics Laboratory	0	0	2	1
II.8			ME24102	Engineering Graphics	0	0	4	2
I.9			PE24102	Workshop Practice	0	0	2	1
I.10		MC	MC24 106/107/108/109 /110	Choice of : NCC/NSS/ PT & Games/ Creative Arts (CA) /Entrepreneurship	0	0	2	1
TOTAL (Theory + Labs)								**22**
GRAND TOTAL FOR FIRST YEAR								**44.5**
FE24102 Vocational Course I: Basics of Food Processing Preservation					**1**	**0**	**4**	**3**
FE24104 Vocational Course II: Basics of Food Analysis					**1**	**0**	**3**	**3**

	THIRD	**THEORY**						
III.1		PC	CL24201	Thermodynamics	3	1	0	4
III.2		PC	CL24203	Fluid Mechanics	3	1	0	4
III.3			CL24205	Chemical Process Calculations	2	1	0	3
III.4		PC	CL24207	Heat Transfer Operations	3	1	0	4
III.5		FS	MA24201	Numerical Methods	2	0	0	2
III.6		HSS	MT24131	UHV-II: Understanding Harmony	3	0	0	3
		LABORATORIES						
III.7		FS	MA24202	Numerical Methods Laboratory	0	0	2	1
III.10		MC	MC24 201/202/2 03/204 /205	Choice of : NCC/NSS/ PT & Games/ Creative Arts (CA) / Entrepreneurship	0	0	2	1
	TOTAL (Theory + Labs)							**22**
	FOURTH	**THEORY**						
IV.1		PC	CL24209	Mechanical Operations	3	0	0	3
IV.2			FE24201	Principle of Food Processing and Preservation	3	0	0	3
IV.3			FE24203	Programming Language and Data Base Management System	3	0	0	3
IV.4			FE24205	Biochemistry and Human Nutrition	3	0	0	3
IV.5		PE	FE24XXX	Program Elective (PE-I)	3	0	0	3
IV.6		OE	XX24XXX/ MO24201	Open Elective - I / MOOC - I	3	0	0	3
IV.7		HSS	HS24211	Indian Knowledge System	2	0	0	0
		LABORATORIES						
IV.8		PC	FE24204	Programming Language and Data Base Management System Lab	0	0	3	1.5
		PC	FE24206	Food Process Engineering & Technology Lab I	0	0	3	1.5
IV.12		MC	MC24 206/207/2 08/209/21 0	Choice of : NCC/NSS/ PT & Games/ Creative Arts (CA) / Entrepreneurship	0	0	2	1
TOTAL (Theory + Labs)								**22.0**
GRAND TOTAL FOR SECOND YEAR								**44**
FE 24252 Vocational Course III: Food Microbiology & Safety					**1**	**0**	**4**	**3**
FE 24254 Vocational Course IV: Food chemistry and Quality Control					**1**	**0**	**4**	**3**
	FIFTH	**THEORY**						
V.1		PC	FE24301	Food Microbiology	4	0	0	4
V.2		PC	FE24303	Technology of Fruits, Vegetable, Spices and Plantation Crops	3	0	0	3
V.3		PC	FE24305	Food Chemistry	3	0	0	3

V.4		PC	CL24305	Project Engineering and Economics	3	0	0	3
V.5		PE	FE24XXX	Program Elective-II)	3	0	0	3
V.6		OE	XX24XXX/ MO24301	Open Elective - II / MOOC - II	3	0	0	3
		LABORATORIES						
V.7		PC	FE24302	Food Microbiology Lab	0	0	3	1.5
V.8			FE24304	Food Chemistry and Quality Control Lab 1	0	0	3	1.5
V.9		HSS	HS24133	Communication Skill - II	0	0	3	1.5
V.10		PC	CL24300	Project - I				2
TOTAL (Theory + Labs)								**25.5**
	SIXTH	**THEORY**						
VI.1		PC	CL24311	Process Control & Instrumentation	3	1	0	4
		PC	FE 24311	Food Process Engineering	3	0	0	3
VI.2		PC	FE 24313	Cereal, Pulses and Oilseeds Processing Technology	3	0	0	3
VI.3		PE	FE24XXX	Program Elective -III	3	0	0	3
VI.4		PE	FE24XXX	Program Elective -IV	3	0	0	3
VI.5		OE	XX24XXX/ MO24303	Open Elective - III / MOOC - III	3	0	0	3
		LABORATORIES						
VI.6		PC	FE24306	Food Chemistry and Quality Control Lab II	0	0	3	1.5
VI.8			FE24350	Project-II	0	0	0	2
TOTAL (Theory + Labs)								**22.5**
GRAND TOTAL FOR THIRD YEAR								**48**
	SEVENTH	**THEORY**						
VII.1		PC	FE24401	Food Quality Control, Laws, Standard and Regulation	3	0	1	4
		PC	FE24403	Dairy and Animal Product Processing Technology	3	0	0	3
VII.2		PE	FE24XXX	Program Elective -V	3	0	0	3
VII.3		PE	FE24XXX	Program Elective -VI	3	0	0	3
VII.4		OE	XX24XXX/ MO24401	Open Elective (OE-IV)/MOOC-IV	3	0	0	3
VII.5		HSS	MT24204	Constitution of India	2	0	0	0
		LABORATORIES						
VII.6		PC	FE24402	Food Process Engineering & Technology Lab -II	0	0	3	1.5
VII.8		MC	MC24400	Summer Training				4
VII.9		PC	FE24400	Project – III				3
TOTAL (Theory + Labs)								**24.5**
VIII.1	**EIGHTH**	PC	FE24450/ FE24490	Project-IV / Industry Internship				6
VIII.2			FE24498	Comprehensive Viva				1
	TOTAL (Theory + Labs)							**7**
GRAND TOTAL FOR FOURTH YEAR								**31.5**
GRAND TOTAL FOR B.TECH.								**168**

PE / LEVEL		Code no.	Name of the PE courses	L	T	P	C
2	PE 1 (IV Sem)	FE 24231	Applied Statistics for Food Engineering Technology	3	0	0	3
		FE 24233	Statistical Machine Learning I	3	0	0	3
		FE 24235	Algorithms For Big Data I	3	0	0	3
		FE 24237	Entrepreneurship Development	3	0	0	3
		FE 24239	Food Business Management	3	0	0	3
		CL 24237	Waste Management	3	0	0	3
3	PE 2 (V Sem)	FE 24331	Regression Techniques	3	0	0	3
		FE 24333	Statistical Machine Learning II	3	0	0	3
		FE 24335	Nutraceutical & Functional Foods	3	0	0	3
		FE 24337	Food Additives & Ingredients	3	0	0	3
		CL24341	Analytical Instrumental Methods	3	0	0	3
3	PE 3(VI Sem)	FE 24347	Big Data Analytics	3	0	0	3
		FE 24349	Data Mining and Data Visualization	3	0	0	3
		FE 24351	Engineering Properties of Foods	3	0	0	3
		FE 24353	Food Supply Chain Management	3	0	0	3
		CL 24353	Design and Analysis of Experiments	3	0	0	3
3	PE 4 (VI Sem)	FE 24363	Food Packaging and Safety Management	3	0	0	3
		FE 24365	Modern Food Packaging Technologies and Regulatory Aspects	3	0	0	3
		FE 24367	Novel Techniques in Food Processing and Packaging	3	0	0	3
		FE 24369	Food Packaging Technology	3	0	0	3
4	PE 5 (VII Sem)	FE 24431	Fats and Oil Processing Technology	3	0	0	3
		FE 24433	Flavor Technology	3	0	0	3
		FE 24435	Food Product Development and Consumer Science	3	0	0	3
		FE 24437	Enzyme Technology	3	0	0	3
		FE 24439	Bakery and Confectionary Technology	3	0	0	3
		CL24435	Microfluidics	3	0	0	3

4	PE 6 (VII Sem)	FE 24423	Refrigeration and Air Conditioning Engineering	3	0	0	3
		FE 24425	Biochemical Engineering	3	0	0	3
		FE 24427	Post Harvest Engineering	3	0	0	3
		FE 24429	Food Processing Plant Engineering & Layout	3	0	0	3
		FE 24431	Energy Utilization of Food Industries	3	0	0	3
		FE 24433	Food Processing Equipment Design	3	0	0	3

CENTRE FOR FOOD ENGINEERING AND TECHNOLOGY OPEN ELECTIVES (OE)* OFFERED FOR LEVEL 1-4						
OE / LEVEL	**Code no.**	**Name of the PE courses**	**L**	**T**	**P**	**C**
OE2	FE 24343	Nutraceutical & Functional Foods	3	0	0	3
OE3	FE 24355	Food Supply Chain Management	3	0	0	3

BIRLA INSTITURE OF TECHNOLOGY - MESRA, RANCHI
NEW COURSE STRUCTURE - To be effective from academic session 2024-2025
Based on NEP 2020, CBCS & OBE model

Vocational Courses

	Course Level	**Category of course**	**Course Code**	**Courses**	**Mode of delivery & credits L-Lecture; T-Tutorial; P-Practical**			**Total Credits *C - Credits***
					L	**T**	**P**	**C**
	First	PC	FE24102	Basics of Food Processing Preservation	1	0	4	3
	First		FE24104	Basics of Food Analysis	1	0	4	3
TOTAL (Minimum requirement for Certificate in Engineering)								**6**
	Second	PC	FE 24252	Food Microbiology and Safety	1	0	4	3
	Second		FE 24254	Food Chemistry and Quality Control	1	0	4	3
TOTAL (Minimum requirement for Diploma in Engineering)								**6**

BIRLA INSTITUTE OF TECHNOLOGY

NEP-2020 CURRICULUM BOOK
(Effective from Academic Session: Monsoon 2024)

Bachelor of Technology

CENTRE FOR FOOD ENGINEERING AND TECHNOLOGY
FIRST YEAR (SEMESTER – I)

COURSE INFORMATION SHEET

Course Code: MA24101
Course Title: Mathematics-I
Pre-requisite(s): -
Co- requisite(s): --
Credits: 4 (L: 3 T: 1 P: 0)
Class schedule per week: 4
Class: B. Tech.
Semester / Level: FIRST
Branch: Chemical Engineering
Name of Teacher:

COURSE OBJECTIVES

This course envisions to impart to students to:

1.	Understand infinite sequences and series
2.	Apply theory of matrices including elementary transformations, rank and its application in consistency of system of linear equations, eigenvalues, eigenvectors etc.
3.	Understand multivariable functions, partial differentiation, properties and applications of partial derivatives.
4.	Apply integrals of multivariable functions viz. double and triple integrals with their applications
5.	Acquitted with properties like gradient, divergence, curl associated with derivatives of vector point functions and integrals of vector point functions

COURSE OUTCOMES (COs)

After the completion of this course, students will be able to:

CO1	Decide the behavior of sequences and series using appropriate tests.
CO2	handle problems related to the theory of matrices including elementary transformations, rank and its application in consistency of system of linear equations, eigenvalues, eigenvectors etc.
CO3	Get an understanding of partial derivatives and their applications in finding maxima - minima problems.
CO4	Apply the principles of integrals (multivariable functions viz. double and triple integrals) to solve a variety of practical problems in engineering and sciences.
CO5	Get an understanding of gradient, divergence, curl associated with derivatives of vector point functions and integrals of vector point functions and demonstrate a depth of understanding in advanced mathematical topics, enhance and develop the ability of using the language of mathematics in engineering.

SYLLABUS

MODULE	(NO. OF LECTURE HOURS)
MODULE – I: Sequences and Series Sequences, Convergence of Sequence. Series, Convergence of Series, Tests for Convergence: Comparison tests, Cauchy's Integral test, Ratio test, Cauchy's root test, Raabe's test, Gauss test, Alternating series, Leibnitz test, Absolute and Conditional Convergence.	**9**
MODULE – II: Matrices Rank of a Matrix, elementary transformations. Vectors, Linear Independence and Dependence of Vectors. Consistency of system of linear equations. Eigenvalues, Eigenvectors, Cayley - Hamilton theorem.	**9**
MODULE – III:: Advance Differential Calculus Function of several variables, Partial derivatives, Euler's theorem for homogeneous functions, Total derivatives, Chain rules, Jacobians and its properties, Taylor series for function of two variables, Maxima – Minima.	**9**
MODULE – IV: Advance Integral Calculus Double integrals, double integrals in polar coordinates, Change of order of integration, Triple Integrals, cylindrical and spherical coordinate systems, transformation of coordinates, Applications of double and triple integrals in areas and volumes.	**9**
MODULE – V: Vector Calculus Scalar and vector point functions, gradient, directional derivative, divergence, curl. Line Integral, Work done, Conservative field, Green's theorem in a plane, Surface and volume integrals, Gauss – divergence theorem, Stoke 's theorem.	**9**

TEXTBOOKS:

1. M. D. Weir, J. Hass and F. R. Giordano: Thomas' Calculus, 11th edition, Pearson Educations, 2008E.
2. H. Anton, I. Brivens and S. Davis, Calculus, 10th Edition, John Wiley and sons, Singapore Pte. Ltd., 2013.
3. Ramana B.V., Higher Engineering Mathematics, Tata McGraw Hill New Delhi, 11th Reprint,2010.

REFERENCE BOOKS:

1. M. J. Strauss, G. L. Bradley And K. J. Smith, Calculus, 3rd Ed, Dorling. Kindersley (India) Pvt. Ltd. (P Ed), Delhi, 2007.
2. David C. Lay, Linear Algebra and its Applications (3rd Edition), Pearson Ed. Asia, Indian Reprint, 2007.
3. Robert Wrede & Murray R. Spiegel, Advanced Calculus, 3rd Ed., Schaum's outline series, McGraw-Hill Companies, Inc.,2010.
4. D. G. Zill and W.S. Wright, Advanced Engineering Mathematics, Fourth Edition, 2011.

GAPS IN THE SYLLABUS (TO MEET INDUSTRY/PROFESSION REQUIREMENTS) --

POS MET THROUGH GAPS IN THE SYLLABUS --

TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN ---

POS MET THROUGH TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN --

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	50
End Semester Examination	50

Continuous Internal Assessment	% Distribution
Mid semester examination	25
Quiz	20
Teacher's Assessment	5

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	√	√	√	√	√
Semester End Examination	√	√	√	√	√

INDIRECT ASSESSMENT

1. Student Feedback on Course Outcome

COURSE DELIVERY METHODS

CD1	Lecture by use of boards/LCD projectors/OHP projectors	√
CD2	Assignments/Seminars	√
CD3	Laboratory experiments/teaching aids	
CD4	Industrial/guest lectures	
CD5	Industrial visits/in-plant training	
CD6	Self- learning such as use of NPTEL materials and internets	√
CD7	Simulation	

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
CO1	3	3	2	2	1	0	0	0	0	0	1			
CO2	3	3	2	2	2	0	0	0	0	0	1			
CO3	3	3	2	2	1	0	0	0	0	0	1			
CO4	3	3	3	3	2	1	0	0	0	0	1			
CO5	3	3	2	3	2	1	1	1	1	1	2			

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD6
CO2	CD1, CD2, CD6
CO3	CD1, CD2, CD6
CO4	CD1, CD2, CD6
CO5	CD1, CD2, CD6

COURSE INFORMATION SHEET

Course Code: PH24101
Course Title: Physics
Pre-requisite(s): Intermediate Physics and Intermediate Mathematics
Co- requisite(s): Mathematics I
Credits: 4 (L: 3 T: 1 P: 0)
Class schedule per week: 4
Class: B. Tech.
Semester / Level: FIRST
Branch: Chemical Engineering
Name of Teacher:

COURSE OBJECTIVES

This course envisions to impart to students:

1.	The principles of physical optics and basic concept of fiber optics.
2.	Fundamental laws of electromagnetism leading to Maxwell's equations.
3.	The postulates of special theory of relativity, Lorenz transformation equation and their consequences: Einstein energy mass relation and relativistic energy-momentum relation
4.	The limitations of classical physics and basic concepts such as wave-particle duality, and working of quantum mechanics with the help of particles in a box problem
5.	Concepts of stimulated emission and working principle of laser with examples, concepts of nuclear physics and plasma physics

COURSE OUTCOMES (COs)

After the completion of this course, students will be able to:

CO1	Analyse the intensity variation of light due to polarization, interference and diffraction.
CO2	Formulate and solve the problems on electromagnetism
CO3	Explain and apply concepts of special theory of relativity and its consequences
CO4	Apply the concepts of quantum mechanics such as wave-particle duality and obtain the solution of simple quantum mechanical problems.
CO5	Explain working principle of lasers and to summarize its applications, describe basic concepts of nuclear and plasma physics

SYLLABUS

MODULE	(NO. OF LECTURE HOURS)
Module – I: **Physical Optics:** Polarization, Malus' Law, Brewster's Law, Double Refraction, Interference in thin parallel films, Interference in wedge-shaped layers, Newton's rings, Fraunhofer diffraction by single slit and double slit. Elementary ideas of fibre optics and application of fibre optic cables.	**8**
Module – II: **Electromagnetic Theory:** Gradient, Divergence and Curl, Statement of Gauss theorem & Stokes theorem, Gauss's law, Applications, Concept of electric potential, Relationship between E and V, Polarization of dielectrics and dielctric constant, Boundary conditions for E & D, Gauss's law in magnetostatics, Ampere's circuital law, Boundary conditions for B & H, Equation of continuity, Displacement current, Maxwell's equations.	**8**
Module – III: **Special Theory of Relativity:** Introduction, Inertial frame of reference, Galilean transformations, Postulates, Lorentz transformations and its conclusions, Length contraction, time dilation, velocity addition, Mass change, Einstein's mass energy relation.	6
Module – IV: **Quantum Mechanics:** Planck's theory of black-body radiation, Compton effect, Wave-particle duality, De Broglie waves, Davisson and Germer's experiment, Uncertainty principle, Brief idea of Wave Packet, Wave Function and its physical interpretation, Schrodinger equation in one-dimension, free particle, particle in an infinite square well.	9
Module – V **Modern Physics:** Laser-Spontaneous and stimulated emission, Einstein's A and B coefficients, Population inversion, Light amplification, Basic laser action, Ruby and He-Ne lasers, Properties and applications of laser radiation, Nuclear Physics: Binding Energy Curve, Nuclear Force, Liquid drop model, Introduction to Shell model, Applications of Nuclear Physics, Concept of Plasma Physics and its applications.	9

TEXTBOOKS:

- A. Ghatak, Optics, 4th Edition, Tata Mcgraw Hill, 2009
- Mathew N.O. Sadiku, Elements of Electromagnetics, Oxford University Press, 2001
- Arthur Beiser, Concept of Modern Physics, 6th edition, Tata McGraw- Hill, 2009
- F. F. Chen, Introduction to Plasma Physics and controlled Fusion, Springer, Edition 2016.

REFERENCE BOOKS:

1. Fundamentals of Physics, Halliday, Walker and Resnick

GAPS IN THE SYLLABUS (TO MEET INDUSTRY/PROFESSION REQUIREMENTS)

POS MET THROUGH GAPS IN THE SYLLABUS

TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN

POS MET THROUGH TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Mid Sem Examination	25
End Sem Examination	50
Quiz	20
Teacher's assessment / Assignment	05

Continuous Internal Assessment	% Distribution
Mid Sem Examination	50
Quiz	40
Teacher's assessment / Assignment	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	Y	Y	Y	Y	
Semester End Examination	Y	Y	Y	Y	Y

INDIRECT ASSESSMENT

1. Student Feedback on Course Outcome

COURSE DELIVERY METHODS

CD1	Lectures by use of boards/LCD projectors/OHP projectors
CD2	Tutorials/Assignments
CD3	Self- learning such as use of NPTEL materials and internets

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
CO1	2	2		1	1				2	1				
CO2	2	2		1	1				2	1				
CO3	2	1		1	1				2	1				
CO4	2	1		1	1				2	1				
CO5	2	1		1	1				2	1				

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD3
CO2	CD1, CD2, CD3
CO3	CD1, CD2, CD3
CO4	CD1, CD2, CD3
CO5	CD1, CD2, CD3

COURSE INFORMATION SHEET

Course Code: BE24101
Course Title: Biological Science for Engineers
Pre-requisite(s):
Co- requisite(s):
Credits: 2 (L:2 T: 0 P:0)
Class schedule per week: 2
Class: B. Tech.
Semester / Level: First
Branch: Chemical Engineering
Name of Teacher:

COURSE OBJECTIVES

This course envisions to impart to students to:

1.	Understand fundamental concepts of biology relevant to engineering.
2.	Explore the structure and function of biological molecules and cells.
3.	Learn about genetic principles and molecular biology techniques.
4.	Understand the applications of biological science in various engineering fields considering global challenges and ethical considerations.

COURSE OUTCOMES (COs)

After the completion of this course, students will be able to:

CO1	Comprehend and apply the fundamental concepts of biological sciences in the context of engineering.
CO2	Analyze the structure and function of biological molecules and cells and their relevance to engineering solutions.
CO3	Demonstrate understanding of genetic principles and molecular biology techniques and their applications in engineering.
CO4	Apply knowledge of biological sciences to innovate and develop solutions in various engineering domains and critically evaluate the role of biological sciences in addressing global challenges, including ethical and safety considerations.

SYLLABUS

MODULE	(NO. OF LECTURE HOURS)
Module I: Introduction to Biological Sciences Overview and importance of biology in engineering, Origin of Life, Cell Theory and Structure.	6
Module II: Molecular Biology and Genetics Central Dogma of Molecular Biology, DNA, RNA and Protein structure and function, Mendelian Genetics, rDNA Technology and Genome Editing.	6
Module III: Biochemistry Cell Metabolism, Enzymes and Catalysis, Cell Communication and Signalling.	6
Module IV: Applications of Biological Sciences in Engineering Biomaterials, Bioinformatics, Biosensors and Bioelectronics (Biological Sensors- Ear & Eye), Synthetic Biology, Nanobiotechnology.	6
Module V: Global Challenges and Ethical Considerations Convergence of AI and Biology, Climate change and food security, Biosafety and Biohazards, Ethical Considerations.	6

TEXTBOOKS:

1. Lehninger A, Principals of Biochemistry
2. Stryer L, Biochemistry
3. K. Wilson & K.H. Goulding, A biologist's guide to Principles and Techniques of Practical Biochemistry.
4. Biology for Engineers" by Arthur T. Johnson

REFERENCE BOOKS:

1. Purves et al, Life: The Science of Biology
2. R. Dulbecco, The Design of Life.
3. Biological Science Edited by Soper, Cambridge low price edition.
4. Synthetic Biology: A Primer" by Paul S. Freemont and Richard I. Kitney
5. "Introduction to Bioinformatics" by Arthur Lesk Genomes" by T.A. Brown

GAPS IN THE SYLLABUS (TO MEET INDUSTRY/PROFESSION REQUIREMENTS)

POS MET THROUGH GAPS IN THE SYLLABUS

TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN

POS MET THROUGH TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Progressive Evaluation	50
End Semester Examination	50

Continuous Internal Assessment	% Distribution
Mid Semester Examination	25
Quiz	20
Teacher's Assessment/Assignent	5

Assessment Components	CO1	CO2	CO3	CO4
Continuous Internal Assessment	√	√	√	√
Semester End Examination	√	√	√	√

INDIRECT ASSESSMENT

1.Student Feedback on Course Outcome

COURSE DELIVERY METHODS

CD1	Lecture by use of boards/LCD projectors/OHP projectors	√
CD2	Assignments/Seminars	√
CD3	Laboratory experiments/teaching aids	
CD4	Industrial/guest lectures	
CD5	Industrial visits/in-plant training	
CD6	Self- learning such as use of NPTEL materials and internets	√
CD7	Simulation	

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PSO 1	PSO 2	PSO 3
CO1	3	3	3	3	1	1	1	2	1	1	1			
CO2	3	3	3	3	1	1	1	2	1	1	1			
CO3	1	3	3	3		1	1	1		1	1			
CO4	2	2	2	2		2	2	2		1	1			
CO5	3	3	3	3	1	1	1	2	1	1	1			

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD 6
CO2	CD1, CD2, CD 6
CO3	CD1, CD2, CD 6
CO4	CD1, CD2, CD 6
CO5	CD1, CD2, CD 6

COURSE INFORMATION SHEET

Course Code: **CS24101**
Course Title: **Programming for Problem Solving**
Pre-requisite(s): **School level mathematics and Science**
Co- requisite(s):
Credits: **4** **(**L: 3 T: 1 P:0)
Class schedule per week: **4**
Class: **B. Tech.**
Semester / Level: **First**
Branch: **Chemical Engineering**
Name of Teacher:

COURSE OBJECTIVES

This course envisions to impart to students to:

1.	Develop Programming Skill.
2.	Understand the fundamental Concepts of Coding
3.	Learn how to Debug Programs
4.	Convert Problems to Programs

COURSE OUTCOMES (COs)

After the completion of this course, students will be able to:

CO1	Formulate Algorithms for arithmetic and logical problems.
CO2	Translate the algorithms to programs.
CO3	Test and execute the programs and correct syntax and logical errors.
CO4	Apply programmatic skills for solving scientific problems.
CO5	Decompose problems into functions and structured programming.

SYLLABUS

MODULE	(NO. OF LECTURE HOURS)
Module – I Representation of an Algorithm: Flowchart/Pseudo code with examples. From algorithms to programs: source code, variables and memory locations, Syntax and Logical Errors in compilation, object and executable code.	**6**
Module – II Structure of a C program, variables and data types, Operators – precedence and associativity, Evaluating expressions, Basic I/O – use of printf, scanf, getchar etc. and format specifiers, Conditional Branching statements – If, If - else, If-else- if, switch case, Writing nested conditional statements.	**8**
Module – III Iterative programming structures – for loops, while loops, do while loops. Understanding break and continue and their usage. Writing Nested loops, Arrays – creation and usage, Strings and string handling.	**8**
Module – IV Functions (including using built in libraries), Parameter passing in functions, call by value, Recursion, as a different way of solving problems, Nested function calls. Understanding scope and lifetime of a variable.	**8**
Module – V Structures - Defining structures, Accessing structures elements, Creating an array of Structures, Nested structures. Some advanced concepts – typedef, enum, macros. An introduction to pointers – understanding, creating pointers and accessing variables using pointers. Passing arrays to functions: idea of call by reference, passing parameters to main.	**10**

TEXTBOOKS:

1. Let us C, Yashwant Kanetkar, 18th Edition, BPB Publications
2. Byron Gottfried, Schaum's Outline of Programming with C, McGraw-Hill
3. E. Balaguruswamy, Programming in ANSI C, Tata McGraw-Hill
4. R.G.Dromey, How to Solve it by Computer, Pearson Education

REFERENCE BOOKS:

1. Brian W. Kernighan and Dennis M. Ritchie, The C Programming Language, Prentice.

GAPS IN THE SYLLABUS (TO MEET INDUSTRY/PROFESSION REQUIREMENTS)

- The syllabus focused on the concepts and basics of Program writing skills.
- Industry often requires debugging of their existing programs/software compare to the new program, which is a knowledge beyond the basics, including real-world software (collection of programs) experience.
- More memory management practices, file handling and library functions

POS MET THROUGH GAPS IN THE SYLLABUS: YES [PO1-PO5 & PO10-PO12]

TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN:

File Handling with memory management, preprocessor directives, Graphics, Data Arrangement, Task scheduling and assembly level programs.

POS MET THROUGH TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN: YES [PO1-PO5]

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Progressive Evaluation	50
End Semester Examination	50

Continuous Internal Assessment	% Distribution
Mid Semester Examination	25
Quiz, Assignment	10 + 10
Teacher's Assessment	5

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	√	√	√	√	√
Semester End Examination	√	√	√	√	√

INDIRECT ASSESSMENT

2. Student Feedback on Course Outcome

COURSE DELIVERY METHODS

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	3	3	3	2			1	2	2			
CO2	3	3	3	3	3	2			1	2	2			
CO3	3	3	3	3	3	2			1	2	2			
CO4	3	3	3	3	3	2			1	2	2			
CO5	3	3	3	3	3	2			1	2	2			

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD3
CO2	CD3, CD5
CO3	CD3, CD5, CD7
CO4	CD2, CD3, CD4, CD6, CD7
CO5	CD1, CD3, CD5, CD7

COURSE INFORMATION SHEET

Course Code: **EE24101**
Course Title: **Basics of Electrical Engineering**
Pre-requisite(s): **Basic Sciences**
Co- requisite(s):
Credits: **3 (L:2 T: 1 P: 0)**
Class schedule per week: **3**
Class: **B. Tech.**
Semester / Level: **FIRST**
Branch: **Chemical Engineering**
Name of Teacher:

COURSE OBJECTIVES

This course envisions to impart to students to:

1.	Realize the electrical signals, elements, and their properties.
2.	Understand the mathematical representation of AC, DC signals and theorems/laws for solving electrical circuits with variations of voltage and frequency.
3.	Perceive the 3-phase AC signal representation and 3-phase circuit analysis for balanced and unbalanced condition.
4.	Understand the characteristics of magnetic material and analysis of magnetic circuits.

COURSE OUTCOMES (COs)

After the completion of this course, students will be able to:

CO1	Explain the voltage, current signals and their characteristics in electrical circuit elements.
CO2	Apply the theorems/laws for electrical circuit analysis.
CO3	Solve the electrical circuits for variable voltage and frequency to observe the resonance, power and power factor in the electric circuit.
CO4	Analyze the 1-phase and 3-phase AC balanced and unbalanced circuits
CO5	Apply the concept of magnetic circuits for magnetic circuit analysis.

SYLLABUS

MODULE	(NO. OF LECTURE HOURS)
Module – I **Introduction:** Importance of Electrical Engineering in day-to-day life, Electrical elements, properties (linear, non-linear, unilateral, bilateral, lumped and distributed, etc.) and their classification, Ideal and Real Sources, Source Conversion, Star-Delta conversion, KCL and KVL, Mesh current and Nodal voltage method.	**8**
Module – II **D.C. Circuits**: Steady state analysis with independent and dependent sources; Series and Parallel circuits. **Circuit Theorems:** Superposition, Thevenin's, Norton's, and Maximum Power Transfer theorems for Independent and Dependent Sources applied to DC circuits.	**8**
Module – III **Single-phase AC Circuits:** Common signals and their waveforms, RMS and Average value. Form factor & Peak factor of a sinusoidal waveform. **Series Circuits:** Impedance of Series circuits. Phasor diagram. Active Power. Power factor. Power triangle. **Parallel Circuits:** Admittance method, Phasor diagram, Power and Power factor Power triangle, Series-parallel Circuit, Power factor improvement, Circuit Theorems applied to AC circuits. **Series and Parallel Resonance**: Resonance curve, Q–factor, Dynamic Impedance, and Bandwidth.	**12**
Module – IV **Three-Phase AC Circuits:** Importance and use of a 3-phase network, types of 3-phase connections- Star and Delta, Line and Phase relations for Star and Delta connection, Phasor diagrams, Power relations, analysis of balanced and unbalanced 3-phase circuits, Measurement of Power in 3-phase star and delta network.	**6**
Module – V **Magnetic Circuits:** Introduction, Series-parallel magnetic circuits, Analysis of Linear and Non-linear magnetic circuits, Energy storage, A.C. excitation, Eddy currents and Hysteresis losses. **Coupled Circuits:** Dot rule, Self and mutual inductances, Coefficient of coupling, working of transformer.	**6**

TEXTBOOKS:

1. W. H. Hayt, Jr J. E. Kemmerly and S. M. Durbin, Engineering Circuit Analysis, 7th Edition TMH, 2010.
2. Hughes, Electrical Technology, Revised by McKenzie Smith, Pearson.
3. Fitzgerald and Higginbotham, Basic Electrical Engineering, McGraw Hill Inc, 1981.

REFERENCE BOOKS:

1. D. P. Kothari and I. J. Nagrath, Basic Electrical Engineering, 3rd Edition, TMH, New Delhi, 2009.
2. Electrical Engineering Fundamental, Vincent Del Toro, Prentice Hall, New Delhi.
3. Rajendra Prasad, Fundamentals of Electrical Engineering, 2nd Edition, PHI, New Delhi, 2011.
4. Raymond A. DeCarlo, Prn-Min Lin, Linear Circuit Analysis Time Domain, Phasor and Laplace Transform Approaches, 2nd Edition, Oxford University, 2001
5. Abhijit Chakrabarti, Sudipta Nath, Chandan Kumar Chanda, Basic Electrical Engineering, Tata McGraw Hill Publication, 2009.

GAPS IN THE SYLLABUS (TO MEET INDUSTRY/PROFESSION REQUIREMENTS)

1. Application of principles of magnetic circuits to electrical machines like transformers, generators and motors.
2. Field applications of three phase equipment and circuits in power system.
3. Applications of circuit theorems in electrical and electronics engineering.

POS MET THROUGH GAPS IN THE SYLLABUS; 3, 4, 12.

TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN

1. Concepts of electric, magnetic and electromagnetic fields.
2. 3 - Φ power generation, transmission, and distribution.
3. Power factor improvement for three phase systems.
4. Utility of reactive power for creation of electric and magnetic fields.

POS MET THROUGH TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN-2, 3, 4, 12

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Progressive Evaluation	50
End Semester Examination	50

Continuous Internal Assessment	% Distribution
Mid Semester Examination	25
Quiz, Assignment	10 + 10
Teacher's Assessment	5

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	√	√	√	√	√
Semester End Examination	√	√	√	√	√

INDIRECT ASSESSMENT

1. Student Feedback on Course Outcome

COURSE DELIVERY METHODS

CD1	Lecture by use of boards/LCD projectors/OHP projectors	√
CD2	Assignments/Seminars	√
CD3	Laboratory experiments/teaching aids	
CD4	Industrial/guest lectures	
CD5	Industrial visits/in-plant training	
CD6	Self- learning such as use of NPTEL materials and internets	√
CD7	Simulation	

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PSO 1	PSO 2	PSO 3
CO1	3	2	1		1	1				1				
CO2	3	3	3	1	2	1				1				
CO3	3	3	3	2	2	1	1			1				
CO4	3	3	3	2	2	1				1				
CO5	3	3	3	2	2	1				1				

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD 6
CO2	CD1, CD2, CD 6
CO3	CD1, CD2, CD 6
CO4	CD1, CD2, CD 6
CO5	CD1, CD2, CD 6

COURSE INFORMATION SHEET

Course Code: PH24102
Course Title: Physics lab
Pre-requisite(s): Intermediate Physics
Co- requisite(s):
Credits: 1 L: 0 T: 0 P: 2
Class schedule per week: 2
Class: B. Tech.
Semester / Level: FIRST
Branch: Chemical Engineering
Name of Teacher:

COURSE OBJECTIVES

This course enables the students to:

1.	Understand the fundamentals of physical measurements and learn to account for inevitable errors in physical measurements.
2.	Understand and verify the basic principles of physics by hands-on experiments and making suitable measurements.
3.	Make electrical connections reliably to form functional circuits for measuring electrical quantities such as voltage, current, resistance, and resistivity
4.	Learn to set up different types of oscillating systems study their characteristics, viz - a-viz resonant frequency, frequency response, phase relationship, bandwidth, and quality factor
5.	Develop an understanding of optical phenomena like dispersion, interference and diffraction and make measurements on the patterns produced to obtain physical quantities such as wavelength of light and refractive index of transparent materials.

COURSE OUTCOMES (COs)

After the completion of this course, students will be able to:

CO1	Make reliable measurements and report results along with errors.
CO2	Wire simple electrical circuits for experimentally determining measurable electrical quantities.
CO3	Build oscillating systems and make measurements over them.
CO4	Set up and customize simple second-order electrical circuits, characterize them, and gain knowledge about their applications such as electrical filters, and tank circuits.
CO5	Produce interference and diffraction patterns and make measurements for determining physical quantities.

SYLLABUS (List of experiments)

1. Error analysis in Physics Laboratory (CO: 1)
2. To determine the frequency of AC mains with the help of a sonometer. (CO:1, 2, 3)
3. To determine the resistance per unit length of a Carey Foster's bridge wire and resistivity of unknown wire. (CO:1, 2)
4. Measurement of electrical equivalent of heat (CO:1, 2)
5. To determine the wavelength of sodium lines by Newton's rings method (CO:1, 5)
6. To determine the frequency of tuning fork using Melde's Experiment (CO:1,3)
7. Measurement of voltage and frequency of a given signal using CRO (CO: 1,2, 3, 4)
8. To determine the emf of a cell using stretched wire potentiometer (CO:1, 2)
9. Determination of refractive index of the material of a prism using spectrometer and sodium light (CO:1, 5)
10. To study the frequency response of a series LCR circuit (CO:1, 2, 3,4)
11. To study Lorentz force using Current balance (CO:1,2)
12. To study electromagnetic induction and verification of Faraday's laws. (CO:1,2,3)
13. To measure the wavelength of prominent spectral lines of mercury light by a plane transmission grating. (CO:1, 5)
14. To determine the Planck's constant using photocell and optical wavelength filters. (CO:1, 2)

REFERENCE MATERIALS:

1. Lab manuals (available on department website)

GAPS IN THE SYLLABUS (TO MEET INDUSTRY/PROFESSION REQUIREMENTS)

POS MET THROUGH GAPS IN THE SYLLABUS

TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN

POS MET THROUGH TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Lab Journal	30
Lab quizes	20
Progressive viva	20
End Sem Examination	30

Continuous Internal Assessment	% Distribution
Lab Journal	30
Lab quiz	10
Progressive viva	20

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	Y	Y	Y	Y	Y
Semester End Examination	Y	Y	Y	Y	Y

INDIRECT ASSESSMENT

1. **Student Feedback on Course Outcome**

COURSE DELIVERY METHODS

CD1	Introductory lecture by use of boards/LCD projectors
CD2	Laboratory experiments/ teaching aid
CD3	Self- learning such as use of NPTEL materials and internets

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
CO1	3	3		1	1				2	1	1			
CO2	3	3		1	1				2	1	1			
CO3	3	2		1	1				2	1	1			
CO4	3	2		1	1				2	1	1			
CO5	3	2		1	1				2	1	1			

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD3
CO2	CD1, CD2, CD3
CO3	CD1, CD2, CD3
CO4	CD1, CD2, CD3
CO5	CD1, CD2, CD3

COURSE INFORMATION SHEET

Course Code: CS24102
Course Title: Programming for Problem Solving Lab
Pre-requisite(s): School level Mathematics and Science
Co- requisite(s): Programming for Problem Solving
Credits: 1 (L: 0 T: 0 P:2)
Class schedule per week: 2
Class: B. Tech.
Semester / Level: First
Branch: Chemical Engineering
Name of Teacher:

COURSE OBJECTIVES

This course enables the students to:

1.	Compile, write and debug simple programs with sequential logic.
2	Apply selection and iteration constructs to solve real-world problems.
3	Explore the use arrays and string handing in implementing solutions to problems.
4	Design and develop solutions to problems using modular programming constructs such as functions.
5	Explore the use of structures and pointers to solve real-world problems.

COURSE OUTCOMES (COs)

After the completion of this course, students will be able to:

CO1	Formulate Algorithms and draw flowchart for arithmetic and logical problems.
CO2	Translate the algorithms/flowcharts to programs.
CO3	Test and execute the programs and correct syntax and logical errors.
CO4	Decompose a problem into functions and develop modular reusable code.
CO5	Use arrays, pointers, strings and structures to solve real-world problems.

SYLLABUS

MODULE	(NO. OF LECTURE HOURS)
Module – I 1. Learn how to compile and debug C programs. (preference should be given to XNIX environments.) 2. Write simple programs using sequential logic requiring the declaration of variables for data types. 3. Write programs that produce formatted output. 4. Write programs to acquire data from users and use them in their programs.	**4**
Module – II 1. Write simple programs to understand the workings of selection structures. 2. Write programs using concepts of nested selection structures. 3. Learn how to program the switch case structure.	**4**
Module – III 1. Write programs using different iterative structures. 2. Write programs using nested iterative structures. 3. Write programs that embed selection structures in loops and vice versa. 4. Writing programs to create and use arrays. 5. Write programs to manipulate strings	**4**
Module – IV 1. Write simple functions demonstrating the concepts of parameter passing and return values. 2. Write programs to access global/extern variables from functions. 3. Write programs to demonstrate calling functions from functions.	**6**
Module – V 1. Write programs to create and use structures. 2. Write programs to demonstrate the concept of array of structures and passing structure variables to functions. 3. Writing programs to create pointers and understanding their basic properties. 4. Performing call by reference function calls.	**8**

TEXTBOOKS:

1. Let us C, Yashwant Kanetkar, 18th Edition, BPB Publications
2. Byron Gottfried, Schaum's Outline of Programming with C, McGraw-Hill
3. E. Balaguruswamy, Programming in ANSI C, Tata McGraw-Hill
4. R.G.Dromey, How to Solve it by Computer, Pearson Education

REFERENCE BOOKS:

1. Brian W. Kernighan and Dennis M. Ritchie, The C Programming Language, Prentice.

GAPS IN THE SYLLABUS (TO MEET INDUSTRY/PROFESSION REQUIREMENTS)

- The syllabus focused on the concepts and basics of Program writing skills.

- Industry often requires debugging of their existing programs/software compared to the new program, which is a knowledge beyond the basics, including real-world software (collection of programs) experience.
- More memory management practices, file handling and library functions

POS MET THROUGH GAPS IN THE SYLLABUS: YES [PO1-PO5 & PO10-PO12]

TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN:

File Handling with memory management, preprocessor directives, Graphics, Data Arrangement, Task scheduling and assembly level programs.

POS MET THROUGH TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN: YES [PO1-PO5]

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	60
End Semester Examination	40

Continuous Internal Assessment	% Distribution
Day-to-day performance & Lab files	30
Quiz	10
Viva	20

End Semester Examination	% Distribution
Examination Experiment Performance	30
Quiz	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	20%[12]	20%[12]	20%[12]	20%[12]	20%[12]
Semester End Examination	20%[8]	20%[8]	20%[8]	20%[8]	20%[8]

INDIRECT ASSESSMENT

1. **Student Feedback on Course Outcome**
2. **Student Feedback on Faculty/Content Delivery**
3. **Student Feedback on Evaluation Procedures**

COURSE DELIVERY METHODS

CD1	Demonstration by use of smart boards/LCD projectors
CD2	Assignments
CD3	Viva-Voce/Quiz (s)
CD4	Software and Hardware
CD5	Laboratory experiments/Coding

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	3	3	2	1	0	0	1	2	1			
CO2	3	3	3	3	2	1	0	0	2	1	1			
CO3	3	3	3	3	2	1	0	0	1	2	1			
CO4	3	3	3	3	2	2	0	0	2	2	2			
CO5	3	2	2	1	2	2	0	0	1	2	2			

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD3
CO2	CD3, CD5
CO3	CD3, CD5
CO4	CD2, CD3, CD4
CO5	CD1, CD3, CD5

COURSE INFORMATION SHEET

Course Code: **EE24102**
Course Title: **Electrical Engineering Laboratory**
Pre-requisite(s): **Physics, Fundamentals of Mathematics and Electrical Engineering**
Co- requisite(s):
Credits: **1** L:0 T: 0 P: 2
Class schedule per week: **2**
Class: **B. Tech.**
Semester / Level: **FIRST**
Branch: **Chemical Engineering**
Name of Teacher:

COURSE OBJECTIVES

This course envisions to impart to students to:

1.	To describe students' practical knowledge of active and passive elements and operation of measuring instruments
2.	To demonstrate electrical circuit fundamentals and their equivalent circuit models for both 1-φ and 3-φ circuits and use circuit theorems
3.	To establish voltage & current relationships with the help of phasors and correlate them to experimental results
4.	1. To conclude performance of 1 – Φ AC series circuits by resonance phenomena 2. To evaluate different power measurement for both 1-φ and 3- φ circuits

COURSE OUTCOMES (COs)

After the completion of this course, students will be able to:

CO1	classify active and passive elements, explain working and use of electrical components, different types of measuring instruments;
CO2	illustrate fundamentals of operation of DC circuits, 1-φ and 3- φ circuits and also correlate the principles of DC, AC 1-φ and 3- φ circuits to rotating machines like Induction motor and D.C machine
CO3	measure voltage, current, power, for DC and AC circuits and also represent them in phasor notations;
CO4	analyze response of a circuit and calculate unknown circuit parameters;
CO5	recommend and justify power factor improvement method in order to save electrical

SYLLABUS

LIST OF EXPERIMENTS ***(The experiment list may vary to accommodate recent development in the field)***

1. **Name:** Measurement of low & high resistance of DC shunt motor
   Aim:
   (i) To measure low resistance of armature winding of DC shunt motor
   (ii) To measure high resistance of shunt field winding of DC shunt motor
2. **Name:** AC series circuit
   Aim:
   (i) To obtain current & voltage distribution in AC RLC series circuit and to draw the phasor diagram
   (ii) To obtain power & power factor of single-phase load using 3- Voltmeter method and to draw phasor diagram.
3. **Name:** AC parallel circuit
   Aim:
   (i) To obtain current & voltage distribution in AC RLC parallel circuit and to draw the phasor diagram
   (ii) To obtain power & power factor of single-phase load using 3- Ammeter method and to draw the phasor diagram
4. **Name:** Resonance in AC RLC series circuit
   Aim:
   (i) To obtain the condition of resonance in AC RLC series circuit
   (ii) To draw phasor diagram
5. **Name:** 3-phase Star connection
   Aim:
   (i) To establish the relation between line & phase quantity in 3 phase star connection
   (ii) To draw the phasor diagram
6. **Name:** 3-phase Delta connection
   Aim:
   (i) To establish the relation between line & phase quantity in 3 phase delta connection
   (ii) To draw phasor diagram
7. **Name:** 3-phase power measurement
   Aim:
   (i) To measure the power input to a 3-phase induction motor using 2 wattmeter method
   (ii) To draw the phasor diagram
8. **Name:** Self & mutual inductance
   Aim: To determine self & mutual inductance of coils
9. **Name:** Verification of Superposition, Thevenin's and the Reciprocity theorem
   Aim:
   (i) To verify the Superposition theorem for a given circuit
   (ii) To verify Thevenin's theorem for a given circuit
10. **Name:** Verification of Norton's, Tellegen's and Maximum Power transfer theorem
    Aim:
    (i) To verify Norton's theorem for a given circuit
    (ii) To verify the Maximum Power transfer theorem for a given circuit

BOOKS:

1. H. Hayt, Jr J. E. Kemmerly and S. M. Durbin, Engineering Circuit Analysis, 7th Edition TMH, 2010.
2 .Hughes, Electrical Technology, Revised by McKenzie Smith, Pearson.
3 Fitzgerald and Higginbotham, Basic Electrical Engineering, McGraw Hill Inc, 1981.

GAPS IN THE SYLLABUS (TO MEET INDUSTRY/PROFESSION REQUIREMENTS)

1. Application of principles of magnetic circuits to electrical machines like transformers, generators and motors
2. Visualize Phase sequence

POS MET THROUGH GAPS IN THE SYLLABUS -, 2, 3, 7.

TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN

1. Assignment: Simulation of electrical circuits with dependent/independent sources by various techniques (Mesh current/Node Voltage/Thevenin's theorem/Norton's theorem/Maximum power transfer theorem etc.) using MATLAB/PSIM/C++ softwares.

2. Active/reactive power calculation for 3 – Φ circuits

POS MET THROUGH TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN -5, 6, 7, 8, 9.

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Lab Journal	30
Lab quizes	20
Progressive viva	20
End Sem Examination	30

Continuous Internal Assessment	% Distribution
Lab Journal	30
Lab quiz	10
Progressive viva	20

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	Y	Y	Y	Y	Y
Semester End Examination	Y	Y	Y	Y	Y

INDIRECT ASSESSMENT

1.Student Feedback on Course Outcome

COURSE DELIVERY METHODS

CD1	Introductory lecture by use of boards/LCD projectors
CD2	Laboratory experiments/ teaching aid
CD3	Self- learning such as use of NPTEL materials and internets

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PSO 1	PSO 2	PSO 3
CO1	3	3	3	1	3	1	1	1						
CO2	3	3	3	1	3	1	1	1						
CO3	3	3	3	3	3	1	2	2		1	1			
CO4	3	3	3	1	3	1	1	1		1	1			
CO5	3	3	3	3	3	1	1	1	1	1	1			

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD3
CO2	CD1, CD2, CD3
CO3	CD1, CD2, CD3
CO4	CD1, CD2, CD3
CO5	CD1, CD2, CD3

BIRLA INSTITUTE OF TECHNOLOGY

NEP-2020 CURRICULUM BOOK
(Effective from Academic Session: Monsoon 2024)

Bachelor of Technology

CENTRE FOR FOOD ENGINEERING AND TECHNOLOGY
FIRST YEAR (SEMESTER – II)

COURSE INFORMATION SHEET

Course Code: MA24103
Course Title: Mathematics II
Pre-requisite(s): Mathematics - I
Co- requisite(s):
Credits: 4(L: 3 T: 1 P: 0)
Class schedule per week: 4
Class: B.Tech.
Semester / Level: Second
Branch: Chemical Engineering
Name of Teacher:

COURSE OBJECTIVES

This course envisions to impart to students to:

1.	various methods to solve linear differential equations of second and higher order
2.	special functions viz. Legendre's and Bessel's and different properties associated with them
3.	diverse mathematical techniques for solving partial differential equations of first order, along with their applications in wave and heat equations using Fourier series
4.	the theory of functions of a complex variable, complex differentiation and integration
5.	about random variables and elementary probability distribution

COURSE OUTCOMES (COs)

After the completion of this course, students will be able to:

CO1	Investigate the occurrence of ordinary differential equations in real-life problems and identify the suitable methods available for their solutions.
CO2	Develop skills to solve and implement various forms of differential equations and special functions in diverse domains.
CO3	Learn to solve various forms of partial differential equations arising in real-world.
CO4	Gain an understanding of complex variable functions and their properties in science and engineering.
CO5	Comprehend and apply the concept of probability distributions in solving problems related to uncertainty.

SYLLABUS

MODULE	(NO. OF LECTURE HOURS)
Module – I: Ordinary Differential Equations – I Linear differential equations, Wronskian, Linear independence and dependence of solutions, Linear differential equations of 2nd and higher order with constant coefficients, Operator method, Euler – Cauchy's form of linear differential equation, Method of variation of parameters.	**9**
Module – II: Ordinary Differential Equations – II Ordinary and singular points of differential equation, Power and Frobenius' series solutions (root differ by non-integer and equal roots). Bessel's differential equation, Bessel function of first kind and its important properties. Legendre's differential equation, Legendre's polynomial and its important properties.	**9**
Module – III: Fourier series and Partial Differential Equations Fourier series: Euler formulae for Fourier series, Half range Fourier series. Partial Differential Equations: Method of separation of variables and its application in solving one dimensional wave and heat equations.	**9**
Module – IV: Complex Variable-Differentiation & Integration Function of a complex variable, Analyticity, Analytic functions, Cauchy – Riemann equations. Cauchy's theorem, Cauchy's Integral formula, Taylor and Laurent series expansions. Singularities and its types, Residues, Residue theorem.	**9**
Module – V: Applied Probability Discrete and continuous random variables, cumulative distribution function, probability mass and density functions, expectation, variance. Introduction to Binomial, Poisson and Normal Distribution.	**9**

TEXTBOOKS:

1. E. Kreyszig, Advanced Engineering Mathematics, 9th Edition, John Wiley & Sons, 2006.
2. D. G. Zill and W.S. Wright, Advanced Engineering Mathematics, Fourth Edition, 2011.
3. J. W. Brown and R. V. Churchill, Complex Variables and Applications, 7th Ed., McGraw Hill, 2004.
4. R.K. Jain and S.R.K. Iyengar, Advanced Engineering Mathematics, Narosa Publishing, 3rd Ed, 2009.
5. R. A. Johnson, I. Miller and J. Freund: Probability and Statistics for Engineers, PHI
6. S. C. Gupta and V. K. Kapoor: Fundamental of Mathematical Statistics, Sultan Chand and Sons

REFERENCE BOOKS:

1. W. E. Boyce and R. C. DiPrima, Elementary Differential Equations and Boundary Value Problems, 9th Edition, Wiley India, 2009.
2. N.P. Bali and Manish Goyal, A text book of Engineering Mathematics, Laxmi Publications, Reprint, 2008.
3. E. A. Coddington, An Introduction to Ordinary Differential Equations, Prentice Hall India, 1995.
4. G. F. Simmons, Differential Equations with Applications and Historical Notes, TMH, 2nd ed., 2003.
5. P. L. Meyer: Introductory Probability and Statistical Applications, Oxford & IBH.

GAPS IN THE SYLLABUS (TO MEET INDUSTRY/PROFESSION REQUIREMENTS) --

POS MET THROUGH GAPS IN THE SYLLABUS --

TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN ---

POS MET THROUGH TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN –

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	50
End Semester Examination	50

Continuous Internal Assessment	% Distribution
Mid semester examination	25
Quiz	20
Teacher's Assessment	5

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	√	√	√	√	√
Semester End Examination	√	√	√	√	√

INDIRECT ASSESSMENT

1. Student Feedback on Course Outcome

COURSE DELIVERY METHODS

CD1	Lecture by use of boards/LCD projectors/OHP projectors	√
CD2	Assignments/Seminars	√
CD3	Laboratory experiments/teaching aids	
CD4	Industrial/guest lectures	
CD5	Industrial visits/in-plant training	
CD6	Self- learning such as use of NPTEL materials and internets	√
CD7	Simulation	

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
CO1	3	3	2	3	2	1	1	0	0	0	1			
CO2	3	3	2	3	2	1	1	0	0	1	1			
CO3	3	3	2	3	2	1	1	0	0	1	1			
CO4	3	2	2	2	2	1	1	0	0	1	1			
CO5	3	3	2	2	2	1	1	1	1	1	2			

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD6
CO2	CD1, CD2, CD6
CO3	CD1, CD2, CD6
CO4	CD1, CD2, CD6
CO5	CD1, CD2, CD6

COURSE INFORMATION SHEET

Course Code: **CH24101**
Course Title: **Chemistry**
Pre-requisite(s): **Intermediate level chemistry**
Co- requisite(s):
Credits: **4** L:3 T:1 P: 0
Class schedule per week: **4**
Class: **B. Tech.**
Semester / Level: **SECOND**
Branch: **Chemical Engineering**
Name of Teacher:

COURSE OBJECTIVES

This course envisions to impart to students to:

1.	Understand the concept of chemical bonding in coordination chemistry
2.	Understand the basics of stereochemistry, aromaticity and reaction mechanism of organic molecules
3.	Understand the reaction dynamics and to know different types of catalysis
4.	Apprehend the basic principles and the application of vibrational, electronic and NMR spectroscopy
5.	Develop knowledge on the physical state and electrochemistry of molecules

COURSE OUTCOMES (COs)

After the completion of this course, students will be able to:

CO1	Explain the bonding in a coordination complex
CO2	Explain the 3D structure, aromaticity and stereochemistry of organic molecules
CO3	Predict the rate, molecularity and mechanism of a simple as well as catalytic reaction
CO4	Explain the UV-vis, IR and NMR spectra of unknown molecules
CO5	Interpret the phase diagram of simple one and two component heterogeneous systems in equilibrium and the electrochemical behavior of the molecules

SYLLABUS

MODULE	(NO. OF LECTURE HOURS)
Module – I **Module I: Coordination Complex and Symmetry:** Introduction to coordination complexes, Crystal Field Theory, Octahedral, Tetrahedral, and Square Planar complexes, Crystal Field Stabilization Energy (CFSE), Jahn-Teller Theorem, Spectral, Electronic, and Magnetic Properties of Coordination Complexes, Point group symmetry and symmetry operation & applications.	**8**
Module – II **Organic Structure and Reactivity:** Aromaticity, Geometrical isomerism, Optical isomerism & Chirality; Wedge, Fischer, Newmann and Sawhorse projection formulae and interconversions; Conformational studies of cyclohexane, CIP Rule of geometrical and optical isomerism & nomenclature. Addition, Elimination, Substitution and Rearrangement reaction.	**8**
Module – III **Kinetics and Catalysis:** Kinetics of Chain, Parallel/Competing/Side, Consecutive reactions; Fast reactions; Outline of Catalysis, Acid-base catalysis, Enzyme catalysis (Michaelis-Menten equation), Important catalysts in industrial processes: Hydrogenation using Wilkinson's catalyst, Phase transfer catalyst.	**8**
Module – IV **Spectroscopic Techniques:** Absorption Spectroscopy, Lambert-Beer's law, Principles and applications of UV-Visible spectroscopy, Principles and applications of Vibrational spectroscopy; Introduction of NMR spectroscopy.	**8**
Module – V **Phase and Chemical equilibrium:** Phase rule: terms involved, Phase diagram of one component (Water) & two component (Pb/Ag) system & their applications; Nernst Equation, Standard electrode potential, EMF measurement and its application, Principle and application in Lithium-ion battery, H_2-O_2 fuel cell, supercapacitor, and electric vehicle.	

TEXTBOOKS:

1. Huheey, J.E., Inorganic Chemistry: Principles of Structure and Reactivity, 4th edition, Pearson.
2. Morrison, R.N. & Boyd, R.N. Organic Chemistry, Seventh Edition, Pearson.
3. Atkins, P.W. & Paula, J. Physical Chemistry, 10th Ed., Oxford University Press, 2014.

REFERENCE BOOKS:

1. Lee, J. D. Concise Inorganic Chemistry ELBS, 1991.
2. Mortimer, R.G. Physical Chemistry 3rd Ed., Elsevier (2009).
3. William Kemp, Organic Spectroscopy, 3rdEd., 2008 Macmillan

GAPS IN THE SYLLABUS (TO MEET INDUSTRY/PROFESSION REQUIREMENTS)

POS MET THROUGH GAPS IN THE SYLLABUS

TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN

POS MET THROUGH TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Progressive Evaluation	50
End Semester Examination	50

Continuous Internal Assessment	% Distribution
Mid Semester Examination	25
Quiz, Assignment	20
Teacher's Assessment	5

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	√	√	√	√	√
Semester End Examination	√	√	√	√	√

INDIRECT ASSESSMENT

2. Student Feedback on Course Outcome

COURSE DELIVERY METHODS

CD1	Lecture by use of boards/LCD projectors/OHP projectors	√
CD2	Assignments/Seminars	√
CD3	Laboratory experiments/teaching aids	
CD4	Industrial/guest lectures	
CD5	Industrial visits/in-plant training	
CD6	Self- learning such as use of NPTEL materials and internets	√
CD7	Simulation	

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	1	1	1			1		1				
CO2	3	3	2	1	1			1		1				
CO3	3	3	2	2	2			1		1				
CO4	3	2	2	2	3			1		2				
CO5	3	3	2	2	2	1	1	1		2	1			

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD 6
CO2	CD1, CD2, CD 6
CO3	CD1, CD2, CD 6
CO4	CD1, CD2, CD 6
CO5	CD1, CD2, CD 6

COURSE INFORMATION SHEET

Course Code: **EC24101**
Course Title: **Basic Electronics**
Pre-requisite(s):
Co- requisite(s):
Credits: **3** **(**L:2 T:1 P:0)
Class schedule per week: **3**
Class: **B. Tech.**
Semester / Level: **SECOND**
Branch: **Chemical Engineering**
Name of Teacher:

COURSE OBJECTIVES

This course envisions to impart to students to:

1.	Understand PN Junction, diodes and their applications.
2.	Comprehend BJT and the bias configurations.
3.	Understand operating principles of FETs
4.	Understand op amp and its applications.
5.	Apprehend number system, Logic Gates and Boolean algebra.

COURSE OUTCOMES (COs)

After the completion of this course, students will be able to:

CO1	Understand the characteristics of electronic devices like PN-diode, BJT, JFET and MOSFET
CO2	Classify and analyze the various circuit configurations of BJTs and MOSFETs.
CO3	Analyze the characteristics of operational amplifier.
CO4	Design electronic circuits using diodes, transistors, op-amp and logic gates for analog and digital applications.
CO5	Solve day-to-day life problems using electronic circuits.

SYLLABUS

MODULE	(NO. OF LECTURE HOURS)
Module – I **Diodes and Applications:** Introduction to semiconductor materials, PN junction diode, barrier potential, depletion layer width, junction capacitance, diode current equation, I-V plot, diode-resistance, temperature dependence, breakdown mechanisms, Zener diode – operation and applications, Diode as a Rectifier: Half Wave and Full Wave Rectifiers with and without C-Filters.	**8**
Module – II **Bipolar Junction Transistors (BJT):** Basic operation of PNP and NPN Transistors, Input and Output Characteristics of CB, CE and CC Configurations. Transistor biasing: operating point, Fixed bias, emitter bias, voltage divider bias, stability factor, small signal analysis (h-parameter model) of CE configuration.	**8**
Module – III **Field Effect Transistors:** JFET: Principle of operation, transfer characteristics, MOSFET: Operation of N-MOS, P-MOS, enhancement and depletion type, transfer characteristics, CS biasing of JFET and MOSFET.	**8**
Module – IV **Operational Amplifiers:** Introduction of Operational Amplifier, Characteristics of Operational Amplifier, Differential Amplifier, CMRR, Slew Rate, input and output offset voltages, Inverting and non-inverting amplifiers, Summing Amplifier, Difference amplifier, Differentiator and Integrator.	**8**
Module – V **Boolean Algebra and Logic Gates:** Boolean Algebra, Boolean operators, Truth table of different digital logic gates (AND, OR, NOT, NAND, NOR, EXOR, EX-NOR), application of diode for design of logic gates, realization of logic gates using universal gates, adder, subtractor.	**8**

TEXTBOOKS:

1. Millman J., Halkias C.C. “Integrated Electronics: Analog and Digital Circuits and Systems”, Tata McGraw-Hill.
2. Boylstead R.L., Nashelsky L., “Electronic Devices and Circuit Theory”, Pearson Education, Inc, 11/e.
3. Mano M.M., Michael D. Ciletti, “Digital Design”, Pearson Education, Inc, 5/e, 2011.

REFERENCE BOOKS:

1. Millman J., Halkias C.C., Parikh Chetan, “Integrated Electronics: Analog and Digital Circuits and Systems”, Tata McGraw-Hill, 2/e.
2. Millman J., Halkias C.C., Satyabrata Jit, “Millman’s Electronic Devices and Circuits”, Tata McGraw-Hill, 3/e.
3. Albert Paul, Malvino, David J. Bates, “Electronic principles”, McGraw-Hill, 8/e, 2015.

GAPS IN THE SYLLABUS (TO MEET INDUSTRY/PROFESSION REQUIREMENTS)

POS MET THROUGH GAPS IN THE SYLLABUS

TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN

POS MET THROUGH TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Progressive Evaluation	50
End Semester Examination	50

Continuous Internal Assessment	% Distribution
Mid Semester Examination	25
Quiz	20
Teacher's Assessment/ Assignment	5

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	√	√	√	√	√
Semester End Examination	√	√	√	√	√

INDIRECT ASSESSMENT

3. Student Feedback on Course Outcome

COURSE DELIVERY METHODS

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PSO 1	PSO 2	PSO 3
CO1	3	3	1	2	3	1	1	2	2	3	2			
CO2	3	3	1	2	3	1	1	2	2	3	2			
CO3	3	3	1	2	3	1	1	2	2	3	2			
CO4	3	3	1	2	3	1	1	2	2	3	2			
CO5	3	3	1	2	3	1	1	2	2	3	2			

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD 6
CO2	CD1, CD2, CD 6
CO3	CD1, CD2, CD 6
CO4	CD1, CD2, CD 6
CO5	CD1, CD2, CD 6

COURSE INFORMATION SHEET

Course Code: **ME24101**
Course Title: **Basics of Mechanical Engineering**
Pre-requisite(s): **NIL**
Co- requisite(s): **NIL**
Credits: **3** **(**L: 2 T:1 P: 0)
Class schedule per week: **3**
Class: **B. Tech**
Semester / Level: **SECOND**
Branch: **Chemical Engineering**
Name of Teacher:

COURSE OBJECTIVES

This course envisions to impart to students to:

1.	Introduce system of forces, and write equation of equilibrium.
2.	Analyse motion of particle and rigid body subjected to force.
3.	Grasp the importance of internal and external combustion engines.
4.	Apprehend the fundamentals of friction.
5.	Understand the different sources of energy.

COURSE OUTCOMES (COs)

After the completion of this course, students will be able to:

CO1	Explain the basics of Mechanical Engineering.
CO2	Apply various laws of mechanics on static and dynamic elements and bodies.
CO3	Analyse various problems of mechanics related to static and dynamic bodies.
CO4	Evaluate the real life problem related to mechanics and energy for its probable solution.

SYLLABUS

MODULE	(NO. OF LECTURE HOURS)
Module – I **System of Forces and Structure Mechanics;** Addition of Forces, Moment of a Force, Couple, Varignon's theorem, Free Body Diagram, Equilibrium in Two and Three Dimensions, Equivalent Forces and Moment. Types of Plane Trusses, Analysis of Plane Trusses by: Method of Joints and Method of Sections. Hooke's Law of elasticity, Stress and Strain, Relation between elastic constants.	**8**
Module – II **Kinematics & Kinetics of rigid bodies:** Types of rigid body motion– translation, rotation about fixed axis, equations defining the rotation of a rigid body about a fixed axis, plane motion, absolute and relative velocity in plane motion, instantaneous center of rotation. Equation of motion and D'Alembert's principle.	**8**
Module – III **Friction :** Interfacial Friction (a) Laws of dry friction, static & kinetic co-efficient of friction, Analysis of static, kinetic and rolling friction. (b) Analysis of frictional forces in inclined planes, wedges, screw jacks and belt drives.	**8**
Module – IV **Boilers and Internal Combustion Engine;** Classification of Boilers, Fire tube and Water Tube boilers. Boiler Mountings and Accessories. Boiler efficiency. Classification of I C Engines. Basic components and terminology of IC engines, working principle of four stroke and two stroke - petrol and diesel engine.	**6**
Module – V **Non-Conventional Energy Sources** Renewable and Non-renewable Energy Resources, Advantages and Disadvantages of Renewable Resources, Renewable Energy Forms and Conversion- Solar Energy, Wind Energy, Hydro Energy.	**5**

TEXTBOOKS:

1. Engineering Mechanics, Irving H. Shames, P H I. ltd, 2011.
2. Boiler operator, Wayne Smith, LSA Publishers, 2013.
3. Internal Combustion Engines, M. L. Sharma and R. P. Mathur, Dhanpat Rai Publications, 2014.
   Fundamentals of Renewable Energy Processes, Aldo Vieira Da Rosa, Elsevier publication, 2012.

REFERENCE BOOKS:

1. Engineering Mechanics : statics, James L. Meriam, L. G. Kraige, Wiley, 7th Edition, 2011.
2. Engineering Mechanics, S. Rajasekaran & G. Sankarasubramaniam, Vikash publishing house, 2018.
3. An Introduction to Steam Boilers, David Allan Low, Copper Press Publisher, 2012.
4. Internal Combustion Engines – V Ganesan, McGraw hill, 2017.
5. Non Conventional Energy Resources, B. H. Khan, McGraw Hill Education Publisher, 2017.
6. Principles of Mechanical Engineering, R. P. Sharma & Chilkesh Ranjan, Global Academic Publishers, 2016.

GAPS IN THE SYLLABUS (TO MEET INDUSTRY/PROFESSION REQUIREMENTS) : NIL

POS MET THROUGH GAPS IN THE SYLLABUS: NA

TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN: NIL

POS MET THROUGH TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN: NA

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Progressive Evaluation	50
End Semester Examination	50

Continuous Internal Assessment	% Distribution
Mid Semester Examination	25
Quiz, Assignment	10 + 10
Teacher's Assessment	5

Assessment Components	CO1	CO2	CO3	CO4
Continuous Internal Assessment	√	√	√	√
Semester End Examination	√	√	√	√

INDIRECT ASSESSMENT

4. Student Feedback on Course Outcome

COURSE DELIVERY METHODS

CD1	Lecture by use of boards/LCD projectors/OHP projectors	√
CD2	Assignments/Seminars	√
CD3	Laboratory experiments/teaching aids	
CD4	Industrial/guest lectures	
CD5	Industrial visits/in-plant training	
CD6	Self- learning such as use of NPTEL materials and internets	√
CD7	Simulation	

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PSO 1	PSO 2	PSO 3
CO1	3	2	1	1	1		1	2	1	1		NA	NA	NA
CO2	3	3	2	2	2	1	1	1	2	1	1	NA	NA	NA
CO3	3	3	3	3	2	1	1	1	2	2	2	NA	NA	NA
CO4	2	3	3	3	3	2	2	2	2	2	2	NA	NA	NA

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD 6
CO2	CD1, CD2, CD 6
CO3	CD1, CD2, CD 6
CO4	CD1, CD2, CD 6

COURSE INFORMATION SHEET

Course Code: **CE24101**
Course Title: **Environmental Science**
Pre-requisite(s): **NIL**
Co- requisite(s):
Credits: **2** L: 2 T: 0 P:0
Class schedule per week: **2**
Class: **B. Tech.**
Semester / Level: **SECOND**
Branch: **Chemical Engineering**
Name of Teacher:

COURSE OBJECTIVES

This course envisions to impart to students to:

1.	Develop basic knowledge of ecological principles and their applications in environment.
2.	Identify the structure and composition of the spheres of the earth, the only planet sustaining life.
3.	Analyse, how the environment is getting contaminated and probable control mechanisms for them.
4.	Generate awareness and become a sensitive citizen towards the changing environment.

COURSE OUTCOMES (COs)

After the completion of this course, students will be able to:

CO1	Explain the structure and function of ecosystems and their importance in the holistic environment. (K_1,K_2)
CO2	Identify the sources, causes, impacts and control of air pollution. (K_1,K_2)
CO3	Distinguish the various types of water pollution happening in the environment and understand about their effects and potential control mechanisms. (K_1,K_2)
CO4	Judge the importance of soil, causes of contamination and need of solid waste management. (K_1,K_2)
CO5	Know the impacts of noise pollution and its management (K_1,K_2)

SYLLABUS

MODULE	(NO. OF LECTURE HOURS)
Module – I **Ecosystem and Environment :** Concepts of Ecology and Environmental science, ecosystem: structure, function and services, Biogeochemical cycles, energy and nutrient flow, ecosystem management. Concept of Biodiversity.	**5**
Module – II **Air Pollution :** Structure and composition of unpolluted atmosphere, classification of air pollution sources, types of air pollutants, effects of air pollution, monitoring of air pollution, Air pollution control and management.	**5**
Module – III **Water Pollution** : Water Resource; Water Pollution: types and Sources of Pollutants; effects of water pollution; Water quality monitoring, Water quality index, water and wastewater treatment: primary, secondary and tertiary.	**5**
Module – IV **Soil Pollution and Solid Waste Management :** Soil profile, soil properties, soil pollution, Municipal solid waste management. MSW – Functional elements of MSW.	**5**
Module – V **Noise Pollution :** Noise pollution: introduction, sources, outdoor and indoor noise propagation, Effects of noise on health, criteria noise standards and limit values, Noise measurement techniques, prevention and control of noise pollution.	**5**

TEXTBOOKS:

1. A, K. De. (3rd Ed). 2008. Environmental Chemistry. New Age Publications India Ltd.
2. R. Rajagopalan. 2016. Environmental Studies: From Crisis to Future by, 3rd edition, Oxford University Press.
3. Eugene P. Odum. 1971. Fundamentals of Ecology (3rd ed.) -. WB Sunders Company, Philadelphia.
4. C. N. Sawyer, P. L. McCarty and G. F. Parkin. 2002. Chemistry for Environmental Engineering and Science. John Henry Press.
5. S.C. Santra. 2011. Environmental Science. New Central Book Agency.

REFERENCE BOOKS:

1. D.W. Conell. Basic Concepts of Environmental Chemistry, CRC Press.
2. Peavy, H.S, Rowe, D.R, Tchobanoglous, G. Environmental Engineering, Mc-Graw - Hill International
3. G.M. Masters & Wendell Ela. 1991. Introduction to Environmental Engineering and Science, PHI Publishers.

GAPS IN THE SYLLABUS (TO MEET INDUSTRY/PROFESSION REQUIREMENTS)

POS MET THROUGH GAPS IN THE SYLLABUS

TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN

POS MET THROUGH TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Progressive Evaluation	50
End Semester Examination	50

Continuous Internal Assessment	% Distribution
Mid Semester Examination	25
Quiz	20
Teacher's Assessment/Assignment	5

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	√	√	√	√	√
Semester End Examination	√	√	√	√	√

INDIRECT ASSESSMENT

5. Student Feedback on Course Outcome

COURSE DELIVERY METHODS

CD1	Lecture by use of boards/LCD projectors/OHP projectors	√
CD2	Assignments/Seminars	√
CD3	Laboratory experiments/teaching aids	
CD4	Industrial/guest lectures	
CD5	Industrial visits/in-plant training	
CD6	Self- learning such as use of NPTEL materials and internets	√
CD7	Simulation	

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
CO1		1	3			1	3							
CO2		1	3			1	3							
CO3		1	3			1	3							
CO4		1	3			1	3							
CO5		1	3			1	3							

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD 6
CO2	CD1, CD2, CD 6
CO3	CD1, CD2, CD 6
CO4	CD1, CD2, CD 6
CO5	CD1, CD2, CD 6

COURSE INFORMATION SHEET

Course Code: CH24102
Course Title: Chemistry Lab
Pre-requisite(s): Intermediate level Chemistry
Co- requisite(s):
Credits: 1 (L:0 T:0 P:2)
Class schedule per week: 2
Class: B. Tech.
Semester / Level: SECOND
Branch: Chemical Engineering
Name of Teacher:

COURSE OBJECTIVES

This course envisions to impart to students to:

1.	Understand about synthesis of Organic and Inorganic compounds.
2.	Understand the spectroscopic data
3.	Develop concept of potentiometric and pH metric titration of acid and base
4.	Understand the rate constant of chemical reaction
5.	Develop knowledge of melting point and estimation of Eutectic and transition temperature

COURSE OUTCOMES (COs)

After the completion of this course, students will be able to:

CO1	Perform Synthesis of Organic and Inorganic compounds.
CO2	Analyze the spectroscopic data
CO3	Perform potentiometric and pH metric titration of acid and base
CO4	Determine the rate constant of chemical reaction
CO5	Perform measurement of melting point and estimation of Eutectic and transition temperature

SYLLABUS

List of Experiments:

1. Gravimetric estimation of Nickel by Dimethylglyoxime.
2. Quantitative estimation of Ca^{2+} and Mg^{2+} ions by complexometric titration using Na_2-EDTA.
3. To verify Bears Law using Fe^{3+} solution by spectrophotometer/colorimeter and to determine the concentration of a given unknown Fe^{3+} solution.
4. Preparation of Diazoamino Benzene and report the melting point and yield of product.
5. Draw melting point-mass percent composition diagram for two component mixture and determine the Eutectic Temperature.
6. To study the kinetics of acid-catalyzed hydrolysis of ethyl acetate and to evaluate the value of the rate constant.
7. To determine the strength of the given strong acid by strong base potentiometrically.
8. To determine the transition temperature of the given salt hydrate.
9. Qualitative detection of special elements in organic compounds.
10. To draw the pH-titration curve of strong acid vs strong base.

BOOKS:

1. Experimental Physical Chemistry, By B. Viswanathan, P. S. Raghavan, Narosa Publishing House (1997).
2. Vogels Textbook of Practical Organic Chemistry
3. Experiments in General chemistry, C. N. R. Rao and U. C. Agarwal
4. Experimental Organic Chemistry Vol 1 and 2, P R Singh, D S gupta, K S Bajpai, Tata McGraw Hill

Lab Check-In:

General:

- Laboratory apron and experimental notebook is mandatory to work in the laboratory.
- Be sure that all of your glassware, labwares, equipment etc. is present with you to conduct your experiment.
- Once you have checked-in, you will be responsible for missing labware items issued to you. Pay particular attention to the labwares, which is expensive and required for several students for their experiments, treat it with respect.
- It is your responsibility to clean all of the used labwares, glassware etc. and your work place after completion of your experiment before leaving lab.
- Learn the cleaning and drying technique for glassware's. Always use clean and dry glassware's for your experiment.
- Learn Good and Safe Laboratory Practice. Learn the safe handling of labwares, glassware's, chemicals, equipment, etc. Ask you lab instructor/Teacher for any queries.
- You need to maintain your lab record book updated as per instruction and be sure to get verified &

signed by your teacher in every lab classes.

- Keep your personal safety googles, lab aprons etc. with you for your next time use.

GAPS IN THE SYLLABUS (TO MEET INDUSTRY/PROFESSION REQUIREMENTS)

POS MET THROUGH GAPS IN THE SYLLABUS

TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN

POS MET THROUGH TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Lab Journal	30
Lab quizes	20
Progressive viva	20
End Sem Examination	30

Continuous Internal Assessment	% Distribution
Lab Journal	30
Lab quiz	10
Progressive viva	20

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	Y	Y	Y	Y	Y
Semester End Examination	Y	Y	Y	Y	Y

INDIRECT ASSESSMENT

1. **Student Feedback on Course Outcome**

COURSE DELIVERY METHODS

CD1	Introductory lecture by use of boards/LCD projectors
CD2	Laboratory experiments/ teaching aid
CD3	Self- learning such as use of NPTEL materials and internets
CD4	
CD5	
CD6	
CD7	

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
CO1	3	3	3	2	2	1	1	1	2	2	2			
CO2	2	2	3	1	3	1	2	2	2	3	2			
CO3	2	3	2	3	2	2	1	1	2	2	2			
CO4	3	3	3	3	3	1	2	1	2	2	2			
CO5	2	3	2	2	3	1	1	1	2	2	2			

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD3
CO2	CD1, CD2, CD3
CO3	CD1, CD2, CD3
CO4	CD1, CD2, CD3
CO5	CD1, CD2, CD3

COURSE INFORMATION SHEET

Course Code: **EC24102**
Course Title: **Basic Electronics Lab**
Pre-requisite(s):
Co- requisite(s):
Credits: **1** L:0 T:0 P: 2
Class schedule per week: **2**
Class: **B. Tech.**
Semester / Level: **SECOND**
Branch: **Chemical Engineering**
Name of Teacher:

COURSE OBJECTIVES

This course envisions to impart to students to:

1.	Measure magnitude, time-period, frequency, phase of signals using CRO
2.	Know PN junction characteristics and its applications
3.	Understand the working of transistor amplifier
4.	Understand the working of operational amplifier and circuits
5.	Realize logic gates and implement simple Boolean expression

COURSE OUTCOMES (COs)

After the completion of this course, students will be able to:

CO1	Familiarize with electronics components like diode, transistors, ICs
CO2	Make use of measuring instruments and function generators
CO3	Verify characteristics of diodes, transistors and op-amp
CO4	Design electronic circuits using diodes, transistors, op-amp for analog applications
CO5	Design electronic circuits using logic gates for digital applications

SYLLABUS

List of Experiments

Experiment No.	Name of the Experiments
	(A) HARDWARE BASED EXPERIMENTS
1.	**MEASURMENTS USING CRO** AIM-1: To understand the Measurement of voltage, time-period and frequency of different signals on CRO. AIM-2: To measure the frequency and phase of two different signals using Lissajous pattern.
2.	**HALF-WAVE AND FULL WAVE RECTIFIER CIRCUITS** AIM-1: To understand the basic operation principle of Half-wave rectifier circuit and measurement of rectification efficiency and ripple factor with and without C-Filter. AIM-2: To understand the basic operation principle of Full-wave rectifier circuit and measurement of rectification efficiency and ripple factor with and without C-Filter.
3.	**COMMON EMITTER (CE) TRANSISTOR AMPLIFIER** AIM-1: To understand the basic operation principle of CE transistor amplifier circuit and finding its frequency response. AIM-2: To determine the gain bandwidth product of CE transistor amplifier from its frequency response.
4.	**INVERTING OPERATIONAL AMPLIFIER (OP-AMP)** AIM: To design the inverting operational amplifier using IC741 OP-AMP and find its Gain and Frequency Response.
5.	**DIFFERENTIAL AMPLIFIER** AIM-1: To design common mode and differential mode circuit using IC741 OP-AMP AIM-2: To obtain common mode gain and differential mode gain and calculate CMRR.
6.	**REALIZATION OF LOGIC GATES** AIM-1: To understand basic Boolean logic functions (NOT, AND, OR). AIM-2: To realize the basic logic gates (AND, OR, NOT) using NAND Gate (IC-7400).
	(B) SOFTWARE BASED EXPERIMENTS
1.	**PN JUNCTION CHARACTERISTICS** AIM-1: To determine the forward bias V-I characteristics of PN junction diode and finding its forward cut-in voltage. AIM-2: To determine the reverse bias V-I characteristics of PN junction diode and finding its reverse breakdown voltage.
2.	**ZENER DIODE CHARACTERISTICS** AIM-1: To design a basic voltage regulator circuit using Zener diode. AIM-2: To determine the reverse bias V-I characteristics of Zener diode and finding its reverse breakdown voltage.
3.	**FIELD EFFECT TRANSISTOR CHARACTERISTICS** AIM-1: To determine the output and transfer characteristics of JFET. AIM-2: To measure the voltage, gain of JFET.
4.	**NON-INVERTING OPERATIONAL AMPLIFIER (OP-AMP)** AIM: To design the non-inverting operational amplifier using IC741 OP-AMP and find its Gain and Frequency Response.
5.	**DIFFERENTIATOR AND INTEGRATOR CIRCUITS USING OP-AMP** AIM-1: To design differentiator circuit using IC741 OP-AMP and observe waveforms. AIM-2: To design integrator circuit using IC741 OP-AMP and observe waveforms.

6.	**IMPLEMENTATION OF BOOLEAN FUNCTION** AIM-1: To understand the AND Gate IC (IC 7408) and OR Gate IC (IC 7432) AIM-2: To implement a given Boolean expression using logic gate ICs.

TEXTBOOKS:

1. Millman J., Halkias C.C., Parikh Chetan, "Integrated Electronics: Analog and Digital Circuits and Systems", Tata McGraw-Hill, 2/e.
2. Mano M.M., "Digital Logic and Computer Design", Pearson Education, Inc, Thirteenth Impression, 2011.

REFERENCE BOOKS:

1. Boylstead R.L., Nashelsky L., "Electronic Devices and Circuit Theory", Pearson Education, Inc, 10/e.

GAPS IN THE SYLLABUS (TO MEET INDUSTRY/PROFESSION REQUIREMENTS)

POS MET THROUGH GAPS IN THE SYLLABUS

TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN

POS MET THROUGH TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Progressive Evaluation	**(60)**
Attendance Marks	**12**
Day-to-day performance Marks	**06**
Lab Viva marks	**20**
Lab file Marks	**12**
Lab Quiz-I Marks	**10**
End SEM Evaluation	**(40)**
Lab Quiz-II Marks	**10**
Lab performance Marks	**30**

INDIRECT ASSESSMENT

6. Student Feedback on Course Outcome

COURSE DELIVERY METHODS

CD1	Lecture by use of Boards/LCD Projectors
CD2	Tutorials/Assignments
CD3	Seminars/ Quiz (s)
CD4	Mini Projects/Projects
CD5	Laboratory Experiments/Teaching Aids
CD6	Industrial/Guest Lectures
CD7	Industrial Visits/In-plant Training
CD8	Self- learning such as use of NPTEL Materials and Internets
CD9	Simulation

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PSO 1	PSO 2	PSO 3
CO1	3	2	2	1	2		1	1	1	1	1			
CO2	2	2	3	2	3			1	2	1	1			
CO3	2	2	3	1	3		1	1	2	2	2			
CO4	1	1	2	1	2	3	2	2	1	1	1			
CO5	1	1	1	1	2			2	3	2	2			

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD5, CD9
CO2	CD1, CD5, CD9
CO3	CD1, CD5, CD9
CO4	CD1, CD5, CD9
CO5	CD1, CD5, CD9

COURSE INFORMATION SHEET

Course Code: **ME24102**
Course Title: **Engineering Graphics**
Pre-requisite(s): **NIL**
Co- requisite(s): **NIL**
Credits:2 **(**L:0 T: 0 P:4)
Class schedule per week: **4**
Class: **B. Tech.**
Semester / Level: **SECOND**
Branch: **Chemical Engineering**
Name of Teacher:

COURSE OBJECTIVES

This course envisions to impart to students to:

1.	Understand the basic principles of Engineering Graphics, which include projections of 1D, 2D and 3D objects.
2.	Visualize a solid object (including sectioned) and convert it into drawing.
3.	Visualize different views of any object.
4.	Develop skill to draw objects using AutoCAD software.
5.	Inculcate the imagination and mental visualization capabilities for interpreting the geometrical details of common engineering objects.

COURSE OUTCOMES (COs)

After the completion of this course, students will be able to:

CO1	Explain the fundamentals of Engineering Graphics and projection and acquire visualization skills.
CO2	Demonstrate the concept of projections of points and lines for various engineering applications.
CO3	Apply the concept of projections to construct planes and solids, and its orthographic projections which are positioned in various configurations..
CO4	Demonstrate the understanding of AutoCAD software commands to draw projections of points, lines, planes and solids.

SYLLABUS

MODULE	(NO. OF LECTURE HOURS)
Module – I Introduction to Engineering Graphics, dimensioning and projections, orthographic projections, Fundamentals of First and Third Angle projection, Orthographic projections of points.	**9**
Module – II Orthographic projections of straight lines: lines parallel to HP and VP, lines inclined to HP and Parallel to VP, line inclined to VP and parallel to HP, line inclined to both reference planes. Orthographic projections of planes/lamina: lamina perpendicular to both HP and VP, lamina parallel to HP and perpendicular to VP (and vice versa), lamina inclined to HP and perpendicular to VP, lamina inclined to VP and perpendicular to HP, lamina inclined to both reference planes.	**9**
Module – III Projections of solids (cube, prism, pyramid, tetrahedron) - axis perpendicular to HP and inclined to VP and inclined to one or both planes. Section of solids: sectional plane perpendicular to one plane and parallel/inclined to another plane.	**9**
Module – IV Working with AutoCAD Commands, Cartesian Workspace, Basic Drawing & Editing Commands, Drawing: Lines, Rectangles, Circles, Arcs, Polylines, Polygons, Ellipses, Creating Fillets and Chamfers, Creating Arrays of Objects, Working with Annotations, Adding Text to a Drawing, Hatching, Adding Dimensions, Dimensioning Concepts, Adding Linear Dimensions, Adding Radial & Angular Dimensions, Editing the Dimensions.	**9**
Module – V Create views of points, lines, planes, and various types of solids (cube, prism, pyramid, tetrahedron, etc.) using AutoCAD software.	**9**

TEXTBOOKS:

1. Engineering Drawing by N. D. Bhatt, Charotar Publishing House Pvt.Ltd., 53rd, Edition, 2014.
2. Engineering Drawing and Graphics + AutoCAD by K. Venugopal, New Age International (P) Limited, 4th Reprint: June, 2017.

REFERENCE BOOKS:

1. Engineering Graphics with Autocad by J. D. Bethune, Prentice Hall, 2007.

GAPS IN THE SYLLABUS (TO MEET INDUSTRY/PROFESSION REQUIREMENTS) : NIL

POS MET THROUGH GAPS IN THE SYLLABUS: NA

TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN: NIL

POS MET THROUGH TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN: NA

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Progressive Evaluation	60
End Semester Test	40

Continuous Internal Assessment	% Distribution
Day to day performance & Lab files	30
Lab Quiz 1	10
Viva-voce	20
End Semester Examination	**% Distribution**
Examination: Experiment Performance	30
Lab Quiz 2	10

Assessment Components	CO1	CO2	CO3	CO4
Continuous Internal Assessment	√	√	√	√
Semester End Examination	√	√	√	√

INDIRECT ASSESSMENT

1. **Student Feedback on Course Outcome**

COURSE DELIVERY METHODS

CD1	Lecture by use of boards/LCD projectors/OHP projectors	
CD2	Assignments/Seminars	
CD3	Laboratory experiments/teaching aids	√
CD4	Industrial/guest lectures	
CD5	Industrial visits/in-plant training	
CD6	Self- learning such as use of NPTEL materials and internets	
CD7	Simulation	

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PSO 1	PSO 2	PSO 3
CO1	3	2	2		2					2				
CO2	3	3	2		2					2				
CO3	3	3	3	2	2				2	2				
CO4	2	2	2	2	3				2	3	2			

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD3
CO2	CD3
CO3	CD3
CO4	CD3

COURSE INFORMATION SHEET

Course Code: PE24102
Course Title: Workshop Practice
Pre-requisite(s): None
Co-requisite(s): None
Credits: 1 (L:0 T:0 P: 2)
Class schedule per week: 2
Class: B.Tech.
Semester / Level: SECOND
Branch: Chemical Engineering
Name of Teacher:

Course Objectives:
This course enables the students to:

1	Familiarize with the basics of manufacturing processes.
2	Impart knowledge and skill to use tools, machines, equipment, and measuring instruments.
3	Practice on manufacturing of components using workshop trades.
4	Educate students on the safe handling of machines and tools.
5	Exercise individual as well as group activity with hands-on training in different workshop trades.

Course Outcomes:
At the end of the course, a student should be able to:

CO1	Be conversant with the basic manufacturing processes.
CO2	Identify and apply suitable tools and instruments for carpentry, foundry, welding, fitting, and conventional and modern machining.
CO3	Manufacture different components using various workshop trades.
CO4	Take safety and precautionary measures for self and machines during operations.
CO5	Develop skills to work as an individual or in a team during trade practices.

SYLLABUS

LIST OF EXPERIMENT	**(NO. OF PRACTICAL HOURS)**
1. CARPENTRY SHOP **EXPERIMENT-I: Carpentry Tools and Instruments** **Objective**: To study the various tools, instruments, and equipment used in carpentry practice.	**2**
2. CARPENTRY SHOP **EXPERIMENT-II: Carpentry Practice** **Objective:** To perform the carpentry work by making a wooden job using different tools.	**2**
3. FOUNDRY SHOP **EXPERIMENT-I: Green Sand Moulding** **Objective:** To get acquainted with various tools and equipment used in making green sand mould (to practice green sand mould making with single-piece patterns).	**2**
4. FOUNDRY SHOP **EXPERIMENT-II: Aluminium Casting** **Objective:** To get acquainted with melting and pouring metal in a mould (given two-piece patterns of handle) and to make aluminium casting.	**2**

5. WELDING SHOP **EXPERIMENT-I: Manual Metal Arc Welding** **Objective:** To study arc welding processes including arc welding machines (AC & DC), electrodes and equipment. To join two pieces of given metal by the arc welding process.	**2**
6. WELDING SHOP **EXPERIMENT-II: Gas Welding** **Objective:** To study gas welding processes, including types of flames produced, filler metals and fluxes, etc. To join two pieces of given metal by the gas welding process.	**2**
7. FITTING SHOP **EXPERIMENT-I: Fitting Tools and Measuring Instruments** **Objective**: To study the various tools used in the fitting shop and perform fitting operations (like marking, chipping, hack-sawing, filing, drilling, etc.)	**2**
8. FITTING SHOP **EXPERIMENT-II: Fitting Assembly Practice** **Objective:** To make a job clamping plate as per the given drawing by fitting operations and to check for its assembly with a given component.	**2**
9. MACHINE SHOP **EXPERIMENT – I: Centre Lathe Machine** **Objective**: To study lathe machine and to machine a given job on the center lathe as per drawing.	**2**
10. MACHINE SHOP **EXPERIMENT-II: Shaper Machine** **Objective:** To study the Shaper machine and to machine a given job on the shaper as per drawing.	**2**
11. MODERN MACHINE SHOP **EXPERIMENT – I: CNC Lathe Machine** **Objective**: To provide an introduction to the functionality and operation of the CNC Lathe Machine through practical demonstration.	**2**
12. MODERN MACHINE SHOP **EXPERIMENT-II: CNC Surface Grinding Machine** **Objective:** To provide an introduction to the functionality and operation of the CNC Surface Grinding Machine through practical demonstration	**2**

Books recommended:

TEXT BOOK

1. S K Hajra Choudhury, A K. Hajra, "Elements of Workshop Technology: Vol- I and Vol -II", Media Promotors Pvt Ltd. **(T1)**
2. B S Raghuwanshi, "A course in Workshop Technology", Dhanpat Rai Publications. **(T2)**

REFERENCE BOOK

1. P.N. Rao, "Manufacturing Technology Vol-1and Vol-II", Tata McGraw Hill. **(R1)**
2. Kalpakjian, "Manufacturing Engineering and Technology", Pearson. **(R2)**

Gaps in the syllabus (to meet Industry/Profession requirements):

POs met through Gaps in the Syllabus:

Topics beyond syllabus/Advanced topics/Design:

POs met through Topics beyond syllabus/Advanced topics/Design:

Course Delivery Methods:

CD1	Lecture by use of boards/LCD projectors/OHP projectors	√
CD2	Assignments/Seminars	
CD3	Laboratory experiments/teaching aids	√
CD4	Industrial/guest lectures	
CD5	Industrial visits/in-plant training	
CD6	Self- learning such as use of NPTEL materials and internets	
CD7	Simulation	√

Course Evaluation:

Direct Assessment-

Assessment Tool	**% Contribution during CO Assessment**
Continuous Internal Assessment	60
Semester End Examination	40

Continuous Internal Assessment	**% Distribution**
Day to day performance & Lab files	30
Quiz 1	10
Viva-voce	20
End Semester Examination	**% Distribution**
Examination: Experiment Performance	30
Quiz 2	10

Assessment Components	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**
Continuous Internal Assessment	√	√	√	√	√
Examination: Experiment Performance	√	√	√	√	√

Indirect Assessment –

1. Student Feedback on Course Outcome

Mapping of Course Outcomes (COs) onto Program Outcomes (POs) and Program Specific Outcomes (PSOs):

COs	**PSOs**													
	1	2	3	4	5	6	7	8	9	10	11	13	14	15
CO1	3	2	1		1	1	1	1	1	1	1			
CO2	2	3	2	1	3	1	1	1	1	2	2			
CO3	2	2	3	2	3	1	1	1	2	2	2			
CO4	1	1	2	1	2	2	2	3	1	1	1			
CO5	1	1	2		1			1	3	3	3			

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

Mapping Between Course Outcomes (COs) and Course Delivery Method

Course Outcomes	Course Delivery Method
CO1	CD1, CD3, CD6
CO2	CD1, CD3
CO3	CD1, CD3
CO4	CD1, CD3
CO5	CD3

BIRLA INSTITUTE OF TECHNOLOGY

NEP-2020 CURRICULUM BOOK
(Effective from Academic Session: Monsoon 2024)

Bachelor of Technology

CENTRE FOR FOOD ENGINEERING AND TECHNOLOGY
THIRD YEAR (SEMESTER – III-IV)

Year II (3rd Semester)

COURSE INFORMATION SHEET

Course code	**CL24201**
Course title	**Thermodynamics**
Pre-requisite(s)	
Co- requisite(s)	
Credits	**L: 3 T: 1 P: 0**
Class schedule per week	**4**
Class	**B. Tech.**
Semester / Level	**III / 02**
Branch	**Chemical Engineering**
Name of Teacher	

Course Objectives

This course enables the students to:

1.	Apply the concept of Fluid Mechanics to solve physical and chemical problems encountered in chemical and biochemical industries.
2.	Apply knowledge of thermodynamics principles in heat transfer, mass transfer and chemical reaction engineering.
3.	Analyze and interpret data, to identify, formulate, and solve engineering problems.
4.	Solve real world engineering problems using thermodynamic principles.
5.	Apply the knowledge of thermodynamics to design chemical engineering equipment.

Course Outcomes

After the completion of this course, students will be able to:

CO24201.1	Apply the laws of thermodynamics on closed and open systems.
CO24201.2	Evaluate the properties of real gases.
CO24201.3	Solve problems involving various thermodynamic cycles.
CO24201.4	Evaluate the thermodynamic properties (Such as Partial molar properties, Fugacity coefficients, activity coefficients) of pure fluid and mixtures.
CO24201.5	Predict equilibrium composition of mixtures under phase and chemical-reaction equilibria.

SYLLABUS

MODULE	NO. OF LECTURE HOURS
Module 1: Introduction and Basic Concepts First law of thermodynamics, Energy balance for closed systems, Mass and Energy balances for open systems, Volumetric properties of pure fluids, Virial equations of state, Cubic equations of state, Theorem of corresponding states, Acentric factor, generalized correlations for gases and liquids, Statements of the second law, Heat engines, Carnot cycle, Refrigerator and Heat pump, Third law of thermodynamics, Microscopic interpretation of entropy.	8
Module 2: Thermodynamic Relations and Thermodynamic Properties of Fluids Euler relation, Gibbs-Duhem relation, Helmholtz free energy, Gibbs free energy, Maxwell relations, Gibbs energy as a generating function, Joule-Kelvin Effect, Clausius/Clapeyron equation, Antoine equation, Residual properties, Thermodynamic properties of real gases.	8
Module 3: Vapor-Liquid Equilibrium in Mixtures Introduction to Vapor-Liquid Equilibrium, Vapor-Liquid Equilibrium in ideal mixtures, Dew point and bubble point temperatures/Pressures, VLE from K-value correlations (Flash calculations), Low-Pressure Vapor-Liquid equilibrium in non-ideal mixtures.	8
Module 4: Thermodynamics of Multicomponent Mixtures Fundamental Property Relation, The Chemical Potential and Phase Equilibria, Partial Properties, The Ideal-Gas Mixture Model, Fugacity and Fugacity Coefficient (Pure Species and Species in Solution), The Ideal-Solution Model, Excess Properties, The Excess Gibbs Energy and the Activity Coefficient, Models for the Excess Gibbs Energy (Margules equation, Redlich-Kister equation, van Laar equation, Wilson equation, NRTL model and UNIQUAC equation).	8
Module 5: Chemical Reaction Equilibria The reaction coordinate, Application of Equilibrium Criteria to Chemical Reactions, The standard Gibbs Energy Change and the Equilibrium Constant, Effect of Temperature on the Equilibrium Constant, Evaluation of Equilibrium Constants, Relation of equilibrium constants to composition, Equilibrium Conversions for single Reactions, Phase Rule and Duhem's Theorem for Reacting Systems, Multi-reaction equilibria.	8

Textbooks:

1. Introduction to Chemical Engineering Thermodynamics: J.M. Smith, H.C. Van ness, and M.M. Abbot. 7th Edition, McGraw-Hill's Chemical Engineering Series.
2. Chemical, Biochemical and Engineering Thermodynamics: Stanley I. Sandler. Fourth Edition, John Wiley & Sons, Inc.
3. Chemical Engineering Thermodynamics: Y V C Rao, University Press.

Reference books:

1. Molecular Thermodynamics of Fluid-Phase Equilibria: J.M. Prausnitz, R.N. Lichtenthaler, E G de Azevedo. 3rd Edition, Prentice Hall International Series in the Physical and Chemical Engineering

Sciences.
2. Engineering and Chemical Thermodynamics: Milo D. Koretsky. 2nd Edition, John Wiley & Sons, Inc.
3. Using Aspen Plus in Thermodynamics Instruction: Stanley I. Sandler, John Wiley & Sons, Inc.

Gaps in the syllabus (to meet Industry/Profession requirements)
Use of process simulator such as ASPEN to study phase equilibria/reaction equilibria.

POs met through Gaps in the Syllabus
PO3, PO4, PO5

Topics beyond syllabus/Advanced topics/Design
Introduction to molecular/statistical thermodynamics.

POs met through Topics beyond syllabus/Advanced topics/Design
PO3, PO4, PO5

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
First Quiz	10
Mid Semester Examination	25
Second quiz/seminar/assignment/others/seminar/assignment/others	10
Teacher's Assessment	5
End Semester Examination	50

Indirect Assessment –
1. Student Feedback on Course Outcome

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO 1	3	3	3	2	2	2	2	0	1	2	0	3	3	3
CO 2	3	2	1	2	3	0	1	0	1	2	0	3	3	3
CO 3	3	1	1	1	1	0	0	0	1	1	0	3	3	3
CO 4	3	3	2	2	3	1	2	0	1	2	0	3	3	3
CO 5	3	3	1	2	3	2	2	0	1	2	0	3	3	3

Correlation Levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Mapping Between COs and Course Delivery (CD) methods

CD Code	Course Delivery methods	Course Outcome	Course Delivery Method Used
CD1	Lecture by use of boards/LCD projectors/OHP projectors	CO1	CD1, CD2, CD8
CD2	Tutorials/Assignments	CO2	CD1, CD2, CD8
CD 3	Seminars	CO3	CD1, CD2, CD4, CD8
CD 4	Mini projects/Projects	CO4	CD1, CD2, CD4, CD8

CD 5	Laboratory experiments/teaching aids	CO5	CD1, CD2, CD4, CD8
CD 6	Industrial/guest lectures		
CD 7	Industrial visits/in-plant training		
CD 8	Self- learning such as use of NPTEL materials and internets		
CD 9	Simulation		

COURSE INFORMATION SHEET

Course code	**CL24203**
Course title	**Fluid Mechanics**
Pre-requisite(s)	
Co- requisite(s)	
Credits	**L: 3 T: 1 P: 0**
Class schedule per week	**4**
Class	**B. Tech**
Semester / Level	**III / 02**
Branch	**Chemical Engineering**

Course Objectives

This course enables the students to:

1.	Develop an appreciation for the properties of Newtonian fluids.
2.	Understand the working principle of pressure measuring and flow measuring devices.
3.	Apply concepts of mass and momentum conservation to fluid flows and analytically solve a variety of simplified problems.
4.	Understand the dynamics of fluid flows and the governing non-dimensional parameters.
5.	Understand the working principle of fluid moving machines.

Course Outcomes

After the completion of this course, students will be able to:

CO1	Describe fluid pressure, its measurement and calculate forces on submerged bodies.
CO 2	Explain the flow visualization, boundary layer and momentum correction factor, state the Newton's law of viscosity and Reynolds number. Analyze fluid flow problems with the application of the continuity and momentum equation.
CO 3	Examine energy losses in pipe transitions and evaluate pressure drop in pipe flow using Hagen-Poiseuille's equation and Bernoulli's principle for laminar flow.
CO 4	Explain the basics of drag, lift, streamlining, equivalent diameter, sphericity, determine minimum fluidization velocity in fluidized bed and Compute pressure drop in fixed bed, packed bed and fluidized system.
CO 5	Analyze the general equation for internal flow meters and determine the performance aspects of fluid machinery.

SYLLABUS

MODULE	NO. OF LECTURE HOURS
Module 1: Fluid Statics: Basic equation of fluid statics; pressure variation in a static field; pressure measuring devices–manometer, U-tube, inclined tube, well, diaphragm, hydraulic systems – force on submerged bodies (straight, inclined), pressure centre.	8
Module 2: Fluid flow phenomena: Fluid as a continuum, Terminologies of fluid flow, velocity – local, average, maximum, flow rate – mass, volumetric, velocity field; dimensionality of flow; flow visualization – streamline, path line, streak line, stress field; viscosity; Newtonian fluid; Non-Newtonian fluid; dimensional analysis and similitude criterion, Buckingham's Pi theorem. Reynolds number-its significance, laminar, transition and turbulent flows: Prandtl boundary layer, compressible and incompressible. Momentum equation for integral control volume, momentum correction factor.	8
Module 3: Internal incompressible viscous flow: Introduction; flow of incompressible fluid in circular pipe; laminar flow for Newtonian fluid; Hagen-Poiseuille equation; flow of Non-Newtonian fluid, introduction to turbulent flow in a pipe; energy consideration in pipe flow, relation between average and maximum velocity, Bernoulli's equation–kinetic energy correction factor; head loss; friction factor; major and minor losses, Pipe fittings and valves.	8
Module 4: Flow past of immersed bodies: Introduction; concept of drag and lift; variation of drag coefficient with Reynolds number; streamlining; packed bed; concept of equivalent diameter and sphericity; Ergun equation, Fluidization: Introduction; different types of fluidizations; fluidized bed assembly; governing equation; industrial use. Agitation and mixing of liquids: agitated vessel, blending & mixing, suspension of solid particles. Dispersion operation. Turbine Design/scale up, Flow number, Power Requirement.	8
Module 5: Flow measurement: Introduction; general equation for internal flow meters; Orifice meter; Venturimeter; concept of area meters: rotameter; Local velocity measurement: Pitot tube. Fluid moving machines: Introduction; Basic classification of pumps, Mechanical pump: Centrifugal and Positive displacement pumps (rotary, piston, plunger, diaphragm pumps); pump specification; basic characteristics curves for centrifugal pumps; fan, blower and compressor.	8

Text books:

1. Fox and McDonald′s Introduction to Fluid Mechanics by Philip J. Pritchard, Wiley; 8th Edition, 2010.

2. Frank M. White, Fluid Mechanics, Sixth Edition, Tata McGraw-Hill, New Delhi, 2008.

3. McCabe, W.L., Smith J.C., and Harriot, P., "Unit Operations in Chemical Engineering", McGraw-Hill, Inc.

Reference books:

1. Geankoplis, C.J., "Transport Processes and Unit Operations", Prentice-Hall Inc.
2. Coulson, J.M. and Richardson, J.F., "Chemical Engineering, Volume I", Pergamon Press.

Gaps in the syllabus (to meet Industry/Profession requirements)

Solution of industrial problems.

POs met through Gaps in the Syllabus

PO2, PO3, PO4, PO5

Topics beyond syllabus/Advanced topics/Design

Numerical solution of fluid related industrial problems.

POs met through Topics beyond syllabus/Advanced topics/Design

PO2, PO3, PO4, PO5

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
First Quiz	10
Mid Semester Examination	25
Second quiz/seminar/assignment/others/seminar/assignment/others/seminar/assignment/other	10
Teacher's Assessment	5
End Semester Examination	50

Indirect Assessment –

1. Student Feedback on Course Outcome

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO 1	3	3	2	2	2	2	2	2	3	3	1	3	3	3
CO 2	3	3	2	2	2	2	2	2	3	3	1	3	3	3
CO 3	3	3	2	2	2	2	2	2	3	3	1	3	3	3
CO 4	3	3	3	2	2	2	2	2	3	3	1	3	3	3
CO 5	3	3	3	2	2	2	2	2	3	3	1	3	3	3

Correlation Levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Mapping Between COs and Course Delivery (CD) methods

CD Code	Course Delivery methods	Course Outcome	Course Delivery Method Used
CD1	Lecture by use of boards/LCD projectors/OHP projectors	CO1	CD1, CD2, CD7, CD8
CD2	Tutorials/Assignments	CO2	CD1, CD2, CD8
CD3	Seminars	CO3	CD1, CD2, CD8
CD4	Mini projects/Projects	CO4	CD1, CD2, CD8
CD5	Laboratory experiments/teaching aids	CO5	CD1, CD2, CD7, CD8
CD6	Industrial/guest lectures		
CD7	Industrial visits/in-plant training		
CD8	Self- learning such as use of NPTEL materials and internets		
CD9	Simulation		

COURSE INFORMATION SHEET

Course code: **CL24205**
Course title: **Chemical Process Calculations**
Pre-requisite(s):
Co- requisite(s):
Credits: **L: 2 T: 1 P: 0**
Class schedule per week: **3 hrs**
Class: **B. Tech.**
Semester / Level: **III / 02**
Branch: **Chemical Engineering**
Name of Teacher:

Course Objectives
This course enables the students to:

1.	Understand the fundamental concepts and calculations of process calculation.
2.	Use basic, applied chemistry/ thermodynamics for material balance calculations for different unit operations and unit processes.
3.	Use basic, applied chemistry/ thermodynamics for energy balance calculations for different unit operations and unit processes.
4.	Understand the various heats and their calculations related to chemical reactions.
5.	Develop understanding about humidity and usage of psychrometric chart.

Course Outcomes
After the completion of this course, students will be able to:

CO1	Apply the concept of dimension and unit conversion to check dimensional consistency of balanced equation and understand the specific terms used in process calculation.
CO 2	Solve problems related to ideal and real gas and solution.
CO 3	Solve material balance problems without chemical reactions.
CO 4	Solve material balance problems with chemical reactions.
CO 5	Solve energy balance problems of various unit processes.

SYLLABUS

MODULE	NO. OF LECTURE HOURS
Module I: Introduction to Stoichiometry: Units and Dimensions: Conversion of Equations, Systems of Units, Dimensional Homogeneity and Dimensionless Quantities, Buckingham Pi-theorem for Dimensional Analysis, Introduction to Chemical Engineering Calculations: Basis, Mole Fraction and Mole Percent, Mass Fraction and Mass Percent, Concentration of different forms, Conversion from one form to another, Stoichiometric and composition relations, Excess & Limiting reactants, Degree of completion, Conversion, Selectivity and Yield.	8
Module II: Gas Calculations, Humidity & Saturation: Gas laws-Ideal gas law, Dalton's Law, Amagat's Law, and Average molecular weight of gaseous mixtures. Vapour pressure, partial pressure, Vapour pressures of miscible, immiscible liquids and solutions. Real-gas relationships, Raoult's Law, Henry's law, Antoine's Equation, Clausius Clapeyron Equation. PVT calculations using ideal and real gas relationships, Relative Humidity and percent saturation; Dew point, Dry and Wet bulb temperatures; Use of humidity charts for engineering calculations.	8
Module III: Material Balance without Chemical Reaction: Unit Operations & Process Variables, Degree of Freedom Analysis, Application of material balances to single and multiple unit operations without chemical reactions involving distillation column, absorption column, evaporators, driers, crystallizer, liquid-liquid and liquid-solid extraction units, Unsteady state material balances.	8
Module IV: Material Balance with Chemical Reaction: Material balances with Single Reaction & Multiple Reactions applicable to single and multiple unit operations, Recycle, purge, bypass in batch, stage wise and continuous operations in systems with or without chemical reaction. Material balances in combustion, gas-synthesis, acid-alkali production reactions.	8
Module V: Energy Balance: Heat capacity of solids, liquids, gases and solutions, use of mean heat capacity in heat calculations, problems involving sensible and latent heats, Evaluation of enthalpy, Standard heat of reaction, heat of formation, combustion, solution mixing etc., Calculation of standard heat of reaction, Hess Law, Energy balance for systems with and without chemical reaction, Unsteady state energy balances.	8

Text books:

1. Haugen, P.A. Watson, K.M., Ragatz R.A Chemical Process Principles Part - I
2. Himmelblau, D.M Basic Principles and Calculation in chemical engineering, Prentice Hall
3. Bhatt B.L.Vora, S.M Stoichiometry, Tata McGraw Hill Publishing Co. Ltd., New Delhi

Reference books:

1. Felder, R. M.; Rousseau, R. W., "Elementary Principles of Chemical Processes", Third Edition, John Wiley & Sons, 2000
2. Venkataramani, V., Anantharaman, N., Begum, K. M. MeeraSheriffa, "Process Calculations", Second Edition, Prentice Hall of India.
3. Sikdar, D. C., "Chemical Process Calculations", Prentice Hall of India

Gaps in the syllabus (to meet Industry/Profession requirements)

Material and energy balance of industrial processes.

POs met through Gaps in the Syllabus

PO2, PO3, PO4, PO5

Topics beyond syllabus/Advanced topics/Design

Use of process simulator to study industrial processes.

POs met through Topics beyond syllabus/Advanced topics/Design

PO2, PO3, PO4, PO5

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
First Quiz	10
Mid Semester Examination	25
Second quiz/seminar/assignment/others	10
Teacher's Assessment	5
End Semester Examination	50

Indirect Assessment –

1.Student Feedback on Course Outcome

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO 1	3	3	0	0	2	0	0	0	1	0	0	3	3	3
CO 2	3	3	2	1	1	1	0	0	1	1	0	3	3	3
CO 3	3	3	0	1	1	2	2	2	2	2	2	3	3	3
CO 4	3	3	2	0	1	2	2	2	2	2	2	3	3	3
CO 5	3	3	2	0	1	2	2	2	2	2	2	3	3	3

Correlation Levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Mapping between COs and Course Delivery (CD) methods

CD Code	Course Delivery methods	Course Outcome	Course Delivery Method Used
CD 1	Lecture by use of boards/LCD projectors/OHP projectors	CO1	CD1, CD2, CD8
CD 2	Tutorials/Assignments	CO2	CD1, CD2, CD8
CD 3	Seminars	CO3	CD1, CD2, CD8
CD 4	Mini projects/Projects	CO4	CD1, CD2, CD8

CD 5	Laboratory experiments/teaching aids	CO5	CD1, CD2, CD8
CD 6	Industrial/guest lectures		
CD 7	Industrial visits/in-plant training		
CD 8	Self- learning such as use of NPTEL materials and internets		
CD 9	Simulation		

COURSE INFORMATION SHEET

Course code: **CL24207**
Course title: **Heat Transfer Operations**
Pre-requisite(s):
Co- requisite(s):
Credits: **L: 3 T: 1 P: 0**
Class schedule per week: **4 hrs**
Class: **B. Tech**
Semester / Level: **III /02**
Branch: **Chemical Engineering**
Name of Teacher:

Course Objectives
This course enables the students to:

1.	Understand the basic laws of heat transfer.
2.	Develop methodologies for solving various practical engineering problems.
3.	Understand working principles of heat transfer equipment.
4.	Design heat exchangers and evaporators and analyze their performance.
5.	Develop basic competence related to other courses involving thermal energy systems and processes.

Course Outcomes
After the completion of this course, students will be able to:

CO 1	Understand mechanism of heat transfer and heat transfer related dimensionless numbers.
CO 2	Determine heat transfer co-efficient using empirical correlations and apply to various heat transfer related problems.
CO 3	Analyze the effect of boundary condition on heat transfer process.
CO 4	Explain and apply concept of phase change.
CO 5	Design heat exchangers.

SYLLABUS

MODULE	NO. OF LECTURE HOURS
Module I **Basic Concepts:** Modes of heat transfer, conduction, convection and radiation, analogy between heat flow and electrical flow. **Conduction:** One dimensional steady state heat conduction, the Fourier heat conduction equation, conduction through plane wall, conduction through cylindrical wall, spherical wall, conduction through composite slab, cylinder and sphere, critical radius of insulation, **Extended surfaces:** heat transfer from a fin, fin effectiveness and efficiency, Introduction to unsteady state heat conduction.	8
Module II **Convection:** Natural and forced convection, the convective heat transfer coefficient. **Forced Convection:** Correlation equations for heat transfer in laminar and turbulent flows in a Circular tube and duct, Reynolds and Colburn analogies between momentum and heat transfer, heat transfer to liquid metals and heat transfer to tubes in cross flow. **Natural Convection:** Natural convection from vertical and horizontal surfaces, Grashof and Rayleigh numbers.	8
Module III **Heat transfer by radiation:** Basic Concepts of radiation from surface: black body radiation, Planks law, Wien's displacement law, Stefan Boltzmann's law, Kirchhoff's law, grey body, Radiation intensity of black body, View factor, emissivity, radiation between black surfaces and grey surfaces. Solar radiations, combined heat transfer coefficients by convection and radiation.	8
Module IV **Boiling and Condensation:** Pool boiling, pool boiling curve for water, maximum and minimum heat fluxes, correlations for nucleate and film pool boiling, drop wise and film wise condensation, Nusselt analysis for laminar film wise condensation on a vertical plate, film wise condensation on a horizontal tube, effect of non-condensable gases on rate of condensation. **Evaporation:** Types of evaporators, boiling point elevation and Duhring's rule, material and energy balances for single effect evaporator, multiple effect evaporators: forward, mixed and backward feeds, capacity and economy of evaporators.	8
Module V **Heat Exchangers:** Introduction, Industrial use, Types of heat exchangers, Co-current, Counter-current & Cross-current, Principal Components of a Concentric tube & Shell-and Tube Heat Exchanger, Baffles, Tubes and Tube Distribution, Tubes to Tube sheets Joint, Heat Exchangers with Multiple Shell & tube Passes, Fixed-Tube sheet and Removable-Bundle Heat Exchangers, log-mean temperature difference, overall heat transfer coefficient, fouling factors, Design of double pipe and shell and tube heat exchangers.	8

Text books:

1. Holman, J. P., 'Heat Transfer ', 9th Edn., McGraw Hill, 2004.
2. Kern, D.Q., "Process Heat Transfer ", McGraw-Hill, 1999.
3. Cengel, Y.A., Heat Transfer - A Practical Approach, McGraw-Hill, 1998.

Reference books:

1. Incropera, F.P. and Dewitt, D.P., Fundamentals of Heat and Mass Transfer, 5th ed., John Wiley, 2002.
2. McCabe, W.L., Smith, J.C., and Harriot, P., "Unit Operations in Chemical Engineering", 6th Edn., McGraw-Hill, 2001.

3. Coulson, J.M. and Richardson, J.F., "Chemical Engineering " Vol. I, 4th Edn., Asian Books Pvt. Ltd., India, 1998.

Gaps in the syllabus (to meet Industry/Profession requirements)

POs met through Gaps in the Syllabus

Topics beyond syllabus/Advanced topics/Design

POs met through Topics beyond syllabus/Advanced topics/Design

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
First Quiz	10
Mid Semester Examination	25
Second quiz/seminar/assignment/others	10
Teacher's Assessment	5
End Semester Examination	50

Indirect Assessment –

1.Student Feedback on Course Outcome

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO 1	3	3	3	2	2	2	2	1	2	2	1	3	3	3
CO 2	3	3	3	2	2	2	2	1	2	2	1	3	3	3
CO 3	3	3	3	2	2	2	2	1	2	2	1	3	3	3
CO 4	3	3	3	3	2	2	2	1	2	3	1	3	3	3
CO 5	3	3	3	3	2	2	2	1	2	3	1	3	3	3

Correlation Levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Mapping between COs and Course Delivery (CD) methods

CD Code	Course Delivery methods	Course Outcome	Course Delivery Method Used
CD1	Lecture by use of boards/LCD projectors/OHP projectors	CO1	CD1, CD2, CD8
CD2	Tutorials/Assignments	CO2	CD1, CD2, CD8
CD3	Seminars	CO3	CD1, CD2, CD8
CD4	Mini projects/Projects	CO4	CD1, CD2, CD7, CD8
CD5	Laboratory experiments/teaching aids	CO5	CD1, CD2, CD7, CD8
CD6	Industrial/guest lectures		
CD7	Industrial visits/in-plant training		
CD8	Self- learning such as use of NPTEL materials and internets		
CD9	Simulation		

Year II (4th Semester)

COURSE INFORMATION SHEET

Course code	**CL24209**
Course title	**Mechanical Operations**
Pre-requisite(s)	
Co- requisite(s)	
Credits	**L: 3 T: 0 P: 0**
Class schedule per week	**3**
Class	**B. Tech.**
Semester / Level	**IV /02**
Branch	**Chemical Engineering**
Name of Teacher	

Course Objectives

This course enables the students to:

1.	Develop an understanding of basics of mechanical operations.
2.	Understand storage and transportation of solids.
3.	Understand size analysis, size reduction and working principle of associated equipment used for size reduction.
4.	Understand solid-liquid and liquid-liquid mechanical separation.
5.	Understand gas-solid and solid-solid mechanical separation.

Course Outcomes

After the completion of this course, students will be able to:

CO1	Remembering the fundamental laws of particulate separation and basic mathematical formulae.
CO 2	Understanding the need of mechanical operations in chemical engineering industries.
CO 3	Analysis of size reduction machineries for various industries and solid-fluid separation units .
CO 4	Concept of size reduction machineries for various industries, solid-fluid separation units.
CO 5	Compare among different mechanical separation units for solid-fluid separation.

SYLLABUS

MODULE	NO. OF LECTURE HOURS
Module 1: Characterization of solid particles: Particle Shape. Particle size analysis Differential and cumulative analysis. **Properties of particulate masses:** Bulk density, coefficient of Internal Friction, Storage of solids, Pressure distribution in hopper. Janssen Equation. **Transportation of Solids**: Studies on performance and operation of different conveyors eg. Belt, Screw, Apron, Flight etc. and elevators.	8
Module 2: Size Reduction: Rittinger's law, Kick's law, Bond's law, Work index, Types of comminuting equipment - Jaw Crushers, Gyratory Crusher, Roll crushers; Grinders-hammer Mill, Ball Mill, Rod Mill etc. Dry and wet grinding, open and closed circuit. Simulation of Milling operation grinding rate function, breakage function.	8
Module 3: Solid Liquid separation: Gravity Settling process – Clarifiers and Thickeners, Flocculation Design of Gravity Thickener, **Centrifugal Settling:** principle, Centrifuges for solid liquid and liquid-liquid separation.	8
Module 4: Filtration: Theory of solid-liquid filtration, principle of filtration, constant pressure and constant rate filtration, compressible and incompressible cakes, Filter aids, Equipment of liquid solid filtration, Batch and continuous pressure filters. Theory of centrifugal filtration, Equipment for centrifugal filtration.	8
Module 5: Solid Solid Separation: Industrial Screening equipment: Screen effectiveness and Capacity. **Wet Classification:** Differential settling, Liquid cyclones, Drag, Rake and Spiral, Bowl, Hydroseparator, Hydaulic classifiers, Tabling, Jigging, Froth floatation, Dense media separation etc. Magnetic separation, Electrostating Separation. **Gas-solid separation:** Settling chambers, centrifugal settling, Cyclones, ESP, Scrubbers, Filters.	8

Text books:

1. McCabe, W.L., Smith J.C., and Harriot, P., "Unit Operations Chemical Engineering", McGraw-Hill, Inc.

2. Coulson, J.M. and Richardson, J.F., "Chemical Engineering, VolumeI", Pergamon Press.

Reference books:

1. Geankoplis, C.J., "Transport Processes and Unit Operations", Prentice-Hall Inc.

Gaps in the syllabus (to meet Industry/Profession requirements) :

POs met through Gaps in the Syllabus

Topics beyond syllabus/Advanced topics/Design :

POs met through Topics beyond syllabus/Advanced topics/Design

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
First Quiz	10
Mid Semester Examination	25
Second quiz/seminar/assignment/others	10
Teacher's Assessment	5
End Semester Examination	50

Indirect Assessment –

1.Student Feedback on Course Outcome

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO 1	3	3	3	2	3	2	2	1	1	1	1	3	3	3
CO 2	3	3	3	2	3	2	2	1	1	1	1	3	3	3
CO 3	3	3	3	2	3	2	2	1	1	1	1	3	3	3
CO 4	3	3	3	2	3	2	2	1	1	1	1	3	3	3
CO 5	3	3	3	2	3	1	1	1	1	1	1	3	3	3

Correlation Levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Mapping Between COs and Course Delivery (CD) methods

CD Code	Course Delivery methods	Course Outcome	Course Delivery Method Used
CD 1	Lecture by use of boards/LCD projectors/OHP projectors	CO1	CD1, CD2, CD8
CD 2	Tutorials/Assignments	CO2	CD1, CD2, CD8
CD 3	Seminars	CO3	CD1, CD2, CD8
CD 4	Mini projects/Projects	CO4	CD1, CD2, CD8
CD 5	Laboratory experiments/teaching aids	CO5	CD1, CD2, CD8
CD 6	Industrial/guest lectures		
CD 7	Industrial visits/in-plant training		
CD 8	Self- learning such as use of NPTEL materials and internets		
CD 9	Simulation		

COURSE INFORMATION SHEET

Course code: **FE24201**
Course title: **Principle of Food Processing and Preservation**
Pre-requisite(s):
Co- requisite(s):
Credits:3 **L:03 T:00 P:00**
Class schedule per week: **03**
Class: **B. Tech**
Semester / Level: **IV/02**
Branch: **Food Engineering and Technology**
Name of Teacher:

Course Objectives

This course enables the students:

1.	To develop knowledge of preserving food to prevent wastages and losses
2.	To make use of information on the scientific mechanism of food preservation
3.	To build practical knowledge to various methods of food processing.
4.	To apply variety in the diet by providing a range of attractive flavors, colors, aromas and textures in food (collectively known as eating quality, sensory characteristics or organoleptic quality)
5	To apply in shelf life prediction of the food

Course Outcomes

After the completion of this course, students will be:

CO1	Able to justify the need for food processing.
CO2	Able to discover the various processing techniques.
CO3	Able to understand the various methods by which foods could be preserved.
CO4	Able to discuss on the methods to extend the shelf life to allow time for distribution, sales and home storage.
CO5	Able to measure the shelf life of the food

SYLLABUS

MODULE	NO. OF LECTURE HOURS
Module 1: Introduction to food processing: Basic principles, importance of food processing and preservation, classification of foods, types of food spoilage, viz. microbiological, enzymatic, chemical and physical spoilages and their effects on food quality; Objectives and techniques of preservation by using high temperature, using low temperature, using chemicals, and removing moisture. Water activity (a_w) in foods: Role of water activity in food preservation, control of a_w by addition of solutes and moisture removal, moisture sorption isotherm, measurements of water activity, intermediate moisture food (IMF); Processing by Moisture Removal: Evaporation, Concentration and Dehydration, Drying operation, Drying of solid and liquid foods, Types of dryers, their advantages and disadvantages, Concentration of liquid food by evaporators, Continuous, Multiple effect, Falling and rising film evaporators, Principles of freeze concentration, Membrane processes for liquid food concentration.	8
Module 2: Law of mass action, Theory of Reaction Rates : Types of Reactions Elementary Reactions Reaction Order -Zero-Order Reactions , First-Order Reactions, Second-Order Reactions, nth-Order Reactions , Pseudo-first order reaction , Non Elementary Reactions, Equilibrium rate constant, Reactions Where Product Concentration Is Rate Limiting, The Reaction Rate Constant, Temperature Dependence of Reaction Rates , The Arrhenius Equation , The Q10 Value , The z Value, Determination of Reaction Kinetic Parameters , Use of Chemical Reaction Kinetic Data for Thermal Process Optimization, Le-Chatelier's principle, Collision Theory, Systems Requirements for In-Can Processing i.e., Stationary Retorts, Hydrostatic Cooker, Continuous Agitating Retorts, Crateless Retorts , Systems Requirements for Processing Products Packaged in Flexible Plastic Containers, Processing in Glass Containers, Flame Sterilization Systems, Continuous Flow Sterilization: Aseptic or Cold Fill , Steam-Air Mixtures for Thermal Processing;	8
Module 3: High temperature processing: Principles of thermal processing, Blanching, Pasteurization and Sterilization, microbial destruction in batch and continuous sterilization, methods of heat transfer, Basic concepts in thermal inactivation of microorganisms-D, Z, F values, TDT curve heat resistance of micro-organisms, factors affecting heat resistance of micro-organisms, canning of foods, categories of foods for canning, heat penetration into food containers, calculating the process time for canned food, UHT processing, Microwave and radio frequency processing of foods.	8
Module 4: Low temperature processing: refrigeration, chilling and freezing of food, freezing principles, low and fast freezing, freezing process, determining freezing load, ammonia refrigeration systems, freezing rate, estimation of freezing time of foods, Types of freezers, thawing of frozen food; Freezing damage-osmotic damage, Refrigeration, Food preservation by packaging: role, function and impact assessment, shelf life of packaged foods: factors affecting product quality and shelf life. Controlled Atmosphere Storage (CAS), Modified Atmosphere Storage (MAS).	8
Module 5: Concept of cold sterilization. Food Preservation by Irradiation: Introduction, units of radiation, kinds of ionizing radiations used in food irradiation, mechanism of action, uses of radiation processing in food industry, Food Preservation by Fermentation - Principles, Types of fermentation, Advantages; Food Preservation by Chemicals: Use of preservatives in foods: Class 1 and Class II preservatives, Chemical Food Preservatives & their acceptable daily intake, bio preservatives. Food preservation by sulphating, smoking, and pickling; **Hurdle technology**: definition and applications. Effects of various food processing operations on the nutritive value of foods.	8

Extrusion: Introduction. Functions and advantages of extrusion process. Single screw extruder (SSE): different parts present and their functions. Three zones in SSE and their functions. Screw compression ratio (SCR), L/D ratio, Expansion ratio (ER). Screw pitch. Double screw extruder (DSE): counter and co-current, intermeshing and non-intermeshing. Advantages of DSE over SSE.	

Text books:

1. Food Scienceby Norman, N.P. and Joseph, H.H. (1997).. Fifth edition, CBS Publication, New Delhi.**(T1)**
2. Food Microbiologyby Frazier, W.C. and Westhoff, D.C. (1996). 4th edn, Tata McGraw Hill Pvt. Ltd., New Delhi. **(T2)**
3. Food Processing Technology byFellows, P.J. (2002).: Principles and Practice, 2nd edn, Woohead Pub. Ltd. **(T3)**
4. Principles of Food Science, Part II, Physical Principles of Food Preservation by Marcel Dekker, Inc. **(T4)**
5. M. Shafeiur Rahman (1999). Handbook of Food Preservation, Marcel Dekker, Inc. **(T5)**
6. Vickie A. Valdavik and Elizabeth, W. Christian (2003). Essentials of Food Science. Springers. **(T6)**

Reference books:

1. Food storage and preservation by Vijayakhader**(R1)**
2. Food Science by B. Srilakshmi **(R2)**
3. Food Preservation by Desrosier **(R3)**
4. Physical Principles of Food Preservation Fennema **(R4)**
5. Fruit & vegetables preservation and practice by K. Sanjeev & Srivastava R.P**(R5)**

Gaps in the syllabus (to meet Industry/Profession requirements)

Industrial visit and designing of operational flow diagram of respective food industry

POs met through Gaps in the Syllabus

PO3, PO4, PO5

Topics beyond syllabus/Advanced topics/Design

Recent advances in non thermal preservation techniques

POs met through Topics beyond syllabus/Advanced topics/Design

PO3, PO4, PO5

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
First Quiz	10
Mid Semester Examination	25
Second quiz/seminar/assignment/others	10
Teacher's Assessment	5
End Semester Examination	50

Indirect Assessment –

1.Student Feedback on Course Outcome

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO 1	3	1	3	3	1	1	2	1	2	1	3	3	3	3
CO 2	3	1	3	3	2	2	3	1	2	1	3	3	3	3
CO 3	3	1	3	3	2	1	2	1	2	1	3	3	3	3
CO 4	3	1	3	3	1	2	2	1	2	1	3	3	3	3
CO 5	3	1	3	3	1	1	2	1	2	1	3	3	3	3

Correlation Levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Mapping Between COs and Course Delivery (CD) methods

CD Code	Course Delivery methods	Course Outcome	Course Delivery Method Used
CD 1	Lecture by use of boards/LCD projectors/OHP projectors	CO1	CD1, CD2, CD8
CD 2	Tutorials/Assignments	CO2	CD1, CD2, CD8
CD 3	Seminars	CO3	CD1, CD2, CD4, CD8
CD 4	Mini projects/Projects	CO4	CD1, CD2, CD4, CD8
CD 5	Laboratory experiments/teaching aids	CO5	CD1, CD2, CD4, CD8
CD 6	Industrial/guest lectures		
CD 7	Industrial visits/in-plant training		
CD 8	Self- learning such as use of NPTEL materials and internets		
CD 9	Simulation		

COURSE INFORMATION SHEET

Course code	**FE24203**
Course title	**Programming Language and Data Base Management System**
Pre-requisite(s)	**Basics of C Programming and Data Structures**
Co- requisite(s)	
Credits	L: 3 T: 0 P: 0
Class schedule per week	**3**
Class	**B. Tech.**
Semester / Level	IV / Second
Branch	**Food Engineering and Technology**

Course Objectives: This course enables the students to

1.	Understand the fundamentals of programming languages such as C++ and Python
2.	Introduce the basic concepts of a Database Management System
3.	Introduce the concepts of Relational Models
4.	Introduce the concepts of Relational Languages
5.	Introduce the concepts of Database Design

Course Outcomes: After completion of the course, the learners will be able to

CO1	Apply the fundamentals of programming languages such as C++ and Python
CO2	Analyze the basic concepts of a Database Management System
CO3	Evaluate the concepts of Relational Models
CO4	Apply the concepts of Relational Languages
CO5	Applythe concepts of Database Design

SYLLABUS

MODULE	NO. OF LECTURE HOURS
Module 1: ***Programming Languages*** Basics of object-oriented programming: Introduction, classes and methods, polymorphism, inheritance; basics of C++, Python (both must), Basics of functional programming, logic programming. Efficiency issues.	8
Module 2: ***Introduction to Database Management System*** Introduction to database management system (DBMS): What is a Database? Purpose of DBMS, types of databases, data models, DBMS architecture, schemes and instances, database designers, administrators and users, interactions; data dictionary, data independence, overall system structure; database languages, storage system, DBMS vs. file system, indexing, hashing.	8
Module 3: ***Introduction to Relational Model*** Relational database and model: Structure of database, relational algebra, operation on relations, relational calculus, salient features of a query language; Relational model, advantages and disadvantages of relational database system.	8
Module 4: ***Relational Languages*** SQL: Introduction, characteristics, data type, construction, data definition language, commands, create, alter, drop and truncate of tables; data manipulation language, select, insert, update and delete; query structure and examples, natural joins and other set operations, advanced joins, operators, aggregations, nested sub-queries, clauses, views, integrity constraints, keys, cascading actions; data control language, grant, invoke; authorization and roles.	8
Module 5: ***Database Design*** Entity relationship (ER) model: Basic concepts, entities and entity sets, attributes, relationships and relationship sets, diagram representation and notations, strong and weak entities, mapping constraints, keys, primary keys, reducing ER diagrams to tables. Introduction to hierarchical and network models: Data description and tree diagram, data retrieval and update facilities, limitations; Database task group (DBTG) model, retrieval and update facilities, limitations.	8

Textbooks:

1. B. Stroustrup: The C++ Programming Language, 2nd ed., 1995, Addison-Wesley.
2. Cay S. Horstmann: Core Java Volume I – Fundamentals, 11th ed., 2018, Prentice Hall
3. Avi Silberschatz, Henry F. Korth, S. Sudarshan: Database System Concepts, Sixth edition, McGraw-Hill.
4. Garret Grolemund and Hadley Wickham: R for Data Science.
5. Andreas C. Müller, Sarah Guido: Introduction to Machine Learning with Python: A Guide for Data Scientists, 2016.

Reference books:

1. B.W. Kernighan and D.M. Ritchie: The C Programming Language, 1980, Prentice Hall.
2. B. Gottfried: Programming in C, 1996, Schaum Outline Series.
3. Joshua Bloch: Effective Java, 3rd ed., 2018, Addison-Wesley.
4. B.W. Kernighan and R. Pike: The Practice of Programming, Addison-Wesley.
5. J. Bentley: Programming Pearls, 1986, Addison-Wesley.

6. J. Bentley: More Programming Pearls, 1988, Addison-Wesley.
7. B.W. Kernighan and R. Pike: The Unix Programming Environment, Prentice Hall.
8. Raghu Ramakrishnan and Johannes Gehrke: Database Management Systems, Third edition, McGraw-Hill.
9. Jure Leskovec, Anand Rajaraman, Jeff Ullman Mining of Massive Datasets, Cambridge University Press.
10. Jake Vander Plas: Python Data Science Handbook.

Gaps in the Syllabus (to meet Industry/Profession requirements)

NA

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
First Quiz	10
Mid Semester Examination	25
Second quiz/seminar/assignment/others	10
Teacher's Assessment	5
End Semester Examination	50

Indirect Assessment –

1.Student Feedback on Course Outcome

Mapping of course outcomes onto program outcomes

Course Outcome	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO 1	2	3	1	-	-	-	2	1	2	1	-	3	3	3
CO 2	2	3	1	-	-	-	2	1	2	1	-	3	3	3
CO 3	2	3	1	-	-	-	2	1	2	1	-	3	3	3
CO 4	2	3	1	-	-	-	2	1	2	1	-	3	3	3
CO 5	2	3	1	-	-	-	2	1	2	1	-	3	3	3

Correlation Levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

If satisfying< 34%=1, 34-66% =2, > 66% = 3

CD Code	Course delivery methods
CD1	Lecture by use of boards/lcd projectors/ohp projectors
CD2	Tutorials/assignments
CD3	Seminars
CD4	Mini projects/projects
CD5	Laboratory experiments/teaching aids
CD6	Industrial/guest lectures
CD7	Industrial visits/in-plant training
CD8	Self- learning such as use of nptel materials and internets
CD9	Simulation

Mapping Between COs and Course Delivery (CD) methods Course Outcome	Course Delivery Method Used
CO1	CD1, CD 2, CD8
CO2	CD1, CD2, CD8
CO3	CD1, CD2, CD8
CO4	CD1, CD2, CD8
CO5	CD1, CD2, CD8

COURSE INFORMATION SHEET

Course code:	**FE24205**
Course title:	**Biochemistry and Human nutrition**
Pre-requisite(s):	
Co- requisite(s):	
Credits:	L:03 T:00 P:00
Class schedule per week:	03
Class:	**B. Tech**
Semester / Level:	**IV/02**
Branch:	**Food Engineering and Technology**
Name of Teacher:	

Course Objectives

This course enables the students:

1.	To develop knowledge in different aspects of nutrition and the functions of food
2.	To analyze the relationship between food and nutrients as well as the function and contribution of nutrients to the health of individuals
3.	To develop the knowledge on physiological and metabolic functions of nutrients
4.	To discover the methods of nutritional assessment, RDA and Dietary Recommendations & Guidelines.
5.	To interpret the food classification, nutrition during special conditions and role of special functional food

Course Outcomes

After the completion of this course, students will be:

CO1	Able to judge physiological and metabolic functions of nutrients
CO2	Able to evaluate with nutritional assessment, RDA and Dietary Recommendations & Guidelines.
CO3	Able to develop effective understanding of diet planning principles, exchange lists, food labels and nutrition facts for balanced nutrition and healthy diets.
CO4	Able to combine and use effectively diet planning principles, exchange lists, food labels and nutrition facts for balanced nutrition and healthy diets.
CO5	Able to analyze functions of specific nutrients in maintaining health, identifying nutrient specific foods and apply principles from the various facets of food science and related disciplines to solve practical as well as real-world problems

SYLLABUS

MODULE	NO. OF LECTURE HOURS
Module 1: Definition, six classes of nutrients, energy values calculation from food; RDA, nutritional status, nutritional requirement, malnutrition, nutritional assessment of individuals and populations, dietary recommendations; research methods in nutrition; Balanced diet; Healthy Diet: Diet planning principles, dietary guidelines; diet planning guides such as food groups, exchange lists, personal diet analysis; Food labels: serving sizes, nutrition facts, daily values, descriptive terms, health claims; Digestion, Absorption and Transport: Anatomy and physiology of the digestive tract, mechanical and chemical digestion, absorption of nutrients.	8
Module 2: Digestion and absorption of carbohydrates, lactose intolerance; Glycemic and Non-glycemic carbohydrates, blood glucose regulation, recommendations of sugar intake for health, health effects of fiber and starch intake, artificial sweeteners; Nutrition and Diabetes: Complications of diabetes mellitus, importance of blood sugar regulation, dietary recommendations for NIDDM and IDDM; Prebiotics.	8
Module 3: 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; Chronic Energy; Deficiency- short term and long term effects.	8
Module 4: Review of catabolic and anabolic pathways of glucose, fats and amino acids; Definition, units, calorific value of foods – 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.	8
Module 5 Water Soluble Vitamins: B vitamins (Thiamine, Riboflavin, Niacin, Pyridoxine, Biotin, folate B12, choline, pantothenic acid, and carnitine) and in concert, deficiencies, toxicities, and food sources; vitamin C roles and recommended intake, deficiency, toxicity and food sources. Fat Soluble Vitamins: A, D, E, and K: Function, recommended intakes, toxicities, Food sources; Water and Major Minerals: Water balance and recommended intakes; fluid/electrolyte balance, acid-base balance; function, recommended intakes, and regulation of sodium, potassium, and calcium. Trace Minerals: Food sources, function, recommended intakes, toxicities, deficiencies and transport of iron and zinc; importance of selenium, copper, fluoride, and chromium. co-factors, anti-nutrients, nutraceuticals, Beneficiary microbes and their metabolism for improving health	8

Text books:

1. Essentials of Human Nutrition by Mann, Jim and Stewart Truswell "3rd Edition. Oxford University Press, 2007.**(T1)**

2. Introduction to Human Nutrition by Gibney, Michael J., et al2nd Edition. Blackwell,2009.**(T2)**

3. Advanced Nutrition and Human Metabolism, Gropper, Sareen S. and Jack L.Smith 5th Edition. Wadsworth Publishing, 2008.**(T3)**

Reference books:

1. Food Scienceby Charley, H, "John Wiley and Sons Inc., New York 1982.**(R1)**

2. The Sensory Properties ofFoods by Birch, G.G., Brennan, J. G. and Parker, K. J, "Applied Science Publication, London 1977. **(R2)**

3. Food – Biochemistry and Nutritional Value by Robinson, D. S, Longman Scientific and Technical, London 1987. **(R3)**

Gaps in the syllabus (to meet Industry/Profession requirements)

Industrial important food hydrocolloid

POs met through Gaps in the Syllabus

PO3, PO4, PO5

Topics beyond syllabus/Advanced topics/Design

Food hydrocolloids its role in human nutrition

POs met through Topics beyond syllabus/Advanced topics/Design

PO3, PO4, PO5

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
First Quiz	10
Mid Semester Examination	25
Second quiz/seminar/assignment/others	10
Teacher's Assessment	5
End Semester Examination	50

Indirect Assessment –

1.Student Feedback on Course Outcome

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO 1	2	2	1	3	3	1	3	1	3	2	3	3	3	3
CO 2	2	2	1	3	1	1	3	1	2	1	3	3	3	3
CO 3	2	2	1	3	2	1	3	1	3	1	3	3	3	3
CO 4	2	2	1	3	2	1	3	1	3	1	3	3	3	3
CO 5	2	2	1	3	3	1	3	1	3	1	3	3	3	3

Correlation Levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Mapping Between COs and Course Delivery (CD) methods

CD Code	Course Delivery methods	Course Outcome	Course Delivery Method Used
CD 1	Lecture by use of boards/LCD projectors/OHP projectors	CO1	CD1, CD2, CD8
CD 2	Tutorials/Assignments	CO2	CD1, CD2, CD8
CD 3	Seminars	CO3	CD1, CD2, CD4, CD8
CD 4	Mini projects/Projects	CO4	CD1, CD2, CD4, CD8
CD 5	Laboratory experiments/teaching aids	CO5	CD1, CD2, CD4, CD8
CD 6	Industrial/guest lectures		
CD 7	Industrial visits/in-plant training		
CD 8	Self- learning such as use of NPTEL materials and internets		
CD 9	Simulation		

PROGRAMME ELECTIVE (PE1)
IV SEMESTER

COURSE INFORMATION SHEET

Course code: 24231
Course title: Applied Statistics for Food Engineering Technology
Pre-requisite(s): MA24101, MA24103
Co- requisite(s):
Credits: 3 L:03 T:00 P:00
Class schedule per week: 03
Class: B. Tech
Semester / Level: IV/02
Branch: Food Engineering and Technology
Name of Teacher:

Course Objectives

This course enables the students:

1.	To understand statistics application in Food.
2.	To understand the philosophy and basic concepts of quality improvement.
3..	To gather knowledge on food quality system and statistical quality control
4.	To demonstrate the ability to use the methods of statistical process control.
5.	To develop the skills on statistical methods and to understand data analysis for writing up a dissertation/ thesis/research article

Course Outcomes

After the completion of this course, students will:

CO 1	Be able to interpretive data from statistical point of view.
CO 2	Be able to identify and apply appropriate research methods and techniques to design, plan and execute targeted experiments or simulations independently and critically evaluate and interpret the collected data.
CO 3	Be able to apply statistical principles to food science applications.
CO 4	Students will have a thorough understanding of the arrangement of data to draw an analytical conclusion.
CO 5	Can convincingly and professionally defend personal research, thoughts, ideas, and opinions of proposals, both written and oral, to different actors and stakeholders from peers to a general public.

SYLLABUS

MODULE	NO. OF LECTURE HOURS
Module 1: Food Quality System- Scope, Systems and programs for food quality- The Formalized Quality System, Quality System Guidelines, Malcolm Baldridge National Quality Award, Total Quality Management, Team Quality Systems, Computer Network Quality Systems Food safety, System for food safety; HACCP, ISO-22000.	8
Module 2: Analysis of Data , Frequency distribution, Normal, Binomial, Poisson, Geometric ,Exponential distribution, The t-Test, Chi-square test, F-test, ANOVA (Analysis of variance), Regression, Pearson square test, Standard error, Root mean square error (RMSE),Sum of square error (SSE).	8
Module 3: Statistical quality control-Quality control techniques, Sampling-Sampling plan, How to Take Samples , Types of Samples , Sampling plan for prepackaged foods FAO/WHO, Codex alimentarius procedure, Coefficient of correlation, Partial correlation, Regression analysis.	8
Module 4: Statistical basics: -Mean median mode, Standard deviation, Degree of freedom, Degree of variance, Coefficient of variance, Null hypothesis; Vendor Quality Assurance- Vendor-Vendee Relations, Specifications for Raw Materials, Ingredients, Supplies, Quality Assurance of Purchased Goods, Selecting and Nurturing a Supplier, Packaging Supplier Quality Assurance, Supplier Certification Programs.	8
Module 5: Process Capability- Capability Index, Benchmarking;Process Control-Chart Patterns, Control Chart as a Quality Management; Concept of six sigma; Sensory Testing- The Senses, Sensory Testing Methods, Types of Panels, Selection and Training.	8

Text books:

1. Hubbard, Merton R., Statistical Quality Control for the Food Industry, Springer US
2. Montgomery, Douglas C. (2009). Introduction to Statistical Quality Control, Sixth Edition. John Wiley and Sons, Inc. (ISBN: 978-0-470-16992-6).
1. Food quality assurance by Rangana,1995.

Reference books:

1. Statistical methods by S.P.Gupta ,2006

Gaps in the syllabus (to meet Industry/Profession requirements)

POs met through Gaps in the Syllabus

Topics beyond syllabus/Advanced topics/Design

POs met through Topics beyond syllabus/Advanced topics/Design

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
First Quiz	10
Mid Semester Examination	25
Second quiz/seminar/assignment/others	10
Teacher's Assessment	5
End Semester Examination	50

Indirect Assessment –

1.Student Feedback on Course Outcome

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**1**	**2**	**3**
CO 1	3	3	2	3	1	2	2	3	2	1	1	3	3	3
CO 2	3	3	2	3	1	2	2	3	2	1	2	3	3	3
CO 3	3	3	2	3	1	2	2	3	2	2	2	3	3	3
CO 4	3	3	2	3	2	2	2	3	2	1	1	3	3	3
CO 5	3	3	2	3	1	2	2	3	2	1	2	3	3	3

Correlation Levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Mapping Between COs and Course Delivery (CD) methods

CD Code	Course Delivery methods	Course Outcome	Course Delivery Method Used
CD 1	Lecture by use of boards/LCD projectors/OHP projectors	CO1	CD1, CD2, CD8
CD 2	Tutorials/Assignments	CO2	CD1, CD2, CD8
CD 3	Seminars	CO3	CD1, CD2, CD4, CD8
CD 4	Mini projects/Projects	CO4	CD1, CD2, CD4, CD8
CD 5	Laboratory experiments/teaching aids	CO5	CD1, CD2, CD4, CD8
CD 6	Industrial/guest lectures		
CD 7	Industrial visits/in-plant training		
CD 8	Self- learning such as use of NPTEL materials and internets		
CD 9	Simulation		

COURSE INFORMATION SHEET

Course code: FE 24233
Course title: Statistical Machine Learning 1
Pre-requisite(s): MA24101, MA24103
Co- requisite(s):
Credits: L: 3 T: 00 P:00
Class schedule per week: 03
Class: B. Tech
Semester / Level: IV/02
Branch: Food Engineering and Technology
Name of Teacher:

Course Objectives: This course enables the students to

1.	Understand the Hypothesis Generation using Concept Learning.
2.	Understanding the Concept of Supervised Learning and Un-Supervised Learning
3.	Understand the Application of linear and nonlinear algorithms for various learning problems
4.	Understand the Concept of performance evaluation metrics according to real world problems
5.	Develop the machine learning based models for various real-world problems.

Course Outcomes: After completion of the course, the learners will be able to

CO1	Apply the concept of the Hypothesis Generation using Concept Learning
CO2	Apply the Concept of Supervised Learning and Un-Supervised Learning
CO3	Apply the Concept of linear and nonlinear algorithms for various learning problems
CO4	Apply the Concept of performance evaluation metrics according to real world problems
CO5	Develop the machine learning based models for various real-world problems.

SYLLABUS

MODULE	NO. OF LECTURE HOURS
Module 1: Overview of supervised and unsupervised classification. Supervised classification: Loss function, riskfunction, admissible, minimax and Bayes rules.	8
Module 2: Linear methods of classifications including Fisher's discriminant function, linear discriminant analysis, Mahalanobis distance, logistic regression, separating hyperplanes, SVM and distance weighted discrimination; Other methods including quadratic discriminant analysis, regularized discriminant analysis, nonlinear SVM, kernel density estimation and kernel discriminant analysis; (K-) Nearest neighbour classification.	8
Module 3: Additive models, projection pursuit, neural network, deep learning, classification using kernel regression. Principal component analysis (PCA). Basics of classification tree and random forests.	8
Module 4: Unsupervised classification: k-means, k-medoids and linkage methods, Gap statistics, clustering usingGaussian mixtures.	8
Module 5: Computer applications using R and other packages.	8

Text books:

Reference books:

1. Richard O. Duda, Peter E. Hart and David G. Stork: Pattern Classification.
2. Trevor Hastie, Robert Tibshirani and Jerome Friedman: The Elements of Statistical Learning, 2nd Edition.
3. Brian D. Ripley: Pattern recognition and neural networks.
4. M. P. Wand and M. C. Jones: Kernel Smoothing.
5. Vladimir N. Vapnik: Statistical Learning Theory.
6. Leo Breiman, Jerome Friedman, Richard Olsen and Charles Stone: CART.
7. Christopher J.C. Bugres: Tutorial on Support Vector Machines.
8. Tom M. Mitchell: Machine Learning, McGraw-Hill International Edition, 1997.
9. Christopher M. Bishop: Pattern recognition and Machine Learning, Springer, 2006(Journal articles are available for some of the materials for which there are no books.)

Gaps in the syllabus (to meet Industry/Profession requirements)

POs met through Gaps in the Syllabus

Topics beyond syllabus/Advanced topics/Design

POs met through Topics beyond syllabus/Advanced topics/Design

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment

First Quiz	10
Mid Semester Examination	25
Second quiz/seminar/assignment/others	10
Teacher's Assessment	5
End Semester Examination	50

Indirect Assessment –

1.Student Feedback on Course Outcome

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO 1	3	1	2	3	2	1	2	1	2	2	3	3	3	3
CO 2	3	2	2	3	2	2	3	1	2	2	3	3	3	3
CO 3	2	1	2	3	2	1	2	1	2	2	3	3	3	3
CO 4	3	1	2	3	2	1	2	1	1	1	3	3	3	3
CO 5	3	3	3	3	2	3	2	3	2	2	3	3	3	3

Correlation Levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Mapping Between COs and Course Delivery (CD) methods

CD Code	Course Delivery methods	Course Outcome	Course Delivery Method Used
CD 1	Lecture by use of boards/LCD projectors/OHP projectors	CO1	CD1, CD2, CD8
CD 2	Tutorials/Assignments	CO2	CD1, CD2, CD8
CD 3	Seminars	CO3	CD1, CD2, CD4, CD8
CD 4	Mini projects/Projects	CO4	CD1, CD2, CD4, CD8
CD 5	Laboratory experiments/teaching aids	CO5	CD1, CD2, CD4, CD8
CD 6	Industrial/guest lectures		
CD 7	Industrial visits/in-plant training		
CD 8	Self- learning such as use of NPTEL materials and internets		
CD 9	Simulation		

COURSE INFORMATION SHEET

Course code: **FE 24235**
Course title: **Algorithms for Big Data I**
Pre-requisite(s): **MA24101, MA24103**
Co- requisite(s):
Credits: **L: 03 T: 00 P:00**
Class schedule per week: **03**
Class: **B. Tech**
Semester / Level: **IV/02**
Branch: **Food Engineering and Technology**
Name of Teacher:

Course Objectives

This course enables the students:

1	To Understand the High-Dimensional Space using Algorithms.
2.	To Understand the Concept of Algorithms for massive data problems.
3.	To Understand the Application of Random graph algorithms,
4.	To Understand the Concept of Clustering.
5.	To develop communication complexity and computer communications using R

Course Outcomes

After the completion of this course, students will be:

CO1	To apply the High-Dimensional Space using Algorithms.
CO2	To apply the Concept of Algorithms for massive data problems.
CO3	To apply the Application of Random graph algorithms,
CO4	To apply the Concept of Clustering.
CO5	To apply communication complexity and computer communications using R

SYLLABUS

MODULE	NO. OF LECTURE HOURS
Module 1: High-Dimensional Space: Algorithms for solving systems of linear equations; inverse or generalized inverse of a matrix, sensitivity of A-inverse with respect to changes in A, singular value decomposition, best rank-k approximations; Matrix multiplication, sampling, low-rank approximation, least squares, optimal solution with respect to various methodologies.	8
Module 2: Algorithms for massive data problems: Streaming, Sketching, and Sampling algorithms; Distinct elements,frequent elements, moments; sketches of documents.	8
Module 3: Random graph algorithms: Connectivity, phase transitions, subgraphs, spectral sparsifiers, spanners, graphsketching, matching; small world graphs, tree algorithms.	8
Module 4: Clustering: k-means clustering, k-center clustering, spectral clustering, high density clusters, soft and hardclustering; robust linkage. Topic Models; Markov Random fields; Graphical models and belief propagation, Bayesian or belief networks	8
Module 5: Dimension Reduction: Johnson- Lindenstrauss lemma, impossibility results. Locality Sensitive Hashing: Similarity estimation, search for approximate nearest neighbour, data dependent hashing using various techniques. Communication complexity: Measures of complexity, Index problem, lower bound for Equality and Disjointness. (Computer applications using R and other packages.)	8

Text books:

Reference books:

1. Avrim Blum, John Hopcroft, and Ravindran Kannan: Foundations of Data Sciences,https://www.cs.cornell.edu/jeh/book.pdf
2. Dimitri P. Bertsekas and John N. Tsitsiklis: Introduction to Probability, 2nd Edition,2008, Athena Scientific.
3. Michael Mitzenmacher and Eli Upfal: Probability and Computing, 2nd Edition, 2017,Cambridge University Press.
4. Noga Alon and Joel Spencer: The Probabilistic Method, 4th Edition, 2016, Wiley-Blackwell.
5. Gilbert Strang: Linear Algebra and Learning from Data, Wellesley-Cambridge Press,2019.
6. Tim Roughgarden: Communication Complexity (for Algorithm Designers).
7. S. S. Vempala: The Random Projection Method, 2004, American Mathematical Society.
8. W. Hackbusch: Hierarchical Matrices, Algorithms and Analysis, 2015, Springer, Berlin.
9. Jiri Matoušek: Lectures on Discrete Geometry, 2002, Springer-Verlag, New York.(Journal articles are available for some of the materials for which there are no books.)

Gaps in the syllabus (to meet Industry/Profession requirements)

POs met through Gaps in the Syllabus

Topics beyond syllabus/Advanced topics/Design

POs met through Topics beyond syllabus/Advanced topics/Design

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
First Quiz	10
Mid Semester Examination	25
Second quiz/seminar/assignment/others	10
Teacher's Assessment	5
End Semester Examination	50

Indirect Assessment –

1.Student Feedback on Course Outcome

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO 1	3	1	2	3	2	1	2	1	2	2	3	3	3	3
CO 2	3	2	2	3	2	2	3	1	2	2	3	3	3	3
CO 3	2	1	2	3	2	1	2	1	2	2	3	3	3	3
CO 4	3	1	2	3	2	1	2	1	1	1	3	3	3	3
CO 5	3	3	3	3	2	3	2	3	2	2	3	3	3	3

Correlation Levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Mapping Between COs and Course Delivery (CD) methods

CD Code	Course Delivery methods	Course Outcome	Course Delivery Method Used
CD 1	Lecture by use of boards/LCD projectors/OHP projectors	CO1	CD1, CD2, CD8
CD 2	Tutorials/Assignments	CO2	CD1, CD2, CD8
CD 3	Seminars	CO3	CD1, CD2, CD4, CD8
CD 4	Mini projects/Projects	CO4	CD1, CD2, CD4, CD8
CD 5	Laboratory experiments/teaching aids	CO5	CD1, CD2, CD4, CD8
CD 6	Industrial/guest lectures		
CD 7	Industrial visits/in-plant training		
CD 8	Self- learning such as use of NPTEL materials and internets		
CD 9	Simulation		

COURSE INFORMATION SHEET

Course code: FE 24237
Course title: Entrepreneurship Development
Pre-requisite(s): FE 24203, FE 24207
Co- requisite(s):
Credits: L: 03 T: 00 P:00
Class schedule per week: 03
Class: B. Tech
Semester / Level: IV/02
Branch: Food Engineering and Technology
Name of Teacher:

Course Objectives

This course enables the students:

1	To know the concept of Entrepreneurship importance and growth
2.	To understand the concept of entrepreneurial and managerial characteristics
3.	To understand the importance of women entrepreneurship
4.	To understand the Government schemes and incentives for promotion of entrepreneurship
5.	Characteristics of Indian food processing industries and export

Course Outcomes

After the completion of this course, students will be:

CO1	To apply the concept of Entrepreneurship importance and growth
CO2	To apply the concept of entrepreneurial and managerial characteristics
CO3	To apply the importance of women entrepreneurship in food industry.
CO4	To apply the Government schemes and incentives for promotion of entrepreneurship
CO5	Characteristics of Indian food processing industries and export

SYLLABUS

MODULE	NO. OF LECTURE HOURS
Module 1: Entrepreneurship: Importance and growth, characteristics and qualities of entrepreneur, creativity; role of entrepreneurship, ethics and social responsibilities; Entrepreneurship development: Overview of Indian social, political and economic systems and their implications for decision making by individual entrepreneurs.	8
Module 2: Concept of entrepreneurship, entrepreneurial and managerial characteristics, managing an enterprise, motivation and entrepreneurship development, importance of planning, monitoring, evaluation and follow up, managing competition, entrepreneurship development programs, SWOT analysis, generation, incubation and commercialization of ideas and innovations	8
Module 3: Women entrepreneurship: Role and importance, problems; Corporate entrepreneurship: Role, mobility of entrepreneur; Entrepreneurial motivation	8
Module 4: Government schemes and incentives for promotion of entrepreneurship; Government policy on small and medium enterprises (SMEs)/SSIs; Export and import policies relevant to food processing sector; Venture capital; Contract farming and joint ventures, public-private partnerships.	8
Module 5: Overview of food industry inputs; Characteristics of Indian food processing industries and export; Social responsibility of business. Public enterprises, private enterprises and agro-processing/food business centers; SWOT analysis process of public enterprises and private enterprises; Project writing as entrepreneur – individual and group; Presentation of project proposals in the class.	8

Text books:

1. Khanka, S. S. 2013. Entrepreneurial Development (Fourth Revised & Millennium Edition) New Delhi: Sultan Chand & Sons Publishers.
2. Mohanty, S.K. 2005. Fundamentals of Entrepreneurship. New Delhi: Prentice Hall of India.
3. Desai, Vasant.1997. Management of Small-Scale Industries. New Delhi: Himalayan Publishing House.
4. Kumar, S. Anil. 2008. Entrepreneurship Development. New Delhi: New Age International
5. Entrepreneurship Development in India, Sami Uddin, Mittal Publications, 1989, ISBN, 8170991900, 9788170991908
6. Entrepreneurship Development in public Enterprises, Joseph Prokopenko, Igor Pavlin, International Labour Office, 1991 ISBN-10: 922107286X ISBN-13: 978-9221072867

Reference books:

Gaps in the syllabus (to meet Industry/Profession requirements)

POs met through Gaps in the Syllabus

Topics beyond syllabus/Advanced topics/Design

POs met through Topics beyond syllabus/Advanced topics/Design

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
First Quiz	10

Mid Semester Examination	25
Second quiz/seminar/assignment/others	10
Teacher's Assessment	5
End Semester Examination	50

Indirect Assessment –

1.Student Feedback on Course Outcome

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO 1	3	1	2	3	2	1	2	1	2	2	3	3	3	3
CO 2	3	2	2	3	2	2	3	1	2	2	3	3	3	3
CO 3	2	1	2	3	2	1	2	1	2	2	3	3	3	3
CO 4	3	1	2	3	2	1	2	1	1	1	3	3	3	3
CO 5	3	3	3	3	2	3	2	3	2	2	3	3	3	3

Correlation Levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Mapping Between COs and Course Delivery (CD) methods

CD Code	Course Delivery methods	Course Outcome	Course Delivery Method Used
CD 1	Lecture by use of boards/LCD projectors/OHP projectors	CO1	CD1, CD2, CD8
CD 2	Tutorials/Assignments	CO2	CD1, CD2, CD8
CD 3	Seminars	CO3	CD1, CD2, CD4, CD8
CD 4	Mini projects/Projects	CO4	CD1, CD2, CD4, CD8
CD 5	Laboratory experiments/teaching aids	CO5	CD1, CD2, CD4, CD8
CD 6	Industrial/guest lectures		
CD 7	Industrial visits/in-plant training		
CD 8	Self- learning such as use of NPTEL materials and internets		
CD 9	Simulation		

COURSE INFORMATION SHEET

Course code: **FE 24239**
Course title: **Food Business Management**
Pre-requisite(s):
Co- requisite(s):
Credits: 3 **L:03 T:00 :00**
Class schedule per week: **3**
Class: **B. Tech**
Semester / Level: **IV/02**
Branch: **Food Engineering and Technology**
Name of Teacher:

Course Objectives

This course enables the students:

1.	To Identify emerging issues that could change or enhance the agri and food business in the coming decades
2.	To understand the industry's main drivers of innovation, customers, technology and the environment and how to leverage them
3.	To Identify emerging opportunities for growth in both domestic and international markets Position the individual and his help to position his organization to compete effectively in food production and supply systems
4.	To extend the participants network by making new connections with peers from across the global food business industry.
5.	To prepare the detailed project report to food industry

Course Outcomes

After the completion of this course, students will be:

CO 1	Able to analyze emerging issues that could change or enhance the agri and food business in the coming decades
CO 2	Able to evaluate the organization and function of the Food industry
CO 3	Able to develop understanding in the industry's main drivers of innovation, customers, technology and the environment and how to leverage them
CO 4	Able to construct the participants network by making new connections with peers from across the global food business industry.
CO 5	Able to collaborate and communicate with fellow students and the instructor in a professional manner

SYLLABUS

MODULE	NO. OF LECTURE HOURS
Module 1: Organisation & Management: Introduction to Organisation, Role of Managers, Managerial Skills, Basic Management Functions – Planning, Organising, Staffing, Directing (Leadership and Communication), Controlling, Executive Functions	8
Module 2: Human Resource Management: The HRM Process, Introduction to Manpower Planning, Recruitment, Selection, Training & Development, Performance Appraisal and Compensation Management	8
Module 3: Marketing Management: Core Concepts of Marketing, Identifying a Marketing opportunity**,** Segmentation, Targeting and Positioning decisions, Dynamics of Consumer Behaviour, Significance of Marketing Research and Marketing Research Process, Introduction to Distribution & Logistics functions.	8
Module 4: Financial Management: Goals of Financial Management- Profit Maximization Vs Wealth Maximization, Introduction to Accountancy,. Accounting Principles and Conventions, Double Entry system, Journal, Ledger, Trial Balance and Preparation of Final Account. Statement of Changes in Financial Position; Preparation of Funds Flow Statement, Preparation of Cash Flow Statement, Introduction to Financial ratios.	8
Module 5: Entrepreneurship & IPR: Concept of Entrepreneurship & Intrapreneurship, Characteristics and skills of entrepreneurs, **Sources of Finance -** Equity vs. Debt Capital, Sources of Equity Finance, Institutional finance, Venture Capital, Lease Finance, **Forms of Business Ownership - ** Sole Proprietorship, Partnership, Corporations and other forms of ownership, Intellectual **Property Management:** Importance of innovation, Patents& Trademarks in Small Businesses, Introduction tolaws relating to IPR in India	8

Text books:

1. Principles of Agri Business Management by D. David and S Erickson 1987. Mc Graw Hill Book Co., New Delhi.
2. Agricultural Marketing in India by Acharya S S and Agarwal N L 1987. Oxford & ISH Publishing Co., New Delhi.
3. Marketing in the International Environment by Cundiff Higler 1993, Prentice Hall of India, New Delhi.
4. GAD implications of Denkel proposals - G S Batra & Narindev kumar (1994) Azmol Publications Pvt., New Delhi.

Reference Books

1. Management Process and Perspectives by Chhabra TN & Suria RK. 2001. Kitab Mahal.
2. International Economics by Jhingan ML. 2005.. 5th Ed. Virnda Publ.
3. Marketing Management by Kotler P. 2000. Prentice Hall.
4. Agricultural Economics by Reddy SS, Ram PR, Sastry TVN & Bhavani ID. 2004.. Oxford & IBH

Gaps in the syllabus (to meet Industry/Profession requirements)

POs met through Gaps in the Syllabus

Topics beyond syllabus/Advanced topics/Design

POs met through Topics beyond syllabus/Advanced topics/Design

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
First Quiz	10
Mid Semester Examination	25
Second quiz/seminar/assignment/others	10
Teacher's Assessment	5
End Semester Examination	50

Indirect Assessment –

1.Student Feedback on Course Outcome

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO 1	3	1	2	3	2	1	2	1	2	2	3	3	3	3
CO 2	3	2	2	3	2	2	3	1	2	2	3	3	3	3
CO 3	2	1	2	3	2	1	2	1	2	2	3	3	3	3
CO 4	3	1	2	3	2	1	2	1	1	1	3	3	3	3
CO 5	3	3	3	3	2	3	2	3	2	2	3	3	3	3

Correlation Levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Mapping Between COs and Course Delivery (CD) methods

CD Code	Course Delivery methods	Course Outcome	Course Delivery Method Used
CD 1	Lecture by use of boards/LCD projectors/OHP projectors	CO1	CD1, CD2, CD8
CD 2	Tutorials/Assignments	CO2	CD1, CD2, CD8
CD 3	Seminars	CO3	CD1, CD2, CD4, CD8
CD 4	Mini projects/Projects	CO4	CD1, CD2, CD4, CD8
CD 5	Laboratory experiments/teaching aids	CO5	CD1, CD2, CD4, CD8
CD 6	Industrial/guest lectures		
CD 7	Industrial visits/in-plant training		
CD 8	Self- learning such as use of NPTEL materials and internets		
CD 9	Simulation		

COURSE INFORMATION SHEET

Course code:	**CL 24237**
Course title:	**Waste Management**
Pre-requisite(s):	**CH24101, PH24101**
Co- requisite(s):	
Credits: 3	**L:03 T:00 P:00**
Class schedule per week:	**03**
Class:	**B. Tech**
Semester / Level:	**IV/02**
Branch:	**Chemical Engineering**
Name of Teacher:	

Course Objectives

This course enables the students to:

1.	Learn about the problem of waste generation and its impact on environment and human health.
2.	Familiarize with the existing legislation, knowledge and practices regarding waste management in the country.
3.	Familiarize with the waste conversion/treatment processes.
4.	Understand engineering, financial and technical options for waste management.
5.	Develop an ability to manage the solid waste effectively.

Course Outcomes

After the completion of this course, students will be able to:

CO1	Present an overview of the steps of SWM from waste generation to final step and select the most suitable SWM option.
CO2	Explain plastic waste related terms and various management practices.
CO3	Explain E-waste related terms and various management practices.
CO4	Explain food waste related terms and various management processes.
CO5	Explain Biomedical Waste Management, treatment and disposal processes.

SYLLABUS

MODULE	NO. OF LECTURE HOURS
Module 1: Overview, MSW and its management, Generation of MSW, Management practices of MSW in developing countries, Solid waste management rules (India) 2016, Technologies for municipal solid waste management, Kinetics of waste degradation.	8
Module 2: Plastics – What it is? Types, Uses and Global Statistics, Plastic Waste – Sources, Production, Global and Indian Context, Plastic Waste Management Rules 2016/2018/2022 (India) and Global Rules and Regulations, Impact of Plastics on Marine Life, Effect on Wildlife, Human Health and Environment, Plastic Waste Management Practices – Use of Plastic waste in roads, chemical routes for recycling, conversion of plastic waste to fuel, Possible Alternate Materials to Plastics - Greener Alternatives, Plastics Resource Recovery and Circular Economy.	8
Module 3: E-Waste, E-waste management, Environmental and public health issues, E- waste health risk assessment, Recovery of materials from E-Waste, E-Waste Management Rules of India (2016 and 2018 Rules), E-waste Management: Case Studies and Unique Initiatives from around the World.	8
Module 4: Introduction: sources and characterization of food waste and food industry wastes, Valorization of food waste for bioethanol, biobutanol, biodiesel and organic acids production, State of the art of food waste management in various countries.	8
Module 5: Bio-medical waste, type of waste, classification, sources, health risks, environmental impact, treatment, processing, disposal, Bio-medical waste management rules 2016, BMW management during a pandemic.	8

Textbooks:

1. Municipal solid waste management in developing countries, sunil kumar, CRC press.
2. https://onlinecourses.swayam2.ac.in/ugc19_bt18/preview.
3. Plastic Waste and Recycling Environmental Impact, Societal Issues, Prevention, and Solutions, 1st Edition - March 10, 2020, Editor: Trevor Letcher.
4. Datta P, Mohi GK, Chander J. Biomedical waste management in India: Critical appraisal. J Lab Physicians. 2018 Jan-Mar;10(1):6-14. doi: 10.4103/JLP.JLP_89_17. PMID: 29403196; PMCID: PMC5784295.
5.https://cpcb.nic.in/uploads/Projects/Bio-Medical-Waste/Pictorial_guide_covid.pdf.
6. https://www.aiims.edu/en/departments-and-centers/central-facilities/265-biomedical/7346-bio- medical-waste-management.html.

Reference books:

1. The Escalating Biomedical Waste Management To Control the Environmental Transmission of COVID-19 Pandemic: A Perspective from Two South Asian Countries, Environ. Sci. Technol. 2021, 55, 7, 4087–4093.

2. https://www.who.int/news-room/fact-sheets/detail/health-care-waste.

Gaps in the syllabus (to meet Industry/Profession requirements) POs met through Gaps in the Syllabus

Topics beyond syllabus/Advanced topics/Design

POs met through Topics beyond syllabus/Advanced topics/Design

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
First Quiz	10
Mid Semester Examination	25
Second quiz/seminar/assignment/others	10
Teacher's Assessment	5
End Semester Examination	50

Indirect Assessment –
1.Student Feedback on Course Outcome

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO 1	3	3	3	2	2	2	2	0	1	2	0	3	3	3
CO 2	3	2	1	2	3	0	1	0	1	2	0	3	3	3
CO 3	3	1	1	1	1	0	0	0	1	1	0	3	3	3
CO 4	3	3	2	2	3	1	2	0	1	2	0	3	3	3
CO 5	3	3	1	2	3	2	2	0	1	2	0	3	3	3

Correlation Levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Mapping Between COs and Course Delivery (CD) methods

CD Code	Course Delivery methods	Course Outcome	Course Delivery Method Used
CD 1	Lecture by use of boards/LCD projectors/OHP projectors	CO1	CD1, CD2, CD8
CD 2	Tutorials/Assignments	CO2	CD1, CD2, CD8
CD 3	Seminars	CO3	CD1, CD2, CD4, CD8
CD 4	Mini projects/Projects	CO4	CD1, CD2, CD4, CD8
CD 5	Laboratory experiments/teaching aids	CO5	CD1, CD2, CD4, CD8
CD 6	Industrial/guest lectures		

CD 7	Industrial visits/in-plant training		
CD 8	Self- learning such as use of NPTEL materials and internets		
CD 9	Simulation		

LABORATORY
COURSE INFORMATION SHEET

Course code: FE 24204
Course title: Programming Language and Database Management System Lab
Pre-requisite(s):
Co- requisite(s):
Credits: 1.5 (L: 0 T: 0 P: 3)
Class schedule per week: 3
Class: B. Tech.
Semester / Level: IV / 02
Branch: Food Engineering and Technology
Name of Teacher:

Course Objectives
This course enables the students to:

1.	Understand the fundamentals of C++ Programming and Python
2.	Understand and apply the concepts of Object-Oriented Programming using C++/Python
3.	Understand the fundamentals of Structured Query Language (SQL)
4.	Understand and apply the concepts of Normalization using SQL
5.	Understand the concept DDL, DML, and DCL commands in a database

Course Outcomes
After the completion of this course, students will be able to:

CO 1	Apply the fundamentals of C++ Programming and Python
CO 2	Apply the concepts of Object Oriented Programming using C++/Python
CO 3	Apply the fundamentals of Structured Query Language (SQL)
CO 4	Apply the concepts of Normalization using SQL
CO 5	Apply the concept DDL, DML, and DCL commands in a database

LIST OF EXPERIMENTS:

Sl. No.	Description
1.	Write a program in C++ to demonstrate the use of new and delete for dynamic memory allocation.
2.	Implement operator overloading for addition of two complex numbers.
3.	Write a program to demonstrate the use of templates in C++.
4.	Write a Python program to demonstrate list comprehensions and lambda functions.
5.	Implement a Python program to demonstrate exception handling.
6.	Write a program to demonstrate Python's @staticmethod and @classmethod decorators.
7.	Write a program in C++ and Python to create a Car class with attributes like make, model, and year and a method to display car details.
8.	Write a program in Python and C++ to create a student class with attributes name and age and methods to display the student's information.
9.	Implement a program in Python and C++ to demonstrate constructors and destructors.
10.	Write a program to demonstrate method overloading in C++ and Python.
11.	Write a program in C++ to demonstrate function overloading and overriding.
12.	Write a Python program to implement polymorphism using method overriding with an example of a base class Shape and derived classes Circle and Rectangle.
13.	Implement a program in C++ to demonstrate runtime polymorphism using virtual functions.
14.	Write a program in C++ to demonstrate single and multiple inheritance.
15.	Implement a Python program to demonstrate multilevel inheritance with a base class Animal, a derived class Mammal, and another derived class Dog.
16.	Write a program in C++ to demonstrate hierarchical inheritance.
17.	Explain the concept of functional programming and its differences from imperative programming.
18.	Write a Python program to demonstrate the use of higher-order functions (map, filter, and reduce).
19.	Write a Python program using recursion to calculate the factorial of a number.
20.	Explain immutability in functional programming with examples in Python.
21.	Write a program to create a pure function in Python
22.	Explain the principles of logic programming. How is it different from functional programming?
23.	Write a simple Prolog program to determine if a given person is a sibling of another person.

24. Implement a Python program to solve a logic puzzle using backtracking.
25. Write a program in Python to demonstrate unification in logic programming using a library like pyDatalog.
26. Discuss the efficiency of recursion versus iteration. Write Python and C++ programs to compute Fibonacci numbers using both approaches.
27. Write a program in C++ to measure the time complexity of a sorting algorithm (e.g., bubble sort).
28. Implement a Python program to compare the performance of a list and a dictionary for search operations.
29. Write a Python program to demonstrate memory efficiency using generators.
30. Write a program in C++ to optimize a matrix multiplication using efficient memory access patterns.
31. Write an SQL script to create and query a database that stores book details for a library system.
32. Use SQL to query the data dictionary to list all tables in a database.
33. Write an SQL script to create, modify, and delete a table in a database.
34. Demonstrate the use of DDL, DML, and DCL commands in a database.
35. Write a Python program using sqlite3 to connect to a database, create a table, insert data, and retrieve data.
36. Write an SQL query to create an index on a table and demonstrate its impact on query performance.
37. Write an SQL script to simulate a banking database with tables for customers, accounts, and transactions. Perform queries to calculate the total balance of a customer.
38. Write SQL queries to simulate the following relational algebra operations:
    - Selection: Retrieve students with marks greater than 80.
    - Projection: Display only the name and roll_no of students.
    - Union: Combine two tables of students from different departments.
    - Intersection: Find common courses between two course tables.
    - Difference: Retrieve students enrolled in Math but not in Science.
    - Cartesian Product: Combine records from Students and Courses tables.
39. Write SQL queries to:
    - Insert data into a table.
    - Update a student's marks based on their id.

- Delete a record where marks < 50.

40. Implement a query to perform a join operation between Students and Enrollments tables to display which courses a student is enrolled in.
41. Write SQL queries to perform Tuple Relational Calculus (TRC):
    - Retrieve names of all students with marks greater than 90.
    - Retrieve id of students who have enrolled in the course Data Science.
42. Write queries to perform Domain Relational Calculus (DRC):
    - Retrieve all courses offered by a specific department.
    - List teachers who teach more than 3 subjects.
43. Write an SQL query to create a View for students scoring above 75 marks.
44. Design a relational model for an online shopping system with tables for Users, Products, Orders, and OrderDetails. Write the SQL queries to:
    - Create the tables.
    - Insert sample data into the tables.
    - Retrieve the list of products ordered by a specific user.
45. Explain and write SQL queries for keys:
    - Primary key
    - Foreign key
    - Candidate key
    - Composite key
46. Design an ER diagram for a University Database where entities include Professor, Student, Course, and Department.
47. Draw an ER diagram for a College Database involving entities like Student, Course, Instructor, and Department. Use proper notations to represent relationships, attributes, and cardinalities.
48. Design an ER diagram for an Order Processing System where Order is a weak entity dependent on the Customer (strong entity).
49. Design an ER diagram for a Hospital Management System where a Doctor can treat many Patients (1:N relationship) and a Patient can have multiple Doctors (M:N relationship). Include the appropriate mapping constraints

Text books:

Reference books:

Gaps in the syllabus (to meet Industry/Profession requirements)

NA

POs met through Gaps in the Syllabus
Topics beyond syllabus/Advanced topics/Design

POs met through Topics beyond syllabus/Advanced topics/Design

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
(1) Progressive Evaluation	60
(2) End Semester	40

Indirect Assessment –

1.Student Feedback on Course Outcome

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO 1	1	1	3	3	3	3	1	1	3	1	1	3	3	3
CO 2	3	3	3	1	1	3	1	1	3	3	1	3	3	3
CO 3	1	3	3	1	3	3	3	1	1	3	1	3	3	3
CO 4	1	1	1	3	3	3	1	1	3	3	1	3	3	3
CO 5	1	1	1	1	1	3	1	1	1	3	1	3	3	3

Correlation Levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Mapping Between COs and Course Delivery (CD) methods

CD Code	Course Delivery methods	Course Outcome	Course Delivery Method Used
CD1	Lecture by use of boards/LCD projectors/OHP projectors	CO1	CD4, CD5, CD7, CD8
CD2	Tutorials/Assignments	CO2	CD4, CD5, CD7, CD8
CD3	Seminars	CO3	CD4, CD5, CD7, CD8
CD4	Mini projects/Projects	CO4	CD4, CD5, CD7, CD8
CD5	Laboratory experiments/teaching aids	CO5	CD4, CD5, CD7, CD8
CD6	Industrial/guest lectures		
CD7	Industrial visits/in-plant training		
CD8	Self- learning such as use of NPTEL materials and internets		
CD9	Simulation		

COURSE INFORMATION SHEET

Course code: FE 24206
Course title: Food Process Engineering & Technology Lab -I
Pre-requisite(s):
Co- requisite(s):
Credits:1.5 **L: 00 T: 00 P: 03**
Class schedule per week: 03
Class: B. Tech
Semester / Level: IV/02
Branch: Food Engineering and Technology

Course Objectives

This course enables the students to:

1.	Demonstrate deep understanding and knowledge of principles of advanced food processing technologies
2.	Identify and critically analyse main advantages and disadvantages of emerging food processing technologies
3.	Compare and contrast conventional and emerging food processing technologies in real-life food processing
4.	Apply selected novel processing technologies to preserve and improve microbiological, nutritional or functional characteristics of foods
5	Apply errors in measurements and assess the result.

Course Outcomes

After the completion of this course, students will be:

CO1	Demonstrate various fluid flow measuring devices and examine the performance of a centrifugal pump.
CO2	Operate mechanical separation equipments and analyse the results.
CO3	To explain the mechanisms of spoilage and deterioration of foods and raw materials: microbial, chemical, physical, biochemical, etc.
CO4	Evaluate heat transfer in composite wall and shell and tube heat exchanger.
CO5	Evaluate errors in measurements and assess the result.

List of experiments

1) Studies on Venturimeter, Orificemeter and Rotameter.
2) Studies on flow over notches
3) Studies on friction in pipes and pipe fittings
4) Centrifugal Pump test rig.
5) Studies on Ball Mill
6) Studies on Cyclone Separator.
7) Studies on Plate and Frame Filter Press.
8) Particle size analysis & Characterization of particulate solids.
9) Heat Transfer by Conduction and Convections.
10) Shell and tube heat exchanger.
11) Heat conduction in fluids
12) Heat conduction in metals
13) Studies on Fluidization.
14) Studies on solid conveyor (bucket conveyor).

Text Book:

1. S. Ranganna, Hand Book of Analysis and Quality Control forFruits and Vegetable Products, Tata McGraw Hill, 2002
2. Y. H. Hui, S. Ghazala, D.M. Graham, K.D. Murrell and W.K.Nip, Handbook of Vegetable Preservation and Processing, Marcel Dekker,2003.

Reference Book:

1. Winton AL (1999)Techniques of food analysis, Allied Science Publications NewDelhi.
2. Pomeranze Y (2004). Food analysis - Theory and Practice CBS Publications, New Delhi.
3. Jacob MB (1999). The chemical analysis of foods and food products. CBS Publ. New Delhi

Gaps in the syllabus (to meet Industry/Profession requirements)

POs met through Gaps in the Syllabus

Topics beyond syllabus/Advanced topics/Design

POs met through Topics beyond syllabus/Advanced topics/Design

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
(1) Progressive Evaluation	60
Day-to-day performance	(10)
Lab files	(20)
Attendance	(10)
Viva	(20)
(2) End Semester	40
Quiz	(10)
Lab Performance	(30)

Indirect Assessment –

1.Student Feedback on Course Outcome

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**1**	**2**	**3**
CO 1	3	1	3	3	3	3	3	2	2	1	3	3	3	3
CO 2	2	1	3	3	3	3	3	2	2	1	3	3	3	3
CO 3	2	1	3	3	3	3	3	2	2	1	3	3	3	3
CO 4	2	1	3	3	3	3	3	2	2	1	3	3	3	3
CO 5	3	2	3	3	3	3	3	2	2	1	3	3	3	3

Correlation Levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Mapping Between COs and Course Delivery (CD) methods

CD Code	Course Delivery methods	Course Outcome	Course Delivery Method Used
CD1	Lecture by use of boards/LCD projectors/OHP projectors	CO1	CD4, CD5, CD7, CD8
CD2	Tutorials/Assignments	CO2	CD4, CD5, CD7, CD8
CD3	Seminars	CO3	CD4, CD5, CD7, CD8
CD4	Mini projects/Projects	CO4	CD4, CD5, CD7, CD8
CD5	Laboratory experiments/teaching aids	CO5	CD4, CD5, CD7, CD8
CD6	Industrial/guest lectures		
CD7	Industrial visits/in-plant training		
CD8	Self- learning such as use of NPTEL materials and internets		
CD9	Simulation		

BIRLA INSTITUTE OF TECHNOLOGY

NEP-2020 CURRICULUM BOOK
(Effective from Academic Session: Monsoon 2024)

Bachelor of Technology

CENTRE FOR FOOD ENGINEERING AND TECHNOLOGY
THIRD YEAR (SEMESTER – V-VI)

COURSE INFORMATION SHEET

Course code: FE 24301
Course title: Food Microbiology
Pre-requisite(s): Microbiology
Co- requisite(s):
Credits: L: 04 T: 00 P:00
Class schedule per week: 04
Class: B. Tech
Semester / Level: V/03
Branch: Food Engineering and Technology
Name of Teacher:

Course Objectives

This course enables the students:

1	To interpret the principles of Food Microbiology.
2.	To experiment with the microbes in relation to food spoilage, food-borne diseases and food preservation
3.	To interpret the role and significance of intrinsic and extrinsic factors on growth and response of microorganisms in foods.
4.	To identify ways to control microorganisms in foods.
5.	To infer the conditions under which the important pathogens and spoilage microorganisms are commonly inactivated, killed or made harmless in foods.

Course Outcomes

After the completion of this course, students will be:

CO1	Able to develop knowledge in the basic area of Food Microbiology.
CO2	Able to explain the role of microbes in food spoilage, preservation of foods and food borne infections.
CO3	Able to predict the role of microbes in health and diseases
CO4	Able to analyze and explain the characteristics of important pathogens and spoilage microorganisms in foods.
CO5	Able to develop success skills in communication, critical thinking, interaction, information acquisition and interpretation, organization, professionalism, leadership, auto-didactics and life-long-learning.

SYLLABUS

MODULE	NO. OF LECTURE HOURS
Module 1: Food microbiology and its scope; History of microbiology of food; Types of microorganism associated with food: bacteria, fungi, yeast & mold; Characteristics of predominant microorganisms in Food: morphology of bacteria, yeast, mold and actinomycetes, spores and vegetative cells, gram-staining; Sources of microorganisms in food: Plants, Animals, Air, soil, sewage, waters, humans, food ingredient, equipment; Intrinsic and extrinsic factors on growth and response of microorganisms in foods, Microbial control, Importance of microorganism in food industry.	8
Module 2: Microbiological Inactivation Rates at Constant Temperature , Rate of Microbial Inactivation, Shape of Microbial Inactivation Curves, Sterilizing Value or Lethality of a Process , Acceptable Sterilizing Value for Processes, Selection of Inoculation Levels in Inoculated Packs , Determination of D Values Using the Partial Sterilization Technique, The Heat Resistance of Spoilage Microorganisms, F0 Values Used in Commercial Sterilization of Canned Foods, Surface Sterilization Effect of Temperature on Thermal Inactivation of Microorganisms, Inactivation of Microorganisms and Enzymes in Continuously Flowing Fluids, Time and Temperature Used in the Pasteurization of Fluid Foods, Microbial Inactivation in Continuously Flowing Fluids . Nutrient Degradation, High-Pressure Pasteurization , High-Pressure Systems, High-Pressure Pasteurization, High-Pressure Sterilization, Sterilization of Fluids Containing Discreet Particulates, Sterilizing Value of Processes Expressed as F0, Thermal Process Calculations for Canned Foods, The General Method, Heat Transfer Equations and Time-Temperature Curves for Canned Foods, Plotting Heat Penetration Data, Determination of fh and j, Determination of fc and jc Formula Methods for Thermal Process Evaluation , Stumbo's Procedure , Hayakawa's Procedure, Evaluation of Probability of Spoilage from a Given Process, Constant Temperature Processes, Process Temperature Change, Broken Heating Curves Quality Factor Degradation	8
Module 3: Microbiology of milk & milk products like cheese, butter, ice-cream, milk powder; Microbiology of meat, fish, poultry & egg and their products; Fermented meat, fish, and poultry products; Microbiology of fruits & vegetable and products like jam, jelly, sauce, juice; Microbiology of cereal and cereal products like bread, biscuits, confectionary	8
Module 4: Food Contamination and Spoilage Food microbiology and public health - Food poisoning, food poisonings due to pathogens, important features - A brief account of various organisms related with food poisoning; Food Borne diseases: Toxins from microbes: pathogens and non-pathogens including Staphylococcus, Salmonella, Shigella, Escherichia, Bacillus, Clostridium, and Aspergillus genera; Beneficial roles of microorganisms: Introduction to prebiotics and probiotics.	8
Module 5: Fermented food products: Fermented fruit, vegetable and cereal products pickles, soya-sauce, sauerkraut, idli, dosa, vinegar, alcoholic beverages. Fermented fish; Fermented meats; Fermented beverages: Beer, Vinegar and Wine; Production of baker's yeast, food yeast, Single cell protein, bread, beer, wine, cider, vinegar, organic acids (eg. Citric, lactic, Acetic acids, Fumaric and Gluconic acid) and enzymes (eg. Amylases, protease, lipases, pectinases, celluloses, hemicellulose etc.). IMFL/ distilled spirits (eg. Rum, gin, whisky). Mushroom cultivation. Fermented milk and milk products: curd, yoghurt, cheese	8

Text books:

1. Essentials of Microbiology by K. S. Bilgrami; CBS Publishers, Delhi **(T1)**
2. Food Microbiology by WC Frazier; Tata McGraw Hill, Delhi**(T2)**
3. Modern Food Microbiology by James M Jay; CBS Publishers, Delhi**(T3)**
4. Food Microbiology by M. R. Adams **(T4)**

Reference books:

1. Fundamental Food Microbiology by Bibek Ray, Arun Bhunia, Fifth Edition **(R1)**

Gaps in the syllabus (to meet Industry/Profession requirements)

Kits used for food microbial spoilage detection

POs met through Gaps in the Syllabus

PO3, PO4, PO5

Topics beyond syllabus/Advanced topics/Design

Scientific basis behind the different Kits used for food microbial spoilage detection

POs met through Topics beyond syllabus/Advanced topics/Design

PO3, PO4, PO5

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
First Quiz	10
Mid Semester Examination	25
Second quiz/seminar/assignment/others	10
Teacher's Assessment	5
End Semester Examination	50

Indirect Assessment –

1.Student Feedback on Course Outcome

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO 1	3	1	2	3	2	1	2	1	2	2	3	3	3	3
CO 2	3	2	2	3	2	2	3	1	2	2	3	3	3	3
CO 3	2	1	2	3	2	1	2	1	2	2	3	3	3	3
CO 4	3	1	2	3	2	1	2	1	1	1	3	3	3	3
CO 5	3	3	3	3	2	3	2	3	2	2	3	3	3	3

Correlation Levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Mapping Between COs and Course Delivery (CD) methods

CD Code	Course Delivery methods	Course Outcome	Course Delivery Method Used
CD 1	Lecture by use of boards/LCD	CO1	CD1, CD2, CD8

	projectors/OHP projectors		
CD 2	Tutorials/Assignments	CO2	CD1, CD2, CD8
CD 3	Seminars	CO3	CD1, CD2, CD4, CD8
CD 4	Mini projects/Projects	CO4	CD1, CD2, CD4, CD8
CD 5	Laboratory experiments/teaching aids	CO5	CD1, CD2, CD4, CD8
CD 6	Industrial/guest lectures		
CD 7	Industrial visits/in-plant training		
CD 8	Self- learning such as use of NPTEL materials and internets		
CD 9	Simulation		

COURSE INFORMATION SHEET

Course code: FE 24303
Course title: Technology of Fruits, Vegetable, Spices and Plantation Crops
Pre-requisite(s): Food Processing & Preservation
Co- requisite(s):
Credits: 3 L:03 T:00 P:00
Class schedule per week: 03
Class: B. Tech
Semester / Level: V/3
Branch: Food Engineering and Technology
Name of Teacher:

Course Objectives

This course enables the students:

1.	To develop the knowledge of students in the area of vegetable and fruit processing and technology
2.	To interpret the specific processing technologies used for vegetables and fruits and the various products derived from these materials
3.	To apply the application of scientific principles in the processing technologies specific to the materials
4.	To interpretate the alteration of composition after processing
5.	To propose the processing methods depending upon the raw material.

Course Outcomes

After the completion of this course, students will be:

CO1	Able to develop thorough knowledge of the specific processing technologies used for vegetables and fruits and the various products derived from these materials.
CO2	Able to adapt better understand of the application of scientific principles in the processing technologies specific to the materials
CO3	Able to understand the changes in the composition of foods with respect to the type of processing technology used.
CO4	To propose the application of scientific principles in the processing technologies specific to the materials
CO5	To explain the changes in the composition of foods with respect to the type of processing technology used.

SYLLABUS

MODULE	NO. OF LECTURE HOURS
Module 1: Composition, nutritional, structural features and health value of fruits & vegetables, Indian spices and plantation crops. Climacteric and non- climacteric fruits, ripening process, phytonutrients in fruits and vegetables Post harvest losses and preventive measures; Post harvest operations; Handling & transportation; Supply chain management & storage; Quality assurance and control (QA/QC). Fruits and vegetables as living products, Deterioration factors and their control- Enzymatic changes, Chemical changes, Physical changes, biological changes; Methods of reducing deterioration (Physical, chemical, biological and combined technique), Post harvest handling and storage of fresh fruits and vegetables-Handling, grading, cleaning, pretreatments, modified atmosphere packaging, controlled atmosphere ripening process, chilling, transportation.	8
Module 2: Basics of processing and preservation of horticulture & plantation crop products; Processing by removal of water; Processing by addition of heat; Processing by removal of heat; Irradiation of fruits, vegetables and spices. Cleaning operations; Sorting and grading; Peeling, coring, slicing; Containers and packaging materials; Packaging methods and equipment. Minimal processing strategies; Hurdle technology concepts; Intermediate and high moisture fruit products; Cut fruits and vegetables. Juice extraction & clarification; Concentrates and pastes; Aseptic processing and packaging; RTS and RTD beverages; Quality and safety aspects.	8
Module 3: Drying techniques and equipment; Powders and premixes; RTE fruit products; Dehydrated and instant cooking vegetables. Plantation crops processing and products: processing methods of tea, coffee, cocoa and its quality attributes. Tea and tea products; Coffee processing; Cocoa and chocolate technology; Vanilla essence and flavour; Coconut processing. Processing of spices; Spice powders; Spice pastes, sauces and gravies; Essential oil and oleoresins; Condiments technology. Spice Processing viz. cleaning, grading, drying, grinding, packaging and storage. Oleoresins and essential oils.	8
Module 4: Fruits and vegetables processing: extraction, clarification, concentration and packaging of fruit juice, jam, jelly, marmalade, squash, candies, tomato sauce, ketchup, puree, paste and sauce, potato chips. By products utilization of fruits and vegetable processing industry- Production of pectin, vitamins from apple pomace; Production of citrus oil from peels of citrus fruits, candied peel, Role of Pectinases. Chemistry and manufacture of pectin, role in gel formation and products like jellies and marmalades. Technology of preservatives, pickles, chutney, soup. Nature and control of spoilage in these products. Re-structured fruits and vegetables. Preparation and utilization of fruits and vegetables juices in non-fermented/ fermented/ aerated beverages, health drinks. Fermentation technology; Fermented fruits and vegetable-based product (wine, pickles, soya-sauce, sauerkraut etc.), Fruit wines and ciders; Probiotic/Fermented vegetable products; Carbonated fruit juices, premixes; Quality assurance/quality control.	8
Module 5: Packaging methods and materials; Active/Intelligent packaging; Edible coatings & films; Modified atmosphere packaging; Controlled atmosphere packaging. Green technologies and near zero waste processing; Extraction of bioactives and pigments from fruits and vegetables industrial waste; Valorisation of waste into value-added	8

products; FSSAI regulations & FSMS guidelines for fruits, vegetables, spices and plantation crops.	

Text books:

1. Fruit and vegetable processing by Mircea Enachescu Dauthy Consultant FAO Agricultural services bulletin No.119 Food and Agriculture Organization of the United Nations Rome, 1995
2. Preservation of Fruits & Vegetables by Girdhari Lal, Sidhapa and Tandon
3. Food Science by Potter
4. Principles of Food Science, Vol-I by Fennma Karrel
5. Food Science by Mudambi

Reference books:

1. Fruit and Vegetable Preservation by Srivastava and Sanjeev Kumar
2. Food Science by Mudambi
3. L. Somogyi, D.M. Barette and Y.H. Hui, Processing Fruits:Science and Technology, Vol II:
4. Major Processed Products,Woodhead Publishing, 1996.
5. Y. H. Hui, S. Ghazala, D.M. Graham, K.D. Murrell and W.K.Nip,Handbook of Vegetable
6. Preservation and Processing, MarcelDekker,2003.

Gaps in the syllabus (to meet Industry/Profession requirements)

CIP in fruits and vegetable processing

POs met through Gaps in the Syllabus

PO3, PO4, PO5

Topics beyond syllabus/Advanced topics/Design

Sanitization in during fruits and vegetable processing

POs met through Topics beyond syllabus/Advanced topics/Design

PO3, PO4, PO5

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
First Quiz	10
Mid Semester Examination	25
Second quiz/seminar/assignment/others	10
Teacher's Assessment	5
End Semester Examination	50

Indirect Assessment –

1.Student Feedback on Course Outcome

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO 1	3	2	2	3	3	2	3	1	1	1	3	3	3	3
CO 2	3	2	2	3	2	2	3	1	1	1	3	3	3	3
CO 3	3	2	2	3	2	2	3	1	1	1	3	3	3	3

CO 4	3	2	2	3	2	2	3	1	1	1	3	3	3	3
CO 5	3	2	2	3	2	2	3	2	1	1	3	3	3	3

Correlation Levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Mapping Between COs and Course Delivery (CD) methods

CD Code	Course Delivery methods	Course Outcome	Course Delivery Method Used
CD 1	Lecture by use of boards/LCD projectors/OHP projectors	CO1	CD1, CD2, CD8
CD 2	Tutorials/Assignments	CO2	CD1, CD2, CD8
CD 3	Seminars	CO3	CD1, CD2, CD4, CD8
CD 4	Mini projects/Projects	CO4	CD1, CD2, CD4, CD8
CD 5	Laboratory experiments/teaching aids	CO5	CD1, CD2, CD4, CD8
CD 6	Industrial/guest lectures		
CD 7	Industrial visits/in-plant training		
CD 8	Self- learning such as use of NPTEL materials and internets		
CD 9	Simulation		

COURSE INFORMATION SHEET

Course code	**FE 24305**
Course title	**Food Chemistry**
Pre-requisite(s)	
Co- requisite(s)	
Credits	**L: 3 T: 0 P: 0**
Class schedule per week	**3**
Class	**B. Tech.**
Semester / Level	**V /Second**
Branch	**Food Engineering and Technology**
Name of Teacher	

Course Objectives

This course enables the students:

1.	To interpret chemical interactions and reactions of food components and their effect on sensory, nutritional, and functional properties of foods, and how processing influences these properties
2.	To identify the structure of food constituents and relate the structure to the constituents function and importance in foods with respect to food quality, nutrition, safety, processing, etc.
3.	To classify and compare the various food groups; the nutrient components(macro and micro), proximate composition.
4.	To explain how environmental factors such as temperature, pH, ionic characteristic and strength, bonding, light, etc. affect chemical changes in food systems and judge how to adjust these conditions to improve or minimize chemical and biochemical deterioration of food systems.
5.	To interpret chemical interactions and reactions of food components and their effect on sensory, nutritional, and functional properties of foods, and how processing influences these properties

Course Outcomes

After the completion of this course, students will be:

CO 1	Able to develop the knowledge in the basic area of Food Chemistry
CO 2	Able to discover the functional role of food components and their interaction infood products in terms of colour, flavour, texture and nutrient composition
CO 3	Able to combine chemistry and biochemistry principles into real-world foodscience and nutritional problems
CO 4	Able to discover the functional application of major food components
CO 5	Able to predict the changes of food quality with respect to compositional change

SYLLABUS:

MODULE	NO. OF LECTURE HOURS
Module 1: Introduction to different food groups and importance of food chemistry; Proximate composition of foods; Water: Definition of water in foods, physical properties of water and ice, structure of water and ice, interaction of water with solutes, sorption phenomenon, types of water; water activity, Methods to determine moisture content in food.	8
Module 2: Carbohydrate: Sources of food carbohydrates, definition, classification, structure of monosaccharides, disaccharides, oligosaccharides polysaccharides (starch, glycogen, cellulose, hemi-cellulose, lignin, pectin, gums and mucilage); Chemical reactions of carbohydrates; gelatinization and retrogradation of starch, Effect of processing and storage condition on carbohydrates: Modified starches; Role of carbohydrates in the food industry. Methods to determine carbohydrate content in food.	8
Module 3: Fats: Sources, definition, classification, structures, physical and chemical properties of lipids andfatty acids; Effect of processing and storage on fats and oils; PUFA, hydrogenation, polymerization, polymorphism and rancidity; Crude oils refining, hydrogenation and winterization, vegetable and animal fat, margarine, lard, butters, and shortening; Saponification number, Peroxide value , iodine value, Reichert-Meissl number, Polenske value; Biological important lipid like cholesterol and phospholipids; Methods to determine fat content in food.	8
Module 4: Proteins : Sources , primary & secondary structures, amino-acids - classification, essential and non-essential amino-acids, structures and properties; Peptides -peptide bonds and some important peptides; Purification and denaturation of proteins; Protein interaction and degradation, protein-lipid complexes and protein-carbohydrate complex; Major protein systems and factors affecting them; Modified protein, important food proteins; changes of proteins on processing and storage with special emphasis on enzymatic and non-enzymatic browning such asMaillard reactions and Strecker degradation; Methods to determine protein content in food.	8
Module 5: Enzymes**:** specificity, simple and inhibition kinetics, coenzymes, enzymatic and non-enzymatic browning, enzymes in food processing, immobilization of enzymes, removal of toxicants throughenzymes. Msinerals and Vitamins: Sources and structures of minerals & vitamins; Effect of processing and storage of vitamins; Pro vitamins A & D; Vitamins as antioxidants. Pigments: carotenoids, chlorophylls, anthocyanins, tannins and myoglobin. Food flavours: terpenes, esters, aldehydes, ketones and quinines. Flavor and Aroma of foods - Taste, odor, feeling, blends, control of aroma in processed food.	8

Text Books:

1. M.S. Swaminathan. Essentials of Food & Nutrition by, Vol. 1 & 2

2. L. H. MuyerFood Chemistry

3. S. Damordaran, K. Parkin, O. Fennema Eds. CRC Press. Fennema's Food Chemistry,2007. 4th Edition.

4. J. deMan. Principles of Food Chemistry, 1999. 3rd Edition. Aspen Publishers, New York.

Reference books:

1. S. Ranganna. Hand Book of Analysis of fruits & vegetables

2. Linhinger, Food Chemistry

3. RS Kirk and R Sawyor. Composition and Analysis of Foods, (1991). Longman Scientificand Technical, UK

Gaps in the syllabus (to meet Industry/Profession requirements) :

POs met through Gaps in the Syllabus

Topics beyond syllabus/Advanced topics/Design :

POs met through Topics beyond syllabus/Advanced topics/Design

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
First Quiz	10
Mid Semester Examination	25
Second quiz/seminar/assignment/others	10
Teacher's Assessment	5
End Semester Examination	50

Indirect Assessment –

1.Student Feedback on Course Outcome

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO 1	3	3	3	2	3	2	2	1	1	1	1	3	3	3
CO 2	3	3	3	2	3	2	2	1	1	1	1	3	3	3
CO 3	3	3	3	2	3	2	2	1	1	1	1	3	3	3
CO 4	3	3	3	2	3	2	2	1	1	1	1	3	3	3
CO 5	3	3	3	2	3	1	1	1	1	1	1	3	3	3

Correlation Levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Mapping Between COs and Course Delivery (CD) methods

CD Code	Course Delivery methods	Course Outcome	Course Delivery Method Used
CD 1	Lecture by use of boards/LCD projectors/OHP projectors	CO1	CD1, CD2, CD8
CD 2	Tutorials/Assignments	CO2	CD1, CD2, CD8
CD 3	Seminars	CO3	CD1, CD2, CD8
CD 4	Mini projects/Projects	CO4	CD1, CD2, CD8
CD 5	Laboratory experiments/teaching aids	CO5	CD1, CD2, CD8
CD 6	Industrial/guest lectures		
CD 7	Industrial visits/in-plant training		
CD 8	Self- learning such as use of NPTEL materials and internets		
CD 9	Simulation		

COURSE INFORMATION SHEET

Course code	**CL24305**
Course title	**PROJECT ENGINEERING AND ECONOMICS**
Pre-requisite(s)	Chemical Process Calculations (CL24205) Chemical Reaction Engineering-I (CL 24213)
Co- requisite(s)	
Credits	**L: 3 T: 0 P: 0**
Class schedule per week	**3**
Class	**B. Tech.**
Semester / Level	**V /Third**
Branch	**Food Engineering and Technology**
Name of Teacher	

Course Objectives

This course enables the students to:

1.	To develop the concept of plant start-up with process design and flow sheet development.
2	To understand the various components of the project cost and the estimation methods.
3.	To understand the paying capital cost, plant profit and loss, depreciated values, profitability.
4.	To understand the optimization methodology in a process plant.
5.	Identify and understand various hazards and safety measures and analysis in the chemical industry.

Course Outcomes:

After the completion of this course, students will be able to:

CO24305.1	Evaluate process design parameters and estimate capital cost and product cost.
CO24305.2	Calculate interest on loan, profit, and cash flow to evaluate the breakeven point.
CO24305.3	Evaluate the feasibility of the project in terms of profit, payback period and other components.
CO24305.4	To solve optimization problems in chemical process industries.
CO24305.5	Adopt safety measures in chemical process industries through HAZOP studies, hazard Analyzes, and hazard quantifications.

SYLLABUS

MODULE	NO. OF LECTURE HOURS
Module 1: Process design development, Preliminary design methodology, Process flow diagram, Flow sheet, Computer aided design Cash flow diagram, Capital investment, Total production cost, Cost index, Estimations of equipment cost, total capital cost, and total product cost, and manufacturing cost, Estimations of revenue, gross profit, net profit, Break-even analysis and estimation of break-even point.	8
Module 2: Time value of money: Interests and Investment costs, Simple Interest,, Compound interest, Nominal and Effective interest rates, Continuous interest, Cost of Capital, Cash Flow Patterns, Compounding and discounting factors, Present worth and Discount, Annuities, Perpetuities, and Capitalized costs of investments.	8
Module 3: Depreciation: Reasons for replacement, book value, Present Value, Salvage Value, Market Value, Replacement Value. Straight line method, Declining-balance or Fixed percentage method, Sum -of -the-years-digits method, Sinking -fund Method, Accelerated cost recovery system. Profitability analysis: Gross profit, Income tax, Net profit, Rate of return on investment, Present worth and discounted cash flow rate of return, Payback period, Capitalized costs.	8
Module 4: Optimum design and design strategy: Procedure with one, two and more variables, Optimum cost, equipment size and production rates in plant operation, Optimization case studies in chemical process plant, Linear Programming, Simplex algorithm.	8
Module 5: Safety and Loss Prevention: Hazard, Safety measures and loss prevention in chemical process industries, Hazard and operability study (HAZOP), Fault tree analysis (FTA). Case studies of HAZOP and FTA in chemical process plants.	8

Text books:

1. Plant Design and Economics for Chemical Engineers, M. S. Peters, K. D. Timmerhaus, and R. E. West, 5th Edition, McGraw-Hill Inc.
2. Coulson & Richardson's Chemical Engineering Design, R K Sinnott, Vol. 6., Fourth Edition, Elsevier.
3. Project planning and control with PERT & CPM, B. C. Punmia, and K. K. Khandelwal. Firewall media, 2002.

Reference books:

1. Process Engineering Economics, J. R. Couper, Marcel DekkerInc.
2. Dryden's Outlines of Chemical Technology, M. Gopala Rao, M. Sittig, 3rd Edition, East West Press.

Gaps in the syllabus (to meet Industry/Profession requirements) POs

Process modeling, simulation, computer aided design,
Plant design

POs met through Gaps in the Syllabus

Topics beyond syllabus/Advanced topics/Design

Process modeling, simulation, computer aided design, plant design

POs met through Topics beyond syllabus/Advanced topics/Design Course Outcome (CO) Attainment

Assessment tools & Evaluation Direct Assessment

Assessment Tool	% Contribution during CO Assessment
First Quiz	10
Mid Semester Examination	25
Second quiz/seminar/assignment/others	10
Teacher's Assessment	5
End Semester Examination	50

Indirect Assessment –

1. Student Feedback on CourseOutcome

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO 1	3	3	3	2	2	2	2	0	1	2	0	3	3	3
CO 2	3	2	1	2	3	0	1	0	1	2	0	3	3	3
CO 3	3	1	1	1	1	0	0	0	1	1	0	3	3	3
CO 4	3	3	2	2	3	1	2	0	1	2	0	3	3	3
CO 5	3	3	1	2	3	2	2	0	1	2	0	3	3	3

Correlation Levels 1, 2 or 3 as defined below:

1:Slight(Low) 2: Moderate (Medium) 3: Substantial(High)

Mapping Between COs and Course Delivery (CD) methods

CD Code	Course Delivery methods	Course Outcome	Course Delivery Method Used
CD1	Lecture by use of boards/LCD projectors/OHP projectors	CO1	CD1, CD2, CD8
CD2	Tutorials/Assignments	CO2	CD1, CD2, CD8
CD3	Seminars	CO3	CD1, CD2, CD8
CD4	Mini projects/Projects	CO4	CD1, CD2, CD8
CD5	Laboratory experiments/teaching aids	CO5	CD1, CD2, CD8
CD6	Industrial/guest lectures		

CD7	Industrial visits/in-plant training		
CD8	Self- learning such as use of NPTEL materials and internets		
CD9	Simulation		

PROGRAMME ELECTIVE -II (PE-II)

V SEMESTER

COURSE INFORMATION SHEET

Course code: FE 24331
Course title: Regression Techniques
Pre-requisite(s): MA24101, MA24103
Co- requisite(s):
Credits: L: 03 T: 00 P:00
Class schedule per week: 03
Class: B. Tech
Semester / Level: V/03
Branch: Food Engineering and Technology
Name of Teacher:

Course Objectives

This course enables the students:

1	To conceptual and practical introduction to the basic concepts and techniques of regression analysis.
2.	To apply linear regression models in practice: identify situation where linear regression is appropriate; build and fit linear regression models with software; interpret estimates and diagnostic statistics; produce exploratory graphs.
3.	To learn about the theory underlying point estimation, hypothesis and confidence intervals for linear regression models.
4.	To learn how to derive multiple linear regression models, how to use software to implement them, and what assumptions underlie the models.
5.	To Concepts of lasso, ridge regressions, non-parametric regressions

Course Outcomes

After the completion of this course, students will be able:

CO1	To apply the concepts of both simple and multiple regression models.
CO2	Analyze the model's fit, test model's assumptions and transform predictor and response variables to improve outcomes.
CO3	Apply different models under generalized linear models such as Logit and Probit models.
CO4	Apply different non-parametric regression techniques
CO5	Apply the concept of regime-switching models

SYLLABUS

MODULE	NO. OF LECTURE HOURS
Module 1: Review of Classical Linear Regression Models (CLRM) Review of classical (multiple) linear regression model as well as models with heteroscedasticity and autocorrelation of errors. White's heteroscedasticity consistent standard error of the OLS estimator of coefficient vector	8
Module 2: Assumptions Check of CLRM and Robust Regression Techniques Variable selection, overfitting, collinearity and its consequences, assessment and strategies, shrinkage regression, various dimension reduction methods, ridge 82 regression, LASSO; outlier and influential observations, diagnostics and strategies. Robust regression techniques; introduction to Least Absolute Deviation regression, Least Median of Squares regression and Least Trimmed Squares regression, properties, illustrations	8
Module 3: Generalized Linear Models Logistic regression, Loglinear models, Generalized Linear Models (GLMs), illustrations with probit and logit analyses, link function, canonical link function, deviance; iterative ML estimation, iteratively reweighted least squares algorithm; assessment of model fit, goodness-of-fit test.	8
Module 4: Nonparametric Regression Techniques Nonparametric regression techniques, smoothing, kernel regression, NadarayaWatson estimator, local linear estimator, lowess, k-nearest neighbor (k-nn) and weighted k-nn methods, local polynomial, spline. Data analysis and application of the above methods using computer packages.	8
Module 5: Regime Switching Models Regime switching models; Threshold autoregressive (TAR) models, Self-exciting TAR (SETAR) models; and Smooth transition regression models	8

Text books:

Douglas C. Montgomery: Introduction to Linear Regression Analysis.
Daniel B. Wright and Kamala London: Modern Regression Techniques Using R.
H. Ichimura and P. Todd: Implementing Nonparametric and Semi-Parametric Estimators, in Handbook of Econometrics, Volume 6B.

David A. Belsley, Edwin Kuh and Roy E. Welsch: Regression Diagnostics: Identifying Influential Data and Source of Collinearity.

Reference books:

- Thomas P. Ryan: Modern Regression Methods. B. E. Hansen: Econometrics.
- Jim Frost: Regression Analysis: An Intutive Guide for Using and Interpreting Linear Models.
- Peter J. Rousseeuw and Annick M. Leroy: Robust Regression and Outlier Detection.
- P. McCullagh and John A. Nelder: Generalized linear models.
- Matt Wand and M. C. Jones: Kernel Smoothing.
- J. Fan and I. Gijbels: Local Polynomial Modelling and Its Applications.
- Philip Hans Franses and Dick van Dijk: Nonlinear Time Series Models in Empirical Finance, Cambridge University Press.
- Pagan and A. Ullah: Nonparametric Econometrics

Gaps in the syllabus (to meet Industry/Profession requirements)
NA

POs met through Gaps in the Syllabus

Topics beyond syllabus/Advanced topics/Design

POs met through Topics beyond syllabus/Advanced topics/Design

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
First Quiz	10
Mid Semester Examination	25
Second quiz/seminar/assignment/others	10
Teacher's Assessment	5
End Semester Examination	50

Indirect Assessment –

1.Student Feedback on Course Outcome

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO 1	3	1	2	3	2	1	2	1	2	2	3	3	3	3
CO 2	3	2	2	3	2	2	3	1	2	2	3	3	3	3
CO 3	2	1	2	3	2	1	2	1	2	2	3	3	3	3
CO 4	3	1	2	3	2	1	2	1	1	1	3	3	3	3
CO 5	3	3	3	3	2	3	2	3	2	2	3	3	3	3

Correlation Levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Mapping Between COs and Course Delivery (CD) methods

CD Code	Course Delivery methods	Course Outcome	Course Delivery Method Used
CD 1	Lecture by use of boards/LCD projectors/OHP projectors	CO1	CD1, CD2, CD8
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CD 3	Seminars	CO3	CD1, CD2, CD4, CD8
CD 4	Mini projects/Projects	CO4	CD1, CD2, CD4, CD8
CD 5	Laboratory experiments/teaching aids	CO5	CD1, CD2, CD4, CD8
CD 6	Industrial/guest lectures		
CD 7	Industrial visits/in-plant training		
CD 8	Self- learning such as use of NPTEL materials and internets		
CD 9	Simulation		

COURSE INFORMATION SHEET

Course code: **FE 24333**
Course title: **Statistical Machine Learning II**
Pre-requisite(s):
Co- requisite(s):
Credits: **L: 03 T: 00 P:00**
Class schedule per week: **03**
Class: **B. Tech**
Semester / Level: **V/03**
Branch: **Food Engineering and Technology**
Name of Teacher:

Course Objectives

This course enables the students:

1	To know the use of classification tools and techniques
2.	To understand the concept of Simulated Annealing
3.	To understand the concept of Resampling for classifier design
4.	To know the Multilayer Neural Networks and Deep learning
5.	To understand the computer applications using R

Course Outcomes

After the completion of this course, students will be:

CO1	To apply the use of classification tools and techniques
CO2	To apply the concept of Simulated Annealing
CO3	To apply the concept of Resampling for classifier design
CO4	To apply the Multilayer Neural Networks and Deep learning
CO5	To apply the computer applications using R

SYLLABUS

MODULE	NO. OF LECTURE HOURS
Module 1: Review of classification tools and techniques, clustering and hierarchical clustering, feature extraction.	8
Module 2: Simulated Annealing, Boltzman Learning, Genetic algorithms. Regularization and Reproducing Kernel Hilbert Spaces; Gram matrix, Mercer's Theorem; Kernel PCA; Vapnik–Chervonenkis Dimension, Half- space data depth, Bayes'Classifier, PAC Learning, Rademacher Complexity.	8
Module 3: EM algorithm, mixture models; MM (majorization-minimization and minorization-maximization) algorithm. Resampling for classifier design: Bagging, boosting, learning with queries. Estimating and comparing classifiers: cross-validation, Jackknife and Bootstrap. Estimation of classification accuracy. Combining classifiers; Ensemble learning	8
Module 4: Multilayer Neural Networks, Deep learning. Backpropagation algorithms. Semi-supervised learning;multi-task learning; reinforced learning. Hidden Markov models, Tree algorithms.	8
Module 5: Computer applications using R and other software's.	8

Text books:
Reference books:

1. Tom M. Mitchell: Machine Learning.
2. Richard O. Duda, Peter E. Hart and David G. Stork: Pattern Classification.
3. Trevor Hastie Robert Tibshirani and Jerome Friedman: The Elements of StatisticalLearning, 2nd edition.
4. Christopher M. Bishop: Pattern recognition and Machine Learning.
5. Vladimir N. Vapnik: Statistical Learning Theory.
6. Leo Breiman, Jerome Friedman, Richard Olsen and Charles Stone: CART.
7. Christopher J.C. Bugres: Tutorial on Support Vector Machines.
8. Brian D. Ripley: Pattern Recognition and Neural Networks.
9. M. P. Wand and M. C. Jones: Kernel Smoothing.
10. Brian D. Ripley: Pattern recognition and Neural Networks.
11. Avrim Blum, John Hopcroft and Ravindran Kannan: Foundations of Data Science.(Journal articles are available for some of the materials for which there are no books.)

Gaps in the syllabus (to meet Industry/Profession requirements)

POs met through Gaps in the Syllabus

Topics beyond syllabus/Advanced topics/Design

POs met through Topics beyond syllabus/Advanced topics/Design

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
First Quiz	10
Mid Semester Examination	25
Second quiz/seminar/assignment/others	10
Teacher's Assessment	5
End Semester Examination	50

Indirect Assessment –

1.Student Feedback on Course Outcome

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO 1	3	1	2	3	2	1	2	1	2	2	3	3	3	3
CO 2	3	2	2	3	2	2	3	1	2	2	3	3	3	3
CO 3	2	1	2	3	2	1	2	1	2	2	3	3	3	3
CO 4	3	1	2	3	2	1	2	1	1	1	3	3	3	3
CO 5	3	3	3	3	2	3	2	3	2	2	3	3	3	3

Correlation Levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Mapping Between COs and Course Delivery (CD) methods

CD Code	Course Delivery methods	Course Outcome	Course Delivery Method Used
CD 1	Lecture by use of boards/LCD projectors/OHP projectors	CO1	CD1, CD2, CD8
CD 2	Tutorials/Assignments	CO2	CD1, CD2, CD8
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CD 4	Mini projects/Projects	CO4	CD1, CD2, CD4, CD8
CD 5	Laboratory experiments/teaching aids	CO5	CD1, CD2, CD4, CD8
CD 6	Industrial/guest lectures		
CD 7	Industrial visits/in-plant training		
CD 8	Self- learning such as use of NPTEL materials and internets		
CD 9	Simulation		

COURSE INFORMATION SHEET

Course code: **FE 24335**
Course title: **Nutraceutical & Functional Foods**
Pre-requisite(s): **FE 24203, FE 24207**
Co- requisite(s):
Credits: **L: 03 T: 00 P:00**
Class schedule per week: **03**
Class: **B. Tech**
Semester / Level: **V/03**
Branch: **Food Engineering and Technology**
Name of Teacher:

Course Objectives

This course enables the students:

1	To understand the principles of nutraceuticals and functional foods.
2.	To understand the importance of Nutraceuticals for specific situation
3.	To know the Protein component as a functional food ingredient
4.	To study the vegetable products as a functional food ingredient.
5.	To remember the Marketing and regulatory issues.

Course Outcomes

After the completion of this course, students will be:

CO1	To apply the concept of nutraceuticals and functional foods.
CO2	To apply the concept of Nutraceuticals production for specific requirement.
CO3	To apply the concept of development of Protein based as a functional food
CO4	To apply the vegetable ingredient as a functional food product.
CO5	To apply the Marketing and regulatory issues in food industry.

SYLLABUS

MODULE	NO. OF LECTURE HOURS
Module 1: Defining nutraceuticals and functional foods, Nature, type and scope. Nutraceuticals and functional foods applications and their health benefits, classification based on chemical and biochemical nature with suitable and relevant descriptions	8
Module 2: Nutraceuticals for specific situation such as cancer, heart diseases, stress, Osteoarthritis, hypertension etc. Antioxidants and other phytochemicals, iso-flavones, lycopene, their role in nutraceuticals and functional foods. Dietary fibers and complex carbohydrates as ingredients of functional foods.	8
Module 3: Protein as a functional food ingredient, Probiotic foods and their functional role, Herbs as functional foods, health promoting activity of common herbs. Cereals products as functional foods- Oats, Wheat bran, rice bran etc.	8
Module 4: Functional vegetable products, oil seeds and sea foods. Coffee, tea and other beverages as functional foods/drinks and their protective effects. Effects of processing and storage and interaction of various environmental factors on the potentials of such foods.	8
Module 5: Marketing and regulatory issues for functional foods and nutraceuticals. Recent developments and advances in the area of nutraceuticals and functional foods	8

Text books:

1. Functional Foods and Nutraceuticals, Rotimi E. Aluko, Springer New York Dordrecht Heidelberg London ISSN 1572-0330 ISBN 978-1-4614-3479-5
2. Functional foods Concept to product Edited by Glenn R. Gibson and Christine M. Williams, Woodhead Publishing Limited Abington Hall, Abington Cambridge CB1 6AH England, ISBN 1 85573 503 2, ISBN 0-8493-0851-8
3. Handbook of Nutraceuticals, Volume 1: Ingredients, Formulations, and Applications, Yashwant Pathak, CRC Press, ISBN: 978-1-4200-8221-0
4. Handbook of Nutraceuticals and Functional Foods (2nd Edition), Robert E.C. Wildman, Robert Wildman, Taylor C. Wallace, CRC Press, ISBN9780429195563

Reference books:

Gaps in the syllabus (to meet Industry/Profession requirements)

POs met through Gaps in the Syllabus

Topics beyond syllabus/Advanced topics/Design

POs met through Topics beyond syllabus/Advanced topics/Design

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
First Quiz	10
Mid Semester Examination	25

Second quiz/seminar/assignment/others	10
Teacher's Assessment	5
End Semester Examination	50

Indirect Assessment –

1.Student Feedback on Course Outcome

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**1**	**2**	**3**
CO 1	3	1	2	3	2	1	2	1	2	2	3	3	3	3
CO 2	3	2	2	3	2	2	3	1	2	2	3	3	3	3
CO 3	2	1	2	3	2	1	2	1	2	2	3	3	3	3
CO 4	3	1	2	3	2	1	2	1	1	1	3	3	3	3
CO 5	3	3	3	3	2	3	2	3	2	2	3	3	3	3

Correlation Levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Mapping Between COs and Course Delivery (CD) methods

CD Code	Course Delivery methods	Course Outcome	Course Delivery Method Used
CD 1	Lecture by use of boards/LCD projectors/OHP projectors	CO1	CD1, CD2, CD8
CD 2	Tutorials/Assignments	CO2	CD1, CD2, CD8
CD 3	Seminars	CO3	CD1, CD2, CD4, CD8
CD 4	Mini projects/Projects	CO4	CD1, CD2, CD4, CD8
CD 5	Laboratory experiments/teaching aids	CO5	CD1, CD2, CD4, CD8
CD 6	Industrial/guest lectures		
CD 7	Industrial visits/in-plant training		
CD 8	Self- learning such as use of NPTEL materials and internets		
CD 9	Simulation		

COURSE INFORMATION SHEET

Course code: FE 24337
Course title: Food Additives & Ingredients
Pre-requisite(s): FE 24203, FE 24207
Co- requisite(s):
Credits:3 L:03 T:00 P:00
Class schedule per week: 03
Class: B. Tech
Semester / Level: V/03
Branch: Food Engineering and Technology
Name of Teacher:

Course Objectives
This course enables the students:

1.	To learn the diverse types of food additives, their functions and the properties of these additives, both in terms of chemical as well as physical properties.
2.	To build knowledge of international and national legislation on the use of food additives.
3.	To construct knowledge on Food additive classification and its mechanism of action
4.	To summarize advantages and risks of additives.
	To extend the participants network by making new connections with peers from across the global food business industry.

Course Outcomes
After the completion of this course, students will be:

CO 1	Able to explain how some foods in the diet can be combined to produce synergistic biological effects through their bioactive compounds
CO 2	Able to state the categories of additives, explain their purpose and discuss how additive use has shifted over the past century, including economic implications
CO 3	Able to compare and contrast the biological health effects of natural vs. artificial additives
CO 4	Able to outline differences between intentional and non-intentional food additives, and explain possible health implications resulting from effect of additives on biological systems
CO 5	Able to acquire competence in the proper use of additives in safe food production.

SYLLABUS

MODULE	NO. OF LECTURE HOURS
Module 1: Definitions of Food Additives, Classification and Functions, Legitimate uses of Additives in foods, Intentional & Non-Intentional additives, Indirect food additives; Difference between Additives & Adulterants, Food uses and functions in formulations; Toxicological and Safety Evaluation of Food Additives evaluation of food additives: Food Additives generally recognized as safe (GRAS), acute and chronic studies, NOAEL, ADI, LD50.Indirect food additives.	8
Module 2: Naturally occurring Food Additives - Classification - Role in Food Processing – Health Implications. Food colors - What are food colors - Natural Food Colors - Synthetic food colors - types -their chemical nature - their impact on health. Preservatives - What are preservatives - natural preservation- chemical preservatives – their chemical action on foods and human system. Manufacturing and applications of fibres from food sources, fructooligosaccharides.	8
Module 3: Anti-oxidants & chelating agents - what are anti-oxidants - their role in foods - types of antioxidants - natural & synthetic - examples - what are chelating agents - their mode of action in foods - examples. Surface active agents - What are surface active agents - their mode of action in foods -examples. Stabilizers & thickeners - examples - their role in food processing. Flavourings agents - natural flavors & synthetic flavors - examples & their chemical nature -role of flavoring agents in food processing.	8
Module 4: Bleaching & maturing agents: what is bleaching - Examples of bleaching agents - What is maturing - examples of maturing agents - their role in food processing. Starch modifiers: what are starch modifiers - chemical nature - their role in food processing. Buffers - Acids & Alkalis - examples - types - their role in food processing. Anti-caking agents - their role in food processing, Humectants - definition on their role in food processing. Clarifying agents - definition examples - their role in food processing	8
Module 5: Ingredients used in food production e.g. sugar, starches/modified starches, fibres, proteins/protein hydrolysates and fats etc and their technology of production and application. Sugars and Sweeteners: Sugars, syrups, sugar alcohols, potent sweeteners, sugar products, caramelization. Sweetener chemistry related to usage in food Products. Artificial sweeteners &nonnutritive sweeteners - special dietary supplements & their health implication - role in food processing. Proteins and Lipids as functional ingredients isolation, modification, specifications, functional properties and application in foods and nutraceuticals	8

Books:

1. Food Additive by Branen, A. L. et al (2001)., 2nd Edition, Marcel Dekker.
2. Encyclopedia of food and color additives by George, A. B. (1991)., Vol III, CRC Press.
3. Stephen AM. (Ed.). 2006. Food Polysaccharides and Their Applications. Marcel Dekker.

Fennema OR.1996. Food Chemistry. Marcel Dekker.

References:

1. Food proteins. Processing Applications by Nakai, S. and Modler, H. W (2000)., Wiley
2. Morton ID & Macleod AJ .1990. Food Flavours. Part A, BC. Elsevier.

Gaps in the syllabus (to meet Industry/Profession requirements)

Recent FSSAI guidelines for Food additives

POs met through Gaps in the Syllabus

PO3, PO4, PO5

Topics beyond syllabus/Advanced topics/Design

Recent FSSAI guidelines for Food additives

POs met through Topics beyond syllabus/Advanced topics/Design

PO3, PO4, PO5

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
First Quiz	10
Mid Semester Examination	25
Second quiz/seminar/assignment/others	10
Teacher's Assessment	5
End Semester Examination	50

Indirect Assessment –

1.Student Feedback on Course Outcome

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO 1	3	2	3	3	3	2	3	1	2	3	3	3	3	3
CO 2	3	2	3	3	3	2	3	1	2	3	3	3	3	3
CO 3	3	2	3	3	3	2	3	1	2	3	3	3	3	3
CO 4	3	2	3	3	3	2	3	1	2	3	3	3	3	3
CO 5	3	2	3	3	3	2	3	1	2	3	3	3	3	3

Correlation Levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Mapping Between COs and Course Delivery (CD) methods

CD Code	Course Delivery methods	Course Outcome	Course Delivery Method Used
CD 1	Lecture by use of boards/LCD projectors/OHP projectors	CO1	CD1, CD2, CD8
CD 2	Tutorials/Assignments	CO2	CD1, CD2, CD8
CD 3	Seminars	CO3	CD1, CD2, CD4, CD8
CD 4	Mini projects/Projects	CO4	CD1, CD2, CD4, CD8
CD 5	Laboratory experiments/teaching aids	CO5	CD1, CD2, CD4, CD8
CD 6	Industrial/guest lectures		
CD 7	Industrial visits/in-plant training		
CD 8	Self- learning such as use of NPTEL materials and internets		
CD 9	Simulation		

COURSE INFORMATION SHEET

Course code: **CL24341**
Course title: **Analytical Instrumental Methods**
Pre-requisite(s): **CH24101, PH24101**
Co- requisite(s):
Credits: **L: 03 T: 00 P: 00**
Class schedule per week: **03**
Class: **B. Tech**
Semester / Level: **V/03**
Branch: **Chemical Engineering**
Name of Teacher:

Course Objectives:
This course enables the students to:

1.	Remember: Recite the different interactions of light with matter for chemical structure determination
2.	Understand: Summarize the different chromatographic techniques for separations of organic compounds
3.	Apply: Illustrate the microscopic techniques for materials characterization
4.	Analyze: Classify different spectroscopic techniques for structural determination
5.	Evaluation: Given a sample identify the structure and properties of the materials

Course Outcomes:
After the completion of this course, students will be able to:

CO 1	Remember: Describe the different spectroscopic techniques for chemical structure determination
CO 2	Understand: Discuss the different chromatographic techniques for organic compounds
CO 3	Apply: Given a sample assess the physical and chemical characteristics.
CO 4	Analyze: Outline the working principles of various microscopy.
CO 5	Evaluation: Applying different instrumental techniques evaluate its properties

SYLLABUS

MODULE	NO. OF LECTURE HOURS
Module 1:-Spectroscopic methods (Absorption UV-VIS, NIR, IR, Raman, AAS), Emission Spectroscopy (fluorescence, phosphorescence), $_1H^1$, C^{13} NMR basic principles, Electron spin resonance spectroscopy, Mass spectroscopy.	8
Module 2:-Chromatography: Principles and Applications of High Performance Liquid Chromatograpy and High Performance Thin Layer Chromatography, Gas Chromatography, Affinity Chromatography, Pyrolysis Gas Chromatograph. Electrochemical analysis.	8
Module 3: Optical microscopy, Electron microscopy – TEM, SEM, Principle, Instrument, Specimen preparations, applications. Energy Dispersive Spectroscopy (EDS), Auger Electron spectroscopy (AES). Electron scanning chemical analysis (ESCA).	8
Module 4: Light Scattering,Principle of X Ray Scattering, Application of WAXS and SAXS, Degree of Crystallinity (Ruland's method), Crystallite size analysis.	8
Module 5:- Principle, Instrument, and application - Differential Scanning Calorimetry(DSC), Differential thermal analysis (DTA), Thermogravimetric analysis (TGA), Dynamic mechanical thermal analysis (DMTA).BET surface area, Physisorption and Chemisorption.	8

TEXT BOOKS:

1. SKOOG, D. A., HOLLER, F. J., CROUCH, S. R. (2007). Principles of instrumental Analysis,ed., Belmont: Thomson Brooks/Cole. ISBN-10: 0495012017
2. David Harvey, Modern Analytical Chemistry, McGraw Hill Co. 2000
3. Helmut Gunzlar and Alex Williams (Edited), Hand book of Analytical Techniques, Wiley VCH 2001.
4. https://en.wikipedia.org/wiki/List_of_chemical_analysis_methods
5. https://en.wikipedia.org/wiki/List_of_materials_analysis_methods

REFERENCE BOOKS:

1. Text book of polymer Science: Billimeyer F.W., 3rd Edn., Wiley Interscience, 1984
2. Principles of Polymer Systems, Rodriguez, F, Taylor& Francis, 4th Edn., 1996.
3. Fundamentals of Polymer Science: Kumar Anil & Gupta R.K. Mc Graw Hill, 1998.
4. Structural Investigation of Polymer: Bodor G., 1st Ed., Ellis Harwood Ltd., 1991.
5. Introduction to Polymer Science 3rd edition, L.H.Sperling, John Wiley and Sons 2001

Gaps in the syllabus (to meet Industry/Profession requirements):

POs met through Gaps in the Syllabus:

Topics beyond syllabus/Advanced topics/Design:

POs met through Topics beyond syllabus/Advanced topics/Design:

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
First Quiz	10
Mid Semester Examination	25
Second quiz/seminar/assignment/others	10
Teacher's Assessment	5
End Semester Examination	50

Indirect Assessment –

1.Student Feedback on Course Outcome

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO 1	3	3	2	2	3	2	1	1	3	3	1	3	3	3
CO 2	3	3	2	2	3	2	1	1	3	3	1	3	3	3
CO 3	3	3	2	2	3	2	1	1	3	3	1	3	3	3
CO 4	3	3	1	1	3	1	1	1	3	3	1	3	3	3
CO 5	3	3	1	1	3	1	1	1	3	3	1	3	3	3

Correlation Levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Mapping Between COs and Course Delivery (CD) methods

CD Code	Course Delivery methods	Course Outcome	Course Delivery Method Used
CD1	Lecture by use of boards/LCD projectors/OHP projectors	CO1	CD1, CD2, CD5, CD8
CD2	Tutorials/Assignments	CO2	CD1, CD2, CD5, CD8
CD3	Seminars	CO3	CD1, CD2, CD5, CD8
CD4	Mini projects/Projects	CO4	CD1, CD2, CD5, CD8
CD5	Laboratory experiments/teaching aids	CO5	CD1, CD2, CD5, CD8
CD6	Industrial/guest lectures		
CD7	Industrial visits/in-plant training		

CD8	Self- learning such as use of NPTEL materials and internets		
CD9	Simulation		

OPEN ELECTIVE II
(V SEMESTER)

COURSE INFORMATION SHEET

Course code: **FE 24343**
Course title: **Nutraceutical & Functional Foods**
Pre-requisite(s): **Nil**
Co- requisite(s):
Credits: **L: 03 T: 00 P:00**
Class schedule per week: **03**
Class: **B. Tech**
Semester / Level: **V/03**
Branch: **Food Engineering and Technology**
Name of Teacher:

Course Objectives

This course enables the students:

1	To understand the principles of nutraceuticals and functional foods.
2.	To understand the importance of Nutraceuticals for specific situation
3.	To know the Protein component as a functional food ingredient
4.	To study the vegetable products as a functional food ingredient.
5.	To remember the Marketing and regulatory issues.

Course Outcomes

After the completion of this course, students will be:

CO1	To apply the concept of nutraceuticals and functional foods.
CO2	To apply the concept of Nutraceuticals production for specific requirement.
CO3	To apply the concept of development of Protein based as a functional food
CO4	To apply the vegetable ingredient as a functional food product.
CO5	To apply the Marketing and regulatory issues in food industry.

SYLLABUS

MODULE	NO. OF LECTURE HOURS
Module 1: Defining nutraceuticals and functional foods, Nature, type and scope. Nutraceuticals and functional foods applications and their health benefits, classification based on chemical and biochemical nature with suitable and relevant descriptions	8
Module 2: Nutraceuticals for specific situation such as cancer, heart diseases, stress, Osteoarthritis, hypertension etc. Antioxidants and other phytochemicals, iso-flavones, lycopene, their role in nutraceuticals and functional foods. Dietary fibers and complex carbohydrates as ingredients of functional foods.	8
Module 3: Protein as a functional food ingredient, Probiotic foods and their functional role, Herbs as functional foods, health promoting activity of common herbs. Cereals products as functional foods- Oats, Wheat bran, rice bran etc.	8
Module 4: Functional vegetable products, oil seeds and sea foods. Coffee, tea and other beverages as functional foods/drinks and their protective effects. Effects of processing and storage and interaction of various environmental factors on the potentials of such foods.	8
Module 5: Marketing and regulatory issues for functional foods and nutraceuticals. Recent developments and advances in the area of nutraceuticals and functional foods	8

Text books:

1. Functional Foods and Nutraceuticals, Rotimi E. Aluko, Springer New York Dordrecht Heidelberg London ISSN 1572-0330 ISBN 978-1-4614-3479-5
2. Functional foods Concept to product Edited by Glenn R. Gibson and Christine M. Williams, Woodhead Publishing Limited Abington Hall, Abington Cambridge CB1 6AH England, ISBN 1 85573 503 2, ISBN 0-8493-0851-8
3. Handbook of Nutraceuticals, Volume 1: Ingredients, Formulations, and Applications, Yashwant Pathak, CRC Press, ISBN: 978-1-4200-8221-0
4. Handbook of Nutraceuticals and Functional Foods (2nd Edition), Robert E.C. Wildman, Robert Wildman, Taylor C. Wallace, CRC Press, ISBN9780429195563

Reference books:

Gaps in the syllabus (to meet Industry/Profession requirements)

POs met through Gaps in the Syllabus

Topics beyond syllabus/Advanced topics/Design

POs met through Topics beyond syllabus/Advanced topics/Design

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment

First Quiz	10
Mid Semester Examination	25
Second quiz/seminar/assignment/others	10
Teacher's Assessment	5
End Semester Examination	50

Indirect Assessment –

1.Student Feedback on Course Outcome

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO 1	3	1	2	3	2	1	2	1	2	2	3	3	3	3
CO 2	3	2	2	3	2	2	3	1	2	2	3	3	3	3
CO 3	2	1	2	3	2	1	2	1	2	2	3	3	3	3
CO 4	3	1	2	3	2	1	2	1	1	1	3	3	3	3
CO 5	3	3	3	3	2	3	2	3	2	2	3	3	3	3

Correlation Levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Mapping Between COs and Course Delivery (CD) methods

CD Code	Course Delivery methods	Course Outcome	Course Delivery Method Used
CD 1	Lecture by use of boards/LCD projectors/OHP projectors	CO1	CD1, CD2, CD8
CD 2	Tutorials/Assignments	CO2	CD1, CD2, CD8
CD 3	Seminars	CO3	CD1, CD2, CD4, CD8
CD 4	Mini projects/Projects	CO4	CD1, CD2, CD4, CD8
CD 5	Laboratory experiments/teaching aids	CO5	CD1, CD2, CD4, CD8
CD 6	Industrial/guest lectures		
CD 7	Industrial visits/in-plant training		
CD 8	Self- learning such as use of NPTEL materials and internets		
CD 9	Simulation		

LABORATORIES

COURSE INFORMATION SHEET

Course code: **FE 24302**
Course title: **Food Microbiology Laboratory**
Pre-requisite(s):
Co- requisite(s): **Food Microbiology**
Credits: 1.5 **L: 00 T: 00 P: 03**
Class schedule per week: **03**
Class: **B. Tech**
Semester / Level: **V/03**
Branch: **Food Engineering and Technology**

Course Objectives
This course enables the students:

1.	Recognize and describe the characteristics of important pathogens and spoilage microorganisms in foods.
2.	Understand the role and significance of intrinsic and extrinsic factors on growth and response of microorganisms in foods.
3.	Describe the beneficial role of microorganisms in fermented foods and in food processing.
4.	Utilize laboratory techniques to detect, quantify, and identify microorganisms in foods.
5.	Acquire, discover, and apply the theories and principles of food microbiology in practical, real-world situations and problems.

Course Outcomes
After the completion of this course, students will be:

CO1	Understand the principles of microorganisms during various food-processing and preservation steps.
CO2	Isolation, identification, and enumeration of the most common microorganisms found in specific food products
CO3	Recognize specific types of microbial spoilage during various food shelf life stages.
CO4	Analyze different foods for presence of hazardous microorganisms using traditional and modern food microbiology technology
CO5	Describe the situations where improper food handling and storage may lead to the spoilage or contamination of food.

List of experiments

1. Food Microbiology Laboratory Safety and Notebook Record
2. Staining Technology and Bright-Field Microscope Use
3. Enumeration of Bacteria in Broth Suspension by Spread and Pour Plating
4. Isolation of Foodborne Pathogens on Selective, Differential, and Enriched Medium by Streak Plating
5. Enumeration of Aerobic Plate Counts, Coliforms, and *Escherichia coli* of Organic Fruit Juice on Petrifilm
6. Enumeration and Identification of *Staphylococcus aureus* in Chicken Salads
7. Enumeration and Identification of *Listeria monocytogenes* on Ready-to-Eat (RTE) food
8. Isolation and Identification of *Salmonella* and *Campylobacter spp*. on Broiler Carcasses

9. Isolation and Identification of *Salmonella* and *Campylobacter spp.* on Broiler Carcasses
10. Cultivation of Anaerobic Bacteria in Canned Food
11. Observation and Enumeration of Molds from Spoiled Bread
12. Environmental Influences and Control of Microbial Growth
    a. Temperature: Effects on Growth and Lethal Effects
    b. pH and Microbial Growth
    c. Osmotic Pressure and Bacterial Growth
    d. Oligodynamic Action
13. Ultraviolet Light Lethal Effects
14. Evaluation of Disinfectants and antimicrobial action The Use-Dilution Method
15. Alcohol Its Effectiveness as a Skin Degerming Agent
    a. Evaluation of Antiseptics: The Filter Paper Disk Method
16. Antimicrobial Sensitivity Testing: The Kirby-Bauer Method

Text Book:

1. S. Ranganna, Hand Book of Analysis and Quality Control for Fruits and Vegetable Products, Tata McGraw Hill, 2002
2. John Wiley Frobischer M. 1968. *Fundamentals of Microbiology*.
3. Hans G. 1986. *General Microbiology*. Cambridge Univ. Press.

Reference Book:

1. Winton AL (1999)Techniques of food analysis, Allied Science Publications New Delhi.
2. Pomeranze Y (2004). Food analysis - Theory and Practice CBS Publications, New Delhi.
3. Jacob MB (1999). The chemical analysis of foods and food products. CBS Publ. New Delhi

Gaps in the syllabus (to meet Industry/Profession requirements)

POs met through Gaps in the Syllabus

Topics beyond syllabus/Advanced topics/Design

POs met through Topics beyond syllabus/Advanced topics/Design

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
(1) Progressive Evaluation	60
Day-to-day performance	(10)
Lab files	(20)
Attendance	(10)
Viva	(20)
(2) End Semester	40
Quiz	(10)
Lab Performance	(30)

Indirect Assessment –

1.Student Feedback on Course Outcome

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3

CO 1	3	2	2	3	3	3	3	1	2	3	3	3	3	3
CO 2	3	2	2	3	3	3	3	1	2	3	3	3	3	3
CO 3	3	2	2	3	3	3	3	1	2	3	3	3	3	3
CO 4	3	2	2	3	3	3	3	1	2	3	3	3	3	3
CO 5	3	3	3	3	3	3	3	1	2	3	3	3	3	3

Correlation Levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Mapping Between COs and Course Delivery (CD) methods

CD Code	Course Delivery methods	Course Outcome	Course Delivery Method Used
CD1	Lecture by use of boards/LCD projectors/OHP projectors	CO1	CD4, CD5, CD7, CD8
CD2	Tutorials/Assignments	CO2	CD4, CD5, CD7, CD8
CD3	Seminars	CO3	CD4, CD5, CD7, CD8
CD4	Mini projects/Projects	CO4	CD4, CD5, CD7, CD8
CD5	Laboratory experiments/teaching aids	CO5	CD4, CD5, CD7, CD8
CD6	Industrial/guest lectures		
CD7	Industrial visits/in-plant training		
CD8	Self- learning such as use of NPTEL materials and internets		
CD9	Simulation		

COURSE INFORMATION SHEET

Course code: FE 24304
Course title: Food Chemistry and Quality Control Lab I
Pre-requisite(s): -
Co- requisite(s):
Credits:1.5 L: 00 T: 00 P: 03
Class schedule per week: 03
Class: B. Tech
Semester / Level: V/03
Branch: Food Engineering and Technology

Course Objectives

This course enables the students:

1.	Recognize the important reactions in food chemistry and their consequences.
2.	Be familiar with methods to measure these reactions.
3.	Be capable of reporting their results in an appropriate format.
4.	Be capable of designing and conducting an experiment to understand a food chemistry problem.
5	Be capable of applying the experimental result in quality control

Course Outcomes

After the completion of this course, students will be:

CO1	Conduct appropriate laboratory experiments common to basic and applied food chemistry and interpret the results.
CO2	Work cooperatively in a team to identify a food chemistry problem, design and conduct the experiments, and analyze and interpret the data.
CO3	Clearly communicate research results using appropriate written, oral, and visual communication techniques.
CO4	Conduct appropriate laboratory experiments specific to particular group of food product.
CO5	Work cooperatively in a team to interpret analytical data for report preparation.

List of experiments

1. Analysis of moisture content by different methods
2. Determination of pH (using pH paper, universal indicator and pH meter), titratable acidity and TSS content
3. Determination of Ash content (Acid soluble and insoluble Ash)
4. Estimation of Crude fat content
5. Crude Protein- Kjeldahl Method
6. Quantitative estimation of endpoint using UV-Vis spectrophotometer.
7. Protein estimation by using Lowry method.
8. Determination of Total Carbohydrate content
9. Estimation of Crude Fiber content
10. Determination of acidity of given honey sample, extracted fat in a given sample of biscuit
11. Determination of reducing and non- reducing sugars in a given food samples
12. Estimation of sulphur dioxide (KMS), sodium benzoate, sorbic acid and sorbate, Propyl gallate content
13. Determination of Vitamin- C (Ascorbic Acid) in a given food sample
14. Determination of Diastase enzyme (α- amylase) activity in a given food sample by Falling Number test
15. Identification of pigments in a given food sample by paper chromatography
16. Detection of Saccharine in beverages

Text Book:

1. S. Ranganna, Hand Book of Analysis and Quality Control for Fruits and Vegetable Products, Tata McGraw Hill, 2002.

Reference Book:

1. Winton AL (1999)Techniques of food analysis, Allied Science Publications NewDelhi.
2. Pomeranze Y (2004). Food analysis - Theory and Practice CBS Publications, New Delhi.
3. Jacob MB (1999). The chemical analysis of foods and food products. CBS Publ. New Delhi

Gaps in the syllabus (to meet Industry/Profession requirements)

POs met through Gaps in the Syllabus

Topics beyond syllabus/Advanced topics/Design

POs met through Topics beyond syllabus/Advanced topics/Design

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
(1) Progressive Evaluation	60
Day-to-day performance	(10)
Lab files	(20)
Attendance	(10)
Viva	(20)
(2) End Semester	40
Quiz	(10)
Lab Performance	(30)

Indirect Assessment –

1.Student Feedback on Course Outcome

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**1**	**2**	**3**
CO 1	3	3	3	3	3	3	3	1	1	3	2	3	3	3
CO 2	3	3	3	3	3	3	3	2	1	3	2	3	3	3
CO 3	2	3	3	3	3	3	3	1	3	3	2	3	3	3
CO 4	3	3	3	3	3	3	3	1	1	3	2	3	3	3
CO 5	3	3	3	3	3	3	3	2	1	3	2	3	3	3

Correlation Levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Mapping Between COs and Course Delivery (CD) methods

CD Code	Course Delivery methods	Course Outcome	Course Delivery Method Used
CD1	Lecture by use of boards/LCD projectors/OHP projectors	CO1	CD4, CD5, CD7, CD8
CD2	Tutorials/Assignments	CO2	CD4, CD5, CD7, CD8
CD3	Seminars	CO3	CD4, CD5, CD7, CD8
CD4	Mini projects/Projects	CO4	CD4, CD5, CD7, CD8
CD5	Laboratory experiments/teaching aids	CO5	CD4, CD5, CD7, CD8
CD6	Industrial/guest lectures		
CD7	Industrial visits/in-plant training		
CD8	Self- learning such as use of NPTEL materials and internets		
CD9	Simulation		

Year III (6th Semester)

Course Information Sheet

Course code: CL 24311
Course title: Process Control and Instrumentation
Pre-requisite(s): Mathematics - I -MA24101; Mathematics - II-MA24103; Chemical Process Calculations-CL24205
Co- requisite(s): Chemical Reaction Engineering – I CL24213
Credits: L:3 T:1 P:0
Class schedule per week: 4
Class: B. Tech
Semester / Level: VI / Third
Branch: Chemical Engineering
Name of Teacher:

Course Objectives:

This course enables the students to:

1.	Understand the key concepts of instrumentation and measurements of a chemical process plant.
2.	Understand and analyze the dynamics of different types of open loop and closed loop system.
3.	Analyze stability and tuning of a control system.
4.	Apply the concepts of control in unit operation and unit process.
5.	Apply the concepts of various types of computer-based control and advanced control strategies.

Course Outcomes:

After the completion of this course, students will be:

CO24311.1	Define the operating principles of various instruments and measurements in a chemical process plant.
CO24311.2	Developing transfer function models, block diagram and compute the response of the developed transfer function for various forcing functions.
CO24311.3	Analyze the stability of a control system given a mathematical model of a control system including its components.
CO24311.4	Design of controller using different tuning techniques.
CO24311.5	Apply computer-based advanced process control for better accuracy, economy, product quality and safety.

SYLLABUS

MODULE	NO. OF LECTURE HOURS
Module 1: Process Instrumentation, measurement and its classification by physical characteristics, working principles of transducers/sensors employed for the measurement of flow, level, pressure, temperature, concentration, etc. Control valves and their characteristics.	8
Module 2: The concept of process dynamics and control, review of Laplace transform methods, Laplace transform of disturbances and building functions, dynamic response of first and second order system, interacting and noninteracting system, transportation lag, measurement lag. Linear closed-loop system, its different elements, block diagram, negative feedback and positive feedback system, servo problem and regulator problem.	8
Module 3: Controllers and final control element, PID. Stability of a linear closed-loop system, generalized stability criteria, Routh stability criteria, root locus, Frequency Response-Bode stability criteria, Bode plot.	8
Module 4: Controller tuning- Ziegler-Nichols rules, Cohen and Coon rules, criteria for good control, control system design by frequency response, use of gain and phase margins. Basic concepts of Control of Reactors, Unit operation equipment- heat exchanger, distillation column, flash chamber, mixer.	8
Module 5: Digital computer control loop and its elements, modes of computer control- direct digital control, SCADA, PLC, DCS. Advanced control strategies- feedforward, cascade, dead time compensation, ratio control, multivariable control.	8

Text books:

1. Coughanowr, Process Systen Analysis, MGH.
2. Stephenopolos, S., "Chemical process control", Prentice Hall of India, New Delhi, 1984.
3. Considine, D.M., "Process/Industrial Instruments and Controls Handbook", McGraw Hill, 1993.

Reference books:

1. Hughes T.A., Measurement and control basis, 3rd eds., ISA, 2002.
2. Dunn, W.C., Introduction to Instrumentation, Sensors, and Process Control, ARTECH HOUSE, INC, 2006.
3. Luyben, W.L., "Process modelling, simulation, and control for Chemical Engineers" McGrawHill, 1989
4. Oggunaika B.A. and Ray W.H., "Process Dynamics, Modeling and control". Oxford University Press, U.K. 1994.

Gaps in the syllabus (to meet Industry/Profession

requirements) POs met through Gaps in the Syllabus
Topics beyond syllabus/Advanced topics/Design

POs met through Topics beyond syllabus/Advanced topics/Design

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure Direct Assessment

Assessment Tool	% Contribution during CO Assessment
First Quiz	10
Mid Semester Examination	25
Second quiz/seminar/assignment/others	10
Teacher's Assessment	5
End Semester Examination	50

Indirect Assessment –

1. Student Feedback on Course Outcome

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO 1	3	3	1	3	1	1	1	1	0	1	0	3	3	3
CO 2	3	3	3	2	3	0	0	0	2	0	0	3	3	3
CO 3	3	3	2	2	3	0	0	0	2	0	0	3	3	3
CO 4	2	3	3	3	3	2	3	2	2	2	0	3	3	3
CO 5	2	3	3	3	3	2	3	2	2	2	0	3	3	3

Correlation Levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Mapping Between COs and Course Delivery (CD) methods

CD Code	Course Delivery methods	Course Outcome	Course Delivery Method Used
CD1	Lecture by use of boards/LCD projectors/OHP projectors	CO1	CD1, CD2, CD8
CD2	Tutorials/Assignments	CO2	CD1, CD2, CD8
CD3	Seminars	CO3	CD1, CD2, CD8
CD4	Mini projects/Projects	CO4	CD1, CD2, CD8
CD5	Laboratory experiments/teaching aids	CO5	CD1, CD2, CD8
CD6	Industrial/guest lectures		
CD7	Industrial visits/in-plant training		

CD8	Self- learning such as use of NPTEL materials and internets		
CD9	Simulation		

Course Information Sheet

Course code: **FE 24311**
Course title: **Food Process Engineering**
Pre-requisite(s):
Co- requisite(s):
Credits: 3 **L:03 T:00 P:00**
Class schedule per week: **03**
Class: **Food Engineering and Technology**
Semester / Level: **VI/03**
Branch: **Food Engineering and Technology**
Name of Teacher:
Course Objectives

This course enables the students:

1.	To explain thermodynamic terminology and concepts appropriately
2.	To define appropriate system boundaries for analyzing a variety of thermodynamic components and systems
3.	To apply the basic of refrigerating and its applications in food engineering
4.	To develop knowledge in thermodynamic properties of food in relation to different unit operations.
5.	To use tables, charts, equations, and software, in conjunction with appropriate property diagrams, to fix states of a pure substance and determine relationships among pressure, temperature, specific volume, internal energy, enthalpy and entropy

Course Outcomes

After the completion of this course, students will be:

CO 1	Able to demonstrate the principles of conservation of mass, conservation of energy, and the second law of thermodynamics to thermodynamic cycles.
CO 2	Able to build the ability to analyze the performance of vapor and gas power cycles
CO 3	Able to develop the ability to analyze the performance of vapor and gas refrigeration and heat pump cycles.
CO 4	Able to utilize states and performance parameters for vapor power cycles based on the Rankine cycle with superheat, reheat, and regeneration
CO 5	Able to collaborate and communicate with fellow students and the instructor in a professional manner

SYLLABUS

MODULE	NO. OF LECTURE HOURS
Module 1: Diffusion and Mass Transfer in Food Materials: Molecular diffusion in solids and fluids: Ficks 1st law for molecular diffusion, diffusion through varying cross sectional area, molecular diffusion in liquids, molecular diffusion in biological solutions and gels, molecular diffusion in solids, diffusion coefficients in gas, liquid and solid, numerical solution of steady state diffusion, Ficks 2nd law and unsteady state operation, mass transfer coefficients, interphase mass transfer, diffusion of gases in porous solids and capillaries. .	8
Module 2: Gas - liquid Operations: Absorption: equilibria, single and multiple stages, mass transfer using film mass transfer coefficients, overall mass transfer coefficient, equipment; distillation: phase rule, ideal solutions and Roults law, constant pressure and temperature equilibria, relative volatility, deviations from ideality (azeotropes), distillation methods, McCabe- Thiele method, stage efficiencies, enthalpy concentration method.	8
Module 3: Liquid liquid Operations: Liquid equilibria, equipment, liquid - liquid extraction. Solid - fluid Operations: Leaching (viz. Edible oil extraction): equilibria, percolation tank (Shanks system), equipment for steady and unsteady state operations; Solid-Liquid Extraction: Supercritical Fluid Extraction crystallization: equilibria, types of crystals, rate of growth, size distribution, equipment: adsorption and ion exchange: types, adsorbents, equilibria, stage operations, equipment.	
Module 4: Dehydration Water Activity, Thermodynamic Basis for Water Activity. Osmotic Pressure Water Activity at High Moisture Contents Gibbs-Duhem Equation, Water Activity at Low Moisture Contents, The GAB (Guggenheim-Anderson-de Boer) Equation, Mass Transfer, Mass Diffusion , Mass Transfer from Surfaces to Flowing Air , Psychrometry, Carrying Capacity of Gases for Vapors, The Psychrometric Chart Use of Psychrometric Chart to Follow Changes in the Properties of Air-Water Mixtures Through a Process, The Stages of Drying, Prediction of Drying Times from Drying Rate Data, Materials with One Falling Rate Stage Where the Rate of Drying Curve Goes Through the Origin, Materials with More Than One Falling Rate Stage The Constant Drying Rate, Spray Drying, Drying Times in Spray Drying, Freeze Drying, Drying Times for Symmetrical Drying, Vacuum Belt Dryer **Evaporation:** Single-Effect Evaporators: The Vapor Chamber, The Condenser, Removal of Incondensable Gases, The Heat Exchanger, Improving the Economy of Evaporators, Vapor Recompression Multiple-Effect Evaporators: Entrainment, Essence Recovery	8
Module 5: Refrigeration: Basic refrigeration cycles and concepts: Refrigeration equipment: Compressor, condenser, evaporator, expansion valve, Chilling and Freezing; Freezing curve and water activity; Properties of frozen foods; Enthalpy change during freezing; Plank's equation for freezing time; Cold storage and Refrigeration load; Refrigeration cycle; Cryogenic freezing and IQF; Freeze concentration and freeze drying. **Food Plant Utilities & Services:** Classification of Various Utilities and Services in food Plant/ industry. Commercial energy Pricing, Electrical System, Electrical motors, Compressed air system, HV AC & Refrigeration system , Fans and blowers	8

, Pumps and pumping systems , DG set system , Fuels and combustion , Boilers , Steam system , Waste heat recovery , Other utilities & services	

Text books:

1. R. Paul Singh. Introduction to Food Engineering,, , Dennis R. Heldman, Academic Press, 2009.(T1)
2. Elements of Food Engineering by R.T. Toledo, (T2)
3. Food Process Engineering and Technology, Zeki Berk), Academic Press.(T3)
4. FOOD PROCESSING TECHNOLOGY, Principles and Practice, P. Fellows, CRC Press.(T4)

Reference:

1. Earle RL. 1985. *Unit Operations in Food Processing*. Pergamon Press.(T1)
2. Sahay KM & Singh KK. 1994. *Unit Operation of Agricultural Processing*.Vikas Pub. (T2)
3. Refrigeration and air-conditioning. Richard C Jordan and Goyle B. Prirster (1956), Prentice Hall,(T3)
4. Refrigeration and air-conditioning. Dr. Manohar Prasad, (1993), WielyEstern, New Delhi.(T4)
5. An introduction to thermodynamics by Y V C Roy (T5)

Gaps in the syllabus (to meet Industry/Profession requirements)

Use of process simulator

POs met through Gaps in the Syllabus

PO3, PO4, PO5

Topics beyond syllabus/Advanced topics/Design

Introduction to molecular/statistical thermodynamics

POs met through Topics beyond syllabus/Advanced topics/Design

PO3, PO4, PO5

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
First Quiz	10
Mid Semester Examination	25
Second quiz/seminar/assignment/others	10
Teacher's Assessment	5
End Semester Examination	50

Indirect Assessment –

1.Student Feedback on Course Outcome

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO 1	3	1	3	3	2	1	2	1	2	1	2	3	3	3
CO 2	3	1	3	3	2	1	2	1	2	1	2	3	3	3
CO 3	3	1	3	3	2	1	2	1	2	1	2	3	3	3
CO 4	3	1	3	3	2	1	2	1	2	1	2	3	3	3
CO 5	2	3	3	2	1	3	2	2	1	2	1	3	3	3

Correlation Levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Mapping Between COs and Course Delivery (CD) methods

CD Code	Course Delivery methods	Course Outcome	Course Delivery Method Used
CD 1	Lecture by use of boards/LCD projectors/OHP projectors	CO1	CD1, CD2, CD8
CD 2	Tutorials/Assignments	CO2	CD1, CD2, CD8
CD 3	Seminars	CO3	CD1, CD2, CD4, CD8
CD 4	Mini projects/Projects	CO4	CD1, CD2, CD4, CD8
CD 5	Laboratory experiments/teaching aids	CO5	CD1, CD2, CD4, CD8
CD 6	Industrial/guest lectures		
CD 7	Industrial visits/in-plant training		
CD 8	Self- learning such as use of NPTEL materials and internets		
CD 9	Simulation		

COURSE INFORMATION SHEET

Course code: FE 24313
Course title: Cereal, Pulses and Oilseeds Processing Technology
Pre-requisite(s):
Co- requisite(s):
Credits: 3 L:03 T:00 P:00
Class schedule per week: 03
Class: B. Tech
Semester / Level: VI/04
Branch: Food Engineering and Technology
Name of Teacher:

Course Objectives

This course enables the students:

1.	To understand the basic composition and structural parts of food grains.
2.	To interpret the importance of cereals as foods, and appreciate their nutritional value
3.	To develop the basic knowledge and principles of cereal science, the production processes and technologies for cereal products, and the quality, sanitary control and assurance for cereal processing.
4.	To list the various components of cereals and their approximate levels, their functional roles in the various cereal foods, and methods of analysis
5.	To utilize the application of scientific principles in the processing of cereal and cereal based product.

Course Outcomes

After the completion of this course, students will be:

CO 1	Able to identify the importance of cereals as foods, and understand their nutritional value.
CO 2	Able to discover the proper methods of wheat and grain handling and storage
CO 3	Able to categorize the botanical, physical, and chemical criteria of wheat quality, their methods of evaluation, roles in wheat grading and processing.
CO 4	Able to explain the dry milling processes of bread and durum types of wheat, and how flour grades are obtained.
CO 5	Able to describe how bread, biscuits, pasta, and breakfast cereals are produced, and identify the parameters involved in their quality evaluation

SYLLABUS

MODULE	NO. OF LECTURE HOURS
Module 1: Status, major growing areas and production of cereals and millets in India and in the world; Structure and composition of different grains (wheat, rice, barley, oat, maize and millets); Anti-nutritional factors in grains and oilseeds; Milling, storage and insect control; Wheat– classification, grain quality and milling, *Atta* and *maida*, quality aspects of flour, wheat proteins and their function, rheology; Wheat flour/semolina and its use in traditional/non-traditional foods like breads, biscuits, cakes, doughnuts, buns, pasta goods, extruded, confectionary products, breakfast and snack foods; Preparation of vital wheat gluten and its utilization; Instant ready mixtures; Enzymes (amylases and proteases) in milling and baking.	8
Module 2: Varieties of rice grown in India and other countries; Storage, Insect control; Processing: Rice -Milling, and sorting; Parboiling, Polishing; Quick cooking rice, factors affecting quality of rice, Traditional Indian Products- Puffed Rice, flaked rice, Rheology rice flour; By-products of rice milling and their utilization; Processed products from rice; Bran, germ and novel products from wheat / rice.	8
Module 3: Barley: Pearling, malting, brewing and preparation of malted milk feeds from barley. Significance of β- glucans. Corn - Wet and dry milling, Corn Products – Corn flakes, , corn syrup (HFCS); Corn starch, canned corn products, corn steep liquor and germ oil, puffed product; Oats- Milling, Oat Products – Steel cut, rolled oats, quick cooking; Processing into oat flakes, porridge and oatmeal; Rye bread-Traditional cereal products; Sorghum, Pearl Millet, Finger millet, Foxtail millet, Kodo Millet - storage, insect control; processing - Pearling, Milling, Malting, Malt based foods, flaked and fermented products; Traditional and Nutritional products based on finger millet.	8
Module 4: Pulses: Structure and composition of pulses and their importance in Indian diet; Cleaning, grading, pretreatments for difficult-to-mill (urad, arhar, moong, moth) and easy-to-mill (chana, masoor and pea) legumes, milling practices and actual milling of different legumes. Use in traditional products, protein concentrates and isolates. Oilseeds: edible oilseeds, composition and importance in India; Oilseed processing; Oil extraction and its processing, byproducts of oil refining. Production, packaging and storage of vanaspati, peanut butter, protein concentrates, isolates and their use in high protein foods. Export of oilseed cakes. International market and consumer preferences for quality in cakes for use in textured vegetable proteins; Modified starches and proteins. Processing and utilization of soya bean for value added products.	8
Module 5: Dairy analogues based on plant milk. Spices Processing: Oleoresin and essential oil extraction; Baked foods - chemical dough development, mechanical dough development, sheeting extrusion other rapid methods; Bread staling – theory, manifestation, retardation measures; Indian Confectionery. Extrusion processes for foods- principles of extrusion, Extrusion systems – cold extrusion, extrusion cooking, single and twin-screw extruders. Technology of Macaroni and pasta products, extrusion cooking. Fermented cereal and pulse-based product (Beer, rice beer, Papads, wari, Idli, Dosa, Dhokla, soy sauce etc.); Idli/Dosa/vada mixes and other instant products.	8

Text books:

1. Post Harvest Technology Of Cereals,pulses And Oilseedsby Chakraverty A.3rd Ed.2008**(T1)**

2. The Chemistry and Technology of Cereals as Food and Feedby Matz, Samuel A. 2nd Edition, CBS, 1996.**(T2)**

3. Principles of Cereal Science and TechnologyBy Delcour, Jan A. and R. Carl Hoseney. 3rd Edition. American Association of Cereal Chemists, 2010.**(T3)**

4. Handbook of Cereal Science and Technologyby Kulp, Karel. 2nd Edition,CRC Press, 2000.**(T4)**

5. Cereal Biotechnologyby Morris, Peter C. and James H Bryce CRC / Woodhead, 2000**(T5)**

Reference books:

1. Technology of Cereals by N.L.Kent. pergaman Press,1966**(R1)**

2. Food Facts and Principles by Mannay;New age International (P) Ltd.**(R2)**

3. Food Science by Norman N.Potter;CBS Publications.**(R3)**

4. Development in Milling & Baking Technology by AFST (I), CFDRI, Mysore, India.**(R4)**

Gaps in the syllabus (to meet Industry/Profession requirements)

Recent Industrial developments in Cereal and pulse fortification

POs met through Gaps in the Syllabus

PO3, PO4, PO5

Topics beyond syllabus/Advanced topics/Design

Cereal and pulse fortification

POs met through Topics beyond syllabus/Advanced topics/Design

PO3, PO4, PO5

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
First Quiz	10
Mid Semester Examination	25
Second quiz/seminar/assignment/others	10
Teacher's Assessment	5
End Semester Examination	50

Indirect Assessment –

1.Student Feedback on Course Outcome

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO 1	3	3	3	2	2	1	3	1	2	1	3	3	3	3
CO 2	3	3	3	2	2	1	3	1	2	1	3	3	3	3
CO 3	3	3	3	2	2	1	3	1	2	1	3	3	3	3
CO 4	3	3	3	2	2	1	3	1	2	1	3	3	3	3
CO 5	3	3	3	2	3	2	3	1	2	1	3	3	3	3

Correlation Levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Mapping Between COs and Course Delivery (CD) methods

CD Code	Course Delivery methods	Course Outcome	Course Delivery Method Used
CD 1	Lecture by use of boards/LCD projectors/OHP projectors	CO1	CD1, CD2, CD8
CD 2	Tutorials/Assignments	CO2	CD1, CD2, CD8
CD 3	Seminars	CO3	CD1, CD2, CD4, CD8
CD 4	Mini projects/Projects	CO4	CD1, CD2, CD4, CD8
CD 5	Laboratory experiments/teaching aids	CO5	CD1, CD2, CD4, CD8
CD 6	Industrial/guest lectures		
CD 7	Industrial visits/in-plant training		
CD 8	Self- learning such as use of NPTEL materials and internets		
CD 9	Simulation		

PROGRAMME ELECTIVE-III (PE-III)
VI SEMESTER

COURSE INFORMATION SHEET

Course code: **FE 24347**
Course title: **Big Data Analytics**
Pre-requisite(s): **FE 24233, FE 24333**
Co- requisite(s):
Credits: **L: 03 T: 00 P:00**
Class schedule per week: **03**
Class: **B. Tech**
Semester / Level: **VI/03**
Branch: **Food Engineering and Technology**
Name of Teacher:

Course Objectives

This course enables the students:

1	To understand big data analytics as the next wave for businesses looking for competitive advantage
2.	To understand the financial value of big data analytics
3.	To explore tools and practices for working with big data
4.	To understand how big data analytics can leverage into a key component
5.	To learn about stream computing

Course Outcomes

After the completion of this course, students will be:

CO1	Understand big data analytics as the next wave for businesses looking for competitive advantage
CO2	Understand the financial value of big data analytics
CO3	Explore tools and practices for working with big data
CO4	Understand how big data analytics can leverage into a key component
CO5	Learn about stream computing

SYLLABUS

MODULE	NO. OF LECTURE HOURS
Module 1: Introduction to Big Data: Definition and Characteristics of Big Data (Volume, Velocity, Variety, Veracity, Value), Sources of Big Data: Social Media, IoT, Sensors, Logs, Challenges of Big Data Management, Big Data Lifecycle, Use Cases of Big Data Analytics	8
Module 2: Big Data Storage and Management: Distributed File Systems: HDFS (Hadoop Distributed File System), Data Storage Technologies: Relational Databases (RDBMS) & NoSQL Databases (MongoDB, Cassandra, HBase), Data Warehousing for Big Data, Data Lakes: Architecture and Use Cases, CAP Theorem and BASE Principles	8
Module 3: Big Data Processing Frameworks: Introduction to Hadoop Ecosystem: Hadoop Architecture & YARN (Yet Another Resource Negotiator), MapReduce Programming Model, Apache Spark: Spark Architecture and RDDs (Resilient Distributed Datasets) & Spark vs. Hadoop, Batch vs. Real-Time Processing	8
Module 4: Data Ingestion and ETL Pipelines: Data Ingestion Tools: Sqoop, Flume, Kafka, Extract, Transform, Load (ETL) Processes, Data Preprocessing for Big Data Analytics, Data Cleaning and Normalization Techniques	8
Module 5: Big Data Analytics Tools & Techniques Overview of Big Data Platforms: Cloudera, Hortonworks, AWS EMR, Google BigQuery Tools for Big Data Analytics: Pig: Scripting for Data Processing; Hive: Data Warehousing and SQL for Hadoop; Impala: Interactive Queries, Workflow Orchestration: Apache Airflow, Oozie. *Working on Capstone Project: Work on a Real-World Problem: Example Projects: Customer Segmentation, Sentiment Analysis, IoT Analytics using Tools: Hadoop, Spark, Tableau, Python followed by Presentation and Documentation	8

Text books:

Min Chen, Shiwen Mao, Yin Zhang,Victor C.M. Leung, “Big Data: Related Technologies, Challenges and Future Prospects”, Springer; 2014 edition

Reference books:

1. "Hadoop: The Definitive Guide" by Tom White
2."Big Data: Principles and Best Practices of Scalable Real-Time Data Systems" by Nathan Marz
3."Spark: The Definitive Guide" by Bill Chambers and Matei Zaharia
4."Mining of Massive Datasets" by Jure Leskovec, Anand Rajaraman, and Jeffrey D. Ullman
5."NoSQL Distilled: A Brief Guide to the Emerging World of Polyglot Persistence" by Pramod J. Sadalage and Martin Fowler

Gaps in the syllabus (to meet Industry/Profession requirements)

POs met through Gaps in the Syllabus

Topics beyond syllabus/Advanced topics/Design

POs met through Topics beyond syllabus/Advanced topics/Design

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
First Quiz	10
Mid Semester Examination	25
Second quiz/seminar/assignment/others	10
Teacher's Assessment	5
End Semester Examination	50

Indirect Assessment –

1.Student Feedback on Course Outcome

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO 1	3	1	2	3	2	1	2	1	2	2	3	3	3	3
CO 2	3	2	2	3	2	2	3	1	2	2	3	3	3	3
CO 3	2	1	2	3	2	1	2	1	2	2	3	3	3	3
CO 4	3	1	2	3	2	1	2	1	1	1	3	3	3	3
CO 5	3	3	3	3	2	3	2	3	2	2	3	3	3	3

Correlation Levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Mapping Between COs and Course Delivery (CD) methods

CD Code	Course Delivery methods	Course Outcome	Course Delivery Method Used
CD 1	Lecture by use of boards/LCD projectors/OHP projectors	CO1	CD1, CD2, CD8
CD 2	Tutorials/Assignments	CO2	CD1, CD2, CD8
CD 3	Seminars	CO3	CD1, CD2, CD4, CD8
CD 4	Mini projects/Projects	CO4	CD1, CD2, CD4, CD8
CD 5	Laboratory experiments/teaching aids	CO5	CD1, CD2, CD4, CD8
CD 6	Industrial/guest lectures		
CD 7	Industrial visits/in-plant training		
CD 8	Self- learning such as use of NPTEL materials and internets		
CD 9	Simulation		

COURSE INFORMATION SHEET

Course code: FE 24349
Course title: Data Mining and Data Visualization
Pre-requisite(s): MA24101, MA24103
Co- requisite(s):
Credits: L: 03 T: 00 P:00
Class schedule per week: 03
Class: B. Tech
Semester / Level: VI/03
Branch: Food Engineering and Technology
Name of Teacher:

Course Objectives

This course enables the students:

1	To understand the concepts of tools and techniques for gaining a qualitative understanding
2.	To understand the concepts of Data cleaning and preparation.
3.	To know the concepts of data Aggregation and allocation
4.	Understanding semi-structured or unstructured data usingstatistical tools
5.	To know the concept of Process control and management.

Course Outcomes

After the completion of this course, students will be:

CO1	To apply qualitative tools and techniques in food processing field.
CO2	To apply the concepts of Data cleaning and preparation in food industry.
CO3	To apply the concepts of data Aggregation and allocation.
CO4	To process the semi-structured or unstructured data usingstatistical tools in industry.
CO5	To apply the concept of Process control and management.

SYLLABUS

MODULE	NO. OF LECTURE HOURS
Module 1: Tools and techniques for gaining a qualitative understanding. Line plot, Bar chart, Pie and Donut charts, Histogram plot, and Scatter plot. Visualizing big data: Kernel density estimation for non-parametric data, Box and Whisker plot for large data. Semi-structured and unstructured data: Word clouds, network diagram, correlation matrices	8
Module 2: Data cleaning and preparation; Tracking patterns; Classification; Association; Outlier detection; Clustering; Regression; Prediction; Sequential patterns; Decision trees; Statistical techniques; Visualization; Neural networks; Data warehousing; Long-term memory processing; Machine learning and artificial intelligence	8
Module 3: Aggregation and allocation. Querying, denormalization and standardization. Reporting and analytical alert.	8
Module 4: Interfacing with unstructured data sources. Understanding semi-structured or unstructured data usingstatistical tools. Rolling Forecasts, Optimization of key performance indicator.	8
Module 5: Process control and management.	8

Text books:

Reference books:

1. Avrim Blum: Foundations of Data Science, 1st edition.
2. Richard S. and Andrew G. Barto: Reinforcement Learning: An Introduction (Adaptive Computationand Machine Learning series), 2nd edition.
3. Stuart Russell and Peter Norvig: Artificial Intelligence: A Modern Approach
4. Ralph Kimball, Margy Ross, Warren Thornthwaite, Joy Mundy, Bob Becker: The Data warehouseLifecycle Toolkit
5. Peter Rausch, Alaa F. Sheta, Aladdin Ayesh (eds.): Business Intelligence and Performance Management: Theory, Systems, and Industrial Applications, 2013, Springer Verlag, U.K.
6. J. Mark Munoz: Global Business Intelligence, 2017, Routledge, UK.
7. Michael Mitzenmacher and Eli Upfal: Probability and Computing, 2nd edition, Cambridge University Press
8. Fabrizio Silvestri: Mining Query Logs: Turning Search Usage Data into Knowledge, NOW Publishers.
9. R.L.T. Santos, Craig Macdonald, Iadh Ounis: Search Result Diversification, NOW Publishers
10. Richard O. Duda, Peter E. Hart and David G. Stork: Pattern Classification, 2000, Wiley.
11. Trevor Hastie Robert Tibshirani and Jerome Friedman: The Elements of Statistical Learning
12. Bo Pang, Lillian Lee: Opinion Mining and Sentiment Analysis, NOW Publishers.
13. Ani Nenkova, Kathleen McKeown: Automatic Summarization, NOW Publishers.
14. Christopher M. Bishop: Pattern Recognition and Machine Learning, 2006, Springer.
15. Brian D. Ripley: Pattern Recognition and Neural Networks.
16. M. P. Wand and M. C. Jones: Kernel Smoothing.
17. Vladimir N. Vapnik: Statistical Learning Theory.
18. Leo Breiman, Jerome Friedman, Richard Olsen and Charles Stone: CART.
19. Andy Kirk, Data Visualization: A Handbook for Data Driven Design, 2nd Edition.
20. Steve Wexler, Jeffrey Shaffer and Andy Cotgreave: The Big Book of Dashboards: Visualizing YourData Using Real-World Business Scenarios.

Gaps in the syllabus (to meet Industry/Profession requirements)

POs met through Gaps in the Syllabus

Topics beyond syllabus/Advanced topics/Design

POs met through Topics beyond syllabus/Advanced topics/Design

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
First Quiz	10
Mid Semester Examination	25
Second quiz/seminar/assignment/others	10
Teacher's Assessment	5
End Semester Examination	50

Indirect Assessment –

1.Student Feedback on Course Outcome

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO 1	3	1	2	3	2	1	2	1	2	2	3	3	3	3
CO 2	3	2	2	3	2	2	3	1	2	2	3	3	3	3
CO 3	2	1	2	3	2	1	2	1	2	2	3	3	3	3
CO 4	3	1	2	3	2	1	2	1	1	1	3	3	3	3
CO 5	3	3	3	3	2	3	2	3	2	2	3	3	3	3

Correlation Levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Mapping Between COs and Course Delivery (CD) methods

CD Code	Course Delivery methods	Course Outcome	Course Delivery Method Used
CD 1	Lecture by use of boards/LCD projectors/OHP projectors	CO1	CD1, CD2, CD8
CD 2	Tutorials/Assignments	CO2	CD1, CD2, CD8
CD 3	Seminars	CO3	CD1, CD2, CD4, CD8
CD 4	Mini projects/Projects	CO4	CD1, CD2, CD4, CD8
CD 5	Laboratory experiments/teaching aids	CO5	CD1, CD2, CD4, CD8
CD 6	Industrial/guest lectures		
CD 7	Industrial visits/in-plant training		
CD 8	Self- learning such as use of NPTEL materials and internets		
CD 9	Simulation		

COURSE INFORMATION SHEET

Course code: FE 24351
Course title: Engineering Properties of Food
Pre-requisite(s): CL 203, CL 207, FE 24203, FE 24207
Co- requisite(s):
Credits: L: 03 T: 00 P:00
Class schedule per week: 03
Class: B. Tech
Semester / Level: VI/03
Branch: Food Engineering and Technology
Name of Teacher:

Course Objectives

This course enables the students:

1	To know the Biomaterials and their properties in relation to food processing.
2.	To understand the Mechanical and Rheological Properties
3.	To know the Textural properties of fruits & vegetables
4.	To understand the Thermal, Electrical and Optical Properties
5.	To acquaint with the measurement of thermal, electrical and optical properties of food materials

Course Outcomes

After the completion of this course, students will be:

CO1	To apply the Biomaterials and their properties in relation to food processing
CO2	To apply the Mechanical and Rheological Properties of food in industry.
CO3	To apply the Textural properties of fruits & vegetables
CO4	To point out the Thermal, Electrical and Optical Properties
CO5	To measure thermal, electrical and optical properties of food materials

SYLLABUS

MODULE	NO. OF LECTURE HOURS
Module 1: Biomaterials and their properties in relation to processing, their role in the development of new products and processes. Physico-chemical characteristics: shape, sphericity, size, volume, density, porosity, surface area, coefficients of friction, and angle of repose of food materials.	8
Module 2: Mechanical and Rheological Properties: flow behaviour, Textural profile, mechanical damage on food its significance in causing biological and chemical reactions. Aero and hydrodynamic: Drag coefficients, terminal velocity in agricultural materials.	8
Module 3: Textural properties of fruits & vegetables; Dough, Pasta and Baked products; dairy products; Meat; Fat and fat products; and their instrumental Measurements. Rheology of chocolate, Textural characteristics of food emulsions, Functions of emulsifiers in relation to food texture, Sensory measurement of food texture and texture profile.	8
Module 4: Thermal, Electrical and Optical Properties: Specific heat, thermal conductivity, thermal diffusivity, electrical resistance and conductance, dielectric constant, reflectivity, transmittivity and absorptivity of incident rays: definition, concepts understanding.	8
Module 5: Processes of determination/measurement of thermal, electrical and optical properties of food materials/biomaterials. Application of thermal, electrical and optical properties: processing, handling of agricultural produce and designing of process equipment. Application of engineering properties in process development as well as design and operation of equipment and structures.	8

Text books:

1. Engineering Properties of Foods (Third Edition), M.A. Rao and S.S. H. Rizvi, CRC Press, ISBN: 10: 0-8247-5328-3 ISBN: -13: 978-0-8247-5328-3
2. Microstructural principles of food processing and Engineering, J. M. Aguilera & D. W. Stanley, Elsevier Applied Science, ISBN:9781851664214, 1851664211
3. Physical Properties of Plant and Animal Materials: Structure, Physical Characteristics, and Mechanical Properties, Mohsenin, Nuri N., Published by Gordon and Breach, 1970, ISBN 10: 0677023006 ISBN 13: 9780677023007
4. Physical Properties of Foods. Serpil Sahin and Servet G¨ul¨um Sumnu, Springer, ISBN-10: 0-387-30780-X e-ISBN 0-387-30808-3 Printed on acid-free paper. ISBN-13: 978-0387-30780-0

Reference books:

Gaps in the syllabus (to meet Industry/Profession requirements)

POs met through Gaps in the Syllabus

Topics beyond syllabus/Advanced topics/Design

POs met through Topics beyond syllabus/Advanced topics/Design

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
First Quiz	10
Mid Semester Examination	25
Second quiz/seminar/assignment/others	10
Teacher's Assessment	5
End Semester Examination	50

Indirect Assessment –

1.Student Feedback on Course Outcome

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO 1	3	1	2	3	2	1	2	1	2	2	3	3	3	3
CO 2	3	2	2	3	2	2	3	1	2	2	3	3	3	3
CO 3	2	1	2	3	2	1	2	1	2	2	3	3	3	3
CO 4	3	1	2	3	2	1	2	1	1	1	3	3	3	3
CO 5	3	3	3	3	2	3	2	3	2	2	3	3	3	3

Correlation Levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Mapping Between COs and Course Delivery (CD) methods

CD Code	Course Delivery methods	Course Outcome	Course Delivery Method Used
CD 1	Lecture by use of boards/LCD projectors/OHP projectors	CO1	CD1, CD2, CD8
CD 2	Tutorials/Assignments	CO2	CD1, CD2, CD8
CD 3	Seminars	CO3	CD1, CD2, CD4, CD8
CD 4	Mini projects/Projects	CO4	CD1, CD2, CD4, CD8
CD 5	Laboratory experiments/teaching aids	CO5	CD1, CD2, CD4, CD8
CD 6	Industrial/guest lectures		
CD 7	Industrial visits/in-plant training		
CD 8	Self- learning such as use of NPTEL materials and internets		
CD 9	Simulation		

COURSE INFORMATION SHEET

Course code: FE 24353
Course title: Food Supply Chain Management
Pre-requisite(s): FE 24203, FE 24207
Co- requisite(s):
Credits: L: 03 T: 00 P:00
Class schedule per week: 03
Class: B. Tech
Semester / Level: VI/03
Branch: Food Engineering and Technology
Name of Teacher:

Course Objectives

This course enables the students:

1.	To make acquainted students with Supply Chain Management in Food Industry
2.	To impart basic knowledge of Supply Chain Process Cycles, Information and Communication Technology used in Supply Chain services in Logistical system
3.	To familiarize students with the Bar-coding, Dynamic pricing and Vendor Managed Inventory.
4.	To pass on basic knowledge of cold chain system, importance of cold chaincomponents and retail chain system in food business
5.	To impart knowledge and competencies for designing supply chain strategies.

Course Outcomes

After the completion of this course, students will be:

CO 1	Able to understand the role of Supply Chain in Food Industry.
CO 2	Capable of associate with the Supply Chain in Food Industry
CO 3	Able to associate with the recent methods of minimal processing of fruits and vegetables.
CO 4	Capable of explaining the Bar-coding, dynamic pricing and inventory control infood Industry.
CO 5	Able to predict the losses during distribution and marketing of the food products.

SYLLABUS

MODULE	NO. OF LECTURE HOURS
Module 1: Introduction to Supply Chain Management Concepts, Objectives, Information and Material flow in the Supply Chain, Supply Chain Planning, Supply Chain Decision Making, Benefits of Supply Chain Management in Industry.	8
Module 2: Dynamics of SCM Supply Chain Process Cycles, Supply Chain Integration, Bullwhip effect in Supply Chain, Information Systems and Processing in Supply Chain, Collaborative Planning Forecasting and replenishment (CPFR), Inventory Planning and control. Information and Communication Technology used in Supply Chain Need and Role of an Information System in SCM, Enterprise Resource Lanning (ERP), Concept of SAP in Supply chain, Current Trends of use of IT in SCM, Use of IT enabled technologies / services in Logistical system.	8
Module 3: Supply Chain Management Practices Bar-coding, Tierization of suppliers, Vendor Managed Inventory, Hub and Spoke concept, Dynamic pricing, Third Party Logistics (3 PL's) providers, Fourth Party Logistics (4 PL's) providers, Reverse Logistics, Green Logistics, Cross docking.	8
Module 4: Cold chain in food processing Introduction, scope, importance of cold chain components and retail chain system in foodbusiness, Products going in cold chain, their requirements (temperature and humidity etc.),packaging needs and their compatibility in cold chain. Documentation, recording of temperature and traceability.	8
Module 5: Stages and points of control Stages and points of control in cold storages and structures, functions in cold storages, pallet layout and stacking options, flexibility storage systems cold chain transportation in land and export, retail & supermarket cold chain and display systems.	8

Text books:

1. Systems. Prentice Hall.Chopra S & Meindel P. 2002. Supply Chain Management:Strategy, Planning and Operation. Prentice Hall.
2. Handfield RB &Nochols EL.1999. Introduction to Supply Chain Management. Prentice Hall.
3. Designing and Managing the supply Chain concepts, Strategies and Cases, Simchi - Levi, D.PKaminsky, Edith Simchi-Levi Tata McGraw – Hill.
4. Shapiro JF. 2001. Modeling the Supply Chain. Duxbury Thomson Learning.
5. Supply Chain Management - Test and Cases, Janat Shah, Pearson .

Reference books:

Gaps in the syllabus (to meet Industry/Profession requirements)
POs met through Gaps in the Syllabus

Topics beyond syllabus/Advanced topics/Design

POs met through Topics beyond syllabus/Advanced topics/Design

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
First Quiz	10
Mid Semester Examination	25
Second quiz/seminar/assignment/others	10
Teacher's Assessment	5
End Semester Examination	50

Indirect Assessment –
1.Student Feedback on Course Outcome

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO 1	2	3	2	3	3	3	3	2	3	2	3	3	3	3
CO 2	2	2	2	2	3	3	3	2	3	3	3	3	3	3
CO 3	3	3	3	2	2	3	2	3	3	3	3	3	3	3
CO 4	2	2	2	3	3	3	2	3	3	3	3	3	3	3
CO 5	2	2	2	2	3	3	2	3	3	3	3	3	3	3

Correlation Levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Mapping Between COs and Course Delivery (CD) methods

CD Code	Course Delivery methods	Course Outcome	Course Delivery Method Used
CD 1	Lecture by use of boards/LCD projectors/OHP projectors	CO1	CD1, CD2, CD8
CD 2	Tutorials/Assignments	CO2	CD1, CD2, CD8
CD 3	Seminars	CO3	CD1, CD2, CD4, CD8
CD 4	Mini projects/Projects	CO4	CD1, CD2, CD4, CD8
CD 5	Laboratory experiments/teaching aids	CO5	CD1, CD2, CD4, CD8
CD 6	Industrial/guest lectures		
CD 7	Industrial visits/in-plant training		
CD 8	Self- learning such as use of NPTEL materials and internets		
CD 9	Simulation		

COURSE INFORMATION SHEET

Course code: CL24353
Course title: Design and Analysis of Experiments
Pre-requisite: CH24101, PH24101
Co- requisite(s):
Credits: L: 03 T: 00 P: 00
Class schedule per week: 03
Class: B. Tech
Semester / Level: VI/03
Branch: Chemical Engineering
Name of Teacher:

Course Objectives:
This course enables the students to:

1.	Explain the fundamentals of experiments and its uses.
2.	Learn the basic statistics including ANOVA and regression.
3.	Learn the experimental designs such factorial and fractional factorial designs.
4.	Apply statistical models in analyzing experimental data.
5.	Apply RSM to optimize response of interest from an experiment.

Course Outcomes:
After the completion of this course, students will be able to:

CO 1	Explain basics of design of experiments and basic statistical concepts.
CO 2	Apply methods for the design and analysis of single factor experiments.
CO 3	Apply factorial design for experiments.
CO 4	Apply 2^k and Two-level fractional factorial designs for experiments.
CO 5	Apply Linear Regression models.

SYLLABUS

MODULE	NO. OF LECTURE HOURS
MODULE- I Introduction: Strategy of Experimentation, Applications of Experimental design, Basic Principles, Guidelines for designing experiments. Simple Comparative Experiments: Introduction, Basic Statistical Concepts, Sampling and Sampling distributions.	8
MODULE II: Experiments with a single factor: The Analysis of Variance, Analysis of the fixed effects model, Model adequacy checking, Practical interpretation of results, The regression approach to the analysis of variance, The randomized complete block design.	8
MODULE-III Introduction to factorial designs: Basic definitions and principles, The advantage of factorials, The two-factor factorial design, The general factorial design. The 2^k factorial design: Introduction, the 2^2 design, the 2^3 design, the general 2^k design.	8
MODULE - IV Blocking and confounding in the 2^k factorial design: Introduction, blocking a replicated 2^k factorial design, confounding in the 2^k factorial design, confounding the 2^k factorial design in two blocks, confounding the 2^k factorial design in four blocks, partial confounding. Two-level fractional factorial designs: Introduction, one-half fraction of the 2^k design.	8
MODULE V Fitting Regression models: Introduction, Linear Regression models, estimation of the parameters in linear regression models. Introduction to Response surface methods and designs.	8

Text Books:

1.Design and Analysis of Experiments, Douglas C Montgomery, Eighth edition, Wiley, 2017.
2.Design and Analysis of Experiment, R Panneerselvam, PHI Learning Pvt Ltd, 2012.

Reference books:
Gaps in the syllabus (to meet Industry/Profession requirements)
POs met through Gaps in the Syllabus
Topics beyond syllabus/Advanced topics/Design
POs met through Topics beyond syllabus/Advanced topics/Design
Course Outcome (CO) Attainment Assessment tools & Evaluation procedure
Direct Assessment

Assessment Tool	% Contribution during CO Assessment
First Quiz	10
Mid Semester Examination	25
Second quiz/seminar/assignment/others	10

Teacher's Assessment	5
End Semester Examination	50

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**1**	**2**	**3**
CO 1	3	3	3	2	2	2	2	0	1	2	0	3	3	3
CO 2	3	2	1	2	3	0	1	0	1	2	0	3	3	3
CO 3	3	1	1	1	1	0	0	0	1	1	0	3	3	3
CO 4	3	3	2	2	3	1	2	0	1	2	0	3	3	3
CO 5	3	3	1	2	3	2	2	0	1	2	0	3	3	3

Correlation Levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Mapping Between COs and Course Delivery (CD) methods

CD Code	Course Delivery methods	Course Outcome	Course Delivery Method Used
CD1	Lecture by use of boards/LCD projectors/OHP projectors	CO1	CD1, CD2, CD8
CD2	Tutorials/Assignments	CO2	CD1, CD2, CD8
CD3	Seminars	CO3	CD1, CD2, CD8
CD4	Mini projects/Projects	CO4	CD1, CD2, CD8
CD5	Laboratory experiments/teaching aids	CO5	CD1, CD2, CD8
CD6	Industrial/guest lectures		
CD7	Industrial visits/in-plant training		
CD8	Self- learning such as use of NPTEL materials and internets		
CD9	Simulation		

PROGRAMME ELECTIVE IV (PE-IV)
VI SEMESTER

COURSE INFORMATION SHEET

Course code: FE 24363
Course title: Food Packaging and Safety Management
Pre-requisite(s): FE 24201, FE 24203, FE 24207
Co- requisite(s):
Credits: 3 L:03 T:00 P:00
Class schedule per week: 03
Class: B. Tech
Semester / Level: VI/03
Branch: Food Engineering and Technology
Name of Teacher:

Course Objectives

This course enables the students:

1.	To provide students with a comprehensive understanding of food packaging terminology, functions, and its critical role in food safety, as well as the selection of appropriate packaging materials based on food characteristics.
2.	To explore the various packaging materials (glass, paper, plastic, metal) and their properties, along with safety programs like GMPs, pest control, sanitation procedures, and regulatory requirements for safe food packaging.
3..	To introduce students to advanced packaging systems and methods, hazard analysis, and risk assessment techniques, focusing on food safety management systems such as HACCP and the role of packaging in controlling physical, chemical, and biological hazards.
4.	To develop knowledge of hygiene programs, training, and the design of packaging for different food categories, ensuring packaging solutions address safety, shelf life, moisture control, and temperature management.
5.	To familiarize students with food safety regulations, certifications, and labeling requirements, and the regulatory landscape, including laws governing food packaging, product traceability, and safety in the food industry.

Course Outcomes

After the completion of this course, students will:

CO 1	Will be able to understand and explain the functions and importance of food packaging, identify types of packaging materials, and assess how food characteristics influence packaging decisions.
CO 2	Able to identify and evaluate different packaging materials and their properties, and apply the knowledge of food safety programs and practices to maintain a hygienic and controlled packaging process.
CO 3	Demonstrate the ability to select appropriate packaging systems and methods, while applying hazard analysis principles, including HACCP, to ensure food safety through packaging.
CO 4	Able to design food packaging solutions tailored to various food products, addressing critical aspects such as moisture protection, temperature control, shelf-life extension, and compliance with hygiene standards.
CO 5	Gain the ability to analyze food safety regulations and packaging laws, ensuring compliance with national and international standards, and understanding the certification processes for safe and efficient food packaging practices.

SYLLABUS

MODULE	NO. OF LECTURE HOURS
Module 1: Introduction to Food Packaging and Food Safety Concepts Packaging terminology, functions of food packaging, packaging environment, characteristics of food influencing packaging selection, importance of food safety in the food processing industry, risk classification, national and international food regulatory agencies, general food laws and food safety regulations, nutritional labeling regulation (mandatory and optional nutrients, nutritional descriptors, approved health claims), microbial contamination, chemical contamination, physical contamination, allergen contamination.	8
Module 2: Packaging Materials, Their Properties, and Food Safety Programs Packaging materials and their properties (glass, paper, corrugated fiberboard, metal containers, plastic films, co-extruded films, laminated and metallized films), testing of packaging materials, Good Manufacturing Practices (GMPs), pest control program, facility maintenance, personal hygiene, supplier control, sanitary design of equipment and infrastructure, procedures for raw material reception, storage, and finished product loading, sanitation program (SSOPs), product identification, tracking and recalling program, preventive maintenance program, education and training program.	8
Module 3: Packaging Systems, Methods, and Hazard Analysis Packaging systems and methods (vacuum packaging, controlled atmospheric packaging, modified atmospheric packaging, aseptic packaging, retort processing, microwave packaging, active packaging, intelligent packaging, eco-friendly edible packaging, shrink/stretch packaging), physical hazards (metals, glass), chemical hazards (food additive toxicology, pesticides, antibiotics, hormones, packaging components), biological hazards (pathogens: virus, bacteria, fungi), hazard analysis and risk assessment, Hazard Analysis Critical Control Point (HACCP) system.	8
Module 4: Food Hygiene Programs and Food Packaging Design Personal hygiene programs, training programs, hygiene verification, water quality and treatments in the food industry, cleaning and sanitation procedures (cleaning agents, sanitizing agents, equipment systems), pest control (classification, prevention, and control), packaging design for different food categories (fruits, vegetables, dairy, meat, poultry, seafood, bakery, beverages, dehydrated foods, frozen foods, etc.), moisture protection, temperature control, shelf-life management, and the role of packaging in food marketing.	8
Module 5: Food Safety Regulations, Packaging, and Certification Food safety regulation in India, food laws and regulations, structure, organization, and duties of regulatory systems, duties and responsibilities of food business operators, registration and licensing processes, labeling of food products, traceability, import and export of foods, liability for defective products, food safety management systems, certifications, regulation of special category foods (irradiated foods, biotechnology, genetically modified foods).	8

Text books:

1. Pomeraz, Y. and MeLoari, C.E. (1996): Food Analyasis: Theory and Practice, CBS publishers and Distributor, New Delhi.

2. Bryan, F.L. (1992): Hazard Analysis Critical Control Point Evaluations A Guide to Identifying Hazards and Assessing Risks Associated with Food Preparation and Storage. World Health Organisation, Geneva.
3. Kirk, R.S and Sawyer, R. (1991): Pearson's Composition and Analysis of Foods, Longman Scientific and Technical. 9th Edition, England.
4. FAO (1980): Manuals of Food Quality Control. 2-Additives Contaminants Techniques, Rome.
5. FSSAI, FSIS, EU and FAO website for updates

Reference books:

1. Miquel Angelo P R C, Ricardo Nuno C P, Oscar Leandro D S R, Jose Antonio C T, Antonio Augusto V , 2016, Edible Food Packaging: Materials and Processing Technologies, CRC Press. Taylor & Francis ,Boca Raton , FL
2. Luciano P, Sara L,2016, Food Packaging Materials, Springer cham Heildelberg, New York
3. Robertson, G.L. 2006 Food Packaging: Principles and Practice (2nd ed.), Taylor & Francis
4. NIIR. (2003). Food Packaging Technology Handbook, National Institute of Industrial Research Board, Asia Pacific Business Press Inc.
5. Ahvenainen, R. (Ed.) 2003 Novel Food Packaging Techniques, CRC Press,
6. Han, J.H. (Ed.) 2005 Innovations in Food Packaging, Elsevier Academic Press,
7. Coles, R., McDowell, D. and Kirwan, M.J. (Eds.) 2003 Food Packaging Technology, CRC Press
8. Food Safety and standards Act 2006, Rules 2011, Regulations, 2011, 10th Edition, ILBCO India, Indian Law Book Company, 2013.
9. Early, R. (1995): Guide to Quality Management Systems for the Food Industry, Blackie, Academic and professional, London.
10. Gould, W.A and Gould, R.W. (1998). Total Quality Assurance for the Food Industries, CTI Publications Inc. Baltimore.

Gaps in the syllabus (to meet Industry/Profession requirements)
POs met through Gaps in the Syllabus
Topics beyond syllabus/Advanced topics/Design
POs met through Topics beyond syllabus/Advanced topics/Design
Course Outcome (CO) Attainment Assessment tools & Evaluation procedure
Direct Assessment

Assessment Tool	% Contribution during CO Assessment
First Quiz	10
Mid Semester Examination	25
Second quiz/seminar/assignment/others	10
Teacher's Assessment	5
End Semester Examination	50

Indirect Assessment –
1.Student Feedback on Course Outcome
Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO 1	3	3	2	3	1	2	2	3	2	1	1	3	3	3
CO 2	3	3	2	3	1	2	2	3	2	1	2	3	3	3
CO 3	3	3	2	3	1	2	2	3	2	2	2	3	3	3
CO 4	3	3	2	3	2	2	2	3	2	1	1	3	3	3
CO 5	3	3	2	3	1	2	2	3	2	1	2	3	3	3

Correlation Levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Mapping Between COs and Course Delivery (CD) methods

CD Code	Course Delivery methods	Course Outcome	Course Delivery Method Used
CD 1	Lecture by use of boards/LCD projectors/OHP projectors	CO1	CD1, CD2, CD8
CD 2	Tutorials/Assignments	CO2	CD1, CD2, CD8
CD 3	Seminars	CO3	CD1, CD2, CD4, CD8
CD 4	Mini projects/Projects	CO4	CD1, CD2, CD4, CD8
CD 5	Laboratory experiments/teaching aids	CO5	CD1, CD2, CD4, CD8
CD 6	Industrial/guest lectures		
CD 7	Industrial visits/in-plant training		
CD 8	Self- learning such as use of NPTEL materials and internets		
CD 9	Simulation		

COURSE INFORMATION SHEET

Course code: FE 24365
Course title: Modern Food Packaging Technologies and Regulatory Aspects
Pre-requisite(s): FE 24201, FE 24203, FE 24207
Co- requisite(s):
Credits: 3 L:03 T:00 P:00
Class schedule per week: 03
Class: B. Tech
Semester / Level: VI/03
Branch: Food Engineering and Technology
Name of Teacher:

Course Objectives

This course enables the students:

1.	To understand the functions and requirements of food packaging and the types of packaging materials used (paper, plastics, metals, glass).
2.	To explore the various packaging technologies and methods, including injection molding, blow molding, and lamination.
3..	To analyse global packaging trends, environmental concerns, and sustainable packaging materials such as biodegradable plastics and edible packaging.
4.	To gain knowledge of packaging systems and machinery, including bottling, cartoning, and advanced packaging systems like vacuum and aseptic packaging, while developing an understanding of food-specific packaging design considerations such as temperature control, moisture protection, and shelf-life management.
5.	To learn the testing and regulatory aspects of food packaging, ensuring compliance with safety standards and quality control procedures.

Course Outcomes

After the completion of this course, students will:

CO 1	Be able to describe the functions and requirements of food packaging and identify the various types of packaging materials used in the industry
CO 2	Understand the technologies and methods used in packaging materials production, such as injection molding, blow molding, and lamination.
CO 3	Analyse global packaging trends and environmental concerns, particularly with respect to sustainable packaging materials like biodegradable plastics and edible packaging.
CO 4	Demonstrate the ability to design packaging solutions for different food products
CO 5	Understand testing and quality control methods for packaging materials and products, including their compliance with food packaging laws and regulations.

SYLLABUS

MODULE	NO. OF LECTURE HOURS
Module 1: Introduction to Food Packaging and Packaging Materials Functions of food packaging, types of packaging materials (paper, plastics, metals, glass), packaging technologies (injection molding, blow molding, lamination), printing techniques, barcodes and markings, labelling laws and regulations, requirements for safe and effective packaging.	8
Module 2: Packaging Materials and Technologies Plastics (types, molding processes, lamination), metal packaging (tinplate, tinning process, tin-free cans, metallic films), lacquers, testing of packaging materials (tensile strength, puncture resistance, permeability), innovations in packaging materials for food safety and preservation.	8
Module 3: Packaging Trends and Environmental Considerations Global packaging trends, biodegradable plastics, edible packaging, bio-composites, environmental concerns, recycling practices, disposal of plastic waste, glass packaging composition and properties, glass bottle manufacturing, types of closures for packaging.	8
Module 4: Package Design and Food-Specific Considerations Packaging design for fruits and vegetables, dehydrated foods, frozen foods, fish and fish products, meat products, dairy products, carbonated beverages, tea, coffee, alcoholic beverages, confectionery, fats and oils, baked products, and food grains. Temperature control considerations, moisture protection, shelf-life management, and compatibility between food and packaging materials.	8
Module 5: Packaging Systems, Machinery, and Quality Control Packaging machinery (bottling, cartoning, FFS machines), packaging systems (vacuum, controlled, modified atmospheric packaging, aseptic, retort, blister), active and intelligent packaging systems, testing and quality control (thermal shock resistance, gas/vacuum packaging, water vapor transmission), food packaging laws and regulations.	8

Text books:

1. Coles R, McDowell D, Kirwan MJ Food Packaging Technology. Blackwell, 2003

Reference books:

1. Robertson GL, Food Packaging – Principles and Practice, CRC Press Taylor and Francis Group, 2012
2. Paine FA and Paine HY, A Handbook of Food Packaging, Blackie Academic and Professional, 1992

Gaps in the syllabus (to meet Industry/Profession requirements)

POs met through Gaps in the Syllabus

Topics beyond syllabus/Advanced topics/Design

POs met through Topics beyond syllabus/Advanced topics/Design

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
First Quiz	10
Mid Semester Examination	25

Second quiz/seminar/assignment/others	10
Teacher's Assessment	5
End Semester Examination	50

Indirect Assessment –

1.Student Feedback on Course Outcome

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**1**	**2**	**3**
CO 1	3	3	2	3	1	2	2	3	2	1	1	3	3	3
CO 2	3	3	2	3	1	2	2	3	2	1	2	3	3	3
CO 3	3	3	2	3	1	2	2	3	2	2	2	3	3	3
CO 4	3	3	2	3	2	2	2	3	2	1	1	3	3	3
CO 5	3	3	2	3	1	2	2	3	2	1	2	3	3	3

Correlation Levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Mapping Between COs and Course Delivery (CD) methods

CD Code	Course Delivery methods	Course Outcome	Course Delivery Method Used
CD 1	Lecture by use of boards/LCD projectors/OHP projectors	CO1	CD1, CD2, CD8
CD 2	Tutorials/Assignments	CO2	CD1, CD2, CD8
CD 3	Seminars	CO3	CD1, CD2, CD4, CD8
CD 4	Mini projects/Projects	CO4	CD1, CD2, CD4, CD8
CD 5	Laboratory experiments/teaching aids	CO5	CD1, CD2, CD4, CD8
CD 6	Industrial/guest lectures		
CD 7	Industrial visits/in-plant training		
CD 8	Self- learning such as use of NPTEL materials and internets		
CD 9	Simulation		

COURSE INFORMATION SHEET

Course code: FE 24367
Course title: Novel Techniques in Food Processing and Packaging
Pre-requisite(s): FE 24201, FE 24203, FE 24207
Co- requisite(s):
Credits: 3 L:03 T:00 P:00
Class schedule per week: 03
Class: Food Engineering and Technology
Semester / Level: VI/03
Branch: Food Engineering and Technology
Name of Teacher:
Course Objectives

This course enables the students:

A.	To provide the adequate knowledge on the Novel techniques in food Processing and Packaging
B.	To critically think about science behind different Novel techniques in food Processing and Packaging
C.	To utilize the technologies to solve problems in the food processing sectors.
D.	To understand novel food processing methods including non thermal food processing techniques.
E.	To develop an understanding of major packaging materials used in food packaging.

Course Outcomes

After the completion of this course, students will:

CO 1	Demonstrate deep understanding and knowledge of principles of advanced food processing technologies
CO 2	Identify and critically analyse main advantages and disadvantages of emerging food processing technologies
CO 3	Compare and contrast conventional and emerging food processing technologies in real-life food processing
CO 4	Review and critically appraise the recent literature on the quality of foods processed by advanced food processing technologies
CO 5	Apply selected novel processing technologies to preserve and improve microbiological, nutritional or functional characteristics of foods

SYLLABUS

MODULE	NO. OF LECTURE HOURS
Module 1: Nonthermal Novel techniques: High Pressure Processing, Pulsed Electric Field, High Intensity Light, Irradiation, UV light, Pulsed Light, &Ultra sound, Pulsed X Ray, Oscillating magnetic field, Diagnostics Ultrasound. Theory, Process Parameters, Equipment used, Effect on microorganism, enzyme, texture etc. Application in sterilization, Food safety aspects.	8
Module 2: Thermal Novel techniques: Microwave, Radiofrequency, Infrared, Induction, Ohmic, Sous- vide Processing; Theory, Process Parameters, Equipment, Effect on microorganism, enzyme, texture etc. Application in sterilization, Food safety aspects. Membrane Separation techniques; Theory, Equipment - Membrane materials and modules, Process materials and application in Food Processing: RO, UF, Microfiltration membrane distillation,	8
Module 3: Advances in Drying: Theory, effect of process parameters on mass transfer, equipment, application of Osmotic dehydration. Hybrid drying technologies: combined microwave vacuum drying, combining microwave vacuum drying with other processes etc. Freeze Drying. Supercritical fluid extraction, Extrusion in food product development; Components and functions of an extruder; Classification of extruder; Advantages and disadvantages of different types of extrusion; Change of functional properties of food components during extrusion; Pre and post extrusion treatments; Use of extruder as bioreactor; Manufacturing process of extruded products; Application of extrusion technologies in food industries. Concept of Food Rheology and Measurement techniques, Viscoelasticity of foods	8
Module 4: Introduction to Food Packaging and Packaging Materials Functions of food packaging, types of packaging materials (paper, plastics, metals, glass), packaging technologies (injection molding, blow molding, lamination), printing techniques, barcodes and markings, labelling laws and regulations, requirements for safe and effective packaging. **Packaging Materials and Technologies** Plastics (types, molding processes, lamination), metal packaging (tinplate, tinning process, tin-free cans, metallic films), lacquers, testing of packaging materials (tensile strength, puncture resistance, permeability), innovations in packaging materials for food safety and preservation.	8
Module 5: Current use of novel packaging techniques, Types of packaging and packaging materials. Transport, optical and mechanical properties of packaging materials; Oxygen, ethylene and other scavengers, Oxygen scavenging technology, Ethylene scavenging technology, Carbon dioxide and other scavengers, antimicrobial food packaging. *Non-migratory Biopolymers (NMBP), Biodegradable packaging and edible coatings,* Advanced Modified Atmosphere packaging MAP, Nanotechnology: Principles and applications in food Technology	8

Text books:

1. Sun, D. Emerging Technologies for Food Processing, (Academic Press, 2005)(T1)
2. Barbosa-Canovas, G. V., Tapia, M. S. and Cano, M. P. Novel Food Processing Technologies, (CRC Press, 2004) (T2)
3. **Food Processing Technology, Principles and Practice, P. Fellows, CRC Press.(T3)**

4. R. Paul Singh. Introduction to Food Engineering,, , Dennis R. Heldman, Academic Press, 2009.**(T4)**
5. Food Process Engineering and Technology, **Zeki Berk, Academic Press.(T5)**

Reference books:

1. Ohlsson, T. and Bengtsson, N. Minimal Processing technologies in the food industry, (Woodhead Publishing Limited, 2002). (R1)

Gaps in the syllabus (to meet Industry/Profession requirements)

Fluid flow and mechanical operations machineries used in food sector

POs met through Gaps in the Syllabus

PO3, PO4, PO5

Topics beyond syllabus/Advanced topics/Design

Fluid flow and mechanical operations machineries used in food sector

POs met through Topics beyond syllabus/Advanced topics/Design

PO3, PO4, PO5

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
First Quiz	10
Mid Semester Examination	25
Second quiz/seminar/assignment/others	10
Teacher's Assessment	5
End Semester Examination	50

Indirect Assessment –

1.Student Feedback on Course Outcome

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO 1	3	1	3	3	3	1	3	3	2	2	3	3	3	3
CO 2	3	1	3	3	3	1	3	3	2	2	3	3	3	3
CO 3	3	1	3	3	3	1	3	3	2	2	3	3	3	3
CO 4	3	1	3	3	3	1	3	3	2	2	3	3	3	3
CO 5	3	1	3	3	3	1	3	3	2	2	3	3	3	3

Correlation Levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Mapping Between COs and Course Delivery (CD) methods

CD Code	Course Delivery methods	Course Outcome	Course Delivery Method Used
CD 1	Lecture by use of boards/LCD	CO1	CD1, CD2, CD8

	projectors/OHP projectors		
CD 2	Tutorials/Assignments	CO2	CD1, CD2, CD8
CD 3	Seminars	CO3	CD1, CD2, CD4, CD8
CD 4	Mini projects/Projects	CO4	CD1, CD2, CD4, CD8
CD 5	Laboratory experiments/teaching aids	CO5	CD1, CD2, CD4, CD8
CD 6	Industrial/guest lectures		
CD 7	Industrial visits/in-plant training		
CD 8	Self- learning such as use of NPTEL materials and internets		
CD 9	Simulation		

COURSE INFORMATION SHEET

Course code: FE24369
Course title: Food Packaging Technology
Pre-requisite(s): FE 24201, FE 24203, FE 24207
Co- requisite(s):
Credits: L:03 T:00 P:00
Class schedule per week: 03
Class: B. Tech
Semester / Level: VI/04
Branch: Food Engineering and Technology
Name of Teacher:
Course Objectives

Course Objectives
This course enables the students to:

1.	Study the basic concepts of packaging technology
2.	Understand marketing as an integral tool to packaging
3.	Recognize the importance of product-package interaction & its quality aspects in packaging
4.	Study the overall perspective of the packaging industry
5.	Apply and examine the knowledge of properties for selection of packaging materials

Course Outcomes

After the completion of this course, students will be able to:

CO 1	Remember: Effectively observe and compare the different package forms
CO 2	Understand: Describe the importance of compatibility studies and their associated parameters.
CO 3	Apply: Select the suitable types of packaging material for a particular application(s).
CO 4	Analyze: Analyze the various hazards & environmental issues, aesthetics of a package and the differentiating factors.
CO 5	Evaluate: Able to judge the right kind packaging material with the help of quality parameter(s).

SYLLABUS

MODULE	No. of Lecture Hours
Module:1 Definition of Packaging, Benefits of Packaging, Types of Packaging, Principles of Food Packaging, Climate Hazards on Packages, Functions of Packages. Protective Packaging – Principle, Materials used, Functions. Design Fundamentals- Need for Chances in Package Design, Features of Effective Design, Design Factors, Customer Appeal, Packaging Graphics, Package Colour.	9
Module:2 Packaging in Metal cans - Raw materials, Coatings, film laminates and inks, Processing of food and drinks in metal packages, Shelf life of canned foods Packaging in glass containers- Glass containers market sectors for foods and drinks, Attributes of food packaged in glass containers, Environmental profile Paper and paperboard packaging- Paper and paperboard – fibre sources and fibre separation (pulping), Paper and paperboard manufacture, Properties of paper and paperboard, Package types, Environmental profile.	8
Module3 Plastics in packaging - Use of plastics in food packaging, Types of plastic used in packaging – Polyethylene, Polypropylene (PP), Polyethylene terephthalate, Ethylene vinyl acetate (EVA), Polyamide (PA), Polyvinyl chloride (PVC), Polyvinylidene chloride (PVdC), Polystyrene (PS), Acrylonitrile butadiene styrene (ABS), Ethylene vinyl alcohol (EVOH) etc.	7
Module4 Coating of plastic films – types and properties, Acrylic coatings, PVdC coatings, PVOH coatings, Low-temperature sealing coatings (LTSCs), Metallising with aluminium, Extrusion coating with PE, Printing and labelling, Novel MAP applications for fresh- prepared produce, Novel MAP gases, Food contact and barrier properties, Sealability and closure, Retort pouch..	9
Module 5 Active and intelligent packaging, Active packaging techniques, Intelligent packaging techniques, Environmental and waste management issues with plastic packaging, Legislative issues, developing novel biodegradable materials, Modern packaging systems: Green plastics for food packaging, Recycling packaging materials.	7

Text books:

1. Ahvenainen R. 2001. Novel Food Packaging Techniques.CRC.

2. Crosby NT. 1981.Food Packaging Materials. App. Sci. Publ.
3. Mahadeviah M & Gowramma RV. 1996. Food Packaging Materials. Tata McGraw Hill.
4. FA Paine & H Y Paine, 1992, springer A Handbook of Food Packaging. Blackie.

Reference books:

1. Palling SJ. 1980. Developments in Food Packaging. App. Sci. Publ.
2. Rooney ML. 1988. Active Food Packaging. Chapman& Hall.
3. Sacharow S & Griffin RC.1980. Principles of Food Packaging. AVI Publ.
4. Stanley S & Roger CG. 1998. Food Packaging. AVI Publication.

Gaps in the syllabus (to meet Industry/Profession requirements)
POs met through Gaps in the Syllabus

Topics beyond syllabus/Advanced topics/Design

POs met through Topics beyond syllabus/Advanced topics/Design

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
First Quiz	10
Mid Semester Examination	25
Second quiz/seminar/assignment/others	10
Teacher's Assessment	5
End Semester Examination	50

Indirect Assessment –
1. Student Feedback on Course Outcome

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO 1	3	2	2	1	1	2	3	2	1	2	2	3	3	3
CO 2	3	2	2	1	1	2	3	1	1	2	2	3	3	3
CO 3	3	2	2	1	1	2	3	1	1	2	2	3	3	3
CO 4	2	2	1	1	1	1	1	1	1	2	3	3	3	3
CO 5	2	2	1	1	1	1	1	1	1	2	3	3	3	3

Correlation Levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3 : Substantial (High)

Mapping Between COs and Course Delivery (CD) methods

CD Code	Course Delivery methods	Course Outcome	Course Delivery Method Used
CD1	Lecture by use of boards/LCD projectors/ OHP projectors	CO1	CD1, CD2

CD2	Tutorials/Assignments	CO2	CD1, CD2, CD8
CD3	Seminars	CO3	CD1, and CD2
CD4	Mini projects/Projects	CO4	CD1
CD5	Laboratory experiments/teaching aids	CO5	CD1, and CD2
CD6	Industrial/guest lectures		
CD7	Industrial visits/in-plant training		
CD8	Self- learning such as use of NPTEL materials and internets		
CD9	Simulation		

OPEN ELECTIVE III
(VI SEMESTER)

COURSE INFORMATION SHEET

Course code: FE 24355
Course title: Food Supply Chain Management
Pre-requisite(s): Nil
Co- requisite(s):
Credits: L: 03 T: 00 P:00
Class schedule per week: 03
Class: B. Tech
Semester / Level: VI/03
Branch: Food Engineering and Technology
Name of Teacher:

Course Objectives

This course enables the students:

1.	To make acquainted students with Supply Chain Management in Food Industry
2.	To impart basic knowledge of Supply Chain Process Cycles, Information and Communication Technology used in Supply Chain services in Logistical system
3.	To familiarize students with the Bar-coding, Dynamic pricing and Vendor Managed Inventory.
4.	To pass on basic knowledge of cold chain system, importance of cold chaincomponents and retail chain system in food business
5.	To impart knowledge and competencies for designing supply chain strategies.

Course Outcomes

After the completion of this course, students will be:

CO 1	Able to understand the role of Supply Chain in Food Industry.
CO 2	Capable of associate with the Supply Chain in Food Industry
CO 3	Able to associate with the recent methods of minimal processing of fruits and vegetables.
CO 4	Capable of explaining the Bar-coding, dynamic pricing and inventory control infood Industry.
CO 5	Able to predict the losses during distribution and marketing of the food products.

SYLLABUS

MODULE	NO. OF LECTURE HOURS
Module 1: Introduction to Supply Chain Management Concepts, Objectives, Information and Material flow in the Supply Chain, Supply Chain Planning, Supply Chain Decision Making, Benefits of Supply Chain Management in Industry.	8
Module 2: Dynamics of SCM Supply Chain Process Cycles, Supply Chain Integration, Bullwhip effect in Supply Chain, Information Systems and Processing in Supply Chain, Collaborative Planning Forecasting and replenishment (CPFR), Inventory Planning and control. Information and Communication Technology used in Supply Chain Need and Role of an Information System in SCM, Enterprise Resource Lanning (ERP), Concept of SAP in Supply chain, Current Trends of use of IT in SCM, Use of IT enabled technologies / services in Logistical system.	8
Module 3: Supply Chain Management Practices Bar-coding, Tierization of suppliers, Vendor Managed Inventory, Hub and Spoke concept, Dynamic pricing, Third Party Logistics (3 PL's) providers, Fourth Party Logistics (4 PL's) providers, Reverse Logistics, Green Logistics, Cross docking.	8
Module 4: Cold chain in food processing Introduction, scope, importance of cold chain components and retail chain system in foodbusiness, Products going in cold chain, their requirements (temperature and humidity etc.),packaging needs and their compatibility in cold chain. Documentation, recording of temperature and traceability.	8
Module 5: Stages and points of control Stages and points of control in cold storages and structures, functions in cold storages, pallet layout and stacking options, flexibility storage systems cold chain transportation in land and export, retail & supermarket cold chain and display systems.	8

Text books:

1. Systems. Prentice Hall.Chopra S & Meindel P. 2002. Supply Chain Management: Strategy, Planning and Operation. Prentice Hall.
2. Handfield RB &Nochols EL.1999. Introduction to Supply Chain Management. Prentice Hall.
3. Designing and Managing the supply Chain concepts, Strategies and Cases, Simchi - Levi, D.PKaminsky, Edith Simchi-Levi Tata McGraw – Hill.
4. Shapiro JF. 2001. Modeling the Supply Chain. Duxbury Thomson Learning.
5. Supply Chain Management - Test and Cases, Janat Shah, Pearson .

Reference books:

Gaps in the syllabus (to meet Industry/Profession requirements)
POs met through Gaps in the Syllabus

Topics beyond syllabus/Advanced topics/Design

POs met through Topics beyond syllabus/Advanced topics/Design

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
First Quiz	10
Mid Semester Examination	25
Second quiz/seminar/assignment/others	10
Teacher's Assessment	5
End Semester Examination	50

Indirect Assessment –

1.Student Feedback on Course Outcome

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO 1	2	3	2	3	3	3	3	2	3	2	3	3	3	3
CO 2	2	2	2	2	3	3	3	2	3	3	3	3	3	3
CO 3	3	3	3	2	2	3	2	3	3	3	3	3	3	3
CO 4	2	2	2	3	3	3	2	3	3	3	3	3	3	3
CO 5	2	2	2	2	3	3	2	3	3	3	3	3	3	3

Correlation Levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Mapping Between COs and Course Delivery (CD) methods

CD Code	Course Delivery methods	Course Outcome	Course Delivery Method Used
CD 1	Lecture by use of boards/LCD projectors/OHP projectors	CO1	CD1, CD2, CD8
CD 2	Tutorials/Assignments	CO2	CD1, CD2, CD8
CD 3	Seminars	CO3	CD1, CD2, CD4, CD8
CD 4	Mini projects/Projects	CO4	CD1, CD2, CD4, CD8
CD 5	Laboratory experiments/teaching aids	CO5	CD1, CD2, CD4, CD8
CD 6	Industrial/guest lectures		
CD 7	Industrial visits/in-plant training		
CD 8	Self- learning such as use of NPTEL materials and internets		
CD 9	Simulation		

LABORATORIES

COURSE INFORMATION SHEET

Course code: FE 24306
Course title: Food Chemistry and Quality Control Lab II
Pre-requisite(s): -
Co- requisite(s):
Credits:1.5 L: 00 T: 00 P: 03
Class schedule per week: 03
Class: B. Tech
Semester / Level: VI/03
Branch: Food Engineering and Technology

Course Objectives
This course enables the students:

1.	Recognize the important reactions in food chemistry and their consequences.
2.	Be familiar with methods to measure these reactions.
3.	Be capable of reporting their results in an appropriate format.
4.	Be capable of designing and conducting an experiment to understand a simple food chemistry problem.
5	Be capable of food chemistry and quality decision making based upon the experimental results.

Course Outcomes

After the completion of this course, students will be:

CO1	Conduct appropriate laboratory experiments common to basic and applied food chemistry and interpret the results.
CO2	Work cooperatively in a team to identify a food chemistry problem, design and conduct the experiments, and analyze and interpret the data.
CO3	Clearly communicate research results using appropriate written, oral, and visual communication techniques.
CO4	Conduct appropriate laboratory experiments specific to particular group of food product.
CO5	Work cooperatively in a team to interpret analytical data for report preparation.

List of experiments

1. Determination of calorific value of food samples
2. Quantitative estimation of curcumin content in turmeric using UV-Vis spectrophotometer.
3. Polarimetric estimation of sugars
4. Rancidity determination using rancimat
5. Texture analysis of food samples
6. Power flow measurement of food powders
7. Viscosity of food samples
8. HPLC separation of food constituents
9. Hunter Lab colorimetric studies of food samples.
10. Water activity measurement of food samples
11. Sensory evaluation of foods
12. Gas chromatographic analysis of food constituents
13. Determination of Pka value using eco titrator
14. Densitometric (HPLTC) assay of food constituents
15. Differential scanning calorimetry (DSC) for food samples
16. Atomic absorption spectroscopic analysis of heavy metals in foods
17. Detection of food adulteration
18. Antioxidant Assay (DPPH/FRAP)
19. Estimation of anti-nutritional factors

Text Book:

1. S. Ranganna, Hand Book of Analysis and Quality Control for Fruits and Vegetable Products, Tata McGraw Hill, 2002.

Reference Book:

1. Winton AL (1999)Techniques of food analysis, Allied Science Publications NewDelhi.
2. Pomeranze Y (2004). Food analysis - Theory and Practice CBS Publications, New Delhi.
3. Jacob MB (1999). The chemical analysis of foods and food products. CBS Publ. New Delhi

Gaps in the syllabus (to meet Industry/Profession requirements)

POs met through Gaps in the Syllabus

Topics beyond syllabus/Advanced topics/Design

POs met through Topics beyond syllabus/Advanced topics/Design

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
(1) Progressive Evaluation	60
Day-to-day performance	(10)
Lab files	(20)
Attendance	(10)
Viva	(20)
(2) End Semester	40
Quiz	(10)
Lab Performance	(30)

Indirect Assessment –

1.Student Feedback on Course Outcome

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO 1	3	3	3	3	3	3	3	1	1	3	2	3	3	3
CO 2	3	3	3	3	3	3	3	2	1	3	2	3	3	3
CO 3	2	3	3	3	3	3	3	1	3	3	2	3	3	3
CO 4	3	3	3	3	3	3	3	1	1	3	2	3	3	3
CO 5	3	3	3	3	3	3	3	2	1	3	2	3	3	3

Correlation Levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Mapping Between COs and Course Delivery (CD) methods

CD Code	Course Delivery methods	Course Outcome	Course Delivery Method Used
CD1	Lecture by use of boards/LCD projectors/OHP projectors	CO1	CD4, CD5, CD7, CD8
CD2	Tutorials/Assignments	CO2	CD4, CD5, CD7, CD8
CD3	Seminars	CO3	CD4, CD5, CD7, CD8
CD4	Mini projects/Projects	CO4	CD4, CD5, CD7, CD8
CD5	Laboratory experiments/teaching aids	CO5	CD4, CD5, CD7, CD8
CD6	Industrial/guest lectures		
CD7	Industrial visits/in-plant training		
CD8	Self- learning such as use of NPTEL materials and internets		
CD9	Simulation		

BIRLA INSTITUTE OF TECHNOLOGY

NEP-2020 CURRICULUM BOOK
(Effective from Academic Session: Monsoon 2024)

Bachelor of Technology

CENTRE FOR FOOD ENGINEERING AND TECHNOLOGY
FOURTH YEAR (SEMESTER – VII-VIII)

Year IV (7th Semester)

COURSE INFORMATION SHEET

Course code: FE 24401
Course title: Food Quality Control, Laws Standard and Regulation
Pre-requisite(s):
Co- requisite(s):
Credits: 04 **L: 03 T: 01 P:00**
Class schedule per week: 04
Class: B. Tech
Semester / Level: VII/03
Branch: Food Engineering and Technology
Name of Teacher:

Course Objectives

This course enables the students:

1	To understand the quality of raw material for processing.
2.	To understand the Genetic-physiological defects
3.	To know the Quality assessment of food materials
4.	To understand the Food safety issues and risk analysis
5.	To point out the Food Laws and Standards

Course Outcomes

After the completion of this course, students will be:

CO1	To apply the quality of raw material for processing.
CO2	To apply the Genetic-physiological defects
CO3	To apply the Quality assessment of food materials
CO4	To apply the Food safety issues and risk analysis
CO5	To apply the Food Laws Food Laws and Standards

SYLLABUS

MODULE	NO. OF LECTURE HOURS
Module 1: Introduction to food quality Definition, its role in food industry, Quality attributes, Physical properties: Colour, viscosity, size and shape: Definition, colour measurement techniques by spectrophotometer, Muncell colour system and Lovibond tintometer; Role of viscosity and consistency in food quality: Size and shape, weight, volume, weight volume ratio, length, width, diameter, symmetry, curvature etc. Definition of food quality- ways for describing food quality, factors affecting food quality, Quality aspect in food supply chain and food processing industry Different quality control tools, Food authentication – significance, methods available for food authentication. Quality defects- Classification, Genetic-physiological defects: Structural, off color, character; Entomological defects: Holes, scars, lesions, off coloring, pathological defects; Mechanical defects, extraneous or foreign material defects. Measurement of defects by different techniques.	8
Module 2: Quality Assessment Quality assessment of food materials on the basis of sensory evaluation, Physical, chemical microbiological methods; Quality of products during processing and after processing: Factors influencing the food qualities: Soil, field practices, harvesting practices, procedures, packaging, transportation, storage, conditions, processing conditions, packaging and storage conditions of finished products.	8
Module 3: HACCP – History, Objectives, Identification of Hazards and Control Measures, Assemble HACCP Team , Determination of Significant Hazards, Determination of Acceptable Levels, Consideration of Control Measures, Determination of Critical Control Points, Establishing the Critical Limits, Establishment of a Monitoring System, Establish Corrective Actions , Establish Verification Procedures , Establish Documentation and Record Keeping, Validation, General Errors in HACCP Plans , Quantitative Approach in HACCP -Food Safety Objectives, Numerical Calculations in , Validation of Numerical Values, HACCP and Microbiological Risk Assessment (MRA) Risk assessment studies: Risk management, risk characterization and communication.	8
Module 4: Role of QC and QA Quality: Food safety issues and risk analysis, Quality Control, Quality Assurance, Concepts of quality control and quality assurance functions in food industries. *Quality Improvement techniques*- Total Quality management: Quality evolution, quality gurus, defining TQM, principals of TQM, stages in implementation, TQM road map, *Six sigma, Kaizen, 5S, Lean manufacturing.* Quality improvement tools, customer focus, cost of quality. *Current Good Manufacturing Practices (GMP), Standard Sanitary Operation Procedures, Good Laboratory Practices (GLP), Good Hygienic Practices (GHP).*	8
Module 5: Food Laws and Standards: National and International food laws Mandatory and voluntary food laws. FSSAI Indian Food Regulations and Certifications: Food Safety and Standards Act *FSSAI Rules and Regulations 2011*, food adulteration, misbranding, common adulterants in foods, Duties and responsibilities of Food Safety Authorities. Agricultural Marketing and Grading Standards (AGMARK), Bureau of Indian Standards (BIS) and their certification, FPO –standards and certification process, Weights and Measures Act, 1976 and Packaged commodity rules, Role of CODEX in food safety and standards, Food Safety Management Systems, ISO 22000 – 2005 and other Global Food safety management systems etc. Principles, implementation; documentation, types of records; Auditing, certification procedures, certification bodies, accreditation bodies.	8

Text books:

1. Inteaz Alli. 2004. Food Quality Assurance: Principles and Practices. CRC Press, Boca Raton, FL, USA. Ronald H. Schmidt and Gary E. Rodrick. 2003.
2. Food Safety Handbook. John Wiley & Sons, Inc., Hoboken. New Jersey, USA. R.E. Hester and R.M. Harrison. 2001.
3. Food Safety and Food Quality. Royal Society of Chemistry, Cambridge, UK
4. Universal's - The Food Safety and Standards Act, 2006 (2021 e) with The Food Safety and Standards rules, 2011

Reference books:

Gaps in the syllabus (to meet Industry/Profession requirements)

POs met through Gaps in the Syllabus

Topics beyond syllabus/Advanced topics/Design

POs met through Topics beyond syllabus/Advanced topics/Design

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
First Quiz	10
Mid Semester Examination	25
Second quiz/seminar/assignment/others	10
Teacher's Assessment	5
End Semester Examination	50

Indirect Assessment –

1.Student Feedback on Course Outcome

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO 1	3	1	2	3	2	1	2	1	2	2	3	3	3	3
CO 2	3	2	2	3	2	2	3	1	2	2	3	3	3	3
CO 3	2	1	2	3	2	1	2	1	2	2	3	3	3	3
CO 4	3	1	2	3	2	1	2	1	1	1	3	3	3	3
CO 5	3	3	3	3	2	3	2	3	2	2	3	3	3	3

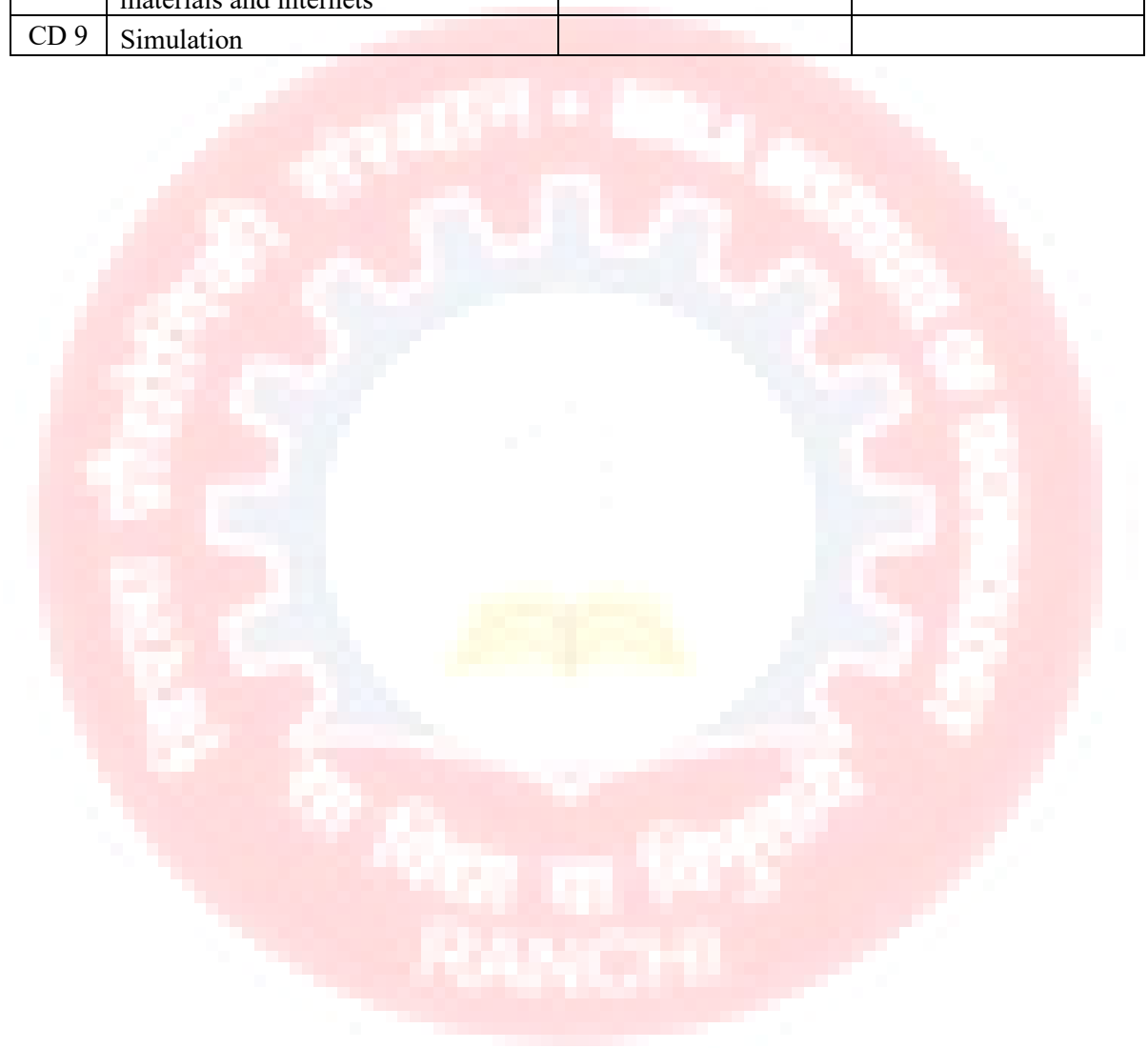
Correlation Levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Mapping Between COs and Course Delivery (CD) methods

CD Code	Course Delivery methods	Course Outcome	Course Delivery Method Used

CD 1	Lecture by use of boards/LCD projectors/OHP projectors	CO1	CD1, CD2, CD8
CD 2	Tutorials/Assignments	CO2	CD1, CD2, CD8
CD 3	Seminars	CO3	CD1, CD2, CD4, CD8
CD 4	Mini projects/Projects	CO4	CD1, CD2, CD4, CD8
CD 5	Laboratory experiments/teaching aids	CO5	CD1, CD2, CD4, CD8
CD 6	Industrial/guest lectures		
CD 7	Industrial visits/in-plant training		
CD 8	Self- learning such as use of NPTEL materials and internets		
CD 9	Simulation		



COURSE INFORMATION SHEET

Course code: **FE 24403**
Course title: **Dairy and Animal Product Processing Technology**
Pre-requisite(s):
Co- requisite(s):
Credits: 3 **L:03 T:00 P:00**
Class schedule per week: **03**
Class: **B. Tech**
Semester / Level: **VII/04**
Branch: **Food Engineering and Technology**
Name of Teacher:
Course Objectives

This course enables the students:

1.	To develop understanding in milk chemistry and interpret the role of the various components of milk as functional components of different dairy products.
2.	To contrast knowledge on the specific processing technologies used for milk and the various products derived from milk and their quality attributes.
3.	To Make use of the understandings on physical, chemical, microbiological properties of milk and their interaction in food products in terms of color, flavor, texture and nutritional composition of milk.
4.	To interpret the significance and role of homogenization, pasteurization, sterilization and UHT in quality of milk and processed products.
5	To apply Dairy and Animal Product Processing knowledge in shelf life extension

Course Outcomes

After the completion of this course, students will be:

CO 1	Able to build knowledge in dairy chemistry and discover the role of the various components of milk as functional components of different dairy products.
CO 2	Able to adapt specific processing technologies used for milk and the various products derived from milk.
CO 3	Able to evaluate the quality attributes of dairy and dairy based product
CO 4	Able to apply starter culture technology and select starters for production of different dairy products.
CO 5	Able to develop competency in the students for adopting dairy processing and animal product manufacturing as an enterprise.

SYLLABUS

MODULE	NO. OF LECTURE HOURS
Module 1: Present status of dairy processing in India and Abroad; Importance of milk processing in India: NDDB & Operation flood. Milk: Definition, types, composition, nutritive value; Physical properties and chemical composition of different milch animal (cow, buffalo and other species); health aspects of milk fat, cholesterol reduced .Checks for quality of milk: different tests associated with purity, contaminations & adulterants: Dairy plant operations viz. receiving, separation, clarification, pasteurization, standardization, homogenization, sterilization, storage, transport and distribution of milk; Centrifugal separation, clarification and bactofugation and factors affecting their efficiency; Homogenization process and its implications in dairy processing; efficiency of homogenization and factors affecting it.	8
Module 2: Pasteurization (LTLT and HTST), sterilization, UHT processing and aseptic packaging; Special milks: Principles of production, processing and marketing of toned, double toned, reconstituted, recombined, flavoured and filled milks; Packaging of fluid milk; Different dairy plant equipments its handling and maintenance. Concentrated and Dried Milk Products: Principles and methods of manufacture, storage and defects in sweetened condensed milk; Evaporated milk, UHT sterilized concentrated milk; Whole milk powder, Skim milk powder, high-fat powders, and ice-cream powder. Instantization of milk powder. Newer technologies and formulations for infant foods and weaning foods, malted milk and malted milk foods.	8
Module 3: Fat rich dairy products: - principles and concepts in production and processing of different types of cream, butter, margarine, fat spreads, butter oil and ghee; fractionation of fat and its application, cholesterol-free dairy products. Frozen Milk Products: Definition, classification and composition of ice-cream and other frozen desserts, role of milk constituents and other ingredients, processing steps, packaging and storage methods on quality of ice cream, Technological aspects of manufacture of plain, fruit, soft-serve, low fat and dietic ice-creams and novelties; Indigenous frozen desserts, kulfi, malai-ka-baraf etc.; their production techniques and quality, distribution of frozen desserts. Newer ingredients for use in the ice-cream industry. Cheese and Fermented Milk Products: their nutritional and therapeutic value, definition and classification of cheese and fermented milks; Milk in relation to cheese making, Manufacture of Cheddar, Gouda, Mozzarella and Swiss cheeses,role of starter cultures, storage and defects. Types of rennet, Physical and chemical changes during cheese ripening, Manufacture of processed cheese, cheese spread and cheese foods; Mechanization of cheese-makingprocess, accelerated cheese ripening, Cheese spreads by spray and roller drying techniques. EMC (Enzyme modified cheese), Enzymes in dairy processing. Production and storage of dahi, yoghurt, shrikhand, lassi and mistidohi. Probiotic dairy products.	8
Module 4: Cleaning and sanitization of dairy plant: properties of important dairy detergents and sanitizers, choice of detergents and sanitizers, guiding principles and limiting factors, Basic principles in formulating the cleaning and sanitizing procedures for dairy equipments, automation in cleaning and sanitization processes including CIP, Quality of water in detergency, Dairy waste disposal; Safety aspects of milk with reference to mycotoxins, antibiotics, pesticides, weedicides and heavy metals; PFA, BIS and Agmark standards for milk and milk products; Quality systems such as HACCP, ISO certification, etc; Packaging application in dairy products.	8

Module 5: Chemistry and microscopic structure of meat tissue. *Slaughtering of Meat*, Ante mortem inspection. Post mortem examination. Rigor mortis. Retails and wholesale cuts. Factors affecting meat quality. Curing, smoking, freezing, canning and dehydration of meat, poultry and their products. Sausage making. Microbial factors influencing keeping quality of meat. Meat tenderization and role of enzymes in meat processing. Processing and preservation of fish and its products. Handling, canning, smoking and freezing of fresh water fish and its products. Utilization of by-products. Zoovosic diseases. Structure and composition of egg and factors effecting quality. Quality measurement. Preservation of eggs using oil coating, refrigeration, thermo stabilization and antibiotics. Packing, storage and transportation of eggs. Technology of egg products viz. egg powder, albumen, flakes and calcium tablets.	8

Text books:

1. Smit, G. (2003) Dairy processing - improving quality. Woodhead Publishing.**(T1)**
2. Walstra P., Geuits T.J., Noomen A., Jellema A. and Van Boekel**(T2)**
3. M.A.J.S. (1999) Dairy technology- Principles of milk properties and processes. Marcel Dekker Inc.**(T1)**
4. Spreer E. (1998) Milk and dairy product technology. Marcel Dekker Inc.**(T3)**
5. Gupta R.P. (2003) Dairy India year Book 2007**(T4)**
6. Robinson R.K. Modern dairy Technology, Vol I Advances in Milk processing.**(T5)**
7. Outlines of Dairy Technology by Sukumar Dey, 1990, Oxford Univ. Press.**(T6)**

Reference books:

1. Lampert, Lincoln M. "Modern Dairy Products: Composition, Food Value, Processing, Chemistry,Bacteriology, Testing, Imitation Dairy Products". Chemical Publishing Company, 1998.**(R1)**

2. Selia, dos Reis Coimbra and Jose A. Teixeir "Engineering Aspects of Milk and Dairy Products" , CRC Press, 2009**(R2)**

Gaps in the syllabus (to meet Industry/Profession requirements)

Online testing kit for dairy analysis

POs met through Gaps in the Syllabus

PO3, PO4, PO5

Topics beyond syllabus/Advanced topics/Design

Recent advances in dairy quality analysis

POs met through Topics beyond syllabus/Advanced topics/Design

PO3, PO4, PO5

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
First Quiz	10
Mid Semester Examination	25
Second quiz/seminar/assignment/others	10
Teacher's Assessment	5

End Semester Examination	50

Indirect Assessment –

1.Student Feedback on Course Outcome

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO 1	2	3	2	3	3	3	3	2	3	2	3	3	3	3
CO 2	2	2	2	2	3	3	3	2	3	3	3	3	3	3
CO 3	3	2	3	2	2	3	2	3	3	3	3	3	3	3
CO 4	2	2	2	2	3	3	2	3	3	3	3	3	3	3
CO 5	2	2	2	2	3	3	2	3	3	3	3	3	3	3

Correlation Levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Mapping Between COs and Course Delivery (CD) methods

CD Code	Course Delivery methods	Course Outcome	Course Delivery Method Used
CD 1	Lecture by use of boards/LCD projectors/OHP projectors	CO1	CD1, CD2, CD8
CD 2	Tutorials/Assignments	CO2	CD1, CD2, CD8
CD 3	Seminars	CO3	CD1, CD2, CD4, CD8
CD 4	Mini projects/Projects	CO4	CD1, CD2, CD4, CD8
CD 5	Laboratory experiments/teaching aids	CO5	CD1, CD2, CD4, CD8
CD 6	Industrial/guest lectures		
CD 7	Industrial visits/in-plant training		
CD 8	Self- learning such as use of NPTEL materials and internets		
CD 9	Simulation		

PROGRAMME ELECTIVE V (PE-V) VII SEMESTER

COURSE INFORMATION SHEET

Course code: FE 24431
Course title: Fats and Oils Processing Technology
Pre-requisite(s): FE 24201, FE 24203, FE 24207, FE 24305
Co- requisite(s):
Credits: 3 L:03 T:00 P:00
Class schedule per week: 03
Class: B. Tech
Semester / Level: VII/04
Branch: Food Engineering and Technology
Name of Teacher:

Course Objectives

This course enables the students:

1.	To demonstrate the general knowledge on the agronomy, production and trade of the current domestic and offshore oilseeds.
2.	To develop the basics of the critical parameters involved in the extraction, refining, bleaching, deodorization of fats and oils and their modifications into functional shortenings and the subsequent handling and the preservation of their quality.
3.	To apply the basic chemistry of fats and oils with focus in the understanding of the relevance of their physicochemical and biochemical properties in their functions as ingredients in foods.
4	Develop various fat modification processes
5	Analyze composition and properties of fats, and fat products, and process development for its protection against auto oxidation

Course Outcomes

After the completion of this course, students will:

CO 1	Able to adapt a comprehensive understanding about agronomy, production and trade of the current domestic and offshore oilseeds.
CO 2	Able to build an integrated view of the chemical, physical and nutritional properties of fats and oils.
CO 3	Able to develop knowledge on physicochemical and biochemical properties of oil, their spoilage and preservation skill.
CO 4	Able to discuss a broad and in-depth knowledge about the extraction, refining, bleaching, deodorization of fats and oils, their modifications into functional shortenings, subsequent handling and the preservation of their quality.
CO 5	Able to elaborate detailed knowledge of the factors inherent in processing, storage and cooking of fats and oils which affect stability, nutritional quality and safety of foods.

SYLLABUS

MODULE	NO. OF LECTURE HOURS
Module 1: Importance of fats and oils in foods; Sources, composition and properties of fats and oils (plant and animal origin); Chemistry & Stability of fats & oils; Triglycerides and phospholipids; emulsions and emulsifiers; Functionality of fats & oils in food systems; Supply chain and trade challenges.	8
Module 2: Processing of fats and oils- Extraction of oil by mechanical expelling and solvent extraction and obtaining deoiled cakes suitable for edible purposes. Processing of other plant sources of edible oils and fats like coconut, cotton seed, rice bran, maize germ etc. Refining and Processing of Oils: Refining Processes, Objectives and characterization. Techniques: degumming, deacidification (acid refining), bleaching, deodorization, winterization.	8
Module 3: Modification of fats and oils -Physical modification (Blending, Emulsification, Fractionation, winterisation), Chemical modification (Hydrogenation, esterification); Plastic fat – Winterization, hydrogenation, esterification, inter-esterification and emulsification; Application of plastic fat in bakery, confectionary (including cocoa butter replacers), shortenings, margarine processing; Manufacture and evaluation of auxiliary materials such as activated earth and carbon, Ni catalysis and hydrogen.	8
Module 4: Animal fats (lard, tallow, ghee etc.)-sources-nutritive value- industrial application; Changes during storage of oil seeds-rancidity-causes-atmospheric oxidation and enzyme action-free fatty acids-Non edible oil Food and non food uses of oilseed cakes and meals; Glycerine; Lecithin and other products. By-products of fat/oil processing industries – Oil seed protein isolates; Quality standards of fats and fatty foods; Antioxidants and its mechanism of application.	8
Module 5: Changes during processing and storage of oils and fats, polymorphism, rancidity and reversion. Composition and properties of spoilage during storage of fats, and fat products, Lipid deterioration -Lypolysis, Factors affecting oxidation, Thermal oxidation of fats and oils, Photosensitised oxidation, Autoxidation; Role of lipids in food flavour, Protection against auto oxidation. Analysis of fats and oils - Composition and identity, Rancidity, hydrogenations, saponification, and iodine value of fats and oils. Tests for adulteration; Nutritional aspects- Fats and oils functionality, Palatability, Satiety; Lipids, Heart Healthy fats & oils: Information on health benefits, Omega-e polyunsaturated fatty acids. Edible fats and oils, identifications of natural fats and oils saturated and unsaturated fatty acids.	8

Text books:

1. Bailey's Industrial Oil and Fat Products, Vol 1 & 2; Swern D; 4th ed, 1982, John Wiley &SonsAdvances in food and nutrition research by Steve L. Taylor
2. The Chemistry & Technology of Edible Oils and Fats; Devine J & Williams PN; 1961, Pergamon Press.Food Chemistry by Belitz and Grosch, 2004
3. Food Oils and their Uses; Weiss TJ; 1983, AVI.
4. Edible Oils & Fats: Developments since 1978 (Food Technology Review # 57); Torrey S; 1983, NDC

Reference books:

1. Gillies, M.T. "Shortenings, Margarine and Food Oils". Noyes Data Corporation, 1974.
2. Paterson, Handling & Storage of Oilseeds, Oils, Fats & Meal, HBW.
3. S.C. Singhal, Modern Technology in the Oils & Fats industry, OTA

4. Weiss, T.J., "Foods, Oils and Other Uses". AVI Publishing Co, 1970.

Gaps in the syllabus (to meet Industry/Profession requirements)

POs met through Gaps in the Syllabus

Topics beyond syllabus/Advanced topics/Design

POs met through Topics beyond syllabus/Advanced topics/Design

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
First Quiz	10
Mid Semester Examination	25
Second quiz/seminar/assignment/others	10
Teacher's Assessment	5
End Semester Examination	50

Indirect Assessment –

1.Student Feedback on Course Outcome

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO 1	3	1	3	3	3	1	3	2	2	3	3	3	3	3
CO 2	3	2	3	2	2	3	3	3	2	3	2	3	3	3
CO 3	3	2	3	3	2	3	2	3	2	3	1	3	3	3
CO 4	3	2	3	3	2	3	3	3	2	3	1	3	3	3
CO 5	3	2	3	3	2	2	2	3	2	3	1	3	3	3

Correlation Levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Mapping Between COs and Course Delivery (CD) methods

CD Code	Course Delivery methods	Course Outcome	Course Delivery Method Used
CD 1	Lecture by use of boards/LCD projectors/OHP projectors	CO1	CD1, CD2, CD8
CD 2	Tutorials/Assignments	CO2	CD1, CD2, CD8
CD 3	Seminars	CO3	CD1, CD2, CD4, CD8
CD 4	Mini projects/Projects	CO4	CD1, CD2, CD4, CD8
CD 5	Laboratory experiments/teaching aids	CO5	CD1, CD2, CD4, CD8
CD 6	Industrial/guest lectures		
CD 7	Industrial visits/in-plant training		
CD 8	Self- learning such as use of NPTEL materials and internets		
CD 9	Simulation		

COURSE INFORMATION SHEET

Course code: FE 24433
Course title: Flavour Technology
Pre-requisite(s): FE 24201, FE 24203, FE 24207, FE 24305
Co- requisite(s):
Credits: 3 L:03 T:00 P:00
Class schedule per week: 03
Class: B. Tech
Semester / Level: VII/04
Branch: Food Engineering and Technology
Name of Teacher:
Course Objectives

This course enables the students:

A.	To understand mechanisms of flavor perception
B.	To include the use of analytical chemistry to identify flavor compounds.
C.	To familiar with analytical methods of flavor analysis
D.	To understand mechanisms of flavor formation
E.	To apply sensory and objective methods of evaluation of food products.
F.	To recognize off-flavor defects in foods and strategies of identification..

Course Outcomes

After the completion of this course, students will:

CO1	Be able to identify the role of flavour molecules in food, from both a sensory and food quality perspective
CO2	Be able to identify the chemical structures of flavour compounds, and how those chemicals are produced from a synthetic or biological perspective.
CO3	Be able to describe manufacturing procedures used to produce the common food flavoring materials
CO4	Be able to understand mechanisms of flavor release
CO5	Be familiar with analytical methods of policing flavor adulteration

SYLLABUS

MODULE	NO. OF LECTURE HOURS
Module 1: Food flavor and its importance to consumers and food processors. Non-enzymatic methods of flavor formation, Lipid Oxidation methods of flavor formation; Enzymatic methods of flavor formation. Objectionable flavor in foods and methods of detection; Flavor and nutrition. Sources, extraction, delivery systems, and analyses (chemical, instrumental, and sensory) off flavors and flavorings in foods.Flavour composition of foods/beverages (identification and quantitative analysis of the flavour precursors and their products, characterization of the staling reaction using stable isotopes). Analysis of odour-active compounds of food/beverages (Charm analysis).	8
Module 2: Sensory perception of flavor: Senses of taste and smell, tasting versus sniffing, astringency, pungency, interaction of senses in flavor perception; taste, odor, and acceptance of flavor stimuli. Flavour enhancers, flavour potentiators or modifiers. Methodology of sensory evaluation and determination of threshold levels as specified by BIS.	8
Module 3: Mechanism of flavor-food interactions, Flavor release on flavor perception ; Flavoring Materials, Flavoring constituents of various foods like meat, fish, milk, vegetables, fruits, fats & oils ,spices & herbs, cereals and pulses. Flavour composition of foods/beverages in relation with maturation and microbial activity/or the processing conditions (e.g. fermented dairy products, beer, wine, honey, fruits). Monitoring Adulteration of Flavors; Flavor changes during preservation, packaging, and storage of foods. Roles as sulfur compounds, fatty acids, amino acids, terpenoids, lactic acid-ethanol in food flavors. Process and reaction flavors/volatiles in foods.	8
Module 4: Spices and herbs as food flavorings: Processing of basil, mint, saffron, cloves, tamarind, ginger, cardamom, chilies, pepper etc. for essential oils, extracts and oleoresins as the case maybe. Determination of hygroscopic nature and shelf life/acceptance of foods. Natural, Nature identical and Synthetic flavors: Definitions, chemical composition/constituents, extraction and preparation of flavors, Stability and utility of flavor preparations. Methods used in flavor evaluation. BIS Specifications/PFA restrictions for use of certain constituents in flavoring materials.	8
Module 5: Synthesis of flavour by microorganisms and plant cells. Lipid derived flavours. Investigation of equilibrium of key flavour compounds that govern the flavour stability of beverages. Natural antioxidant constraints in spices. Role of microorganisms in flavour development. Flavor emulsions, flavour composites, essential oils and oleoresins.	8

Text books:

1. Food Chemistry by Fennema, Marcel Dekker.
2. Spices &Flavor Technology by Pruthi, J.s.
3. Ashurst PR. 1994. Food Flavorings. 2nd Ed. Blackie.
4. Burdock GA. 2004. Fenaroli's Handbook of Flavor Ingredients.5th Ed.CRC Press.

Reference books:

1. Deibler D &Delwiche J. 2004. Handbook of Flavor, Characterization:
2. Sensory Analysis, Chemistry and Physiology. Marcel Dekker.

3. Heath HB &Reineccius G.1986. Flavor Chemistry and Technology. AVI Publ.
4. Taylor A. 2002. Food Flavour Technology. Sheffield Academic Press.

Gaps in the syllabus (to meet Industry/Profession requirements)

POs met through Gaps in the Syllabus

Topics beyond syllabus/Advanced topics/Design

POs met through Topics beyond syllabus/Advanced topics/Design

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
First Quiz	10
Mid Semester Examination	25
Second quiz/seminar/assignment/others	10
Teacher's Assessment	5
End Semester Examination	50

Indirect Assessment –

1.Student Feedback on Course Outcome

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
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CO 2	3	1	2	3	3	2	3	2	2	3	1	3	3	3
CO 3	3	1	2	3	3	2	3	2	2	3	1	3	3	3
CO 4	3	1	2	3	3	2	3	2	2	3	1	3	3	3
CO 5	3	1	2	3	3	2	3	2	2	3	1	3	3	3

Correlation Levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Mapping Between COs and Course Delivery (CD) methods

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CD 5	Laboratory experiments/teaching aids	CO5	CD1, CD2, CD4, CD8
CD 6	Industrial/guest lectures		
CD 7	Industrial visits/in-plant training		

CD 8	Self- learning such as use of NPTEL materials and internets		
CD 9	Simulation		

COURSE INFORMATION SHEET

Course code: **FE 24435**
Course title: **Food Product Development and Consumer Science**
Pre-requisite(s): **FE 24201, FE 24203, FE 24207, FE 24305**
Co- requisite(s):
Credits: 3 **L:03 T:00 P:00**
Class schedule per week: **03**
Class: **B. Tech**
Semester / Level: **VII/04**
Branch: **Food Engineering and Technology**
Name of Teacher:
Course Objectives

This course enables the students:

1	To gather the adequate knowledge of Evaluating a planned and implemented food science experiment in the development of a nutritionally-altered food product
2	Develop a real new food product prototype and prepare a scientifically comprehensive description of this prototype
3	To develop a marketing plan in the promotion of the designed food product.
4	To apply food science knowledge to functions of ingredients in food.
5	To apply sensory and objective methods of evaluation of food products.

Course Outcomes

After the completion of this course, students will:

CO 1	Be able to implement their knowledge for the evaluation of a planned and implemented food science experiment in the development of a nutritionally-altered food product
CO 2	Be able to successfully develop a marketing plan in the promotion of the designed food product.
CO 3	Development of professional oral presentation skills.
CO 4	Understand factors that affect viability and potential of new food products. Patent literature, competition, costs.
CO 5	Understand new products from consumer viewpoint.

Syllabus

MODULE	NO. OF LECTURE HOURS
Module 1: Objectives of product development: Role of food in human nutrition, Social, cultural, psychological and economic considerations. Nutritional disorders, natural contaminants and health hazards associated with food product development. Types of food: Therapeutic, Engineered, Fabricated, organic foods, Nutraceutical and functional foods.	8
Module 2: New Food Products- Defining the Newness and Novelty of food products and their characteristics, Consumer trends and their impact on new product development. Product development processes *viz.* to conceive ideas, evaluation of ideas, developing ideas into products, test marketing and commercialization. Marketing strategies of new products ,Research methodologies and statistics commonly used. Forecasting of product opportunities-short term profitability, payback potential, long run profitability potential; Green & Brown field Projects.	8
Module 3: Organiztion of the Food Products Development Team, The roles and purpose of each member, Budgetary roles, Outsourcing of food development**;** Getting to know your customer- Past trends of consumerism, Product Monopoly, Market research, Defining your market as well as survival protocols for contingencies.	8
Module 4: Development of the food product- Development and Assessment of food products; Ingredient selection and formulation; Packaging and nutritional labelling designs; Product development and testing-Quality control issues, Test market selection, Evaluation of the results, Presentation of results; Product management, Product life cycle.-Introduction, growth, maturity and decline stages. Promotion and Distribution; Reasons for food products being successful in the market. Food product planning-Modifying the product, modifying the market, product Monopoly and repositioning of the product.	8
Module 5: Product Pricing-Revenue and Costs, Break-even analysis, Debt Equity Ratio, Debt Service Coverage Ratio, Profit and Sales Projection, Return on Investment & Capital (ROI& ROC, IRR) and business analysis. Branding, Licensing and Acquisition, Franchising. Product Warranty; Legal and Public Policy Issues-Law and product development, Food regulation and Environmental standards, Pilot and industrial plant establishment, assessment; Feasibility study; Processing equipment selection; Quality and Cost Based Selection; Plant layout, equipment and installation.; Optimization of production operations; Forecasting future trends in the food product developed.	8

Text books:

1. Fuller, G.W. (2011). New food product development: From concept to marketplace. 3rd ed. New York, NY: CRC Press.

Reference books:

1. Berkowitz, E. N; Kerin, Roger, and Rudelius William (1989) Marketing, Homewood, IL, USA..

Gaps in the syllabus (to meet Industry/Profession requirements)

POs met through Gaps in the Syllabus

Topics beyond syllabus/Advanced topics/Design

POs met through Topics beyond syllabus/Advanced topics/Design

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
First Quiz	10
Mid Semester Examination	25
Second quiz/seminar/assignment/others	10
Teacher's Assessment	5
End Semester Examination	50

Indirect Assessment –

1.Student Feedback on Course Outcome

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO 1	3	3	3	3	1	3	1	2	1	1	1	3	3	3
CO 2	3	2	3	3	2	3	1	2	2	1	1	3	3	3
CO 3	3	3	3	2	1	3	1	2	1	2	1	3	3	3
CO 4	3	3	3	3	1	3	1	2	2	1	1	3	3	3
CO 5	3	2	3	3	1	3	1	2	1	1	2	3	3	3

Correlation Levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Mapping Between COs and Course Delivery (CD) methods

CD Code	Course Delivery methods	Course Outcome	Course Delivery Method Used
CD 1	Lecture by use of boards/LCD projectors/OHP projectors	CO1	CD1, CD2, CD8
CD 2	Tutorials/Assignments	CO2	CD1, CD2, CD8
CD 3	Seminars	CO3	CD1, CD2, CD4, CD8
CD 4	Mini projects/Projects	CO4	CD1, CD2, CD4, CD8
CD 5	Laboratory experiments/teaching aids	CO5	CD1, CD2, CD4, CD8
CD 6	Industrial/guest lectures		
CD 7	Industrial visits/in-plant training		
CD 8	Self- learning such as use of NPTEL materials and internets		
CD 9	Simulation		

COURSE INFORMATION SHEET

Course code: FE 24437
Course title: Enzymes Technology
Pre-requisite(s): FE 24201, FE 24203, FE 24207 , FE 24305
Co- requisite(s):
Credits:3 L:03 T:00 P:00
Class schedule per week: 03
Class: B. Tech
Semester / Level: VII/04
Branch: Food Engineering and Technology
Name of Teacher:

Course Objectives

This course enables the students:

1.	To understand basic chemistry of enzymes related to food industry
2.	To explain Enzymes, their Classification, properties, characterization and uses in food.
3.	To provide vast information about the production of protein hydrolysates and bioactive peptides through Enzymes.
4.	To explain the application and role of enzymes in Dairy industry for cheese and whey processing.
5.	To demonstrate the applications and processing effects of enzymes in bakery, fruit & vegetable and meat processing.

Course Outcomes

After the completion of this course, students will be:

CO 1	Able to identify the suitable enzymes for food processing
CO 2	Able to develop desired properties in food material by using enzymes
CO 3	Able to understand the various methods by processing of fruit juices
CO 4	Able to use of enzyme-aided extraction of plant materials for production of flavors
CO 5	Able to explain about different food products from cereals by the applications of various enzymes

Syllabus

MODULE	NO. OF LECTURE HOURS
Module 1: Enzymes–classification, properties, characterization, kinetics, immobilization and production process. Fermentative production of important enzymes in food processing industries and their applications.	8
Module 2: Enzymes for production of protein hydrolysates, maltodextrins and corn syrup solids (liquefaction, saccharification, dextrinization, isomerization for production of high-fructose-corn-syrup), fructose and fructooligosaccharides.	8
Module 3: Role of enzymes in food process like peeling, debittering, decolorization and production of food products like cheese, whey production and fruit juices.	8
Module 4: Role of enzymes in cereal processing like baking, beer/ wine production, meat and poultry processing industry.	8
Module 5: Enzyme processing for flavor production, synthesis of bioactive peptides and tailor-made fats.	8

Books:

1. Flickinger MC & Drew SW. 1999. *Encyclopedia of Bioprocess Technology*. A Wiley- Inter Science Publ.
2. Kruger JE *et al*. 1987. *Enzymes and their Role in Cereal Technology*. American Association of Cereal Chemists Inc.
3. Nagodawithana T & Reed G. 1993. *Enzymes in Food Processing*. Academic Press.
4. Tucker GA & Woods LFJ. 1991. *Enzymes in Food Processing*, Springer.S

POs met through Gaps in the Syllabus

Topics beyond syllabus/Advanced topics/Design

POs met through Topics beyond syllabus/Advanced topics/Design

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
First Quiz	10
Mid Semester Examination	25
Second quiz/seminar/assignment/others	10
Teacher's Assessment	5
End Semester Examination	50

Indirect Assessment –

1.Student Feedback on Course Outcome

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO 1	3	2	2	3	3	2	3	2	3	2	2	3	3	3
CO 2	3	2	2	3	3	2	3	2	3	2	2	3	3	3
CO 3	3	3	2	3	3	2	3	2	3	2	2	3	3	3
CO 4	3	2	2	3	3	2	3	2	3	3	2	3	3	3
CO 5	3	3	2	3	3	2	3	2	3	2	2	3	3	3

Correlation Levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Mapping Between COs and Course Delivery (CD) methods

CD Code	Course Delivery methods	Course Outcome	Course Delivery Method Used
CD 1	Lecture by use of boards/LCD projectors/OHP projectors	CO1	CD1, CD2, CD8
CD 2	Tutorials/Assignments	CO2	CD1, CD2, CD8
CD 3	Seminars	CO3	CD1, CD2, CD4, CD8
CD 4	Mini projects/Projects	CO4	CD1, CD2, CD4, CD8
CD 5	Laboratory experiments/teaching aids	CO5	CD1, CD2, CD4, CD8
CD 6	Industrial/guest lectures		
CD 7	Industrial visits/in-plant training		
CD 8	Self- learning such as use of NPTEL materials and internets		
CD 9	Simulation		

COURSE INFORMATION SHEET

Course code: FE 24439
Course title: Bakery and Confectionary Technology
Pre-requisite(s): FE 24201, FE 24203, FE 24207 , FE 24305
Co- requisite(s):
Credits: 3 L:03 T:00 P:00
Class schedule per week: 03
Class: B. Tech
Semester / Level: VII/04
Branch: Food Engineering and Technology
Name of Teacher:
Course Objectives

This course enables the students:

1.	Impart fundamental knowledge of bakery, confectionery and convenience products and give brief introduction of recent development in bakery, confectionery and convenience product technology.
2.	Demonstrate the knowledge of bakery, confectionery and convenience foods.
3.	Demonstrate skills involved in production of various baked products.
4.	Understand about the machinery involved in manufacture of these products
5.	To utilize knowledge on the methods of packaging, shelf life and food factors affecting the product quality

Course Outcomes

After the completion of this course, students will be:

CO 1	Explain the different ingredients used in bakery
CO 2	Explain the different working temperatures for bakery products
CO 3	Define the bread faults and remedies of bakery products
CO 4	Draw and explain the layout of a bakery
CO 5	Write recipes of different breads, pastries and other products

SYLLABUS

MODULE	NO. OF LECTURE HOURS
Module 1: Introduction to baking; Bakery ingredients and their functions; Machines & equipment for batch and continuous processing of bakery products. Layout designing of bakery industry.	8
Module 2: Bakery and confectionary industry; raw materials and quality parameters; dough development; methods of dough mixing; dough chemistry; rheological testing of dough-Farinograph, Mixograph, Extensograph, Amylograph/ Rapid Visco Analyzer, Falling number, Hosney's dough stickiness tester and interpretation of the data.	8
Module 3: Technology for the manufacture of bakery products – bread, biscuits, cakes and the effect of variations in formulation and process parameters on the quality of the finished product; quality consideration and parameters; Staling and losses in baking. different working temperatures for bakery products	8
Module 4: Chocolate Processing Technology, Compound coatings & Candy Bars, Tempering technology, Chocolate hollow figures, Chocolate shells, Enrobing technology, Manufacture of candy bars, Presentation and application of vegetable fats. Production of chocolate mass.Sugar confectionery manufacture, General technical aspects of industrial sugar confectionary manufacture, Manufacture of high boiled sweets- Ingredients, Methods of manufacture- Types- Center- filled, lollipops, coextruded products. Manufacture of gums and jellies- Quality aspects.	8
Module 5: Quality characteristics of confectionery ingredients; technology for manufacture of flour, fruit, milk, sugar, chocolate and special confectionery products; colour, flavor and texture of confectionery; standards and regulations; machineries used in confectionery industry. Manufacture of Miscellaneous Products, caramel, Toffee and fudge- Liquorices paste and aerated confectionery, Lozenges, sugar panning and Chewing gum, Count lines Quality aspects, fruit confections. Defects in bakery products.	8

Text Books:

1. Extrusion of Food, Vol 2; Harper JM; 1981, CRC Press.
2. Bakery Technology & Engineering; Matz SA; 1960; AVI Pub.

References:

1. Up to-date Bread Making; Fance WJ &Wrogg BH; 1968, Maclasen& Sons Ltd.
2. Modern Cereal Chemistry; Kent-Jones DW & Amos AJ; 1967, Food Trade Press Ltd

Gaps in the syllabus (to meet Industry/Profession requirements)

Recent developments in bakery and confectionary machineries

POs met through Gaps in the Syllabus

PO3, PO4, PO5

Topics beyond syllabus/Advanced topics/Design

Recent developments in bakery and confectionary machineries

POs met through Topics beyond syllabus/Advanced topics/Design

PO3, PO4, PO5

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
First Quiz	10
Mid Semester Examination	25
Second quiz/seminar/assignment/others	10
Teacher's Assessment	5
End Semester Examination	50

Indirect Assessment –

1.Student Feedback on Course Outcome

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO 1	3	2	2	3	2	1	3	1	2	2	2	3	3	3
CO 2	3	2	2	3	2	1	3	1	2	2	2	3	3	3
CO 3	3	2	2	3	2	2	3	1	2	2	2	3	3	3
CO 4	3	2	3	3	2	1	3	1	2	2	2	3	3	3
CO 5	3	2	2	3	2	1	3	1	2	2	2	3	3	3

Correlation Levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Mapping Between COs and Course Delivery (CD) methods

CD Code	Course Delivery methods	Course Outcome	Course Delivery Method Used
CD 1	Lecture by use of boards/LCD projectors/OHP projectors	CO1	CD1, CD2, CD8
CD 2	Tutorials/Assignments	CO2	CD1, CD2, CD8
CD 3	Seminars	CO3	CD1, CD2, CD4, CD8
CD 4	Mini projects/Projects	CO4	CD1, CD2, CD4, CD8
CD 5	Laboratory experiments/teaching aids	CO5	CD1, CD2, CD4, CD8
CD 6	Industrial/guest lectures		
CD 7	Industrial visits/in-plant training		
CD 8	Self- learning such as use of NPTEL materials and internets		
CD 9	Simulation		

COURSE INFORMATION SHEET

Course code: CL24435
Course title: Microfluidics
Pre-requisite(s): CL24203
Co- requisite(s):
Credits: L:03 T:00 P:00
Class schedule per week: 03
Class: B. Tech.
Semester / Level: VII/04
Branch: Chemical Engineering
Name of Teacher:

Course Objectives

This course enables the students to:

1.	Define the basics of microfluidics.
2.	Describe the behaviour of fluids in Microsystems.
3.	Explain the operating principles and physical mechanism unique to microfluidics.
4.	Explain different technological and scientific applications of microfluidics technology.
5.	Demonstrate an understanding of scaling of fundamental dynamics in microfluidic systems.

Course Outcomes

After the completion of this course, students will be able to:

CO24435.1	Explain the theory and physical principles of fluid mechanics on the microscale.
CO24435.2	Solve problems related to surface tension and interfacial energy in microfluidic systems.
CO24435.3	Describe the electrohydrodynamics fundamentals and solve related problems for microfluidic systems.
CO24435.4	Mathematically model microfluidic devices and systems.
CO24435.5	Propose design strategies for microfluidic systems based on fluid mechanics principles.

SYLLABUS

MODULE	NO. OF LECTURE HOURS
Module 1: Origin, Definition, Benefits, Challenges, Commercial activities, Physics of miniaturization, Scaling laws. Intermolecular forces, States of matter, Continuum assumption, Governing equations, Constitutive relations. Gas and liquid flows, Boundary conditions, Slip theory, Transition to turbulence, Low Re flows, Entrance effects. Exact solutions, Couette flow, Poiseuille flow, Stokes drag on a sphere, Time-dependent flows, Taylor-Aris dispersion, Two-phase flows, Flow through deformable channel.	8
Module 2: Surface tension and interfacial energy, Young-Laplace equation, Contact angle, Capillary length and capillary rise, Interfacial boundary conditions, Marangoni effect, lubrication theory, thin film.	8
Module 3: Electrohydrodynamics fundamentals. Electro-osmosis, Debye layer, Thin EDL limit, Ideal electroosmotic flow, Ideal EOF with back pressure, EOF of power-law fluids. Electrophoresis, Dielectrophoresis, Diffusiophoresis, Thermophoresis.	8
Module 4: Fabrication methods in microfluidics, Materials, Clean room, photolithography- mask, spin coating, exposure and development, Wafer bonding. Polymer microfabrication, PMMA/COC/PDMS substrates, micromolding, fluidic interconnections.	8
Module 5: Dynamics of particles and droplets, Droplet spreading, Droplet deformation, Electrowetting, Droplet generators, T-junction and Cross-junction, Droplet formation, breakup and transport.	8

Books:

1. Nguyen, N. T., Werely, S. T., Fundamentals and applications of Microfluidics, Artech house Inc., 2002.
2. Bruus, H., Theoretical Microfluidics, Oxford University Press Inc., 2008.
3. Madou, M. J., Fundamentals of Microfabrication, CRC press, 2002.
4. Tabeling, P., Introduction to microfluidics, Oxford University Press Inc., 2005.

Gaps in the syllabus (to meet Industry/Profession requirements)

POs met through Gaps in the Syllabus

Topics beyond syllabus/Advanced topics/Design

POs met through Topics beyond syllabus/Advanced topics/Design

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment

First Quiz	10
Mid Semester Examination	25
Second quiz/seminar/assignment/others	10
Teacher's Assessment	5
End Semester Examination	50

Indirect Assessment –
1.Student Feedback on Course Outcome

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO 1	3	3	3	2	2	2	2	0	1	2	0	3	3	3
CO 2	3	2	1	2	3	0	1	0	1	2	0	3	3	3
CO 3	3	1	1	1	1	0	0	0	1	1	0	3	3	3
CO 4	3	3	2	2	3	1	2	0	1	2	0	3	3	3
CO 5	3	3	1	2	3	2	2	0	1	2	0	3	3	3

Correlation Levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Mapping Between COs and Course Delivery (CD) methods

CD Code	Course Delivery methods	Course Outcome	Course Delivery Method Used
CD1	Lecture by use of boards/LCD projectors/OHP projectors	CO1	CD1, CD2, CD8
CD2	Tutorials/Assignments	CO2	CD1, CD2, CD8
CD3	Seminars	CO3	CD1, CD2, CD8
CD4	Mini projects/Projects	CO4	CD1, CD2, CD8
CD5	Laboratory experiments/teaching aids	CO5	CD1, CD2, CD8
CD6	Industrial/guest lectures		
CD7	Industrial visits/in-plant training		
CD8	Self- learning such as use of NPTEL materials and internets		
CD9	Simulation		

LABORATORIES

COURSE INFORMATION SHEET

Course code: **FE 24402**
Course title: **Food Process Engineering & Technology Lab -II**
Pre-requisite(s):
Co- requisite(s):
Credits:1.5 **L:00 T:00 P:03**
Class schedule per week: **03**
Class: **B. Tech**
Semester / Level: **VII/04**
Branch: **Food Engineering and Technology**
Name of Teacher:

Course Objectives:
This course enables the students will:

1.	Be familiar with the current state of knowledge on food composition
2.	Understand the principles behind analytical techniques associated with food
3.	Know methods of selecting appropriate analytical techniques when presented with a practical problem
4.	Be able to demonstrate practical proficiency and teamwork in a food analysis laboratory
5.	Be able to use various instrument and protocols for food analysis

Course Outcomes

After the completion of this course, students will be:

CO1	Acquainted with analytical methods used for quality control analysis of raw material and processed food commodities.
CO2	Able to conduct appropriate laboratory experiments common to basic and applied food analysis and interpret the results.
CO3	Able to Work cooperatively in a team to identify a food Analysis problem, design and conduct the experiments, and analyze and interpret the data.
CO4	Able to clearly communicate research results and tell the quality of food products using appropriate techniques.
CO5	To apply critical thinking skills to new food processing situations

List of experiments:

1. Investigating the thermal conductivity of common fluids
2. Determination of thermal conductivity of solid food
3. Drying of Foods: Part I. Tray Drying
4. Drying of Foods: Part II. Spray Drying
5. Drying of Foods: Part III. Freeze Drying
6. Drying of Foods: Part IV. Microwave assisted drying
7. Drying of Foods: Part IV. Microwave assisted Vacuum drying
8. Parboiling of paddy and milling
9. Ultrasonic Extraction of bioactive ingredients
10. Friction Losses Determination in a Pipe in dairy setup
11. Convective Heat Transfer Coefficient Determination
12. Thermal Processing of Foods: Part I. Heat Penetration
13. Thermal Processing of Foods: Part II. Lethality Determination
14. Extrusion of Foods
15. Evaporation of liquid
16. Physical Separations
17. Vacuum packaging of samples
18. Respiration analysis setup
19. Experimentation with CAP and MAP

Text books:

1. Food analysis - S.S. Neilson, Aspen publishers. Gaithery Berg Maryland
2.AOAC methods for Food Analysis.
3. Food Analysis, Theory and practice - Y. Pomeranz and C. EMeloan, A VI publishing company, INC West Port, Connecticut,USA.
4. Fung, D.Y.C. and Matthews, R. (1991): Instrumental Methodsfor Quality Assurance in Foods, Marcel Dekker, Inc. New York
5. Fruit and vegetable processing by Mircea EnachescuDauthy Consultant FAO Agricultural services bulletin No.119 Food and Agriculture Organization of the United Nations Rome, 1995
1. Preservation of Fruits & Vegetables by Girdhari Lal, Sidhapa and Tandon

Reference books:

1. Y. H. Hui, S. Ghazala, D.M. Graham, K.D. Murrell and W.K.Nip,Handbook of Vegetable
2. Preservation and Processing, MarcelDekker,2003

Gaps in the syllabus (to meet Industry/Profession requirements)

POs met through Gaps in the Syllabus

Topics beyond syllabus/Advanced topics/Design

POs met through Topics beyond syllabus/Advanced topics/Design

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
(1) Progressive Evaluation	60
Day-to-day performance	(10)

Lab files	(20)
Attendance	(10)
Viva	(20)
(2) End Semester	40
Quiz	(10)
Lab Performance	(30)

Indirect Assessment –

1.Student Feedback on Course Outcome

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO 1	3	3	2	3	3	3	3	1	1	1	3	3	3	3
CO 2	3	3	2	3	3	3	3	1	1	1	3	3	3	3
CO 3	3	2	3	3	3	3	3	1	2	2	3	3	3	3
CO 4	3	3	3	3	3	3	3	1	2	2	3	3	3	3
CO 5	3	3	3	3	3	3	3	1	2	2	3	3	3	3

Correlation Levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Mapping Between COs and Course Delivery (CD) methods

CD Code	Course Delivery methods	Course Outcome	Course Delivery Method Used
CD1	Lecture by use of boards/LCD projectors/OHP projectors	CO1	CD4, CD5, CD7, CD8
CD2	Tutorials/Assignments	CO2	CD4, CD5, CD7, CD8
CD3	Seminars	CO3	CD4, CD5, CD7, CD8
CD4	Mini projects/Projects	CO4	CD4, CD5, CD7, CD8
CD5	Laboratory experiments/teaching aids	CO5	CD4, CD5, CD7, CD8
CD6	Industrial/guest lectures		
CD7	Industrial visits/in-plant training		
CD8	Self- learning such as use of NPTEL materials and internets		
CD9	Simulation		

PROGRAMME ELECTIVE VI (PE-VI)
VII SEMESTER

COURSE INFORMATION SHEET

Course code: **FE 24423**
Course title: **Refrigeration and Air Conditioning Engineering**
Pre-requisite(s): **CL24201,CL 203, CL 207, FE 24203, FE 24207**
Co- requisite(s):
Credits: 03 **L: 03 T: 00 P:00**
Class schedule per week: **03**
Class: **B. Tech**
Semester / Level: **VII/04**
Branch: **Food Engineering and Technology**
Name of Teacher:

Course Objectives

This course enables the students:

CO1	To acquire understanding of refrigeration and their relevance to food storage
CO2	To understand the working principle of various method to produce low temperature and application refrigeration principles food processing.
CO3	To gain the ability to assess refrigeration system performance and freezing equipment, selection of refrigerants
CO4	With knowledge of refrigeration, will be capable to optimize minimize energy consumption, and maximizing efficiency while maintaining or enhancing food life.
CO5	Through the application of refrigeration principles to food technology, students will enhance their critical thinking abilities, enabling them to address challenges in cold chain, cold storage.

Course Outcomes

After the completion of this course, students will be:

CO1	To apply the understanding of refrigeration and their relevance to food storage
CO2	To apply the working principle of various method to produce low temperature and application refrigeration principles food processing.
CO3	To gain the ability to assess refrigeration system performance and freezing equipment, selection of refrigerants
CO4	To optimize minimize energy consumption and maximizing efficiency while maintaining or enhancing food life.
CO5	To apply their critical thinking abilities, enabling them to address challenges in cold chain, cold storage

SYLLABUS

MODULE	NO. OF LECTURE HOURS
Module 1: Principles of refrigeration: Definition, background with second law of thermodynamics, unit of refrigerating capacity, coefficient of performance, Production of low temperatures: Expansion of a liquid with flashing, reversible/ irreversible adiabatic expansion of a gas/ real gas, thermoelectric cooling, adiabatic demagnetization.	8
Module 2: Air refrigerators working on reverse Carnot cycle: Carnot cycle, reversed Carnot cycle, selection of operating temperatures; Air refrigerators working on Bell Coleman cycle: Reversed Brayton or Joule or Bell Coleman cycle, analysis of gas cycle, polytropic and multistage compression. Vapour refrigeration: Vapor as a refrigerant in reversed Carnot cycle with p-V and T-s diagrams, limitations of reversed Carnot cycle; Vapour compression system: Modifications in reverse Carnot cycle with vapour as a refrigerant (dry Vs wet compression, throttling Vs isentropic expansion), representation of vapor compression cycle on pressure- enthalpy diagram, super heating, sub cooling; effect of suction vapour, super heat and liquid sub cooling on actual vapour compression cycle; Vapour-absorption refrigeration system: Process, calculations, maximum coefficient of performance of a heat operated refrigerating machine; water/lithium bromide & ammonia/water absorption cooling.	8
Module 3: Common refrigerants and their properties: classification, nomenclature, desirable properties of refrigerants- physical, chemical, safety, thermodynamic and economical; azeotrope refrigerants. Components of vapour compression refrigeration system, evaporator, compressor, condenser and expansion valve; Ice manufacture: principles and systems of ice production, basic types of ice, ice makers, Treatment of water for making ice, brines, freezing tanks, ice cans, air agitation, quality of ice;	8
Module 4: Cold storage: Cold store, design of cold storage for different categories of food resources, size and shape, construction and material, insulation, vapour barriers, floors, frost-heave, interior finish and fitting, evaporators, automated cold stores, security of operations. Refrigerated transport: Handling and distribution, cold chain, refrigerated product handling, order picking, refrigerated vans, refrigerated display. Low temperature Refrigeration: cryogenic fluid and fluid properties; liquefaction; application in food	8
Module 5: Air-conditioning: Meaning, factors affecting comfort air- conditioning, classification, sensible heat factor, industrial air- conditioning, problems on sensible heat factor; Winter/summer/year round air-conditioning, unitary air-conditioning systems, central air- conditioning, physiological principles in air-conditioning, air distribution and duct design methods; design of complete air- conditioning systems; humidifiers and dehumidifiers; Cooling/Refrigeration load calculations: Load sources, product cooling, conducted heat, convected heat, internal heat sources, heat of respiration, peak load, miscellaneous loads.	8

Text books:

William C. Whitman, William M. Johnson, John A. Tomczyk and Eugene Silberstein. 2009. Refrigeration & Air Conditioning Technology, 6th Ed. Delmar, Cengage Learning, NY, USA.
C.P. Arora. 2000. Refrigeration and Air Conditioning, 2nd Ed. Tata McGraw-Hill Publishing Co. Ltd., New Delhi.
W.F. Stoecker and J.W. Jones.1982.Refrigeration and Air Conditioning, 2nd Ed. McGraw-Hill Book Co., New York, USA.

Ashrae Handbook, 2006: Refrigeration.

Reference books:

Gaps in the syllabus (to meet Industry/Profession requirements)

POs met through Gaps in the Syllabus

Topics beyond syllabus/Advanced topics/Design

POs met through Topics beyond syllabus/Advanced topics/Design

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
First Quiz	10
Mid Semester Examination	25
Second quiz/seminar/assignment/others	10
Teacher's Assessment	5
End Semester Examination	50

Indirect Assessment –

1.Student Feedback on Course Outcome

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO 1	3	1	2	3	2	1	2	1	2	2	3	3	3	3
CO 2	3	2	2	3	2	2	3	1	2	2	3	3	3	3
CO 3	2	1	2	3	2	1	2	1	2	2	3	3	3	3
CO 4	3	1	2	3	2	1	2	1	1	1	3	3	3	3
CO 5	3	3	3	3	2	3	2	3	2	2	3	3	3	3

Correlation Levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Mapping Between COs and Course Delivery (CD) methods

CD Code	Course Delivery methods	Course Outcome	Course Delivery Method Used
CD 1	Lecture by use of boards/LCD projectors/OHP projectors	CO1	CD1, CD2, CD8
CD 2	Tutorials/Assignments	CO2	CD1, CD2, CD8
CD 3	Seminars	CO3	CD1, CD2, CD4, CD8
CD 4	Mini projects/Projects	CO4	CD1, CD2, CD4, CD8
CD 5	Laboratory experiments/teaching aids	CO5	CD1, CD2, CD4, CD8
CD 6	Industrial/guest lectures		
CD 7	Industrial visits/in-plant training		

CD 8	Self- learning such as use of NPTEL materials and internets		
CD 9	Simulation		

COURSE INFORMATION SHEET

Course code: FE 24425
Course title: Biochemical Engineering
Pre-requisite(s): CL 203, CL 207, FE 24203, FE 24207, FE 24301
Co- requisite(s):
Credits: L: 03 T: 00 P:00
Class schedule per week: 03
Class: B. Tech
Semester / Level: VII/04
Branch: Food Engineering and Technology
Name of Teacher:

Course Objectives

This course enables the students:

1	To study the scope of biochemical engineering
2.	To understand Microbial Growth Kinetics
3.	To know the Transport phenomena in Bioprocess systems
4.	To know the Bioreactor design of microbial reaction process
5.	To know the methods of air sterilization

Course Outcomes

After the completion of this course, students will be:

CO1	To applythe scope of biochemical engineering
CO2	To evaluate Microbial Growth Kinetics
CO3	To determine the Transport phenomena in Bioprocess systems
CO4	To analyze the Bioreactor design of microbial reaction process
CO5	To apply the methods of air sterilization

SYLLABUS

MODULE	NO. OF LECTURE HOURS
Module 1: Definition and scope of biochemical engineering. Unit operations in biochemical processes, Mass and energy balance in microbial processes, Metabolic stoichiometry and bioenergetics, Primary and secondary metabolites.	8
Module 2: Microbial Growth Kinetics: Phase of cell growth, Estimation of cell mass, Kinetics of cell growth in batch, continuous and fed batch system, Monod growth model and its various modifications; concept of limiting nutrient and effect of its concentration on cell growth; Study of growth inhibition kinetics, structured and unstructured kinetic rate models.	8
Module 3: Transport phenomena in Bioprocess systems; gas liquid mass transfer in cellular systems. bubble aeration and mechanical agitation, calculation of power consumption, correlation between oxygen transfer coefficient and operating variables, estimation of KLa in fermentation process, factors affecting volumetric oxygen transfer, rheology of fermentation fluids.	8
Module 4: Bioreactor design and analysis in view of microbial reaction process, operation of batch and continuous fermentation system, oxygen supply and demand	8

in microbial processes, mass transfer resistances, critical value of oxygen concentration and oxygen uptake rate, aeration system in fermenter, types and design of sparger.	
Module 5: Methods of air sterilization, Thermal death kinetics of microorganisms. Batch, continuous sterilization, Sterilization of air. Fermentation Processes and applications, kinetics of substrate Utilisation, Product Formation and Biomass Production.	8

Text books:

1. Biochemical Engineering and Biotechnology, Ghasem D. Najafpour, Elsevier, ISBN-13: 978-0-444-52845-2, ISBN-10: 0-444-52845-8
2. Biochemical Engineering Fundamentals by James E. Bailey& David F. Ollis, McGrew- Hill.
3. Bioprocess Engineering by Shuler & Kargi, Prentice Hall
4. Chemical Reaction Engineering, Levenspiel O., John Wiley& Sons (Asia), 3rd Ed., 2000
5. Biochemical Engineering Fundamentals by James E. Bailey& David F. Ollis, McGrew- Hill.

Reference books:

Gaps in the syllabus (to meet Industry/Profession requirements)

POs met through Gaps in the Syllabus

Topics beyond syllabus/Advanced topics/Design

POs met through Topics beyond syllabus/Advanced topics/Design

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
First Quiz	10
Mid Semester Examination	25
Second quiz/seminar/assignment/others	10
Teacher's Assessment	5
End Semester Examination	50

Indirect Assessment –

1.Student Feedback on Course Outcome

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO 1	3	1	2	3	2	1	2	1	2	2	3	3	3	3
CO 2	3	2	2	3	2	2	3	1	2	2	3	3	3	3
CO 3	2	1	2	3	2	1	2	1	2	2	3	3	3	3
CO 4	3	1	2	3	2	1	2	1	1	1	3	3	3	3
CO 5	3	3	3	3	2	3	2	3	2	2	3	3	3	3

Correlation Levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Mapping Between COs and Course Delivery (CD) methods

CD Code	Course Delivery methods	Course Outcome	Course Delivery Method Used
CD 1	Lecture by use of boards/LCD projectors/OHP projectors	CO1	CD1, CD2, CD8
CD 2	Tutorials/Assignments	CO2	CD1, CD2, CD8
CD 3	Seminars	CO3	CD1, CD2, CD4, CD8
CD 4	Mini projects/Projects	CO4	CD1, CD2, CD4, CD8
CD 5	Laboratory experiments/teaching aids	CO5	CD1, CD2, CD4, CD8
CD 6	Industrial/guest lectures		
CD 7	Industrial visits/in-plant training		
CD 8	Self- learning such as use of NPTEL materials and internets		
CD 9	Simulation		

COURSE INFORMATION SHEET

Course code: FE 24427
Course title: Post Harvest Engineering
Pre-requisite(s): CL 207, FE 24203, FE 24207, FE 24301
Co- requisite(s):
Credits: L:03 T:00 P:00
Class schedule per week: 03
Class: B. Tech
Semester / Level: VII/04
Branch: Food Engineering and Technology
Name of Teacher:

Course Objectives

This course enables the students:

1.	To familiarize students with agricultural produce and post harvest operations
2.	To impart students basic knowledge relating to storage, conditions for storage of perishable products and functional requirements of storage
3.	To familiarize students with the principles of drying and factors affecting drying, types of drying methods and factors drying.
4.	To pass on basic knowledge of Post Harvest Technologies related to Fruits and Vegetables
5.	Student will be made aware of the technological changes that are occurring in this field along with pre and post-harvest technology, physiology and biochemistry, cooling and storage systems, waste management, advances in processing, nutraceuticals and functional foods.

Course Outcomes

After the completion of this course, students will be:

CO 1	Able to understand the agro produce and their post harvest handling methos.
CO 2	Able to understand the role of storage and requirements of storage for extension of shelflife of different agro produce.
CO 3	Able to interpret with the recent methods of minimal processing of fruits and vegetables.
CO 4	Able to describe types of cereals, composition & nutritive value and storage condition of cereals and pulses.
CO 5	Able to describe Post harvest losses in agricultural and horticultural produces.

SYLLABUS

MODULE	NO. OF LECTURE HOURS
Module 1: Introduction of post harvest technology Introduction to post harvest technology of agricultural produce; Status of Production, Losses, Need, Scope and Importance, Introduction to various post harvest operations like Harvesting, Handling cleaning, grading, sorting, drying, storage, milling, size reduction, expelling, extraction, blending, heat treatment, separation, material handling (transportation, conveying, elevating),washing; their functions and use in the post harvest processing	8
Module 2: Spoilage in storage Types and causes of spoilage in storage, conditions for storage of perishable products, functional requirements of storage, control of temperature and relative humidities inside storage, calculation of refrigeration load; modified atmospheric storage and control of its Environment, air movement inside the storage,	8
Module 3: Drying of Cereals and Pulses Introduction, importance of drying, principles of drying and factors affecting drying, types of drying methods i.e. sun drying & artificial drying by mechanical means – Psychometric Chart, Moisture content representation, equilibrium moisture content, determination of moisture content by direct and indirect methods. Introduction to various grain drying systems.	8
Module 4: Storage of Cereals and Pulses: Introduction, need and importance, general principles of storage. Temperature and moisture changes during storage i.e. influence of moisture content, relative humidity, temperature, fungi etc. on stored product. Fungi, insect and other organism / Infections associated with stored grains. Types of storage structures.	8
Module 5: Post Harvest Technology of Fruits and Vegetables Methods of Harvesting and Post harvest losses in fruits and vegetables, Handling of Fruits and Vegetables. Introduction to the storage of fruits and vegetables. Need and importance of storage. Principle of storage of fruits and vegetables. Recommended storage operation conditions for some important fruits and vegetables and their storage life. Post harvest treatment to increase shelf life. Introduction to Packaging of fruits and vegetables and types of packaging. Concept of modified atmosphere packaging.	8

Text books:

1. Post Harvest Technology of Cereal, Pulses, Oil seeds A.Chakraverty Oxford & IBH Publication Co.
2. Unit operation of Agro Processing Engineering Dr.K.M. Sahay& K.K Singh Vikas Publications.
3. Post Harvest Technology of fruits & Vegetables Thompson CBS Publishers and Distributors
4. Post Harvest (Introduction Physiology Handling fruits & Vegetables) Wills R.B.H. Oxford & IBH Publication Co.

Reference books:

1. N Lewis, The Cold Chain, Hamish Hamilton (1988).

Gaps in the syllabus (to meet Industry/Profession requirements)

Fluid flow and mechanical operations machineries used in food sector

POs met through Gaps in the Syllabus

PO3, PO4, PO5

Topics beyond syllabus/Advanced topics/Design

Fluid flow and mechanical operations machineries used in food sector

POs met through Topics beyond syllabus/Advanced topics/Design

PO3, PO4, PO5

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
First Quiz	10
Mid Semester Examination	25
Second quiz/seminar/assignment/others	10
Teacher's Assessment	5
End Semester Examination	50

Indirect Assessment –

1.Student Feedback on Course Outcome

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO 1	2	3	2	3	3	3	3	2	3	2	3	3	3	3
CO 2	2	2	2	2	3	3	3	2	3	3	3	3	3	3
CO 3	3	3	3	2	2	3	2	3	3	3	3	3	3	3
CO 4	2	2	2	3	3	3	2	3	3	3	3	3	3	3
CO 5	2	2	2	2	3	3	2	3	3	3	3	3	3	3

Correlation Levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Mapping Between COs and Course Delivery (CD) methods

CD Code	Course Delivery methods	Course Outcome	Course Delivery Method Used
CD 1	Lecture by use of boards/LCD projectors/OHP projectors	CO1	CD1, CD2, CD8
CD 2	Tutorials/Assignments	CO2	CD1, CD2, CD8
CD 3	Seminars	CO3	CD1, CD2, CD4, CD8

CD 4	Mini projects/Projects	CO4	CD1, CD2, CD4, CD8
CD 5	Laboratory experiments/teaching aids	CO5	CD1, CD2, CD4, CD8
CD 6	Industrial/guest lectures		
CD 7	Industrial visits/in-plant training		
CD 8	Self- learning such as use of NPTEL materials and internets		
CD 9	Simulation		

COURSE INFORMATION SHEET

Course code: FE 24429
Course title: Food Processing Plant Engineering and Layout
Pre-requisite(s): CL 203, CL 207, FE 24203, FE 24207, FE 24301
Co- requisite(s):
Credits: L:3 T:00 P:00
Class schedule per week: 03
Class: B. Tech
Semester / Level: VII/04
Branch: Food Engineering and Technology
Name of Teacher:

Course Objectives

This course enables the students:

1.	To impart the basic principles and knowledge about the food plant layout and design, selection of location and machineries
2.	To educate the students regarding selection parameters for the location of food processing industry.
3.	To enable the students to design layout of various types of food processing industries.
4.	To understand the basic concept of food plant layout design
5.	To acquire basic understanding of design parameter

Course Outcomes

After the completion of this course, students will be able to:

CO 1	To acquaint the students with various aspects of design and layout of food plant.
CO 2	Be able to design layout of various types of food processing industries.
CO 3	Be able to design the process flow sheet
CO 4	Be aware about the selection parameters for the location, machineries, raw materials for food processing industry.
CO 5	Be able to prepare a detailed project report for food industry.

SYLLABUS

MODULE	NO. OF LECTURE HOURS
Module 1: Introduction to plant design - special features of food processing industry, plant location, location factors, site selection, layout - understanding of equipment layout ventilation, Layout objectives, classical and practical layout with reference to bakery and biscuit, fruits, vegetable and beverage processing, and dairy industries; Miscellaneous aspects of plant layout and design like provision for waste disposal, and safety arrangements; Characteristics of an efficient layout	**8**
Module 2: Design consideration for location of food plants, location theory and models; ISO, FPO, MPO requirements in food plant layout and design; Preparation of flow sheets for material movement and utility consumption in food plants; Plant location factors-plant site selection, Theories of Plant location-estimation of series- peak	8

and critical load-Economic plant size.	
Module 3: Development and presentation of the layout, selection of site and Location of plant, General points of considerations for designing food plant, floor plant types of layouts Food building planning, -preparation of machinery layout for fruit, vegetables and meat-size reduction machinery layout; Layout and designing aspects of pilot and semi-commercial food processing plants; Scale-up; Application of Program Evaluation and Review Technique (PERT) and Critical Path Method (CPM) in project planning and monitoring	8
Module 4: Preparation of flow sheets for material movement and utility consumption in food plants, SLP and its application in plant layout, Computerised Layout Planning- ALDEP and CRAFT. Symbols used for food plant design and layout; Food processing enterprise; Engineering economics; Process schedule; Plant operation; Evaporation plant layout-single, multiple, vacuum and film evaporators-types and concepts, drying plant layout, drying process, drier types, selection of driers.	8
Module 5: Baking oven and frying plant-types, concepts and layout. Filling closing and labelling plant layout. Organization and trends in plant layout - sample layout, installation procedure for food processing plant. Dairy Plant Layout Plant layout and design for milk and milk products. Other plant layouts - Layout for extruded and confectionery products, meat and poultry products fat and oil processing industry and beverages.	8

TEXT BOOKS:

1. James, M.More, "Plant Layout and Design". MacMillian Publishing Co., New York 1976
2. Slade, F.H, "Food processing plant". Leonardhill Books, London1967.

References:

Reference books:

3. American Society of Heating, "Refrigerating and Air-Conditioning Engineers", Ashrae Handbook, Fundamentals. ASHRAE, Atlanta, Georgia 1981.
4. Hall,H.S and Y.Rosen, "Milk plant layout" (F.A.O. Publication) 1976.

Gaps in the syllabus (to meet Industry/Profession requirements)

POs met through Gaps in the Syllabus

Topics beyond syllabus/Advanced topics/Design

POs met through Topics beyond syllabus/Advanced topics/Design

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
First Quiz	10
Mid Semester Examination	25
Second quiz/seminar/assignment/others	10
Teacher's Assessment	5
End Semester Examination	50

Indirect Assessment –

1.Student Feedback on Course Outcome

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO 1	3	3	2	3	3	3	3	2	3	2	2	3	3	3
CO 2	3	2	2	2	3	3	3	2	3	2	2	3	3	3
CO 3	3	2	3	2	2	3	2	2	3	3	1	3	3	3
CO 4	2	2	3	3	3	3	2	3	3	3	2	3	3	3
CO 5	3	2	3	2	2	3	2	3	3	2	3	3	3	3

Correlation Levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Mapping Between COs and Course Delivery (CD) methods

CD Code	Course Delivery methods	Course Outcome	Course Delivery Method Used
CD 1	Lecture by use of boards/LCD projectors/OHP projectors	CO1	CD1, CD2, CD8
CD 2	Tutorials/Assignments	CO2	CD1, CD2, CD8
CD 3	Seminars	CO3	CD1, CD2, CD4, CD8
CD 4	Mini projects/Projects	CO4	CD1, CD2, CD4, CD8
CD 5	Laboratory experiments/teaching aids	CO5	CD1, CD2, CD4, CD8
CD 6	Industrial/guest lectures		
CD 7	Industrial visits/in-plant training		
CD 8	Self- learning such as use of NPTEL materials and internets		
CD 9	Simulation		

COURSE INFORMATION SHEET

Course code: FE 24431
Course title: Energy Utilization of Food Industries
Pre-requisite(s): CL 203, CL 207, FE 24203, FE 24207, FE 24301
Co- requisite(s):
Credits: L: 03 T: 00 P:00
Class schedule per week: 03
Class: B. Tech
Semester / Level: VII/04
Branch: Food Engineering and Technology
Name of Teacher:

Course Objectives

This course enables the students:

1	The learners will gain basic knowledge of energy its norms and scenario; energy auditing, data collection and analysis for energy conservation in food processing industries energy sources, Applications of renewable energy in food industry.
2.	The learners also will gain the fundamental aspects of biomass as an alternate source of energy along with its merits and demerits.
3.	The learners would have acquired basic knowledge of solar energy and its application in Indian food industry and other heavy industry along others alternative sources of energy.
4.	Understand the application of energy audit and its management with a case study.
5.	Know about the technique applied for accounting methods of energy and its economic uses.

Course Outcomes

After the completion of this course, students will be:

CO1	Understand Energy Basics and Utility Systems
CO2	Analyze Energy-Intensive Processes in Food Industries
CO3	Assess Electrical and Compressed Air Systems
CO4	Evaluate Pumping, DG Set, and Combustion Systems
CO5	Optimize Boiler, Steam, and Waste Heat Recovery Systems

SYLLABUS

MODULE	NO. OF LECTURE HOURS
Module 1: Introduction: Energy Basics: Types of energy (thermal, electrical, mechanical), units, and conversions. Energy Use in Food Processing: Importance of energy in food preservation, transformation, and storage. Global and Industrial Energy Trends: Energy demand and its impact on the food processing sector. Energy-Intensive Processes in Food Industries Thermal Processes: Heating, drying, evaporation, pasteurization, and sterilization. Mechanical Operations: Size reduction, mixing, separation, and packaging. Cold Chain and Refrigeration: Energy demands in freezing and chilling. Classification of Various Utilities and Services in food Plant/ industry. Commercial energy Pricing. **Electrical System** Introduction to electric power supply systems, electrical billing, electrical load management & maximum demand control, power factor improvement & benefits, transformers, system distribution losses, harmonics, trouble shooting of electrical power system, Energy Conservation in Electrical System **Electrical motors:** Types, losses in Introduction motor, motor efficiency, factors affecting motor performers, performance, rewinding and motor replacement issues, energy saving opportunities with energy efficient motors , Energy Conservation in Electrical motors	8
Module 2: Compressed air system Requirement, types, compressor efficiency, efficient compressor operation, compressed air system components, capacity assessment, leakage test, factors affecting the performance & efficiency HV AC & Refrigeration system: Energy Conservation in Compressed air system **Fans and blowers:** Requirement, types, performance evaluation, efficient system operation, flow control strategies and energy conservation opportunities	8
Module 3: Pumps and pumping systems Requirement, types, performance evaluation, efficient system operation, flow control strategies and energy conservation opportunities **DG set system** Requirement, introduction, factors affecting selection and energy conservation opportunities **Fuels and combustion** Introduction to fuels; properties offuel oil, coal & gas; storage; handling & preparation of fuels; principles of combustion, combustion of oil, coal & gas; draft system , energy conservation opportunities	8
Module 4: **Boilers :** Boiler specification, Indian boiler regulation, system components, types, combustion in boilers, performance terms, analysis of losses, feed water treatment, blow down, energy conservation opportunities **Steam system** Properties of steam, assessment of steam distribution losses, steam leakage, steam trapping, condensate and flash steam recovery system, opportunities for energy savings **Other utilities & services**	8

Lighting, CIP system, waste water/drainage, water treatment, dust removal, fire protection and maintenance system **Waste heat recovery** Classification, advantages and application, commercially viable waste heat recovery devices, saving potential, Heat exchangers, cogeneration, and waste heat utilization.	
Module 5: Conversion of Food Processing Wastes into Energy: Food Processing Wastes and Utilizations, Anaerobic Digestion of Food Processing Wastes, Fermentation of Food Processing Wastes into Transportation Alcohols, Bio-diesel Production from Waste Oils and Fats, Thermo-chemical Conversion of Food Processing Wastes for Energy Utilization **Energy Auditing:** Tools, techniques, and case studies. Sustainability in the Food Industry	8

Text books:
Reference books:

Gaps in the syllabus (to meet Industry/Profession requirements)

POs met through Gaps in the Syllabus

Topics beyond syllabus/Advanced topics/Design

POs met through Topics beyond syllabus/Advanced topics/Design

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
First Quiz	10
Mid Semester Examination	25
Second quiz/seminar/assignment/others	10
Teacher's Assessment	5
End Semester Examination	50

Indirect Assessment –

1.Student Feedback on Course Outcome

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO 1	3	1	2	3	2	1	2	1	2	2	3	3	3	3
CO 2	3	2	2	3	2	2	3	1	2	2	3	3	3	3
CO 3	2	1	2	3	2	1	2	1	2	2	3	3	3	3
CO 4	3	1	2	3	2	1	2	1	1	1	3	3	3	3
CO 5	3	3	3	3	2	3	2	3	2	2	3	3	3	3

Correlation Levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Mapping Between COs and Course Delivery (CD) methods

CD Code	Course Delivery methods	Course Outcome	Course Delivery Method Used
CD 1	Lecture by use of boards/LCD projectors/OHP projectors	CO1	CD1, CD2, CD8
CD 2	Tutorials/Assignments	CO2	CD1, CD2, CD8
CD 3	Seminars	CO3	CD1, CD2, CD4, CD8
CD 4	Mini projects/Projects	CO4	CD1, CD2, CD4, CD8
CD 5	Laboratory experiments/teaching aids	CO5	CD1, CD2, CD4, CD8
CD 6	Industrial/guest lectures		
CD 7	Industrial visits/in-plant training		
CD 8	Self- learning such as use of NPTEL materials and internets		
CD 9	Simulation		

COURSE INFORMATION SHEET

Course code: FE 24433
Course title: Food Processing Equipment Design
Pre-requisite(s): CL 203, CL 207, FE 24203, FE 24207, FE 24301
Co- requisite(s):
Credits: L:3 T:00 P:00
Class schedule per week: 03
Class: B. Tech
Semester / Level: VII/04
Branch: Food Engineering and Technology
Name of Teacher:

Course Objectives

This course enables the students:

1.	To acquaint and equip the students with the design features of different food processing equipments being used in the industries and with the layout, planning of different food and processing plants.
2.	To acquire basic understanding of design parameter, complete knowledge of design procedures for commonly used process equipment and their attachments
3.	To give comprehensive understanding of Performance characteristics f different food equipments
4.	To provide knowhow the design of storage vessels for liquid food and grains
5.	To acquire basic understanding of design parameter of heat exchanger and evaporators

Course Outcomes

After the completion of this course, students will be able to:

CO 1	Illustrate the basics of process equipment design and important parameters of equipment design
CO 2	Outline the design of internal pressure vessels and external pressure vessels
CO 3	Ability to analyze Performance characteristics f different food equipments
CO 4	Describe different equipment fabrication and testing methods
CO 5	Ability to analyze design features of different food processing equipments being used in the industries and with the layout, planning of different food and processing plants.

SYLLABUS

MODULE	NO. OF LECTURE HOURS
Module 1: Introduction: Physical properties of food materials and energy balance calculations for preliminary estimation of plant capacity and equipment sizes. Preparation of flow sheets for material movement and utility consumption in food plant. Materials of construction: welding and machining of stainless steel. Fabrication of equipment. Performance characteristics and selection of fans, blowers, ejector compressors and vacuum pumps.	8

Design of Pressure Vessels, Storage Tanks and Pulper: Application of engineering principles related to design and selection of food processing equipment, Design of pressure vessels and pipe lines, Design aspects of storage tanks. Design of sterilizers and process vats, Design of pulper and crushers, Design considerations, Materials of construction, Installation and operation	
Module 2: **Design Of Mixing, Size Reduction and Conveying Equipments:** Design consideration of mixing and blending equipment. Design of agitators and scale up, Operation and maintenance. Design consideration of size reduction equipment, Installation and maintenance, Design consideration of material conveying equipment, Belt conveyor, Screw conveyor, Bucket elevator. Pneumatic conveyor.	8
Module 3: Design of fluid conveyance system: pipe, sanitary pipe fitting and valves. Performance characteristics and selection of centrifugal and positive displacement sanitary pumps. Design of CIP system. **Design of Cold Storage and Freezers:** Design of pre cooler, Hydro cooling and forced air cooling. Design of cold storage, Factors to be considered. Estimation of cooling load. Construction and operation-construction, installation and maintenance of cold storage. Design consideration for controlled atmospheric storage and modified atmospheric storage of perishables, Design of freezers, Types of freezers, Design considerations, Construction and operation, Design of frozen storage. Installation and operation.	8
Module 4: Design of Filters, Heat Exchangers and Evaporators: Design of filtration process, Installation, Operation, Design consideration of membrane separation process, Ultra filtration, Reverse osmosis. Design of heat exchangers, Plate heat exchanger, Shell and tube heat exchangers, Design of finned type heat exchanger, Materials of construction, Installation and operation, Design of single effect evaporators, Applications, Multiple Effect evaporators, Installation and maintenance.	8
Module 5: Design of Dryers: Cabinet dryer, Fluidized bed dryer, Vacuum dryer, Foam mat dryer and freeze dryer, Design considerations, Installation, Operation and Maintenance, Design of Extruders, Design considerations of food extruders. Single and twin-screw extruders, Installation, Operation and maintenance of food extruders. Design considerations for location of food plant. Equipment layout and ventilation in food process plants.	8

TEXT BOOKS:

1. C. B. Richey. "Agricultural Engineer's Hand Book", 5" edition, McGraw Hill, 1961
2. RT Toledo, Fundamentals of Food Process Engineening", 3" edition, Springer, 1999

References:

1. D. Q. Kern, Process Heat Transfer,McgrawHill
2. J. H. Perry, Chemical Engineers Handbook, McgrawHill
3.. Howerd F. Rase Piping design for process plant, JohnWilley.
4. Stanley M. Walas Chemical Process Equipments , Butterworth, Heinemann.
5. Coulson and Richardson Chemical Engineering Design Vol-6, Butterworth, Heinemann
6. T. Ahmed, "Dairy Plant Engineering and Management", 4" edition, Kitab Mahal, 1997.
7. A. Chakraverty, "Post-harvest Technology of Cereals, Pulses and Oilseeds", 3" edition, Oxford and IBH Publishing, 1981.
8 C. W. Hall and D. C. Davis, "Processing Equipment for Agricultural Products", 2 edition, AVI Publisher, 1979

Gaps in the syllabus (to meet Industry/Profession requirements)

POs met through Gaps in the Syllabus

Topics beyond syllabus/Advanced topics/Design

POs met through Topics beyond syllabus/Advanced topics/Design

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
First Quiz	10
Mid Semester Examination	25
Second quiz/seminar/assignment/others	10
Teacher's Assessment	5
End Semester Examination	50

Indirect Assessment –

1.Student Feedback on Course Outcome

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO 1	3	3	2	3	3	3	3	2	3	2	2	3	3	3
CO 2	3	2	2	2	3	3	3	2	3	2	2	3	3	3
CO 3	3	2	3	2	2	3	2	2	3	3	1	3	3	3
CO 4	2	2	3	3	3	3	2	3	3	3	2	3	3	3
CO 5	3	2	3	2	2	3	2	3	3	2	3	3	3	3

Correlation Levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Mapping Between COs and Course Delivery (CD) methods

CD Code	Course Delivery methods	Course Outcome	Course Delivery Method Used
CD 1	Lecture by use of boards/LCD projectors/OHP projectors	CO1	CD1, CD2, CD8
CD 2	Tutorials/Assignments	CO2	CD1, CD2, CD8
CD 3	Seminars	CO3	CD1, CD2, CD4, CD8
CD 4	Mini projects/Projects	CO4	CD1, CD2, CD4, CD8
CD 5	Laboratory experiments/teaching aids	CO5	CD1, CD2, CD4, CD8
CD 6	Industrial/guest lectures		
CD 7	Industrial visits/in-plant training		
CD 8	Self- learning such as use of NPTEL materials and internets		
CD 9	Simulation		

VOC-I

COURSE INFORMATION SHEET

Course code: **FE24102**
Course title: **Basics of Food Processing Preservation**
Pre-requisite(s):
Co- requisite(s):
Credits: 3 **L:01 T:00 P:04**
Class schedule per week: **3**
Class:
Semester / Level: **2/01**
Branch: **Food Engineering and Technology**
Name of Teacher:

Course Objectives

This course deals with the techniques and principles involved in processing and preserving food substances. The course is an important one and job orienting in nature opens many career scopes after its completion.

This course enables the students:

1.	To develop knowledge of preserving food to prevent wastages and losses
2.	To develop knowledge of cereal grain processing techniques.
3.	To build practical knowledge to various methods of food processing.
4.	To build practical knowledge oil seed processing and preservation techniques.
5.	To build practical knowledge poultry handling and processing techniques.

Course Outcomes

After completion of this course, the student will be able to:

1.	Apply the principles and methods involved in the processing of different foods and discuss the processing of cereals and pulses.
2.	Compare various course cereal grain processing techniques.
3.	Discuss pulse processing, preservation and value addition techniques.
4.	Identify oil seed processing and preservation techniques.
5.	Explain meat, fish and poultry handling and processing techniques.

Syllabus

MODULE	NO. OF LECTURE HOURS
Module 1: Processing of foods: Primary, secondary and tertiary processing, traditional technologies used in processing. Processing parameters and their effects on the components, properties and nutritional value of foods. Processing of cereal, pulses and oilseeds: wheat milling, rice milling, processing of corn, barley and millets, processing of various types of pulses and oilseeds. Milk and milk products: collection, standardization, pasteurization, homogenization and UHT processing. Manufacturing processes for paneer, khoa, curd, yogurt, cream, butter, cheese, ghee, flavoured milk, ice creams and dehydrated milk products.	**8**
Module 2: Fruits and vegetables: Post harvest handling and storage (physiological and bio chemical changes) during ripening. Methods of F&V processing, products their specifications and standards.Meat, fish and poultry: Ageing, tenderizing, curing, smoking, freezing and storage of meat and meat based products. Fish processing procedures like drying, canning, pickling and storage. Processing of poultry and eggs (storage, frozen egg, dehydrated egg powder etc.)	**8**

LABORATORY EXPERIMENTS

1. Drying of fresh fruits and vegetables.
2. Preparation of beverages from seasonal fruits.
3. Preparation of pickled fruits and vegetable products.
4. Preparation of Nutritious Balls and Chikki.
5. Preparation of Khoa, Paneer, Rasagulla and other sweets.
6. Preparation of cereal based snacks and extruded products.
6. Preparation of Mutton Cullet, Fish Finger and Chicken Pie.
7. Preparation of dehydrated egg powder.
8. Milling of wheat and rice.

Text Books:

1. Desrosier N W and Desrosier J N (1987) The Technology of Food Preservation, 4th Edition, CBS, New Delhi.
2. Fellows P J (2000) Food Processing Technology: Principles and Practice 2nd edition CRC Woodhead Publishing Ltd., Cambridge.
Fruit and Vegetable Preservation Principles and practices 3rd ed. by RP Srivastava and Sanjeev Kumar. CBS Publishers & Distributors, CBS 2014. ISBN: 978-81-239-2437-3

References:

1. KhetarpaulNeelam (2005) Food Processing and Preservation, Daya Publications, New Delhi.
2. Salunke D K and Kadam S (1995) Hand book of Food Science and Technology production, composition, storage and processing, Marcel Dekker INC, New York.
3. Sivasankar B (2002) Food Processing & Preservation, Prentice Hall, India

Gaps in the syllabus (to meet Industry/Profession requirements)

Industrial visit and designing of operational flow diagram of respective food industry

POs met through Gaps in the Syllabus

Topics beyond syllabus/Advanced topics/Design

POs met through Topics beyond syllabus/Advanced topics/Design

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Indirect Assessment –

1.Student Feedback on Course Outcome

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO 1	3	1	3	3	1	1	2	1	2	1	3	3	3	3
CO 2	3	1	3	3	2	2	3	1	2	1	3	3	3	3
CO 3	3	1	3	3	2	1	2	1	2	1	3	3	3	3
CO 4	3	1	3	3	1	2	2	1	2	1	3	3	3	3
CO 5	3	1	3	3	1	1	2	1	2	1	3	3	3	3

Correlation Levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Mapping Between COs and Course Delivery (CD) methods

CD Code	Course Delivery methods	Course Outcome	Course Delivery Method Used
CD 1	Lecture by use of boards/LCD projectors/OHP projectors	CO1	CD1, CD2, CD8
CD 2	Tutorials/Assignments	CO2	CD1, CD2, CD8
CD 3	Seminars	CO3	CD1, CD2, CD4, CD8
CD 4	Mini projects/Projects	CO4	CD1, CD2, CD4, CD8
CD 5	Laboratory experiments/teaching aids	CO5	CD1, CD2, CD4, CD8
CD 6	Industrial/guest lectures		
CD 7	Industrial visits/in-plant training		
CD 8	Self- learning such as use of NPTEL materials and internets		
CD 9	Simulation		

VOC-II
COURSE INFORMATION SHEET

Course code: **FE24104**
Course title: **Basics of Food Analysis**
Pre-requisite(s):
Co- requisite(s):
Credits:3 **L:01 T:00 P:04**
Class schedule per week: **3**
Class:
Semester / Level: **2/01**
Branch: **Food Engineering and Technology**
Name of Teacher:

Course Objectives

This course deals with the techniques and principals involved in processing and preserving food substances. The course is an important one and job orienting in nature opens many career scopes after its completion.

This course enables the students:

1.	To develop knowledge of formulating strategies in sensory analysis.
2.	To develop knowledge of assessing quality attributes of food.
3.	To build practical knowledge different additives and their uses as per product requirement.
4.	To build practical knowledge instrumentation analysis techniques
5.	To build practical knowledge applying the laws related with food.

The main objective of this course is to impart knowledge and skills related to analysis of different food products.

Course Outcomes
After successful completion of this course, the student will be able to:

1.	Formulate strategies in sensory analysis.
2.	Assess quality attributes of food.
3.	Able to identify different additives and their uses as per product requirement.
4.	Apply instrumentation analysis techniques in food sector.
5.	Compile and apply the laws related with food.

Syllabus

MODULE	NO. OF LECTURE HOURS
Quality attributes of foods: Food size and shape, colour and gloss, texture – Visual and objectively measurable attributes. Aroma of foods: Introductory ideas, formation and chemistry of food additives, role of ingredients on the taste development. Instrumental techniques: Principles, working mechanism of HPLC, GC, FTIR, Bomb calorrimetry XRD,ICP/AAS	**8**
Introduction to sensory evaluation of food, panel section, methods of sensory analysis, recent development in sensory science. National and international food laws and regulations (FSSAI, BIS, Agmark and FDA).	**8**

LABORATORY EXPERIMENTS

1. Estimation of acidity in milk by Alizarin – Alcohol test.
2. Determination of specific gravity, SNF % and TS% in milk.
3. Estimation the milk fat by Gerber method.
4. Determination of vitamin C in fruit beverages.
5. Sensory evaluation of milk and milk products.
6. Sensory evaluation of fruits and vegetable products.
7. Determination of sugar content in fruits and vegetable products
8. Textural analysis of food products.
9. Qualitative analysis of meat and meat products.

Text book

Pearson D (2002). The Chemical Analysis of Foods, Churchill Livingstone, New York.

Reference Books

Mahindru SN (2000). Food additives.Characteristics, detection and estimation. Tata McGraw-Hill Publishing Company Limited, New Delhi.

Nielsen SS (2004).Introduction to the chemical analysis of foods, Jones and Bartlett Publishers, Boston, London.

Sharma BK (2004). Instrumental Methods of Chemical Analysis, Goel Publishing House, New Delhi.

Gaps in the syllabus (to meet Industry/Profession requirements)

POs met through Gaps in the Syllabus

Topics beyond syllabus/Advanced topics/Design

POs met through Topics beyond syllabus/Advanced topics/Design

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**1**	**2**	**3**
CO 1	3	3	2	3	3	3	3	1	1	1	3	3	3	3
CO 2	3	3	2	3	3	3	3	1	1	1	3	3	3	3
CO 3	3	2	3	3	3	3	3	1	2	2	3	3	3	3

CO 4	3	3	3	3	3	3	3	1	2	2	3	3	3	3
CO 5	3	3	3	3	3	3	3	1	2	2	3	3	3	3

Correlation Levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Mapping Between COs and Course Delivery (CD) methods

CD Code	Course Delivery methods	Course Outcome	Course Delivery Method Used
CD1	Lecture by use of boards/LCD projectors/OHP projectors	CO1	CD4, CD5, CD7, CD8
CD2	Tutorials/Assignments	CO2	CD4, CD5, CD7, CD8
CD3	Seminars	CO3	CD4, CD5, CD7, CD8
CD4	Mini projects/Projects	CO4	CD4, CD5, CD7, CD8
CD5	Laboratory experiments/teaching aids	CO5	CD4, CD5, CD7, CD8
CD6	Industrial/guest lectures		
CD7	Industrial visits/in-plant training		
CD8	Self- learning such as use of NPTEL materials and internets		
CD9	Simulation		

VOC-III
COURSE INFORMATION SHEET

Course code: **FE 24252**
Course title: **Food Microbiology & Safety**
Pre-requisite(s):
Co- requisite(s):
Credits: 3 **L:01 T:00 P:04**
Class schedule per week: **3**
Class:
Semester / Level: **4/02**
Branch: **Food Engineering and Technology**
Name of Teacher:

Course Objectives

This course will enable the students to understand the native microbes present in food, industrial microbiology and their importance in food quality control.
This course enables the students:

1	To interpret the principles of Food Microbiology.
2.	To experiment with the microbes in relation to food spoilage, food-borne diseases and food preservation
3.	To interpret the role and significance of intrinsic and extrinsic factors on growth and response of microorganisms in foods.
4.	To assess microbial quality of food items.
5.	To infer the different microbes and their commercial uses as per product requirement

Course outcome
Students will be able to:

1.	Understanding the basics of food microbiology and role of microorganism in the food industry
2.	Evaluate and compare causes of food deterioration and food borne illness
3.	Apply various control measures to increase product shelf life
4.	Assess microbial quality of food items.
5.	Identify different microbes and their commercial uses as per product requirement.

Syllabus

MODULE	NO. OF LECTURE HOURS
Module 1: Introduction to food microbiology, classification of microorganisms (yeast, moulds, bacteria and viruses), current status, role of food microbes, sources of microorganisms in food. Changes caused by microorganisms. Introduction to food microbiology, classification of microorganisms (yeast, moulds, bacteria and viruses), current status, role of food microbes, sources of microorganisms in food. Changes caused by microorganisms. Growth and survival of microorganisms in foods, biological, chemical and physical changes caused by microorganisms, physical and chemical methods to control microorganisms. Important microbes in food, microbial growth characteristics - Microbial reproduction, nature of growth in food. Food hygiene and sanitation: Contamination during handling and processing and its control; indicator organisms.	8
Module 2: Spoilage in different food groups. i.e., Spoilage of Fruits, Vegetables, and their Products Spoilage of Dairy Products Factors influencing microbial growth in food. Beneficial uses of microorganisms, microorganisms used in food fermentation, application of microorganisms as probiotics, food bio preservatives. Newer Methods for Controlling Spoilage of Food.Predictive Modelling for Food Spoilage, Foodborne Outbreaks- Bacterial Agents for Foodborne Illnesses Fungal and Algal Agents for Foodborne Illnesses, Foodborne Animal Parasites, Principles of Hygiene and Sanitation in Food Service Establishment. Food Safety Laws Food Safety and Quality Management System, Principles and Guidelines for Conducting Microbiological Risk of Food.	8

LABORATORY EXPERIMENTS

1. Introduction to Food Microbiology and Laboratory Safety
2. Use of autoclave, Laminar air flow
3. Functioning and use of compound microscope
4. Preparation and sterilization of nutrient broth
6. Cultivation and sub-culturing of microbes
7. Preparation of slant, stab and plates using nutrient agar
8. Simple staining, Gram Staining- Positive and Negative staining
9. Standard Plate Count of Milk and Foods

Books:

Frazier, W.C. and Westoff, D.C. (1996), Food Microbiology, Tata McGraw Hill Publishing Co. Ltd., New Delhi.

Pelczar, M. Jr.; Chan, E.C.S. and Kreig, N.R. (1993), Microbiology, Tata McGraw Hill Inc., New York.

Garbutt, J. (1998), Essentials of Food Microbiology, Arnold International Student's Edition, London.

Gaps in the syllabus (to meet Industry/Profession requirements)

POs met through Gaps in the Syllabus

Topics beyond syllabus/Advanced topics/Design

POs met through Topics beyond syllabus/Advanced topics/Design

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO 1	3	1	2	3	2	1	2	1	2	2	3	3	3	3
CO 2	3	2	2	3	2	2	3	1	2	2	3	3	3	3
CO 3	2	1	2	3	2	1	2	1	2	2	3	3	3	3
CO 4	3	1	2	3	2	1	2	1	1	1	3	3	3	3
CO 5	3	3	3	3	2	3	2	3	2	2	3	3	3	3

Correlation Levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Mapping Between COs and Course Delivery (CD) methods

CD Code	Course Delivery methods	Course Outcome	Course Delivery Method Used
CD 1	Lecture by use of boards/LCD projectors/OHP projectors	CO1	CD1, CD2, CD8
CD 2	Tutorials/Assignments	CO2	CD1, CD2, CD8
CD 3	Seminars	CO3	CD1, CD2, CD4, CD8
CD 4	Mini projects/Projects	CO4	CD1, CD2, CD4, CD8
CD 5	Laboratory experiments/teaching aids	CO5	CD1, CD2, CD4, CD8
CD 6	Industrial/guest lectures		
CD 7	Industrial visits/in-plant training		
CD 8	Self- learning such as use of NPTEL materials and internets		
CD 9	Simulation		

VOC-IV
COURSE INFORMATION SHEET

Course code: FE 24254
Course title: Food Chemistry and Quality Control
Pre-requisite(s):
Co- requisite(s):
Credits: 3 **L:01** **T:00** **P:04**
Class schedule per week: 3
Class:
Semester / Level: 4/02
Branch: Food Engineering and Technology
Name of Teacher:
Course Objectives

Students will be acquainted with properties and role of various constituents in foods, interaction and changes during processing.
This course enables the students:

This course enables the students:

1.	To interpret physico-chemical and bio-chemical properties of fresh as well as processed food.
2.	To explain the importance of proximate composition of food and its importance in human diet.
3.	To explain basics of food chemistry and role of nutrients in human health.
4.	To explain various methods to increase product shelf life by reducing chemical reactions.
5.	To interpret chemical interactions and reactions of food components and their effect on sensory, nutritional, and functional properties of foods, and how processing influences these properties.

Course outcome
Students will be able to:

1.	Understand the physico-chemical and bio-chemical properties of fresh as well as processed food.
2.	Understand the importance of proximate composition of food and its importance in human diet.
3.	Understand the basics of food chemistry and role of nutrients in human health.
4.	Able to apply various methods to increase product shelf life by reducing chemical reactions
5.	Apply the knowledge for analytical and processing methods.

Syllabus

MODULE	NO. OF LECTURE HOURS
Proximate composition of foods, water, Carbohydrate, (monosaccharides, disaccharides and polysaccharides). Chemistry of starch, glycogen, cellulose, gums and mucilage, crude fibre. Classification of proteins, Physical and chemical properties of proteins, Physical and Chemical properties of amino acids. Amino acid sequence in proteins, Structure of protein and conformation of proteins.	**8**
Enzymes: Role of enzymes in food processing, mechanism of enzyme action, factors influencing enzymatic activity, controlling enzyme action, enzymes added to food during processing, enzymatic browning. Classification of lipids, fats and oils, essential fatty acids, saponification number, acid numbers, iodine value, acetyl value,: Occurrence and chemistry of vitamins & minerals, food sources, deficiency, loss during storage and processing of foods. Natural pigments like chlorophyll, carotenoids, anthocyannics, anthoxanthins, flavonoids, tannins. Natural flavouring agents.	**8**

LABORATORY EXPERIMENTS

1. Qualitative test for proteins and fats/oils and their identification in unknown mixtures free fatty acid, Peroxide value, Saponification value, RM Number, Iodine value.
2. Quantitative estimation of proteins.
3. Estimation of vitamins
4. Analysis of edible common salt for MC, iodine and total chlorides.
5. To determine alcohol soluble and insoluble solids.
6. Proximate analysis of food.
7. Estimation of carbohydrates by Lane and Eynon method
8. Estimation of carbohydrates.

Books:

Food Chemistry Third Edition By Fennema, Marcel Dekker, Inc. New York • Basel • Hong Kong
The Chemistry of Food, 2nd Edition, Jan Velisek, Richard Koplik, Karel Cejpek, ISBN: 978-1-119-53764-9, Wiley-Blackwell
Aurand, L. W. and Wood, A. E. (1973). Food Chemistry. The AVI Publishing Co., Connecticut.
Belitz, H. D., Grosch, W. and Schieberler, P. (2004). Food Chemistry. Springer, Berlin.
DeMan, J. M. (1999). Principles of Food Chemistry. A Chapman and Hall Food Science Book, Aspen Publ., Inc., Gaithersburg, Maryland.
Gopalan, C., Rama Sastri, B.V., and Balasubramaniam, S.C. (1991). Nutritive value of Indian Foods. National Institute of Nutrition (NIN), Indian Council of Medical Research (ICMR), Hyderabad.
Meyer, L. H. (1976). Food Chemistry. Reinhold Publ. Corporation, New York.

Gaps in the syllabus (to meet Industry/Profession requirements) :

POs met through Gaps in the Syllabus

Topics beyond syllabus/Advanced topics/Design :

POs met through Topics beyond syllabus/Advanced topics/Design

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO 1	3	3	3	2	3	2	2	1	1	1	1	3	3	3
CO 2	3	3	3	2	3	2	2	1	1	1	1	3	3	3
CO 3	3	3	3	2	3	2	2	1	1	1	1	3	3	3
CO 4	3	3	3	2	3	2	2	1	1	1	1	3	3	3
CO 5	3	3	3	2	3	1	1	1	1	1	1	3	3	3

Correlation Levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Mapping Between COs and Course Delivery (CD) methods

CD Code	Course Delivery methods	Course Outcome	Course Delivery Method Used
CD 1	Lecture by use of boards/LCD projectors/OHP projectors	CO1	CD1, CD2, CD8
CD 2	Tutorials/Assignments	CO2	CD1, CD2, CD8
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CD 5	Laboratory experiments/teaching aids	CO5	CD1, CD2, CD8
CD 6	Industrial/guest lectures		
CD 7	Industrial visits/in-plant training		
CD 8	Self- learning such as use of NPTEL materials and internets		
CD 9	Simulation		