KPRIET

Learn Beyond

B.Tech.–Chemical Engineering

Curriculum and Syllabi

Regulations 2019

KPRIET
Learn Beyond

I. Vision and Mission of the Institute

Vision

To become a premier institute of academic excellence by imparting technical, intellectual and professional skills to students for meeting the diverse needs of the industry, society, the nation and the world at large.

Mission

- Commitment to offer value-based education and enhancement of practical skills
- Continuous assessment of teaching and learning process through scholarly activities
- Enriching research and innovative activities in collaboration with industry and institute of repute

II. Vision and Mission of the Department

Vision

To produce engineers of high academic standards in all aspects of the engineering profession by providing quality education through research and innovation thereby improving their skills to compete globally.

Mission

- To provide a comprehensive learning ambience and an industry driven and dynamic academic program to train the students in basic sciences, chemical and related engineering fields and to inculcate professional ethical practices.
- To encourage principles of professional ethics, sustainability and stimulate the evolution of environmental friendly techniques for the benefit of the society.
- To motivate students to be professionally vibrant and versatile
- To promote qualities of leadership and teamwork in students to become successful entrepreneurs.

III. Program Educational Objectives (PEOs)

Graduates of B.Tech Chemical engineering will

PEO1: Apply principles of mathematics, science and engineering to analyze and solve problems encountered in chemical engineering and related areas

PEO2: Think critically and creatively, especially about the use of technology to address local and global problems and become a socially responsible engineers by involving with community and professional organizations

PEO3: Exhibit professional, ethical codes of conduct, team work and continuous learning for altering to the ever changing needs of the society.

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IV. Program Outcomes (POs)

Graduates of B.Tech Chemical Engineering will be able to

PO 1 Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO 2 Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO 3 Design and Development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO 4 Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO 5 Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

PO 6 Engineer and society: Apply reasoning informed by the contextual knowledge to access societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO 7 Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO 8 Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO 9 Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO 10 Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO 11 Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO 12 Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

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V. Program Specific Outcomes (PSOs)

Graduates of B.Tech Chemical Engineering will

PSO 1: Acquire the necessary skill, knowledge and competence on the principles of chemical engineering

PSO 2: Adopt Chemical engineering principles with advanced and innovative practices for process and product development.

VI. PEO/PO Mapping

Following three levels of correlation should be used:

1: Low

2: Medium

3: High

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
PEO1	3	3	1	2	-	-	-	-	-	-	-	-
PEO2	-	-	2	1	2	3	2	-	2	2	-	-
PEO3	-	-	-	-	-	2	2	3	3	2	2	2

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VII. Mapping of Course Outcomes with Program Outcomes

SEM	Subject	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
SEM I	Language Elective I*	-	-	-	-	-	✓	✓	-	✓	✓	-	-	-	-
	Calculus and Differential Equations	✓	✓	-	-	-	-	-	-	-	-	-	✓	-	-
	Engineering Physics	✓	✓	✓	-	-	-	-	-	-	-	-	✓	-	-
	Engineering Chemistry – I	✓	✓	-	-	-	-	✓	-	✓	✓	-	✓	-	-
	Basics of Mechanical Engineering	✓	-	-	-	✓	✓	✓	-	-	-	-	-	-	-
	Engineering Graphics	✓	✓	-	-	✓	-	-	-	-	✓	-	✓	✓	-
	Workshop	✓	✓	✓	-	✓	-	-	-	-	-	-	-	✓	✓
SEM II	Language Elective II**	-	-	-	-	-	✓	✓	✓	✓	✓	-	✓	-	-
	Complex Variables and Laplace Transforms	✓	✓	-	-	-	-	-	-	-	-	-	✓	✓	-
	Physics for Chemical Engineers	✓	✓	✓	-	-	-	-	-	-	-	-	✓	-	-
	Chemistry for Technologists	✓	✓	-	-	-	-	✓	-	-	-	-	✓	-	-
	Basics of Electrical Engineering	✓	✓	✓	✓	-	-	-	✓	✓	✓	-	✓	✓	✓
	Basics of Electronics Engineering	✓	✓	✓	–	-	–	-	✓	✓	✓	–	✓	-	-
	Programming in C	✓	✓	✓	-	-	-	-	-	-	-	-	✓	-	-
SEM III	Probability and Statistics	✓	✓	-	-	-	-	-	-	-	-	-	✓	-	-
	Process Calculations	✓	✓	✓	-	-	-	-	-	-	-	-	✓	✓	✓

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	Fluid Mechanics for Chemical Engineers	✓	✓	✓	✓	✓	-	–	–	–	–	–	-	✓	✓
	Environmental Science and	✓	-	-	-	-	-	✓	✓	✓	✓	-	-	✓	✓
	Industrial Organic Chemistry	✓	✓	-	✓	-	-	✓	-	✓	✓	-	✓	-	-
	Computational Thinking	✓	✓	✓	✓	✓	-	-	-	-	-	-	✓	-	-
	Organic Chemistry Laboratory	✓	✓	-	✓	-	-	-	-	✓	✓	-	✓	-	-
SEM IV	Partial Differential Equations	✓	✓	-	-	-	-	-	-	-	-	-	✓	-	-
	Heat Transfer	✓	✓	✓	✓	✓	✓	✓	–	–	–	–	-	✓	✓
	Chemical Engineering Thermodynamics I	✓	✓	✓	-	–	–	-	-	–	-	–	-	✓	✓
	Mechanical Operations	✓	✓	✓	-	-	-	-	-	-	-	-	✓	✓	-
	Fluid Mechanics Laboratory	✓	✓	✓	✓	✓	-	-	-	-	-	-	-	✓	✓
	NAVA-I	✓	-	-	-	-	-	-	-	-	✓	-	-	-	-
SEM V	Numerical methods	✓	✓	-	-	-	-	-	-	-	-	-	✓	-	-
	Mass Transfer I	✓	✓	✓	✓	-	-	-	✓	✓	✓	-	✓	✓	✓
	Chemical Engineering Thermodynamics II	✓	✓	-	-	✓	-	-	-	-	✓	-	-	✓	✓
	Chemical Reaction Engineering	✓	✓	✓	✓	-	-	-	-	✓	✓	-	-	✓	✓
	Material Science and Technology	✓	✓	✓	-	✓	-	-	-	-	-	-	-	✓	✓
	Chemical Reaction Engineering Laboratory	✓	✓	✓	✓	-	-	-	-	-	-	-	-	-	-
	Technical Seminar	✓	✓	✓	✓	✓	✓		✓	✓	✓		✓	✓	✓
	NAVA-II	✓	-	-	-	-	-	-	-	-	✓	-	-	-	-
SEM VI	Mass Transfer II	✓	✓	✓	✓	-	-	-	✓	✓	✓	-	✓	✓	✓
	Chemical Process Industries	✓	✓	✓	-	-	-	✓	–	✓	✓	-	✓	✓	✓

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	Process Instrumentation,	✓	✓	✓	-	-	-	-	-	-	-	-	✓	✓	✓
	Process Control Laboratory	✓	✓	✓	-	✓	-	-	-	-	-	-	✓	✓	✓
	Mass Transfer Laboratory	✓	✓	-	✓	-	-	-	-	✓	-	-	✓	✓	
	Mini Project-I*	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
SEM VII	Process Equipment Design	✓	✓	✓	-	✓	-	-	-	-	-	-	-	✓	✓
	Process Engineering Economics	✓	✓	✓	-	✓	-	-	-	-	-	-	-	✓	✓
	Total Quality Management	✓	✓	✓	-	✓	-	-	-	-	-	-	-	✓	✓
	Design and Simulation Laboratory	-	-	-	✓	✓	-	-	-	-	-	✓	✓	✓	✓
	Mini Project II	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	Project Work	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
TRACK I	Polymer Science and Engineering	✓	✓	-	✓	-	✓	-	-	-	-	-	-	-	-
	Water Conservation & Management	✓	✓	-	-	✓	✓	✓	✓	-	-	-	-	-	-
	Modern Separation Techniques	✓	✓	✓	✓	✓	-	-	✓	-	-	-	-	-	-
	Chemical Metallurgy	✓	✓	✓	-	✓	-	-	-	-	-	-	-	✓	✓
	Fluidization Engineering	✓	✓	-	-	✓	-	-	-	-	✓	-	-	✓	✓
	Process Plant Utilities	✓	✓		-	-	✓	✓	✓	✓	✓	-	-	✓	✓
	Transport Phenomena	✓	✓	✓	-	-	-	-	-	-	-	-	✓	✓	✓
	Pulp and Paper Technology	✓	✓	✓	✓	-	-	-	✓	✓	✓	-	✓	✓	✓
	Energy Technology	✓	-	-	-	-	✓	✓	✓	✓	-	-	-	✓	-
	Industrial safety	✓	✓	-	-	-	✓	-	-	-	-	-	-	-	-

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TR ACK II	Enzyme Engineering	✓	✓	✓	✓	-	-	-	✓	✓	✓	-	✓	✓	✓
	Biochemical Engineering	✓	✓	✓	✓	-	-	-	✓	✓	✓	-	✓	✓	✓
	Fermentation Engineering	✓	✓	✓	✓	-	-	-	✓	✓	✓	-	✓	✓	✓
	Drugs and Pharmaceutical Technology	✓	✓	✓	✓	-	-	-	✓	✓	✓	-	✓	✓	✓
	Nanotechnology and Nanoscience	✓	-	-	-	-	✓	✓	✓	✓	-	-	-	✓	✓
	Fertilizer Technology	✓	✓	-	-	✓	-	-	-	-	-	-	-	✓	✓
TRACK III	Petroleum Refining and Petrochemicals	✓	-	-	-	-	-	-	-	-	-	-	-	✓	-
	Piping and Instrumentation in Chemical Plants	✓	✓	✓	-	-	-	-	-	-	-	-	-	✓	✓
	Corrosion Engineering	✓	✓	✓	✓	✓	✓	-	-	-	-	-	-	-	-
	Oil and Gas Engineering	✓	✓	-	-	-	-	-	-	-	-	-	-	-	-
	Application of Membrane Process	✓	-	-	-	-	✓	✓	-	-	-	-	-	✓	✓
	Supply Chain Management	✓	✓	-	-	-	✓	-	-	-	-	-	-	-	-
TRACK IV	Computer Applications in Chemical Engineering	✓	✓	✓		✓	-	-	-	-	-	-	✓	✓	-
	Process Modeling and Simulation	✓	✓	✓	✓	✓	-	-	-	-	-	-	-	✓	✓
	Computational Fluid Dynamics	✓	✓	✓	✓	✓	-	-	-	-	✓	-	-	✓	✓
	Problem solving and python programming	✓	✓	✓	-	-	-	-	✓	✓	✓	-	✓	-	-
	Artificial Intelligence in Chemical Engineering	✓	✓	✓	-	✓	-	-	-	-	-	-	-	✓	✓

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B.Tech. CHEMICAL ENGINEERING

REGULATIONS – 2019

CHOICE BASED CREDIT SYSTEM

CURRICULUM FOR I TO VIII SEMESTERS

SEMESTER I

SL.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	C
THEORY							
1		Language Elective I*	HSM	1	0	2	2
2	U19MA101	Calculus and Differential Equations	BS	3	1	0	4
3	U19PH101	Engineering Physics	BS	2	0	2	3
4	U19CY101	Engineering Chemistry – I	BS	2	0	2	3
5	U19MEG04	Basics of Mechanical Engineering	ES	3	0	0	3
PRACTICALS							
6	U19MEG01	Engineering Graphics	ES	1	0	4	3
7	U19MEG05	Workshop	ES	0	0	4	2
			TOTAL	**12**	**1**	**14**	**20**

*** U19LE101-Basic English/ U19LE102-Communicative English**

SEMESTER II

SL.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	C
THEORY							
1		Language Elective II**	HSM	1	0	2	2
2	U19MA201	Complex Variables and Laplace Transforms	BS	3	1	0	4
3	U19PH202	Physics for Chemical Engineers	BS	3	0	0	3
4	U19CY202	Chemistry for Technologists	BS	2	0	2	3
5	U19EEG01	Basics of Electrical Engineering	ES	2	0	2	3
6	U19ECG01	Basics of Electronics Engineering	ES	2	0	2	3
7	U19CSG03	Programming in C	ES	2	0	2	3
			TOTAL	**15**	**1**	**10**	**21**

**** U19LE201- Advanced Communicative English/ Other languages**

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SEMESTER III

SL.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	C
		THEORY					
1	U19MA302	Probability and Statistics	BS	3	1	0	4
2	U19CH301	Process Calculations	PC	3	1	0	4
3	U19CH302	Fluid Mechanics for Chemical Engineers	ES	2	1	0	3
4	U19CH303	Environmental Science and Engineering	PC	3	0	0	3
5	U19CH304	Industrial Organic Chemistry	PC	3	0	0	3
6	U19CSG02	Computational Thinking	ES	2	0	2	3
		PRACTICALS					
7	U19CY301	Organic Chemistry Laboratory	BS	0	0	4	2
			TOTAL	**16**	**3**	**6**	**22**

SEMESTER IV

SL.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	C
		THEORY					
1	U19MA402	Partial Differential Equations	BS	2	0	0	2
2	U19CH401	Heat Transfer	PC	3	0	2	4
3	U19CH402	Chemical Engineering Thermodynamics I	PC	2	1	0	3
4	U19CH403	Mechanical Operations	PC	2	0	2	3
5	-	Professional Elective I	PE	3	0	0	3
6	-	Professional Elective II	PE	3	0	0	3
		PRACTICALS					
7	U19CH404	Fluid Mechanics Laboratory	ES	0	0	4	2
8	U19CA001	Numerical Aptitude & Verbal Ability I	EEC	1	0	0	1
			TOTAL	**16**	**1**	**8**	**21**

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SEMESTER V

SL.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	C
		THEORY					
1	U19MA502	Numerical methods	BS	2	0	0	2
2	U19CH501	Mass Transfer I	PC	3	0	0	3
3	U19CH502	Chemical Engineering Thermodynamics II	PC	2	1	0	3
4	U19CH503	Chemical Reaction Engineering	PC	3	1	0	4
	U19CH504	Material Science and Technology	PC	2	0	0	2
5	-	Open Elective I	OE	3	0	0	3
		PRACTICALS					
6	U19CH505	Chemical Reaction Engineering Laboratory	PC	0	0	4	2
7	U19CH506	Technical Seminar	EEC	0	0	2	1
8	U19CA002	Numerical Aptitude & Verbal Ability II	EEC	1	0	0	1
			TOTAL	16	2	6	21

SEMESTER VI

SL.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	C
		THEORY					
1	U19CH601	Mass Transfer II	PC	3	1	0	4
2	U19CH602	Chemical Process Industries	PC	3	0	0	3
3	U19CH603	Process Instrumentation, Dynamics and Control	PC	3	0	0	3
4	-	Professional Elective-III	PE	3	0	0	3
5	-	Open Elective II	OE	3	0	0	3
		PRACTICALS					
6	U19CH604	Process Control Laboratory	PC	0	0	4	2
7	U19CH605	Mass Transfer Laboratory	PC	0	0	4	2
8	U19CH606	Mini Project-I*	EEC	0	0	2	1
			TOTAL	15	1	10	21

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SEMESTER VII

SL.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	C
		THEORY					
1	U19CH701	Process Equipment Design	PC	2	0	2	3
2	U19CH702	Process Engineering Economics	HSM	3	0	0	3
3	U19CH703	Total Quality Management	HSM	3	0	0	3
4	-	Professional Elective IV	PE	3	0	0	3
5	-	Open Elective III	OE	3	0	0	3
6	-	Open Elective IV	OE	3	0	0	3
		PRACTICALS					
7	U19CH704	Design and Simulation Laboratory	PC	0	0	4	2
8	U19CH705	Mini Project II	EEC	0	0	2	1
			TOTAL	**17**	**0**	**8**	**21**

SEMESTER VIII

SL.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	C
		THEORY					
1	-	Professional Elective V	PE	3	0	0	3
2	-	Professional Elective VI	PE	3	0	0	3
		PRACTICALS					
6	U19CH801	Project Work	EEC	0	0	20	10
			TOTAL	**6**	**0**	**20**	**16**

INDUSTRIAL INTERNSHIP

Sl.No.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	C
1	U19CHI01	Industrial Training / Internship *(4 Weeks)	EEC	0	0	0	2
			TOTAL	**0**	**0**	**0**	**2**

*Four Weeks during any semester vacation from III to VI Semester

TOTAL CREDITS: 165

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SUBJECT AREAWISE DETAILS

TRACK I

DESIGN & MANUFACTURING						
Sl.No.	COURSE CODE	COURSE TITLE	L	T	P	C
1	U19CHP05	Polymer Science and Engineering	3	0	0	3
2	U19CHP07	Water Conservation & Management	3	0	0	3
3	U19CHP13	Modern Separation Techniques	3	0	0	3
4	U19CHP15	Chemical Metallurgy	3	0	0	3
5	U19CHP16	Fluidization Engineering	3	0	0	3
6	U19CHP18	Process Plant Utilities	3	0	0	3
7	U19CHP21	Transport Phenomena	3	0	0	3
8	U19CHP29	Industrial safety	3	0	0	3
9	U19CHP31	Pulp and Paper Technology	3	0	0	3
10	U19CHP32	Energy Technology	3	0	0	3

TRACK II

BIOPROCESS ENGINEERING						
Sl.No.	COURSE CODE	COURSE TITLE	L	T	P	C
1	U19CHP02	Enzyme Engineering	3	0	0	3
2	U19CHP22	Biochemical Engineering	3	0	0	3
3	U19CHP26	Fermentation Engineering	3	0	0	3
4	U19CHP23	Drugs and Pharmaceutical Technology	3	0	0	3
5	U19CHP24	Nanotechnology and Nanoscience	3	0	0	3
6	U19CHP33	Fertilizer Technology	3	0	0	3

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TRACK III

OILS, GAS & PETROCHEMICALS						
Sl.No.	COURSE CODE	COURSE TITLE	L	T	P	C
1	U19CHP03	Petroleum Refining and Petrochemicals	3	0	0	3
2	U19CHP20	Piping and Instrumentation in Chemical Plants	3	0	0	3
3	U19CHP27	Corrosion Engineering	3	0	0	3
4	U19CHP09	Oil and Gas Engineering	3	0	0	3
5	U19CHP34	Application of Membrane Process	3	0	0	3
6	U19CHP28	Supply Chain Management	3	0	0	3

TRACK IV

COMPUTATIONAL CHEMICAL ENGINEERING						
Sl.No.	COURSE CODE	COURSE TITLE	L	T	P	C
1	U19CHP10	Computer Applications in Chemical Engineering	3	0	0	3
2	U19CHP14	Process Modeling and Simulation	3	0	0	3
3	U19CHP25	Computational Fluid Dynamics	3	0	0	3
4	U19CHP08	Problem solving and python programming	3	0	0	3
5	U19CHP06	Artificial Intelligence in Chemical Engineering	3	0	0	3

HUMANITIES AND SOCIAL SCIENCES (HSM)

SL.NO.	COURSE CODE	COURSE TITLE	CATE-GORY	L	T	P	C
1	U19LE101	Basic English	HSM	1	0	2	2
2	U19LE102	Communicative English	HSM	1	0	2	2
3	U19LE201	Advanced Communicative English	HSM	1	0	2	2
4	U19CH702	Process Engineering Economics	HSM	3	0	0	3
5	U19CH703	Total Quality Management	HSM	3	0	0	3

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BASIC SCIENCES (BS)

SL.NO.	COURSE CODE	COURSE TITLE	CATE GORY	L	T	P	C
1	U19MA101	Calculus and Differential Equations	BS	3	1	0	4
2	U19PH101	Engineering Physics	BS	2	0	2	3
3	U19CY101	Engineering Chemistry – I	BS	2	0	2	3
4	U19MA201	Complex Variables and Laplace Transforms	BS	3	1	0	4
5	U19PH202	Physics for Chemical Engineers	BS	3	0	0	3
6	U19CY202	Chemistry for Technologists	BS	2	0	2	3
7	U19MA302	Probability and Statistics	BS	3	1	0	4
8	U19CY301	Organic Chemistry Laboratory	BS	0	0	4	2
9	U19MA402	Partial Differential Equations	BS	2	0	0	2
10	U19MA502	Numerical Methods	BS	2	0	0	2

ENGINEERING SCIENCES (ES)

SL.NO.	COURSE CODE	COURSE TITLE	CATE-GORY	L	T	P	C
1	U19MEG04	Basics of Mechanical Engineering	ES	3	0	0	3
2	U19MEG01	Engineering Graphics	ES	1	0	4	3
3	U19MEG05	Workshop	ES	0	0	4	2
4	U19EEG01	Basics of Electrical Engineering	ES	2	0	2	3
5	U19ECG01	Basics of Electronics Engineering	ES	2	0	2	3
6	U19CSG03	Programming in C	ES	2	0	2	3
7	U19CH302	Fluid Mechanics for Chemical Engineers	ES	2	1	0	3
8	U19CSG02	Computational Thinking	ES	2	0	2	3
9	U19CH404	Fluid Mechanics Laboratory	ES	0	0	4	2

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PROFESSIONAL CORE (PC)

SL.NO.	COURSE CODE	COURSE TITLE	CATE-GORY	L	T	P	C
1	U19CH301	Process Calculations	PC	3	1	0	4
2	U19CH303	Environmental Science and Engineering	PC	3	0	0	3
3	U19CH304	Industrial Organic Chemistry	PC	3	0	0	3
4	U19CH401	Heat Transfer	PC	3	0	2	4
5	U19CH402	Chemical Engineering Thermodynamics I	PC	2	1	0	3
6	U19CH403	Mechanical Operations	PC	2	0	2	3
7	U19CH501	Mass Transfer I	PC	3	0	0	3
8	U19CH502	Chemical Engineering Thermodynamics II	PC	2	1	0	3
9	U19CH503	Chemical Reaction Engineering	PC	3	1	0	4
10	U13CH504	Material Science and Technology	PC	2	0	0	2
11	U19CH505	Chemical Reaction Engineering Laboratory	PC	0	0	4	2
12	U19CH501	Mass Transfer II	PC	3	1	0	4
13	U19CH602	Chemical Process Industries	PC	3	0	0	3
14	U19CH603	Process Instrumentation, Dynamics and Control	PC	3	0	0	3
15	U19CH604	Process Control Laboratory	PC	0	0	4	2
16	U19CH605	Mass transfer Laboratory	PC	0	0	4	2
17	U19CH701	Process Equipment Design	PC	2	0	2	3
18	U19CH703	Design and Simulation Laboratory	PC	0	0	4	2

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PROFESSIONAL ELECTIVES (PE)

SL.NO.	COURSE CODE	COURSE TITLE	CATE-GORY	L	T	P	C
1	U19CHP01	Industrial Safety	PE	3	0	0	3
2	U19CHP02	Enzyme Engineering	PE	3	0	0	3
3	U19CHP03	Petroleum Refining and Petrochemicals	PE	3	0	0	3
4	U19CHP04	Food Technology	PE	3	0	0	3
5	U19CHP05	Polymer Science and Engineering	PE	3	0	0	3
6	U19CHP06	Artificial Intelligence in Chemical Engineering	PE	3	0	0	3
7	U19CHP07	Water Conservation & Management	PE	3	0	0	3
8	U19CHP08	Problem Solving and Python Programming	PE	3	0	0	3
9	U19CHP09	Oil and Gas Engineering	PE	3	0	0	3
10	U19CHP10	Computer Applications in Chemical Engineering	PE	3	0	0	3
11	U19CHP11	Professional Ethics in Engineering	PE	3	0	0	3
12	U19CHP12	Comprehension I	PE	3	0	0	3
13	U19CHP13	Modern Separation Techniques	PE	3	0	0	3
14	U19CHP14	Process Modeling and Simulation	PE	3	0	0	3
15	U19CHP15	Chemical Metallurgy	PE	3	0	0	3
16	U19CHP16	Fluidization Engineering	PE	3	0	0	3
17	U19CHP17	Instrument method of Analysis	PE	3	0	0	3
18	U19CHP18	Process Plant Utilities	PE	3	0	0	3
19	U19CHP19	Comprehension II	PE	3	0	0	3
20	U19CHP20	Piping and Instrumentation in Chemical Plants	PE	3	0	0	3
21	U19CHP21	Transport Phenomena	PE	3	0	0	3

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22	U19CHP22	Biochemical Engineering	PE	3	0	0	3
23	U19CHP23	Drugs and Pharmaceutical Technology	PE	3	0	0	3
24	U19CHP24	Nanotechnology and Nanoscience	PE	3	0	0	3
25	U19CHP25	Computational Fluid Dynamics	PE	3	0	0	3
26	U19CHP26	Fermentation Engineering	PE	3	0	0	3
27	U19CHP27	Corrosion Engineering	PE	3	0	0	3
28	U19CHP28	Supply Chain Management	PE	3	0	0	3
29	U19CHP29	Industrial Management	PE	3	0	0	3
30	U19CHP30	Sustainability Engineering	PE	3	0	0	3
31	U19CHP31	Pulp and Paper Technology	PE	3	0	0	3
32	U19CHP32	Energy Technology	PE	3	0	0	3
33	U19CHP33	Fertilizer Technology	PE	3	0	0	3
34	U19CHP34	Application of Membrane Process	PE	3	0	0	3

EMPLOYABILITY ENHANCEMENT COURSES (EEC)

SL.NO.	COURSE CODE	COURSE TITLE	CATE-GORY	L	T	P	C
1.	U19CA001	Numerical Aptitude & Verbal Ability I	EEC	1	0	0	1
2.	U19CH506	Technical Seminar	EEC	0	0	2	1
3.	U19CA002	Numerical Aptitude & Verbal Ability II	EEC	1	0	0	1
4.	U19CH606	Mini Project I	EEC	0	0	2	1
5.	U19CH705	Mini Project II	EEC	0	0	2	1
6.	U19CH801	Project Work	EEC	0	0	20	10
7.	-	Internship	EEC	0	0	0	2

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VIII. Scheme of Credit distribution – Summary

S.No	Stream	Credits/Semester								Credits	%	Suggested by AICTE
		I	II	III	IV	V	VI	VII	VIII			
1.	Humanities and Social Sciences including Management (HSM)	2	2	-	-	-	-	6	-	10	6.1%	12 ± 2
2.	Basic Sciences (BS)	10	10	6	2	2	-	-	-	30	18.2%	25 ± 3
3.	Engineering Sciences(ES)	8	9	6	2	-	-	-	-	25	15.1%	24
4.	Professional Core (PC)	-	-	10	10	14	14	5	-	53	32.1%	48
5.	Professional Elective (PE)	-	-	-	6	-	3	3	6	18	10.9%	18
6.	Open Electives (OE)	-	-	-	-	3	3	6	-	12	7.3%	18
7.	Employability Enhancement Courses (EEC)	-	-	-	1	2	1	1	10	15	10.3%	14 ± 2
8.	Industrial Training/ Internship	-	-	-	-	-	-	-	-	2		
9.	Mandatory Non-Credit Course (MNC)	-	-	-	-	-	-	-	-	-	-	-
Total		**20**	**22**	**21**	**22**	**21**	**23**	**18**	**16**	**165**	**100**	

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SEMESTER-I

U19LE102	COMMUNICATIVE ENGLISH	Category: HSM			
		L	T	P	C
		1	0	2	2

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To develop the ability to read, write and comprehend various texts.
- To enhance the listening skills to understand conversations and deliberations on diverse contexts.
- To make effective presentations and demonstrate concepts within a team.

UNIT I BASICS FOR COMMUNICATION 9

Active and Passive – Conditionals – Reported speech – Degrees of comparison – Phrases and clauses – Idioms – Kinds of sentences – Connectives and Discourse markers – Purpose statements

UNIT II LISTENING 9

Listening to TED talks – Listening to product description – Listening to orations – Listening to news – Radio based listening

UNIT III SPEAKING 9

Group discussion – Extempore – Technical seminar – Product and process description – Role play – Conversation and etiquettes – Short group conversation – Narrating a story – Formal and informal discussions

UNIT IV READING 9

Pre-reading and Post-reading – Intensive reading – Extensive reading – Newspaper reading – Reading longer texts – Reviewing company profile – Reading strategies – Interpreting visual graphics

UNIT V WRITING 9

Interpreting charts and graphs – Recommendations – Minutes of meeting – Job application and cover letter – Report writing – Drafting circulars (Business contexts)

LIST OF EXPERIMENTS

1. Listening to TED talks
2. Listening to product description
3. Listening to news
4. Radio based listening
5. Listening to oration
6. Self Introduction
7. Role play
8. Extempore
9. Presentation
10. Group discussion

Contact Periods:

Lecture: 15 Periods Tutorial: - Periods Practical: 30 Periods Total: 45 Perio

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TEXT BOOKS:

1. Mindscapes: English for Technologist and Engineers", Orient Black Swan, 2014
2. Sudharshana N P and Savitha C, "English for Technical Communication", Cambridge University Press, 2016

REFERENCES:

1. Murphy, Raymond, "Intermediate English Grammar", Cambridge University Press, 2009
2. Means, Thomas L, "English and Communication for Colleges", Cengage 2017
3. "Using English: A Course book for Undergraduate Engineers and Technologists" Orient Black Swan, 2017

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

COs	Statements	K-Level
CO1	Make use of relevant vocabulary in formal and informal contexts	Apply
CO2	Infer and exhibit the ability to listen various professional interactions	Understand
CO3	Express views and perceptions in a technical forum	Understand
CO4	Interpret a given text and relate the content effectively	Understand
CO5	Frame coherent and cohesive sentences in select contexts	Understand

COURSE ARTICULATION MATRIX:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	-	-	-	2	1	-	3	3	-	-	-	-
CO2	-	-	-	-	-	2	1	-	3	3	-	-	-	-
CO3	-	-	-	-	-	2	1	-	3	3	-	-	-	-
CO4	-	-	-	-	-	2	1	-	3	3	-	-	-	-
CO5	-	-	-	-	-	2	1	-	3	3	-	-	-	-
CO	-	-	-	-	-	2	1	-	3	3	-	-	-	-
Correlation levels:	1: Slight (Low)					2: Moderate (Medium)				3: Substantial (High)				

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SEMESTER-I

U19MA101	CALCULUS AND DIFFERENTIAL EQUATIONS	Category: BS			
		L	T	P	C
		3	1	0	4

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- Understand the concepts of matrices and calculus which will enable them to model and analyze physical phenomena involving continuous change
- Apply and summarize the methodologies involved in solving problems related to fundamental principles of calculus
- Develop confidence to model mathematical pattern and give appropriate solutions

UNIT I MATRICES **9 + 3**

Eigen values and Eigenvectors – Properties (without proof) – Cayley Hamilton theorem (without proof) – Diagonalization using orthogonal transformation – Applications : Elastic membrane

UNIT II DIFFERENTIAL CALCULUS **9 + 3**

Curvature – Radius of curvature (Cartesian form only) – Center of curvature – Circle of curvature – Evolute and Envelope of plane curves

UNIT III FUNCTIONS OF SEVERAL VARIABLES **9 + 3**

Partial derivatives – Total derivative – Jacobians – Taylor's series expansion – Extreme values of functions of two variables – Lagrange multipliers method

UNIT IV INTEGRAL CALCULUS **9 + 3**

Evaluation of definite and improper integrals – Applications of definite integrals – Surface areas – Volume of revolutions

UNIT V ORDINARY DIFFERENTIAL EQUATIONS **9 + 3**

Second and Higher order linear differential equations with constant coefficients – variable coefficients – Euler-Cauchy equation – Legendre's equation – Method of variation of parameters – Applications

Contact Periods:

Lecture: 45 Periods Tutorial: 15 Periods Practical: – Periods Total: 60 Periods

TEXT BOOKS:

1. Erwin Kreyszig, "Advanced Engineering Mathematics", 10th Edition Wiley India Pvt Ltd, New Delhi, 2018
2. Grewal B S, "Higher Engineering Mathematics", 44th Edition, Khanna Publishers, New Delhi, 2017

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REFERENCES:

1. Bali N P and Dr Manish Goyal, "A text book of Engineering Mathematics", 12th edition, Laxmi Publications,2016
2. Thomas G B and Finney R L, "Calculus and Analytic Geometry", 14th edition, Pearson Education India, 2018
3. Maurice D Weir, Joel Hass, Christopher Heil, "Thomas Calculus", 14th edition, Pearson Education, India, 2018

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

COs	Statements	K-Level
CO1	Apply the knowledge of matrices with the concepts of Eigen values to study their problems in core areas	Apply
CO2	Study the behavior of a function at infinity, knowledge on curvature with its properties in Cartesian form	Apply
CO3	Develop competency in applying the idea of Lagrange multipliers to find extreme of functions with constraints	Apply
CO4	Compute area and volume using definite and improper integrals	Apply
CO5	Model the problems, when the particle changes with respect to its velocity, acceleration using higher order differential equations	Apply

COURSE ARTICULATION MATRIX:

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

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

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SEMESTER-I

U19PH101	ENGINEERING PHYSICS	Category: BS			
		L	T	P	C
		2	0	2	3

PRE–REQUISITES:

- Higher secondary physics

COURSE OBJECTIVES:

- To understand the concepts of surface tension, flow of liquids, heat transfer and thermal conductivity of materials
- To acquire the knowledge of ultrasonic waves and its production methods with its industrial and medical applications
- To understand the fundamental principles of laser and fiber optics with their applications

UNIT I PROPERTIES OF LIQUIDS 6

Surface tension – Determination of surface tension by Jaeger's method – Effect of temperature on surface tension – Viscosity – Coefficient of viscosity – Streamline and turbulent flow – Stokes law and terminal velocity – Poiseuille's equation for the flow of a liquid through a capillary tube and experimental determination

UNIT II HEAT 6

Modes of heat transfer – Thermal properties(solids and liquids) – Specific heat capacity, thermal capacity, thermal diffusivity and coefficient of linear thermal expansion – Lee's disc method for the determination of thermal conductivity – Heat conduction through compound media(series and parallel) – Solar water heater

UNIT III ULTRASONICS 6

Properties of ultrasonic waves – Production of ultrasonic waves – Magnetostrictive generator – Piezoelectric generator – Acoustic grating – Applications – SONAR – Cavitation – Drilling and welding – Non destructive testing(flaw detection) – Medical applications(fetus heart movement)

UNIT IV LASER 6

Laser characteristics – Spatial and Temporal coherence – Einstein coefficient and its importance – population inversion – optical resonator – Pumping methods – Nd-YAG laser – CO_2 laser – Material processing(drilling, welding) – Medical applications in ophthalmology

UNIT V FIBRE OPTICS 6

Fiber optic cable – Features – Total internal reflection – Numerical aperture and acceptance angle – Classification of optical fibers based on refractive index, modes and materials – Fiber optical communication – Medical endoscopy

LIST OF EXPERIMENTS

1. Determination of viscosity of the given liquid using Poiseuille's flow method
2. Determination of thermal conductivity of a bad conductor using Lee's disc method
3. Determination of velocity of sound and compressibility of a liquid using Ultrasonic

interferometer

4. Determination of particle size of lycopodium powder using laser light
5. Determination of wavelength of a given laser source
6. Determination of acceptance angle and numerical aperture of an optical fiber using laser source
7. Determination of dispersive power of prism using spectrometer
8. Determination of refractive index of a liquid using spectrometer

Contact Periods:

Lecture: 30 Periods Tutorial: – Periods Practical: 30 Periods Total: 60 Periods

TEXT BOOKS:

1. Bhattacharya D K. and Poonam Tandon, "Engineering Physics", Oxford University Press, 2016
2. Pandey B K. and Chaturvedi S, "Engineering Physics", Cengage Learning India, 2013

REFERENCES:

1. Arumugam M, "Engineering Physics", Anuradha Publishers, 2014
2. Murugeshan R, "Properties of Matter", S. Chand and Company Ltd, 2012
3. Gaur R. K. and Gupta S. L., "Engineering Physics", Dhanpat Rai Publishers, 2016

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

COs	Statements	K-Level
CO1	Explain the concept of surface tension and viscosity of liquids	Understand
CO2	Interpret the thermal properties of materials and apply to the field of engineering	Understand
CO3	Illustrate the production methods of ultrasonic waves and use it for the field of engineering and medicine	Understand
CO4	Demonstrate the types of laser for various industrial and medical applications	Understand
CO5	Classify the fiber optic cable and study its engineering applications	Understand

COURSE ARTICULATION MATRIX:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	-	-	-	-	-	-	-	-	1	-	-
CO2	3	2	1	-	-	-	-	-	-	-	-	1	-	-
CO3	3	2	1	-	-	-	-	-	-	-	-	1	-	-
CO4	3	2	1	-	-	-	-	-	-	-	-	1	-	-
CO5	3	2	1	-	-	-	-	-	-	-	-	1	-	-
CO	3	2	1	-	-	-	-	-	-	-	-	1	-	-
Correlation levels: 1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)														

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SEMESTER-I

U19CY101	ENGINEERING CHEMISTRY I	Category: BS			
		L	T	P	C
		2	0	2	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To inculcate the fundamentals of water technology and electrochemistry
- To gain basic knowledge of corrosion of metals and change of phases in alloys
- To acquire knowledge about the preparation, properties and applications of

UNIT I WATER 6

Hardness of water – types – problems in hardness calculations – estimation of hardness by EDTA – boiler feed water – boiler trouble (scale, sludge, priming, foaming and caustic embrittlement) – softening methods – internal treatment (phosphate & calgon) – external treatment (deionization process) – desalination of water- reverse osmosis

UNIT II ELECTROCHEMISTRY 6

Electrochemical cells – types – galvanic cells – redox reactions – EMF – concept of electrode potential - electrodes (Standard Hydrogen and Calomel electrode) – Nernst equation (derivation only) - electrochemical series and its applications – estimation of iron by potentiometry, determination of pH by pH metry

UNIT III CORROSION AND ITS CONTROL 6

Types – chemical corrosion – electrochemical corrosion (galvanic & differential aeration) – factors influencing corrosion – corrosion control methods – sacrificial anode and impressed current method – protective coating – electroplating – Ni plating

UNIT IV PHASE RULE AND ALLOYS 6

Phase rule – explanation of terms – advantages and limitations of phase rule – application of phase rule to one component system (water) – reduced phase rule – two component system (simple eutectic system - Lead – silver system) – alloys – definition – purpose of making alloys –ferrous (stainless steel), heat treatment – non-ferrous alloys (Brass -Dutch metal, German Silver)- composition, properties and uses

UNIT V NANOCHEMISTRY AND ITS APPLICATIONS 6

Types – properties of nanomaterials – size dependent properties – general methods of synthesis – top down (laser ablation and CVD) – bottom up (solvothermal and precipitation) – Application of nanotechnology (medicine, electronics, defence and agriculture)

LIST OF EXPERIMENTS

1. Determination of total, permanent and temporary hardness of a given sample water by EDTA method
2. Determination of chloride content in the water sample

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3. Estimation of ferrous ion by potentiometric titration
4. Determination of strength of HCl by pH metric method
5. Determination of corrosion rate by weight loss method
6. Electroplating of Cu and electroless plating of Cu
7. Estimation of Copper in Brass by EDTA method
8. Determination of phase and degrees of freedom in $CuSO_4$. $5H_2O$ / KI and water / $FeCl_3$. $12H_2O$ / phenol-water
9. Preparation of nano ruby (Al_2O_3-Cr) by combustion method
10. Preparation of nano ZnO by co-precipitation method

Contact Periods:

Lecture: 30 Periods Tutorial: – Periods Practical: 30 Periods Total: 60 Periods

TEXT BOOKS:

1. Jain P C and Monika Jain, "Engineering Chemistry", 16th edition, Dhanpat Rai Publishing Company, Pvt. Ltd., New Delhi, 2015
2. Vairam S, Kalyani P and Suba Ramesh, "Engineering Chemistry", 2nd edition, Wiley India Pvt. Ltd, New Delhi, 2013

REFERENCES:

1. Friedrich Emich, "Engineering Chemistry", 2nd edition, Scientific International Pvt. Ltd, New Delhi, 2014
2. Prasanta Rath, "Engineering Chemistry", 1st edition, Cengage Learning India, Pvt. Ltd, Delhi, 2015
3. Shikha Agarwal, "Engineering Chemistry, Fundamentals and Applications", 1st edition, Cambridge University Press, 2015

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

COs	Statements	K-Level
CO1	Apply the principles of water technology in treatment of industrial and domestic water and estimate the various constituents of industrial water	Apply
CO2	Describe the utilization of electrochemical principles for chemical cells and determine experimentally the EMF of the cells	Understand
CO3	Outline the corrosion process and prevention methods that is adopted in industries	Understand
CO4	Examine the number of phases, components and variants in different heterogeneous systems, construct the phase diagrams and ferrous alloys.	Understand
CO5	Classify the different nanomaterials, recall their properties and relate them to applications	Understand

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COURSE ARTICULATION MATRIX:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1	-	-	-	-	2	-	1	1	-	1	-	-
CO2	3	1	-	-	-	-	2	-	1	1	-	1	-	-
CO3	3	1	-	-	-	-	2	-	1	1	-	1	-	-
CO4	3	1	-	-	-	-	2	-	1	1	-	1	-	-
CO5	3	1	-	-	-	-	2	-	1	1	-	1	-	-
CO	3	1	-	-	-	-	2	-	1	1	-	1	-	-
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)						3: Substantial (High)				

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SEMESTER-I

U19MEG04	BASICS OF MECHANICAL ENGINEERING	Category: ES			
		L	T	P	C
		3	0	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVE

- The students will familiar with basic mechanical elements and power plants.
- The students will aware the principles of refrigeration & air conditioning.
- The students will know different types of manufacturing processes, industrial safety and computer applications in mechanical engineering

UNIT I BASIC MECHANICAL ELEMENTS 9

Basic Concepts and demonstration: Bearings - ball bearing, roller bearing, thrust bearing -Gears - spur, helical, herringbone, internal ring, face, hypoid, straight bevel, spiral bevel. - Screw, worm gears, rack and pinion, sprockets, ratchet and Paul. Belt drives – flat belt, v belt, timing belt drives. Chain drives, cable drives, chain block-Conveyers - roller conveyer, belt conveyer, pneumatic conveyer, chain conveyer, screw conveyer- Shafts, keys, spline shafts- Springs - tension spring, compression spring, coil spring, torsion spring, leaf spring, gas spring-Fasteners - screws, bolts, nuts and their specifications in mm and inch scale-Tools - double end spanners, box spanners, Allen keys and standards.

UNIT II BASICS OF POWER PLANT AND BOILERS 9

Classification of power Plants, working principle of steam, Gas, Diesel, Hydroelectric and Nuclear Power plants, Working principle of Boilers, types of boilers, Turbines, Reciprocating Pumps (single acting and double acting) and Centrifugal Pumps.

UNIT III IC ENGINES AND RAC 9

Internal combustion engines as automobile power plant, Working principle of Petrol and Diesel Engines, Four stroke and two stroke cycles, Comparison of four stroke and two stroke engines, Terminology of Refrigeration and Air Conditioning. Principle of vapor compression and absorption system, Layout of typical domestic refrigerator, Window and Split type room Air conditioner

UNIT IV MANUFACTURING PROCESS 9

Principles of casting process, Metal rolling process, Introduction to CNC machines, Laser Cutting and EDM process, Metal joining process, Welding and Soldering Process, introduction to 3D printing and Rapid prototyping.

UNIT V INDUSTRIAL ENGINEERING 9

Introduction to safety engineering- Evolution of Safety, Improvements Required, Safety Organization, Safety Functions, Workplace Operations Requiring Safety, Safety Benefits. Software in Mechanical Industry- introduction to Modelling and Analysis software, Basic Concepts and Application of IoT to industrial processes

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Professor & Head
Department of Chemical Engineering
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Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Total: 45 Periods

TEXT BOOKS

1 Basant Agarwal and C.M. Agarwal, " Basics of Mechanical Engineering", Wiley India Pvt. Ltd,
2 Venugopal K. and Prabhu Raja V., "Basic Mechanical Engineering", Anuradha Publishers,

REFERENCE BOOKS

1 Palanikumar, K. Basic Mechanical Engineering, ARS Publications, 2010
2 P.N. Rao., "Manufacturing Technology - Vol. 1", Tata McGraw Hill Education India Pvt Ltd,
3 Mikell P. Groover , "Automation, Production Systems, and Computer-Integrated

WEB SOURCES

1 https://www.youtube.com/watch?reload=9&v=ehi_hkLlutw
2 https://www.youtube.com/watch?v=IcCe6r1n4-w

COURSE OUTCOMES (CO)

Upon completion of the course, the student will be able to

COs	Statements	K-Level
CO1	Recognize various mechanical elements like bearings, gears, springs, shaft, belts and fasteners.	Remembering
CO2	Understand the construction and working principles of different power plants and pumps.	Understanding
CO3	Explain the working of an IC engine and a RAC system.	Understanding
CO4	Discuss about primary manufacturing processesand know about 3D printing & Rapid Prototyping.	Understanding
CO5	Recall various safety requirements and software required for mechanical engineering.	Remembering

COURSE ARTICULATION MATRIX:

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

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

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U19MEG01	ENGINEERING GRAPHICS	Category:ES			
		L	T	P	C
		1	0	4	3

PRE-REQUISITES

Nil

COURSE OBJECTIVE

- The students will be exposed to standards and conventions followed in preparation of engineering drawings.
- The students will understand the concepts of orthographic and isometric projections using CAD software.
- The students will develop the ability of producing engineering drawings and conveying the information through drawings using CAD software.

BASICS OF ENGINEERING DRAWING AND CAD (Not for examination) 3

Introduction,drawinginstrumentsanditsuses,sheetlayout,BISconventions,lines,letteringanddimensioningpracticeslines,Coordinatepoints,axes,polylines,square,rectangle,polygons,splines,circles,ellipse,text,move, copy,off-set,mirror,rotate,trim,extend,break,chamfer,fillet,curves, constraints viz. agency, parallelism, inclination and perpendicularity.

UNIT I CONICS,SPECIAL CURVES AND PROJECTION OF POINTS 3+12

Construction of parabola, ellipseandhy perbola using eccentricity method, construction finvolutes for squares and circles, Construction of Tangent and normal to the above curves. Introduction, method of projection, planes of projection, reference line and notations. Orthographic Projection of points: Points in all the four quadrants.

UNIT II PROJECTIONOF STRAIGHT LINES ANDSURFACES. 3+12

Projection of straight lines: Lines inclined to HP/VP plane, inclined to both HP and VP planes (straight lines are assumed to be in first quadrant only). Projection of planes: Projection of square, rectangle, pentagon, hexagon and circular plane–inclined to both the plane by change of position method.

UNIT III PROJECTIONOFSOLIDS 3+12

Introduction, projection of solids: prisms, pyramids, cylinders and cones with axis inclined to both the planes. (Solids resting on HP only)

UNIT IV DEVELOPMENTOFLATERALSURFACESOFSOLIDS 3+12

Introduction, Cutting plane, sectional views of right regular solids resting with base on HP: prisms, pyramids, cylinder and cone and true shapes of the sections.

Developmentoflateralsurfacesofrightregularprisms,pyramids,cylinders,conesrestingwithbaseon HP only. Development of their frustums and truncations.

UNIT V ORTHOGRAPHICANDISOMETRICPROJECTIONS 3+12

Orthographic projection: Simple machine components using free hand sketching.

Isometric projection: Simple Solid exercises and combination of solids.

Contact Periods:

Lecture: 15 Periods Tutorial: – Periods Practical: –60 Periods Total: 75 Periods

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TEXT BOOKS

1 ND Bhat & VM Panchal, Engineering Drawing, Charter Publishing House, Gujarat, 51st edition, 2013.

2 VenugopalK. And Prabhu Raja V.,"Engineering Graphics",New Age International(P) Limited,2010.

REFERENCE BOOKS

1 NatarajanK.V., —A textbook ofEngineeringGraphics,DhanalakshmiPublishers,Chennai, 2017.

2 SamTickoo,AutoCAD 2013forEngineersandDesigners,DreamtechPress,2013.

3 M.H.Annaiah&RajashekarPatil,ComputerAidedEngineeringDrawing,New Age InternationalPublishers,4thEdition,2012

COURSE OUTCOMES (CO)

Upon completion of the course, the student will be able to

COs	Statements	K-Level
CO1	Sketch curves, orthographic projections of points as per BIS conventions.	Applying
CO2	Illustrate the orthographic projections of straight lines and plane surfaces	Applying
CO3	Depict the orthographic projections of solids, lateral surfaces of frustums, truncated solids and its development	Applying
CO4	Translate pictorial and isometric views of simple objects to orthographic views	Applying
CO5	Convert the orthographic views in to isometric projections	Applying

COURSE ARTICULATION MATRIX:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	-	-	3	-	-	-	-	1	-	1	1	-
CO2	3	2	-	-	3	-	-	-	-	1	-	1	1	-
CO3	3	2	-	-	3	-	-	-	-	1	-	1	1	-
CO4	3	2	-	-	3	-	-	-	-	1	-	1	1	-
CO5	3	2	-	-	3	-	-	-	-	1	-	1	1	-
CO	3	2	-	-	3	-	-	-	-	1	-	1	1	-
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)				3: Substantial (High)						

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SEMESTER-I

U19MEG05	WORKSHOP (B. Tech Chemical Engineering)	Category: ES			
		L	T	P	C
		0	0	4	2

PRE–REQUISITES:

Nil

COURSE OBJECTIVE

- The students will learn and apply the carpentry and sheet metal practices
- The students will understand different types of welding processes and plumping methods
- The students will know various tools for smithy and foundry operations

LIST OF EXPERIMENTS

1. Study on fitting tools, different types of fittings and their applications.
2. Study on carpentry tools, wooden joints and their applications.
3. Preparation of T-joint, Dove Tail joint, Mortise and Tenon joint
4. Preparation of components such as paperweight, tools box, key hangers.
5. Study on sheet metal tools, operations and applications.
6. Fabrication of simple objects such as funnel, dust pan, tray.
7. Study on welding tools, welding types, requirements and applications (Arc welding and gas welding)
8. Preparation of joints such as lap joint, butt joint, T-joint andL-joint using Arc welding
9. Study on plumbing and electrician tools, pipeline joints, fittings and pipe Connection requirements for various applications.
10. Preparation of pipe connections with different joints and fittings for domestic applications such as for centrifugal pump, wash basin, water heater.
11. Study on various tools used for dismantling and assembly of various mechanical components
12. Dismantling and Assembly of the air conditioner, centrifugal pump, two stroke / four stroke engine.
13. Demonstration on production of hexagonal headed bolt using different smithy tools.
14. Demonstration on preparation of green sand mould using solid / split pattern using foundry tools.

Contact Periods:

Lecture: – Periods Tutorial: – Periods Practical: 60 Periods Total: 60 Periods

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COURSE OUTCOMES:

Upon completion of the course, the student will be able to

COs	Statements	K-Level
CO1	Demonstrate the knowledge on fitting, carpentry and sheet metal practices.	Applying
CO2	Construct different types of arc welded joints	Applying
CO3	Develop pipe connections for various domestic requirements	Applying
CO4	Perform the assembly and disassembly of various mechanical units.	Applying
CO5	Understand the production of mechanical components using smithy tools and foundry.	Understanding

COURSE ARTICULATION MATRIX:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	-	1	-	-	-	-	-	-	-	2	-
CO2	3	2	1	-	1	-	-	-	-	-	-	-	-	1
CO3	3	2	1	-	1	-	-	-	-	-	-	-	-	1
CO4	3	2	1	-	1	-	-	-	-	-	-	-	-	-
CO5	3	2	1	-	1	-	-	-	-	-	-	-	2	-
CO	3	2	1	-	1	-	-	-	-	-	-	-	2	1
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)						3: Substantial (High)				

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SEMESTER-II

U19LE201	ADVANCED COMMUNICATIVE ENGLISH	Category: HSM			
		L	T	P	C
		1	0	2	2

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- Foster their ability to develop communicative strategies and skills.
- Strengthen the learners to evocate their listening skills and enhance writing ability.
- Exhibit proactive reading strategies and speaking techniques.

UNIT I LANGUAGE ADEPTNERS 9

Cloze test – Sentence completion – Relative clause – Transformation of sentences – Common errors – Discourse markers – Formal and Informal expressions – Framing questions – Figures of speech

UNIT II LISTENING 9

Listening to announcements – Interviews – Group discussions– Dialogues – News items – Documentaries – IELTS – GRE – TOEFL based listening

UNIT III SPEAKING 9

Real life situations through role play – Language use – Pronunciation, Stress and Intonation – Narrating events – Presentation – Group discussion

UNIT IV READING 9

Reading strategies – Reading comprehension – Reading short stories – Journal articles – Inferring editorial column – Cloze reading

UNIT V WRITING 9

Book review – Guided writing – Writing gadget review – Free writing – Rephrasing – Interpreting text – Email writing – Process description

LIST OF EXPERIMENTS

1. Listening for announcements
2. Listening to dialogues
3. Listening to documentaries
4. Listening to interviews
5. IELTS based listening
6. Role play
7. Product description
8. Group discussion
9. Book review
10. General presentation

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Contact Periods:

Lecture: 15 Periods Tutorial: – Periods Practical: 30 Periods Total: 45 Periods

TEXT BOOKS:

1. K N Shoba, Lourdes JoavaniRayen. "Communicative English". Cambridge University Press, 2017
2. Sharshana N P and Savitha C, "English for Technical Communication", Cambridge University Press, 2016

REFERENCE

1. Murphy, Raymond, "Intermediate English Grammar", Cambridge University Press, 2009
2. Means, Thomas L, "English and Communication for Colleges", Cengage 2017
3. "Using English: A Coursebook for Undergraduate Engineers and Technologists" Orient BlackSwan, 2017

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

COs	Statements	K-Level
CO1	Inculcate effective reading strategy	Understand
CO2	Express opinions in real life situations	Understand
CO3	Construct academic and professional writing	Apply
CO4	Impart the listening ability in self learning	Apply
CO5	Adept to the needs of the second language learner in a grammatical context	Understand

COURSE ARTICULATION MATRIX:

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

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

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SEMESTER-II

U19MA201	COMPLEX VARIABLES AND LAPLACE TRANSFORMS	Category: BS			
		L	T	P	C
		3	1	0	4

PRE–REQUISITES:

- Calculus: Differentiation and Integration

COURSE OBJECTIVES:

- Understand the vector calculus, which extends the basic concepts of differential calculus to vector functions
- Use the concepts of complex analysis, in the study of heat flow, fluid dynamics and electrostatics
- Apply and summarize the mathematical aspects of time domain to frequency domain using Laplace transform and Inverse Laplace transform vice versa

UNIT I MULTIPLE INTEGRALS 9 + 3

Double integrals – Change of order of integration – Triple integrals – Applications: Area and volume

UNIT II VECTOR CALCULUS 9 + 3

Gradient – divergence and curl – Directional derivative – Irrotational and solenoidal vector fields – Vector integration – Green's theorem in a plane, Gauss divergence theorem – Stokes' theorem (excluding proofs) – Simple applications involving cubes and rectangular parallelepipeds

UNIT III LAPLACE TRANSFORM 9 + 3

Laplace transform – Conditions for existence – Transform of elementary functions – Standard properties (statement only) – Transforms of unit step function – impulse function – Periodic function – Initial and Final value theorems – Convolution theorem(without proof) – Inverse Laplace transform – Standard properties (statement only) – Second order linear differential equations with constant coefficients

UNIT IV COMPLEX DIFFERENTIATION 9 + 3

Analytic functions: Cauchy – Riemann equations (Cartesian form) and sufficient conditions (excluding proofs) – Harmonic and orthogonal properties of analytic function – Construction of analytic functions – Bilinear transformations

UNIT V COMPLEX INTEGRATION 9 + 3

Complex integration – Statement and applications of Cauchy's Integral theorem and Cauchy's Integral formula – Taylor's and Laurent's series expansions – Singular points – Residues – Cauchy's Residue theorem

Contact Periods:

Lecture: 45 Periods Tutorial: 15 Periods Practical: – Periods Total: 60 Periods

TEXT BOOKS:

1. Erwin Kreyszig, "Advanced Engineering Mathematics", 10th edition Wiley India Pvt Ltd, New Delhi, 2018
2. Grewal B S, "Higher Engineering Mathematics", Khanna Publishers, 44th Edition, 2017

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REFERENCES:

1. Bali N P, and Manish Goyal, "A text book of Engineering Mathematics", Laxmi Publications, 12th Edition, 2016
2. Thomas G B, and Finney R L, "Calculus and Analytic Geometry", Pearson Education India, 9th Edition, 2010
3. James Stewart, "Calculus: Early Transcendental", Cengage Learning, 7th Edition, New Delhi, 2015

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

COs	Statements	K-Level
CO1	Calculate the area and volume of a body on the basis of analysis done with one/two dimensions of a body	Apply
CO2	Apply the theoretical aspects of vector integral calculus in Electro Magnetic Theory and Field	Apply
CO3	Apply the concepts of Laplace transform with their properties in Circuit Theory and Control Systems	Apply
CO4	Identify the complex functions and their mapping in certain complex planes	Apply
CO5	Differentiate and integrate functions represented as power series expansions, including Taylor series, and solve related problems	Apply

COURSE ARTICULATION MATRIX:

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

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

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SEMESTER-II

U19PH202	PHYSICS FOR CHEMICAL ENGINEERS	Category: BS			
		L	T	P	C
		3	0	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To acquire the fundamentals of conducting, superconducting and dielectric materials
- To gain the knowledge of various phase diagrams, preparation methods of thin films and nano materials
- To inculcate the basic concepts of advanced materials

UNIT I CONDUCTING AND SUPERCONDUCTING MATERIALS 9

Classical free electron theory– Expression for electrical conductivity–Thermal conductivity– Widemann-Franz law– Electrons in metals–Density of energy states– Superconducting phenomena– Properties of superconductors– Meissner effect and isotope effect– Type I and Type II superconductors– SQUID

UNIT II SEMICONDUCTING MATERIALS 9

Origin of band gap in solids (qualitative) –Carrier concentration in an intrinsic semiconductor (concept only) –Variation of Fermi level with temperature–Electrical conductivity– Band gap determination– Carrier concentration in n-type and p-type semiconductors – Variation of Fermi level with temperature and impurity concentration – Hall effect – Determination of Hall coefficient

UNIT III DIELECTRIC AND MAGNETIC MATERIALS 9

Dielectric materials – Electronic, ionic, Orientation and space charge polarization – ClausiusMosotti equation – Different types of breakdown – Magnetic materials – Dia, Para & Ferromagnetic materials – Domain theory of ferromagnetism, Hysteresis, Soft and Hard magnetic materials

UNIT IV PREPARATION OF MATERIALS 9

Phases – Phase rule – Binary systems – Tie line rule – Lever rule – Phase diagram – Invariant reactions – Nucleation – Homogeneous and heterogeneous nucleation – Thin films – Preparation: PVD,CVD method – Nanomaterials – Preparation: Solvothermal, Sol – gel method

UNIT V ADVANCED MATERIALS 9

Metallic glasses – Shape memory alloys: NiTi alloy – Ceramics: types and applications – Biomaterials: hydroxyapatite – PMMA – Silicone – Conducting polymers – Sensors: Chemical Sensors – Biosensors

Contact Periods:

Lecture: 45 Periods Tutorial: – Nil Practical: – Nil Total: 45 Periods

TEXT BOOKS:

1. RaghavanV., "Materials Science and Engineering: A first course", PHI Learning 2018
2. BalasubramaniamR., "Callister'sMaterials Science and Engineering",Wiley India Pvt. Ltd,2019

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REFERENCES:

1. RajendranV and MarikaniA., " Material Science" , Tata McGraw Hill Publishing Ltd, 2014
2. RaghavanV.,"Physical Metallurgy: Principles and Practice", PHI Learning 2018
3. Kasap S.O., "Principles of Electronic Materials and Devices" , McGraw-Hill Education, 2017

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

COs	Statements	K-Level
CO1	Understand the electrical characteristics of materials	Understand
CO2	Gain the knowledge of the types of semiconductors and its properties for electronic applications	Understand
CO3	Understand the properties and types of magnetic and dielectric materials	Understand
CO4	Illustrate the phase diagrams for the synthesis of thin films and nano materials	Understand
CO5	Summarize new advance materials for various applications	Understand

COURSE ARTICULATION MATRIX:

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

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

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SEMESTER-II

U19CY202	CHEMISTRY FOR TECHNOLOGISTS	Category: BS			
		L	T	P	C
		2	0	2	3

PRE–REQUISITES:

Engineering Chemistry I

COURSE OBJECTIVES:

- To acquire basic knowledge on organic chemical reactions, mechanism and their applications
- To understand the classification and chemical properties of oils and fats
- To gain knowledge on the synthesis and applications of industrial chemicals, soaps, detergents and dyes

UNIT I REACTION INTERMEDIATES 6

Homolytic and heterolytic fission of a covalent bond - free radicals, carbocations, carbanions and carbenes (generation, structure and stability), electrophiles and nucleophiles, types of organic reactions. Free radical reactions - halogenation of alkane, polymerisation of alkene, thermal cracking of alkanes. Sandmeyer reaction and Hunsdiecker synthesis, allylic halogenation- using N-Bromo Succinimide (NBS)

UNIT II REACTION MECHANISMS -I 6

Electrophilic addition and substitution in aliphatic and aromatic compounds (S_E1, S_E2 mechanism), halogenation of alkene, hydrohalogenation - (addition of HBr on alkene- Markovnikov's rule and anti-Markovnikov's rule), aliphatic compounds - halogenation of ketones and diazonium coupling, aromatic compounds - nitration, sulphonation, Friedel Crafts alkylation, acylation and halogenation

UNIT III OILS, FATS, SOAPS AND DETERGENTS 6

Lipids, Fatty Acids - introduction, structure and chemical composition of oils and fats - types, physical properties, chemical analysis of oils, fats and its significance (Acid, Iodine, Saponification values, Reichert- Meissl value). Soaps and detergents - types, manufacture and cleansing mechanism

UNIT IV INDUSTRIAL CHEMICALS 6

Sugar industry - manufacture of ethyl alcohol from molasses (fermentation process), products and industrial applications, Petroleum industry - composition of crude petroleum, refining, fractional distillation, products and their uses. Glass – types – manufacture - tank furnace, Refractories-types, properties- (refractoriness, refractoriness under load (RUL), dimensional stability, porosity, thermal spalling) – manufacture of alumina, magnesite and zirconia bricks

UNIT V DYE AND COLORANTS 6

Dyes - classification based on structure, mode of dyeing and application methods, relation between colour and chemical constitution, theory of colours - Witt's and Modern theory - chromogen, chromophore and auxochrome, synthesis of some important azo dyes (Methyl orange), triphenylmethane dye (Malachite green), phthalein dyes (Phenolphthalein), Anthraquinone dyes (Alizarin)

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LIST OF EXPERIMENTS

1. Preparation of benzyl bromide using N-bromo succinimide (NBS)
2. Acetylation – Preparation of acetanilide from aniline
3. Nitration – Preparation of picric acid
4. Halogenation - Preparation of 2,4,6- tribromo aniline from aniline
5. Estimation of total fatty acid of soap
6. Determination of saponification value of oil / fat
7. Synthesis of biodiesel by trans esterification method
8. Preparation of azo dye (Para red / 2-Naphthol aniline)
9. Determination of λ max for azo dye (Methyl orange / Phenolphthalein)

Contact Periods:

Lecture: 30 Periods Tutorial: – Periods Practical: 30 Periods Total: 60 Periods

TEXT BOOKS:

1. BhalB.S and Arun Bhal, "A Text Book of Organic Chemistry", 17th edition, S.Chand & Co. New Delhi, 2005
2. Jonathan Clayden, Nick Greeves, Stuart Warren and Peter Wothers, Organic Chemistry, Oxford University Press, 2nd edition, New Delhi, 2013

REFERENCES:

1. Shikha Agarwal, "Engineering Chemistry, Fundamentals and Applications",1st edition, Cambridge University Press, 2015
2. ShenaiV.A, "Chemistry of Dyes and Principles of Dyeing", Sevak Publications, Mumbai,1995
3. SharmaB.K, Industrial chemistry, 19th edition, Krishna Prakashan Media Pvt. Ltd., Meerut, 2011

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

COs	Statements	K-Level
CO1	Explain the various reaction intermediates involved in chemical reactions	Understand
CO2	Illustrate the different electrophilic addition and substitution mechanisms involved in chemical reactions	Understand
CO3	Estimate the saponification value, iodine value, total fatty acid content in the soap, oil and explain the cleansing mechanism of soap and detergents	Understand
CO4	Classify the types, preparation, properties and application of various industrial chemicals	Understand
CO5	Outline the classification, mechanism and synthesis of different dyes	Understand

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COURSE ARTICULATION MATRIX:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1	-	-	-	-	2	-	-	-	-	1	-	-
CO2	3	1	-	-	-	-	2	-	-	-	-	1	-	-
CO3	3	1	-	-	-	-	2	-	-	-	-	1	-	-
CO4	3	1	-	-	-	-	2	-	-	-	-	1	-	-
CO5	3	1	-	-	-	-	2	-	-	-	-	1	-	-
CO	3	1	-	-	-	-	2	-	-	-	-	1	-	-
Correlation levels: 1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)														

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SEMESTER-II

U19EEG01	BASICS OF ELECTRICAL ENGINEERING	Category: ES			
		L	T	P	C
		2	0	2	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To acquire the knowledge on basics of electrical circuits and machines
- To understand the concept of measuring instruments and domestic utilization of electrical energy
- To apply the testing and control methods to various electrical machines

UNIT I BASIC CONCEPTS OF ELECTRIC CIRCUITS 6

Active elements - DC and AC sources - Elements in series and parallel connections - Ohm's law and Kirchhoff's laws - Mesh and Nodal analysis - Power, power factor and energy

UNIT II DC AND AC MOTORS 6

Construction, principle of operation, characteristics and applications: DC shunt and series motors - Single phase and three phase induction motors. (Qualitative Analysis only)

UNIT III TRANSFORMERS 6

Types of transformer - Step up and step down transformer - Principle of operation - Introduction to three phase transformer - Auto transformer - Scott connection - Applications

UNIT IV MEASURING INSTRUMENTS AND PROTECTING DEVICES 6

Construction and working: MC meter - PMMC meter, MI meter - attraction and repulsion type, Wattmeter -Single element – Electro dynamo meter type - single phase energy meter. (Qualitative Analysis only)

UNIT V DOMESTIC UTILIZATION OF ELECTRICAL ENERGY 6

Types of fuses - Switches - MCB, relays and cables - Grounding - Earthing - Types - Need for grounding and earthing - Residential and industrial wiring. (Qualitative Analysis only)

LIST OF EXPERIMENTS

1. Load test on DC shunt motor
2. Speed control of DC shunt motor
3. Load test on DC shunt generator
4. Load test on single phase transformer
5. Load test on three phase induction motor
6. Speed control of three phase induction motor
7. Energy measurement with single phase load
8. Study of starters - Three point starter and Star – delta starter

Contact Periods:

Lecture: 30 Periods Tutorial: – Periods Practical: 30Periods Total: 60 Periods

TEXT BOOKS:

1. Sudhakar A. and Shyam Mohan S.P., "Circuits and Network Analysis and Synthesis", 5th edition, McGraw Hill Education, New Delhi, 2017
2. Rajput R.K., "Electrical Machines", 6th edition, Laxmi Publications, 2016

REFERENCES:

1. Sawhney A.K., "A Course in Electrical and Electronic Measurements and Instrumentation", Dhanpat Rai and Co, 2010
2. Sunil S.Rao, "Switchgear and Protection", 2nd edition, Khanna Publishers, 2018
3. Uppal S.L., "Electrical Wiring, Estimating and Costing", 8th edition, Khanna Publishers, 2018

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

COs	Statements	K-Level
CO1	Solve an electric network by applying basic laws	Apply
CO2	Summarize the operating principle, characteristics and applications of DC motor and induction motor	Understand
CO3	Interpret the construction and working principle of transformer	Understand
CO4	Explain the construction and operation of measuring instruments	Understand
CO5	Discuss the concept of electrical wiring with protection schemes	Understand

COURSE ARTICULATION MATRIX:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1	-	-	-	-	1	1	-	1	2	1
CO2	3	1	1	-	-	-	-	1	1	1	-	1	2	1
CO3	3	1	1	-	-	-	-	1	1	1	-	1	2	1
CO4	3	1	1	-	-	-	-	1	1	1	-	1	2	1
CO5	3	1	1	1	-	-	-	-	1	1	-	1	2	1
CO	3	1	1	1	-	-	-	-	1	1	-	1	2	1
Correlation levels: 1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)														

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SEMESTER-II

U19ECG01	BASICS OF ELECTRONICS ENGINEERING	Category: BS			
		L	T	P	C
		2	0	2	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To understand the operation of basic semiconductor devices and SMPS
- To equip the students with a sound understanding of bipolar junction transistors and field effect transistors.
- To provide basic knowledge about special semiconductor devices and display devices

UNIT I SEMICONDUCTOR DEVICES AND ITS APPLICATIONS 6 + 9

Semiconductor diodes-PN junction and Zener diode-construction, operation and characteristics-Applications- Half wave, full wave and bridge rectifiers-Voltage regulator-SMPS

UNIT II BIPOLAR JUNCTION TRANSISTORS 6 + 6

BJT- Types and operations-Input and output characteristics of CE, CB, CC –Biasing- Fixed bias and voltage divider bias- Transistor switching characteristics

UNIT III FIELD EFFECT TRANSISTORS 6 + 6

JFET – Drain and Transfer characteristics – MOSFET- Characteristics of D-MOSFET, E-MOSFET – MOSFET as a switch

UNIT IV SPECIAL SEMICONDUCTOR DEVICES 6 + 3

Metal-Semiconductor Junction- MESFET, Schottky barrier diode -Varactor diode –Tunnel diode-SCR: Construction, operation-Static characteristics

UNIT V POWER DEVICES AND DISPLAY DEVICES 6 + 6

Introduction – UJT-Power BJT- Solar cell – CCD – LED – LCD-Photo transistor-Opto Coupler

Contact Periods:

Lecture: 30 Periods Tutorial: – Periods Practical: 30 Periods Total: 60 Periods

LIST OF EXPERIMENTS:

1. Characteristics of PN Junction diode
2. AC-to-DC Conversion using PN Junction diode
3. Regulation Characteristics of Zener diode
4. Input-output characteristics of BJT in common Emitter (CE) configuration
5. Input-output characteristics of BJT in common Base (CB) configuration
6. Drain and transfer characteristics of JFET
7. Input and output characteristics of MOSFET
8. VI characteristics of SCR
9. Characteristics of UJT
10. Scrolling display using LED

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TEXT BOOKS:

1. Donald A Neaman, "Semiconductor Physics and Devices", Fourth Edition, Tata McGrawHill, 2012
2. David A. Bell, "Electronic Devices and Circuits", Fifth Edition, Oxford University higher education, 2008

REFERENCES:

1. M. H. Rashid, "Power Electronics circuits, devices and applications", Fourth Edition, Pearson Education , 2013
2. Robert Boylestad and Louis Nashelsky, "Electron Devices and Circuit Theory", Eleventh Edition, Pearson Education, 2014
3. Jacob Millman, Christos C Halkias, Satyabrata Jit, "Electronic Devices and Circuits", Fourth Edition, Mc Graw Hill India, 2015
4. R.S.Sedha, "A Text Book of Applied Electronics", Third Edition, S. Chand Publications, 2006

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

COs	Statements	K-Level
CO1	Make use of semiconductor diodes for simple applications	Apply
CO2	Compare different configurations of bipolar junction transistors	Understand
CO3	Analyze the characteristics of FET in different modes of operation	Analyze
CO4	Illustrate the operation of various special semiconductor diodes	Understand
CO5	Explain the working principle of display devices its	Understand

COURSE ARTICULATION MATRIX:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	-	-	-	-	1	2	1	-	1	-	-
CO2	2	1	-	-	-	-	-	1	2	1	-	1	-	-
CO3	3	3	1	-	-	-	-	1	2	1	-	1	-	-
CO4	2	1	-	-	-	-	-	1	2	1	-	1	-	-
CO5	2	1	-	-	-	-	-	1	2	1	-	1	-	-
CO	2	1	1	-	-	-	-	1	2	1	-	1	-	-
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)						3: Substantial (High)				

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SEMESTER-II

U19CSG03	PROGRAMMING IN C	Category: ES			
		L	T	P	C
		2	0	2	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To learn basic C programming constructs
- To develop C programs using arrays, strings, functions, pointers and structures
- To understand input/output and file handling operations in C

UNIT I C PROGRAMMING BASICS 6

Procedural Programming (Modular and Structural)– Program Compilation–Execution–Debugging–Testing –C Program Development Environment–Writing Portable C Code – C Program Structure–Character Set– Keywords–Data Types and Sizes – Constants – Variables– Declaration –Operators – Arithmetic Operator –Increment – Decrement Operators– Relational & Logical Operators–Comma Operator– Bit Wise Operators– Assignment Operators and Expression– Conditional Expression– Precedence and Order of Evaluation

UNIT II LIBRARY FUNCTIONS AND CONTROL 6

Library Functions – Data Input and Output Function: Getchar, Putchar, Scanf, Printf, Gets, Puts Functions – Preprocessor Directives –Branching: If - Else Statement– Nested If Statement – Switch Case - Looping: While–Do-While – For –Nested Control Structures Break–Continue–Goto Statement

UNIT III ARRAYS AND STRINGS 6

Single Dimensional Array, Strings– and Two – Dimensional Arrays–Array of String–Multidimensional Array: Initialization– Unsized Array Initialization–Variable Length Arrays

UNIT IV FUNCTIONS AND POINTERS 6

Definition of Function – Prototypes – Storage Classes – Scope Rules – Recursion – Command Line Argument–Pointer Declaration – Operations On Pointer –Passing Pointers to a Function – Calling Function: Call by Value–Call by Address – Return Statement – Passing Arrays to Function – Pointers and One Dimensional– Multidimensional Array – Array of Pointers –Function Pointers – Dynamic Memory Allocation.

UNIT V STRUCTURES, UNION AND FILES 6

Definition – Processing a Structure – User Defined Data Types– Typedef – Array of Structure – Pointer to Structure –Passing Structure to Functions – Self-Referential Structures – Nested Structures – Union –Introduction to Files-File Access–File Organization–File Operations.

LIST OF EXPERIMENTS

1. Basic Unix/Linux commands
2. Writing portable C code
3. Formatted I/O statements
4. Decision Making statements: Simple If, If – else, Switch- case

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5. Looping Statements: For, While, Do – while
6. Single dimensional arrays
7. Multi-dimensional array
8. Operations on Strings
9. Pass by value and pass by address
10. Recursion
11. Structures and nested structures
12. String handling operations using pointers
13. Operations on arrays using pointers
14. Passing data through command line arguments
15. Operations on files

Contact Periods:

Lecture: 30 Periods Tutorial: – Periods Practical: 30 Periods Total: 60 Periods

TEXT BOOKS:

1. ReemaThareja, "Programming in C", Second Edition, Oxford University Press, 2016.
2. Anita Goel and Ajay Mittal, "Computer Fundamentals and Programming in C", Second Edition, Pearson India Education Services, 2016.

REFERENCES:

1. Yashavant P. Kanetkar. "Let Us C", SixteenthEdition, BPB Publications, 2017.
2. PradipDey, ManasGhosh, "Fundamentals of Computing and Programming in C", Second Edition, Oxford University Press, 2013.
3. Herbert Schildt, "C – The Complete Reference", First Edition, Tata McGraw Hill Publishing Company, 2010

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

COs	Statements	K-Level
CO1	Understand the basics of C programming language constructs	Understand
CO2	Implement applications using control statements and C libraries	Apply
CO3	Construct C programs using arrays and strings	Apply
CO4	Learn the concepts of functions, recursive functions and pointers in C	Understand
CO5	Develop applications using structures, unions and file processing	Apply

COURSE ARTICULATION MATRIX:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	-	-	-	-	-	-	-	-	1	-	-
CO2	3	2	2	-	-	-	-	-	-	-	-	1	-	-
CO3	3	3	3	-	-	-	-	-	-	-	-	1	-	-
CO4	3	3	3	-	-	-	-	-	-	-	-	1	-	-
CO5	3	3	3	-	-	-	-	-	-	-	-	1	-	-
CO	3	3	2	-	-	-	-	-	-	-	-	1	-	-
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)						3: Substantial (High)				

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SEMESTER-III

U19MA302	PROBABILITY AND STATISTICS	Category: BS			
		L	T	P	C
		3	1	0	4

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- Understand the concepts of probability, random variable and distributions that are applicable in the field of engineering
- Apply the concepts of testing of hypothesis for small and large samples which plays an important role in testing of fertilizers and chemical products
- Apply design of experiments in the field of metal processing and petro-chemical Engineering

UNIT I PROBABILITY **9 + 3**

Probability – Axioms of Probability – Conditional probability – Baye's theorem - Discrete and Continuous random variables – Moments – Moment generating functions

UNIT II DISTRIBUTION FUNCTIONS **9 + 3**

Binomial, Poisson, Geometric, Uniform, Exponential and Normal distributions

UNIT III TWO DIMENSIONAL RANDOM VARIABLES **9 + 3**

Joint distributions – Marginal and Conditional distributions – Covariance – Correlation and linear regression

UNIT IV TESTING OF HYPOTHESIS **9 + 3**

Large sample test for single mean and difference of means – Small sample test: t, F and Chi-square distributions

UNIT V DESIGN OF EXPERIMENTS **9 + 3**

One way and Two way classifications - Completely randomized design – Randomized block design – Latin square design

Contact Periods:

Lecture: 45 Periods Tutorial: 15 Periods Practical: – Periods Total: 60 Periods

TEXT BOOKS:

1. Milton J S and Arnold J C, "Introduction to Probability and Statistics", 4th Edition, Tata McGraw Hill, 2008
2. Gupta S C and Kapoor V K, "Fundamentals of Mathematical Statistics", 11th Edition, Sultan Chand & Sons, New Delhi, 2013

REFERENCES:

1. Johnson R A, "Miller and Freund's Probability and Statistics for Engineers", 8th Edition, Pearson Education, Asia, 2015
2. Devore J L, "Probability and Statistics for Engineering and the Sciences", 8th Edition, Cengage Learning, New Delhi, 2014
3. Ross S M, "Introduction to Probability and Statistics for Engineers and Scientists", 3rd Edition, Elsevier, 2010

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COURSE OUTCOMES:

Upon completion of the course, the student will be able to

COs	Statements	K-Level
CO1	Apply probability axioms and the moments of discrete and continuous random variables	Apply
CO2	Use discrete and continuous probability distributions including requirements, mean and variance for making decisions	Apply
CO3	Distinguish correlation and linear regression in two dimensional random variables	Apply
CO4	Analyze the hypothesis test of small and large samples in the field of Chemical Engineering	Apply
CO5	Design and conduct experiments and analyze the results	Apply

COURSE ARTICULATION MATRIX:

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

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

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SEMESTER-III

U19CH301	PROCESS CALCULATIONS	Category: PC			
		L	T	P	C
		3	1	0	4

PRE–REQUISITES:

- Engineering Chemistry and Basic Mathematics

COURSE OBJECTIVES:

- To acquire knowledge on laws of chemistry
- To apply mass and energy balance equations for single and network of units
- To understand and apply the basics of calculations in combustion of solid, liquid and gaseous fuels

UNIT I UNITS AND DIMENSIONS **9 + 3**

Units , dimensions and conversion – Process variables and properties – Ideal gas laws – Mole fractions and partial pressures – Application of Dalton's and Amagat's law

UNIT II MATERIAL BALANCES **9 + 3**

Introduction to material balances: Material balance problems for single units – Stoichiometry and Chemical reaction equations – Material balance for processes involving reaction bypass, purging, recycle operations

UNIT III HUMIDITY **9 + 3**

Calculation of absolute humidity, molal humidity, relative humidity and percentage humidity – Use of humidity in condensation and drying – Humidity chart, dew point.

UNIT IV ENERGY BALANCES **9 + 3**

Heat capacities of gases as a function of temperature – Mean heat capacity, heat capacity of mixture of gases – Heat capacities of solids and liquids – Kopp's rule and Trouton's rule – Standard heat of reaction, formation and combustion – Hess's law of heat summation and its application– Energy balance for systems with and without chemical reaction

UNIT V COMBUSTION **9 + 3**

Determination of Composition by orsat analysis of products of combustion of solid, liquid and gas fuels – Calculation of excess air from orsat technique – problems on sulphur and sulphur burning compounds

Contact Periods:

Lecture: 45 Periods Tutorial: 15 Periods Practical: – Periods Total: 60 Periods

TEXT BOOKS:

1. Bhatt, B.L., Vora, S.M., "Stoichiometry ", 4th Edition, Tata McGraw-Hill (2004)

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2. Himmelblau, D.M., "Basic Principles and Calculations in Chemical Engineering", EEE Sixth Edition, Prentice Hall Inc.,

REFERENCES:

1. Felder, R. M. and Rousseau, R. W., "Elementary Principles of Chemical Processes", 3rdEdn, John Wiley & Sons, New York, 2000
2. Hougen O A, Watson K M and Ragatz R A, "Chemical process principles" Part I, CBS publishers ,1973
3. Narayanan K. V. and Lakshmikutty B, "Stoichiometry and Process Calculations", 2nd edition, Prentice Hall of India, New Delhi, 2006

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

COs	Statements	K-Level
CO1	Explain the conversions of basic units and dimensions	Understand
CO2	Apply the concept of material balance calculations in unit operations	Apply
CO3	Interpret the parameters of humidity using humidity chart	Analyze
CO4	Apply the concept of energy balance calculations in unit operations	Analyze
CO5	Solve problems in products of combustion of solid, liquid and gaseous fuels	Apply

COURSE ARTICULATION MATRIX:

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

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

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SEMESTER-III

U19CH302	FLUID MECHANICS FOR CHEMICAL ENGINEERS	Category: ES			
		L	T	P	C
		2	1	0	3

PRE–REQUISITES:

- Knowledge in Science, Mathematics and Chemical Engineering

COURSE OBJECTIVES:

- To acquire a sound knowledge on fluid properties fluid statics, dynamic characteristics of fluid flow
- To know the concepts of flow measurement and fluid machineries.
- To understand the mechanisms of fluid flow through pipes and porous medium

UNIT I INTRODUCTION 9

Nature of fluids-properties of fluids, incompressible and compressible, . Potential flow, boundary layer, the velocity field, laminar flow, Newtonian and Non Newtonian fluids, Newton"s law of viscosity, turbulence. Reynolds number and transition from laminar to turbulent flow, Eddy viscosity, flow in boundary layers, laminar and turbulent flow in boundary layers, boundary layer formation in straight tubes.

UNIT II FLUID STATICS 9

Fluid statics – basic equation - equilibrium of fluid element – pressure variation in a static fluid-Manometers U-Tube and inclined. application to manometer – Differential analysis of fluid motion – continuity, equation of motions, Bernoulli equation.

UNIT III DIMENSIONAL ANALYSIS AND SIMILITUDE 9

The principle of dimensional homogeneity – dimensional analysis, Rayleigh method and the Pi theorem - non-dimensional action of the basic equations - similitude - relationship between dimensional analysis and similitude - use of dimensional analysis for scale up studies.

UNIT IV FLOW THROUGH PIPES AND PACKED BEDs 9

Reynolds number regimes, internal flow - flow through pipes – pressure drop under laminar and turbulent flow conditions – major and minor losses; Line sizing; External flows - boundary layer concepts, boundary layer thickness under laminar and turbulent flow conditions- Drag and drag coefficients. terminal settling velocity, free and hindered settlings, Stokes" law, Newton"s law, criterion for settling regime. Fluidization, types of fluidization, Ergun equation, minimum fluidization velocity.

UNIT V FLOW MEASUREMENT 9

Flow measurement - Constant and variable head meters; Velocity measurement techniques; Types, characteristics and sizing of valves; Classification, performance characteristics and sizing of pumps, , developed head, power requirement, suction lift and cavitation, NPSH,compressors and fans

Contact Periods:

Lecture: 30 Periods Tutorial: 15 Periods Practical: – Periods Total: 45 Periods

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TEXT BOOKS:

1. Noel de Nevers, "Fluid Mechanics for Chemical Engineers ", Second Edition, McGraw-Hill, (1991).
2. McCabe W.L, Smith, J C and Harriot. P "Unit operations in Chemical Engineering", McGraw Hill, VII Edition, 2005

REFERENCES:

1.White, F.M., "Fluid Mechanics ", IV Edition, McGraw-Hill Inc., 1999.
2.James O Wilkes and Stacy G Bike, "Fluid Mechanics for Chemical Engineers" Prentice Hall PTR (International series in Chemical Engineering) (1999)

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

COs	Statements	K-Level
CO1	Define the basic principles clearly	Understand
CO2	know the fundamental properties of fluids and its characteristics under static conditions	Apply
CO3	Develop empirical correlation using dimensional analysis	Apply
CO4	Explain the concepts of fluid behaviour through pipe and over the solid.	Analyze
CO5	Understand and select flow meters	Understand

COURSE ARTICULATION MATRIX:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	2	1	-	-	-	-	-	-	-	1	1
CO2	2	2	2	2	1	-	-	-	-	-	-	-	1	1
CO3	1	1	1	-	1	-	-	-	-	-	-	-	1	1
CO4	2	3	1	2	-	-	-	-	-	-	-	-	1	1
CO5	1	2	1	-	-	-	-	-	-	-	-	-	1	1
CO	2	2	1	2	1	-	-	-	-	-	-	-	1	1
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)						3: Substantial (High)				

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SEMESTER-III

U19CH303	ENVIRONMENTAL SCIENCE AND ENGINEERING	Category: PC			
		L	T	P	C
		3	0	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To study the nature and facts about environment.
- To finding and implementing scientific, technological, economic and political solutions to environmental problems.
- To study the interrelationship between living organism and environment.

UNIT I ENVIRONMENT, ECOSYSTEMS AND BIODIVERSITY 12

Definition, scope and importance of environment – need for public awareness - concept of a ecosystem – structure and function of an ecosystem – producers, consumers and decomposers — ecological succession – food chains, food webs and ecological pyramids – Introduction, types, characteristic features, structure and function of the (a) forest ecosystem (b) grassland ecosystem (c) desert ecosystem (d) aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries) – Introduction to biodiversity definition: genetic, species and ecosystem diversity – value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values – Biodiversity at global, national and local levels – hot-spots of biodiversity – threats to biodiversity, conservation of biodiversity, Elements of Environmental Science.

UNIT II ENVIRONMENTAL POLLUTION 9

Definition – causes, effects and control measures of: (a) Air pollution (b) Water pollution (c) Soil pollution (d) Noise pollution (e) Thermal pollution (f) Nuclear hazards – solid waste management: causes, effects and control measures of municipal solid wastes – role of an individual in prevention of pollution –disaster management: floods, earthquake, cyclone and landslides, pollution standards – Pollution monitoring equipment such as Ozone analyzer, high volume analyzer and continuous monitoring system for air and water.

UNIT III NATURAL RESOURCES 9

Forest resources: Use and over-exploitation, deforestation - Water resources: Use and over-utilization of surface and ground water, floods, drought - Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources– Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems - Energy resources: Growing energy needs, renewable and non renewable energy sources, use of alternate energy sources - Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification – role of an individual in conservation of natural resources.

UNIT IV SOCIAL ISSUES AND THE ENVIRONMENT 9

From unsustainable to sustainable development – urban problems related to energy – water conservation, rain water harvesting – environmental ethics: Issues and possible solutions – climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust– wasteland reclamation –environment protection act – Air (Prevention and Control of Pollution) act – Water (Prevention and control of Pollution) act – Wildlife protection act – Forest conservation act – environmental legislation, Environmental audit.

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UNIT V HUMAN POPULATION AND THE ENVIRONMENT 6

Population growth, variation among nations – population explosion – family welfare programme – environment and human health – human rights – value education – HIV / AIDS – women and child welfare.

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Total: 45 Periods

TEXT BOOKS:

1. Benny Joseph, Environmental Science and Engineering", Tata McGraw-Hill, New Delhi, 2006
2. Gilbert M.Masters, Introduction to Environmental Engineering and Science", 2nd edition, Pearson Education, 2004.

REFERENCES:

1. Dharmendra S. Sengar, "Environmental law", Prentice hall of India PVT LTD, New Delhi, 2007.
2. ErachBharucha, Text book of Environmental Studies, Universities Press (I), Pvt. Ltd., Hyderabad, 2015.
3. Rajagopalan, R, "Environmental Studies - From Crisis to Cure"", Oxford University Press, 2005.

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

COs	Statements	K-Level
CO1	Understand the nature and facts about environment.	Understand
CO2	Implement scientific, technological, economic and political solutions to environmental problems.	Apply
CO3	Study the interrelationship between living organism and environment.	Understand
CO4	Appreciate the importance of environment by assessing its impact on the human world.	Apply
CO5	Envision the surrounding environment, its functions and its value.	Understand

COURSE ARTICULATION MATRIX:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	-	-	-	-	3	3	2	3	-	-	-	2	1
CO2	2	-	-	-	-	3	3	2	3	-	-	-	2	1
CO3	2	-	-	-	-	3	3	2	3	-	-	-	2	1
CO4	2	-	-	-	-	3	3	2	3	-	-	-	2	1
CO5	2	-	-	-	-	3	3	2	3	-	-	-	2	1
CO	2	-	-	-	-	3	3	2	3	-	-	-	2	1
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)						3: Substantial (High)				

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SEMESTER-III

U19CH304	INDUSTRIAL ORGANIC CHEMISTRY	Category: PC			
		L	T	P	C
		3	0	0	3

PRE–REQUISITES:

- Chemistry for Technologists

COURSE OBJECTIVES:

- To understand the addition and substitution reactions of aliphatic and aromatic compounds
- To emphasise about the classification, properties and structure of carbohydrates, amino acids, proteins and heterocycles
- To acquire the fundamentals of the structure and properties of drugs

UNIT I ORGANIC REACTION MECHANISM 9

Nucleophilic addition and substitution in aliphatic and aromatic compounds (S_N1, S_N2 & benzyne - mechanism), aliphatic addition – ammonia derivatives – hydroxyl amine, semicarbazide, thiosemicarbazide and phenyl hydrazine, Grignard's reagent, Aldol condensation, Knoevenagel and Wittigs reactions. Aromatic compounds- Riemer Tiemann and Sandmeyer reactions

UNIT II CARBOHYDRATES 9

Introduction – classification, structure and chemical properties of monosaccharides - glucose, fructose, disaccharides - sucrose and polysaccharides - starch and cellulose, industrially used carbohydrate derivatives – structure and properties of artificial sweeteners - Saccharin and Aspartame, cellulose derivatives – carboxy methyl cellulose and gun cotton

UNIT III HETEROCYCLES 9

Classification of heterocyclic compounds, preparation, properties and uses - Furan, Thiophene, Pyrrole, Pyridine, Quinoline, Isoquinoline & Indole

UNIT IV AMINO ACIDS AND PROTEINS 9

Amino acids - classification, preparation-Strecker, Gabriel phthalimide and physical and chemical properties. Proteins - composition, classification, chemical reactions and structure

UNIT V MEDICINAL CHEMISTRY 9

Drugs - Introduction, Requirement of drug, classification based on chemical structure and therapeutic action. Definition, structure and properties - antibacterial agents (sulfonamides, penicillins), Antimalarial (Chloroquinine), analgesics (aspirin, acetaminophen), cardiovascular drugs (barbiturates, Lidocaine), anti-inflammatory agents (Salicylic acid, indomethacin)

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Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Total: 45 Periods

TEXT BOOKS:

1. BhalB.S and Arun Bhal, "A Text Book of Organic Chemistry", 17th edition, S.Chand & Co. New Delhi, 2005
2. MorrisonR.Tand Boyd R.N, "Organic Chemistry", 7th edition, Prentice Hall Inc. USA, 2010

REFERENCES:

1. Jonathan Clayden, Nick Greeves, Stuart Warren and Peter Wothers, "Organic Chemistry", Oxford University Press, 2nd edition, New Delhi, 2013
2. Tiwari K.S, Vishnoi N.K, Mehrotra S.N, "A Text Book of Organic Chemistry", 2nd edition, Vikas Publishing House, New Delhi, 2006
3. Ashutosh Kar, "Medicinal Chemistry", 7th edition, New Age International Pvt, Ltd., 2010

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

COs	Statements	K-Level
CO1	Illustrate the nucleophilic reactions and reaction mechanism	Remember
CO2	Explain the concept of carbohydrates and various reactions involved in it	Understand
CO3	Discuss the various types of heterocycles and their preparation	Remember
CO4	Outline the classification, structure and properties of proteins and amino acids	Remember
CO5	Classify the drugs based on the chemical structure and therapeutic action	Understand

COURSE ARTICULATION MATRIX:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	-	1	-	-	2	-	1	1	-	1	-	-
CO2	3	2	-	1	-	-	2	-	1	1	-	1	-	-
CO3	3	2	-	1	-	-	2	-	1	1	-	1	-	-
CO4	3	2	-	1	-	-	2	-	1	1	-	1	-	-
CO5	3	2	-	1	-	-	2	-	1	1	-	1	-	-
CO	3	2	-	1	-	-	2	-	1	1	-	1	-	-
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)						3: Substantial (High)				

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SEMESTER-III

U19CSG02	COMPUTATIONAL THINKING	Category: ES			
		L	T	P	C
		2	0	2	3

PRE–REQUISITES:

- **Programming In C**

COURSE OBJECTIVES:

- To formulate problems in a way that enables the use of a computer to solve them
- To logically organize and analyze data
- To identify, analyze and implement possible solutions with the goal of achieving the most efficient and effective combination of steps and resources

UNIT I PRINCIPLES OF COMPUTATIONAL THINKING 6

6Programming – Algorithmic thinking – Bitwise and Boolean algebra – Compiler vs interpreter – Pseudo coding – Problem definition – Data collection – Problem decomposition – Abstraction – Flowcharting – Name binding – Selection – Repetition – Modularization – Sample exercise problems and deriving solutions.

UNIT II DATA ORGANIZATION & PROCESSING USING PYTHON 6

Operators –Variables and Data types – Loops and conditions – Nested loop – Strings – Euclid's algorithm – Arrays – Functions – Recursion

UNIT III REVERSE ENGINEERING & SOLUTIONS 6

Algorithm Tracing Technique (simulating execution) – Best practices – keeping it simple – documentation style – idioms – DRY code – naming conventions – and comments – Debugging

Anticipating output from pseudo code

UNIT IV APPLIED COMPUTATIONAL THINKING 6

Operating systems basics – Networking basics – Database Management System (DBMS) – SQL – No SQL – JSON – API – XML

UNIT V EFFICIENCY ANALYSIS AND BENCHMARKING 6

Algorithm efficiency – Time complexity in programs – Mathematical preliminaries – Asymptotic analysis – Recurrence relations – Algorithm design paradigms – Divide and conquer algorithms– Dynamic programming – and Greedy algorithms

LIST OF EXPERIMENTS

1. Print the difference of indices of largest and smallest number in an array
2. Length of the longest substring without repeating characters
3. Prime factors of a given number
4. Product of the sum of diagonals of an array

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5. The greatest common divisor (GCD) of two numbers – with & without Euclid's algorithm
6. Finding output of sequencing and looping puzzles
7. Finding output of pattern matching puzzles
8. Using only indexing technique- storing and retrieving Array elements (without library functions)
9. Add, subtract, multiply, and check for equality in the two given matrices (without library functions)
10. Utilize the Pythagorean Theorem to calculate a third side of a right triangle, given the other two sides
11. Time complexity analysis – Tower of Hanoi (using Recursion) – 3 rods and n disks
12. Time complexity analysis – Tower of Hanoi (using Recursion) – 4 rods and n disks

Contact Periods:

Lecture: 30 Periods Tutorial: – Periods Practical: 30 Periods Total: 60 Periods

TEXT BOOKS:

1. David Riley and Kenny Hunt, "Computational thinking for modern solver",Kindle Edition, Chapman & Hall/CRC,2014
2. Karl Beecher ,"Computational Thinking: A beginner's guide to problem solving and programming", Kindle Edition, BCS, The Chartered Institute for IT,2017

REFERENCES:

1. Paul Curzon and Peter William Mcowan,"Power Of Computational Thinking, The: Games, Magic And Puzzles To Help You Become A Computational Thinker", Kindle Edition, World Scientific Publishing Europe Ltd, 2017
2. FabrizioLuccio, Paolo Ferragina,"Computational Thinking: First Algorithms, Then Code", Kindle Edition, Springer,2018
3. Jane Krauss, Kiki Prottsman,"Computational Thinking and Coding for Every Student: The Teacher's Getting-Started Guide" Kindle Edition, SAGE Publications,2016

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

COs	Statements	K-Level
CO1	Understand the basic principles of Computational thinking	Understand
CO2	Examine the data organization and processing using Python	Apply
CO3	Understand the basic algorithm tracing techniques	Understand
CO4	Explore the basics of operating system, networking, database management system, API and XML	Analyze
CO5	Determine efficiency of algorithms	Apply

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COURSE ARTICULATION MATRIX:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	-	-	-	-	-	-	-	-	2	-	-
CO2	3	2	2	-	-	-	-	-	-	-	-	2	-	-
CO3	3	2	2	2	2	-	-	-	-	-	-	2	-	-
CO4	3	–	–	2	2	-	-	-	-	-	-	2	-	-
CO5	3	3	3	2	–	-	-	-	-	-	-	3	-	-
CO	3	2	2	2	2	-	-	-	-	-	-	2	-	-
Correlation levels:			1: Slight (Low)			2: Moderate (Medium)						3: Substantial (High)		

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SEMESTER-III

U19CY301	ORGANIC CHEMISTRY LABORATORY	Category: BS			
		L	T	P	C
		0	0	4	2

PRE–REQUISITES:

- Chemistry for Technologists

COURSE OBJECTIVES:

- To understand the basic principles involved in identification of various functional groups
- To acquire knowledge on various reactions of carbohydrates and proteins
- To synthesize organic compounds using various process such as acetylation, halogenation and hydrolysis

LIST OF EXPERIMENTS

1. Qualitative analysis of organic compounds - Preliminary Tests, Identification of various functional groups by their characteristic reactions. a) carboxylic acid, b) aldehyde, c) ketone, d) phenol e) amine (primary)
2. Analysis of carbohydrates
3. Analysis of proteins
4. Methodology of filtration and recrystallization
5. Introduction to organic synthetic procedures:
6. Hydrolysis – Preparation of salicylic acid from methyl salicylate
7. Halogenation – Conversion of acetone to iodoform
8. Oxidation – Preparation of benzoic acid from benzaldehyde/ benzyl alcohol
9. Diazotization – Preparation of methyl orange
10. Preparation of Paracetamol from P-amino phenol
11. Preparation of Aspirin from salicylicacid

Contact Periods:

Lecture: – Periods Tutorial: – Periods Practical: 30 Periods Total: 60 Periods

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COURSE OUTCOMES:

Upon completion of the course, the student will be able to

COs	Statements	K-Level
CO1	Distinguish aromatic and aliphatic compounds as well as saturated and unsaturated compounds by preliminary test	Remember
CO2	Identify and confirm the functional groups present in a given organic sample	Understand
CO3	Analyze biomolecules like carbohydrates and proteins	Analyze
CO4	Synthesize organic compounds by halogenation, hydrolysis and oxidation reactions	Remember
CO5	Understand the mechanism of diazotization and acetylation	Understand

COURSE ARTICULATION MATRIX:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	-	1	-	-	-	-	1	1	-	1	-	-
CO2	3	2	-	1	-	-	-	-	1	1	-	1	-	-
CO3	3	2	-	1	-	-	-	-	1	1	-	1	-	-
CO4	3	2	-	1	-	-	-	-	1	1	-	1	-	-
CO5	3	2	-	1	-	-	-	-	1	1	-	1	-	-
CO	3	2	-	1	-	-	-	-	1	1	-	1	-	-
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)						3: Substantial (High)				

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SEMESTER-IV

U19MA402	PARTIAL DIFFERENTIAL EQUATIONS	Category: BS			
		L	T	P	C
		2	0	0	2

PRE–REQUISITES:

- Calculus: Differentiation and Integration

COURSE OBJECTIVES:

- Understand the concepts of partial differential equations in diffusion and concentration of chemicals
- Apply Fourier series to obtain solution of one dimensional wave and heat equation
- Apply Fourier series to obtain solution of two dimensional heat equations

UNIT I FORMATION OF PARTIAL DIFFERENTIAL EQUATIONS 6

Formation of Partial Differential Equations – Singular Integrals – Solutions of standard types of first order Partial Differential Equations

UNIT II SOLUTION OF PARTIAL DIFFERENTIAL EQUATIONS 6

Lagrange's linear equation – Solution methods for second order homogeneous equations with constant coefficients

UNIT III FOURIER SERIES 6

General Fourier series – Full Range Series $(0,2l)$, Half Range Sine and Cosine Series $(0,l)$

UNIT IV ONE DIMENSIONAL BOUNDARY VALUE PROBLEMS 6

Fourier series solution – Vibration of strings – One dimensional wave equation – One dimensional heat flow equation (unsteady state)

UNIT V TWO DIMENSIONAL BOUNDARY VALUE PROBLEMS 6

Fourier series solution – Two dimensional (steady state) heat flow equation (Cartesian form only) – Separation of variables

Contact Periods:

Lecture: 30 Periods Tutorial: – Periods Practical: – Periods Total: 30 Periods

TEXT BOOKS:

1. Grewal B S, "Higher Engineering Mathematics", 44th Edition, Khanna Publishers, New Delhi, 2017
2. Erwin Kreyszig, "Advanced Engineering Mathematics", 10th Edition, John Wiley & Sons, New Delhi, 2018

REFERENCES:

1. Bali N P, and Manish Goyal, "A Textbook of Engineering Mathematics", 9th Edition, Laxmi Publications Pvt Ltd, 2014

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2. Peter V O Neil, "Advanced Engineering Mathematics", 7th Edition, Cengage, New Delhi, 2016

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

COs	Statements	K-Level
CO1	Form Partial Differential Equation	Apply
CO2	Use Partial Differential Equations through mathematical models in Chemical engineering	Apply
CO3	Identify the periodicity of a function and formulate the same as a combination of sine and cosine	Apply
CO4	Analyze solutions of one dimensional wave and heat equation	Apply
CO5	Analyze solutions of two dimensional boundary value problems in partial differential equations	Apply

COURSE ARTICULATION MATRIX:

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

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

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SEMESTER-IV

U19CH401	HEAT TRANSFER	Category: PC			
		L	T	P	C
		3	0	2	4

PRE–REQUISITES:

- Basic knowledge in Physics, Mathematics and Fluid Mechanics

COURSE OBJECTIVES:

- To understand the fundamental concepts of heat transfer viz., conduction, convection, radiation.
- To understand the concept boiling and condensation and its application and also radiative heat transfer including blackbody radiation
- Develop sound practical knowledge for students on different types of heat transfer equipment

UNIT I INTRODUCTION AND CONDUCTION **9 + 6**

6Importance of heat transfer in Chemical Engineering operations - Modes of heat transfer ; One dimensional steady state heat conduction through plane and composite walls, hollow cylinder and spheres - Thermal conductivity measurement-effect of temperature on thermal conductivity; Heat transfer in extended surfaces; Transient heat conduction

UNIT II HEAT TRANSFER BY CONVECTION **9 + 6**

Concepts of heat transfer by convection - Natural and forced convection, Hydrodynamic and thermal Boundary layers; analogies between transfer of momentum and heat - Reynold's analogy, Prandtl and Coulburn analogy. Dimensional analysis in heat transfer, heat transfer coefficient for flow through a pipe, flow past flat plate, and flow through packed beds and fluidized beds.

UNIT III HEAT TRANSFER BY PHASE CHANGE **9 + 6**

Heat transfer to fluids with phase change - heat transfer from condensing vapours, drop wise and film wise condensation, Nusselt equation for vertical and horizontal tubes, condensation of superheated vapours, Heat transfer to boiling liquids - mechanism of boiling, nucleate boiling and film boiling.

UNIT IV EVAPORATION AND RADIATION **9 + 6**

Evaporation- single and multiple effect operation, material and Energy balance in evaporators, boiling point elevation, Duhring's rule. Radiation heat transfer - Black body radiation, Emissivity, Stefan - Boltzman law, Plank's law, radiation between surfaces.

UNIT V HEAT EXCHANGERS **9 + 6**

Heat Exchangers – classification and design, overall and individual film coefficients, mean temperature difference, LMTD correction factor for multiple pass exchanger, NTU and efficiency of Heat exchangers

Contact Periods:

Lecture: 45 Periods Tutorial: 0 Periods Practical: 30 Periods Total: 75 Periods

TEXT BOOKS:

1. Holman, J. P., 'Heat Transfer ', 8th Edn., McGraw Hill, 1997
2. Ozisik, M. N., Heat Transfer: A Basic Approach, McGraw-Hill, 1984

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REFERENCES:

1. McCabe, W.L., Smith, J.C., and Harriot, P., "Unit Operations in Chemical Engineering",6th Edn., McGraw-Hill, 2001
2. Coulson, J.M. and Richardson, J.F., "Chemical Engineering " Vol. I, 4th Edn., Asian Books Pvt. Ltd., India, 1998

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

COs	Statements	K-Level
CO1	To familiarize the students with the fundamental concepts of Heat Transfer. provide the student with knowledge about heat transfer by conduction in solids for steady state	Understand
CO2	Students will understand convective heat transfer and use of heat transfer coefficients for laminar and turbulent flows	Apply
CO3	The course gives the student insight about boundary layer flow, laminar and turbulent flows	Apply
CO4	Students will be able to calculate and use overall heat transfer coefficients in designing heat exchangers	Analyze
CO5	Students will understand radiative heat transfer including blackbody radiation and Kirchoff's law and will be able to solve radiative problems apply knowledge of heat transfer to solve thermal engineering problems	Apply

LIST OF EXPERIMENTS

1. Heat Transfer in a Double Pipe Heat Exchanger
2. Heat transfer in composite wall
3. Heat transfer by Forced / Natural Convection
4. Heat Transfer by Radiation - Determination of Stefan Boltzmann constant
5. Heat Transfer by Radiation - Emissivity
6. Heat transfer in Shell and Tube Heat Exchanger
7. Heat transfer in Open Pan Evaporator
8. Heat transfer by Single effect evaporation
9. Heat Transfer in a Horizontal Condenser / Vertical Condenser
10. Heat Transfer in Helical Coils
11. Heat Transfer in Jacketed vessel

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COURSE ARTICULATION MATRIX:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	1	3	-	-	-	-	-	-	-	2	2
CO2	3	2	2	1	-	2	1	-	-	-	-	-	2	2
CO3	3	2	2	2	-	-	-	-	-	-	-	-	2	2
CO4	3	2	2	1	2	-	-	-	-	-	-	-	2	2
CO5	3	2	2	3	-	-	2	-	-	-	-	-	2	2
CO	3	2	2	1	2	-	1	-	-	-	-	-	2	2
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)						3: Substantial (High)				

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SEMESTER-IV

U19CH402	CHEMICAL ENGINEERING THERMODYNAMICS I	Category: PC			
		L	T	P	C
		2	1	0	3

PRE–REQUISITES:

- Basic knowledge in Science and Mathematics

COURSE OBJECTIVES:

At the end of the course, Students will learn about

- Various laws of thermodynamics and PVT behaviour of fluids,
- Thermodynamic property relations and their application to fluid flow
- Power generation and refrigeration processes

UNIT I INTRODUCTION 9

Scope of thermodynamics; Definition of system, control volume, state and path function, equilibrium, reversibility, energy, work and heat. zeroth law; temperature scales

UNIT II PVT BEHAVIOUR OF FLUIDS 9

PVT behaviour of fluids; Mathematical representation of PVT behaviour; Generalized compressibility factor correlation; Generalized equations of state

UNIT III SECOND AND THIRD LAW OF THERMODYNAMICS 9

Joule's experiment, internal energy, first law, energy balance for closed systems, mass and energy balance for open systems Statements of the second law of thermodynamics, heat engine and refrigerator, Carnot cycle and Carnot theorems, thermodynamic temperature scale, entropy and its calculation, second law of thermodynamics for a control volume, Third law of thermodynamics, entropy from a microscopic point of view.

UNIT IV THERMODYNAMIC PROPERTY RELATIONS 9

Thermodynamic potentials – internal energy, enthalpy, Helmholtz free energy, Gibbs free energy; thermodynamic property relations – Maxwell relations – partial derivatives and Jacobian method; residual properties; thermodynamic property tables and diagrams

UNIT V POWER GENERATION AND REFRIGERATION PROCESSES 9

Duct flow of compressible fluids, Compression and expansion processes, steam power plant, internal combustion engines, jet and rocket engines.

Contact Periods:

Lecture: 30 Periods Tutorial: –15 Periods Practical: – Periods Total: 45 Periods

TEXT BOOKS:

1. Smith, J.M., Van Ness, H.C and Abbot M.M "Introduction to Chemical Engineering Thermodynamics ", McGraw Hill Publishers, VI edition, 2003

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2. Narayanan, K.V. A Textbook of Chemical Engineering Thermodynamics Prentice Hall India, 2004

REFERENCES:

1. Kyle, B.G., "Chemical and Process Thermodynamics III Edition", Prentice Hall of India Pvt. Ltd., 1999.
2. Elliott J.R., Lira, C.T., "Introductory chemical engineering thermodynamics", Prentice Hall, 1998
3. Rao, Y.V.C., "Chemical Engineering Thermodynamics" Universities Press, 2005

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

COs	Statements	K-Level
CO1	Define the basic principles clearly	Understand
CO2	Apply the PVT behaviour concepts clearly	Apply
CO3	Apply second law and analyze the feasibility of systems/devices	Apply
CO4	Analyse the concept of thermodynamic property relation to fluid flow	Analyze
CO5	Understand the real gas behaviour	Understand

COURSE ARTICULATION MATRIX:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1		-	-	-	-	-	-	-	-	-	1	1
CO2	2	2	2	-	-	-	-	-	-	-	-	-	1	1
CO3	1	1	1	-	-	-	-	-	-	-	-	-	1	1
CO4	2	3	1	-	-	-	-	-	-	-	-	-	1	1
CO5	1	2	1	-	-	-	-	-	-	-	-	-	1	1
CO	1	2	1	-	-	-	-	-	-	-	-	-	1	1
Correlation levels: 1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)														

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SEMESTER-IV

U19CH403	MECHANICAL OPERATIONS	Category: PC			
		L	T	P	C
		2	0	2	3

PRE–REQUISITES:

- Basics of Physics and Mathematics

COURSE OBJECTIVES:

- To understand the particle characterization
- To understand the concept of filtration and separation
- To understand about mixing and agitation of solids and liquids

UNIT I CHARACTERISTICS OF SOLIDS 6

General characteristics of solids, different techniques of size analysis, shape factor, surface area determination, estimation of particle size. Screening methods and equipment, screen efficiency, ideal and actual screens

UNIT II SIZE REDUCTION IN SOLDS 6

Laws of size reduction, energy relationships in size reduction, methods of size reduction, classification of equipments, crushers, grinders and its application in cement industries, Size enlargement - Importance of size enlargement, principle of granulation, pelletization, and flocculation

UNIT III SETTLING AND SEPARATIONS 6

Gravity settling, sedimentation, thickening, elutriation, double cone classifier, rake classifier, bowl classifier. Centrifugal separation - cyclones and hydro cyclones, electrostatic and magnetic separators, heavy media separations, floatation, jigging

UNIT IV FILTRATION 6

Theory of filtration, Batch and continuous filters, Flow through filter cake and filter media,

compressible and incompressible filter cakes, filtration equipments - selection, operation - filter aids

UNIT V MIXING, AGITATION AND STORAGE 6

Mixing and agitation - Mixing of liquids (with or without solids), mixing of powders, selection of suitable mixers. Storage and Conveying of solids - Bunkers, silos, bins and hoppers, conveyer selection

LIST OF EXPERIMENTS

1. Sieve analysis
2. Size separation using Sub-Sieving
3. Batch filtration studies using a Leaf filter
4. Batch filtration studies using a Plate and Frame Filter press
5. Characteristics of batch Sedimentation
6. Reduction ratio in Jaw Crusher
7. Reduction ratio in Ball mill

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8. Separation characteristics of Cyclone separator
9. Determination of specific surface area using air permeability set up
10. Separation characteristics of Elutriator

Contact Periods:

Lecture: 30 Periods Tutorial: – Periods Practical: 30 Periods Total: 60 Periods

TEXT BOOKS:

1. McCabe, W.L., Smith, J.C., and Harriot, P., "Unit Operations in Chemical Engineering", 7th Edn., McGraw-Hill, 2005
2. Badger W.L. and Banchero J.T., "Introduction to Chemical Engineering", Tata McGraw Hill, 1997

REFERENCES:

1. Coulson, J.M. and Richardson, J.F., "Chemical Engineering" Vol. II, 4th Edn., Asian Books Pvt.Ltd., India, 1998
2. Foust, A. S., Wenzel, L.A., Clump, C.W., Naus, L., and Anderson, L.B., "Principles of Unit Operations", 2nd Edn., John Wiley & Sons, 1994
3. Hiroaki Masuda , Kohigashitani and Hideto Yoshida, Powder Technology Handbook, 3rd Edition

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

COs	Statements	K-Level
CO1	Characterization of solids particles	Understand
CO2	Apply the laws of size reduction in energy calculation	Apply
CO3	Explain the concepts settling and sedimentation	Understand
CO4	Understand the theory of filtration	Understand
CO5	Explain the concepts mixing and agitation	Understand

COURSE ARTICULATION MATRIX:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	-	-	-	-	-	-	-	-	1	1	-
CO2	3	2	1	-	-	-	-	-	-	-	-	1	1	-
CO3	3	2	1	-	-	-	-	-	-	-	-	1	1	-
CO4	3	2	1	-	-	-	-	-	-	-	-	1	1	-
CO5	3	2	1	-	-	-	-	-	-	-	-	1	1	-
CO	3	2	1	-	-	-	-	-	-	-	-	1	1	-
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)						3: Substantial (High)				

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SEMESTER-IV

		Category: ES			
U19CH404	FLUID MECHANICS LABORATORY	L	T	P	C
		0	0	4	2

PRE–REQUISITES:

- Basic knowledge in Fluid Mechanics

COURSE OBJECTIVES:

To learn experimentally to

- Calibrate flow meters
- Find pressure loss for fluid flows
- To determine pump characteristics.

LIST OF EXPERIMENTS

1. Viscosity measurement of non Newtonian fluids

2. Calibration of constant and variable head meters

3. Calibration of weirs and notches

4. Open drum orifice and draining time

5. Flow through straight pipe

6. Flow through annular pipe

7. Flow through helical coil and spiral coil

8. Losses in pipe fittings and valves

9. Characteristic curves of pumps (Centrifugal / Gear / Reciprocating)

10. Pressure drop studies in packed column

11. Hydrodynamics of fluidized bed

12. Drag coefficient of solid particle

Minimum 10 experiments shall be offered

Contact Periods:

Lecture: - Periods Tutorial: - Periods Practical: 60 Periods Total: 60 Periods

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COURSE OUTCOMES:

Upon completion of the course, the student will be able to

COs	Statements	K-Level
CO1	Use variable area flow meters and variable head flow meters	Understand
CO2	Understand and select flow meters.	Understand
CO3	Get clear idea on open channels and flow past immersed bodies	Understand
CO4	Select pumps for the transportation of fluids based on process conditions	Apply
CO5	Analyze the flow of fluids through closed conduits	Analyze

COURSE ARTICULATION MATRIX:

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

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

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SEMESTER-IV

UI9CA001	NUMERICAL APTITUDE AND VERBAL ABILITY - I	Category: EEC			
		L	T	P	C
		1	0	0	1

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To understand the concepts of coding, decoding, interpreting and applying
- To comprehend the basics concepts of logical reasoning and verbal reasoning

UNIT I CODING AND DECODING 3

Clocks & calendars – Alpha numeric series – Coding & decoding – Blood relations – Odd man out – Direction

UNIT II DATA INTERPRETATION 3

Syllogism – Order and ranking – Puzzles – Cubes and dices – Statements – Assumptions and conclusions – Seating arrangements – Data sufficiency – Data interpretation

UNIT III GRAMMAR 3

Parts of speech (Nouns – Pronouns – Verbs – Adjectives – Adverbs – Prepositions – Conjunctions – Interjections) –Gerunds – Phrases and clauses

UNIT IV WRITING 3

Tenses – Active and passive voice (Tense usage) – Reported speech – Verbal ability (Vocabulary and Reasoning)

UNIT V READING 3

Cloze test – Sentence formation – Para jumbles – Passage formation – Spotting errors – Verbal analogies

Contact Periods:

Lecture: 15 Periods Tutorial: – Periods Practical: – Periods Total: 15 Periods

TEXT BOOKS:

1. R S Aggarwal – Quantitative Aptitude for Competitive Examinations", 17th Edition S Chand Publishing, New Delhi, 2017
2. R S Aggarwal – Objective General English", S Chand Publishing, New Delhi, 2017

REFERENCES:

1. Abhijit Guha – Quantitative Aptitude for Competitive Examination, McGraw Hill Education (India) Private Limited, 5th Edition, 2015
2. R S Aggarwal - A Modern Approach to Verbal & Non-Verbal Reasoning, S Chand Publishing, New Delhi, 2017

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COURSE OUTCOMES:

Upon completion of the course, the student will be able to

COs	Statements	K-Level
CO1	Apply the concept of coding and decoding for numerical reasoning and data interpretation through Graphs and Charts	Apply
CO2	Choose appropriate words / phrases for the sentences and present comprehensively	Understand

COURSE ARTICULATION MATRIX:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	-	-	-	-	-	-	-	-	-	3	-	-	-	-
CO	3	-	-	-	-	-	-	-	-	3	-	-	-	-
Correlation levels:	1: Slight (Low)					2: Moderate (Medium)					3: Substantial (High)			

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SEMESTER-V

U19MA502	NUMERICAL METHODS	Category: BS			
		L	T	P	C
		2	0	0	2

PRE–REQUISITES:

- Calculus: Differentiation and Integration

COURSE OBJECTIVES:

- Understand the concepts of direct and iterative method for solving algebraic and transcendental equations using numerical methods of interpolation
- Obtain the solution of differentiation and integration using standard numerical techniques in solving mass transfer problems
- Obtain the solution of Ordinary differential equation using standard numerical techniques

UNIT I SOLUTION OF TRANSCENDENTAL EQUATIONS **6**

Fixed Point Iteration method – Newton Raphson method

UNIT II SYSTEM OF EQUATIONS **6**

Solution of linear system of equations – Gauss elimination method–Gauss Jordan method – Gauss Seidel method

UNIT III NUMERICAL DIFFERENTIATION **6**

Approximation of derivatives using interpolation polynomials

UNIT IV NUMERICAL INTEGRATION **6**

Numerical integration using Trapezoidal, Simpson's 1/3 rule, Simpson's 3/8 rule

UNIT V NUMERICAL SOLUTIONS OF ORDINARY DIFFERENTIAL EQUATIONS **6**

Taylor's series method – Euler's method - Modified Euler's method – Fourth order Runge – Kutta method for solving first order equations - Multi step methods – Milne's Thomson method

Contact Periods:

Lecture: 30 Periods Tutorial: – Periods Practical: – Periods Total: 30 eriods

TEXT BOOKS:

1.Burden, R L, and Faires, J D, "Numerical Analysis", 9th Edition, Cengage Learning, 2016

2.Grewal, B S, and Grewal, J S, "Numerical Methods in Engineering and Science", 10th Edition, Khanna Publishers, New Delhi, 2015

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REFERENCES:

1.Jain M K, Iyengar S R K, Jain R K, "Numerical Methods for Scientific and Engineering computation", New Age international publishers, 2019

2. Sastr S S, "Introductory Methods of Numerical Analysis", PHI Learning Pvt Ltd, 5th Edition, 2015

3. Steven C Chapra and Raymond P Canale, "Numerical Methods for Engineers", Tata McGraw-Hill, New Delhi, 2017

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

COs	Statements	K-Level
CO1	Compute the roots of algebraic and transcendental equations	Apply
CO2	Identify the basic concepts of solving algebraic and transcendental equations	Apply
CO3	Use differentiation methods for finite difference and finite element method	Apply
CO4	Use integration methods for finite difference and finite element method	Apply
CO5	Use numerical methods to solve ordinary differential equations	Apply

COURSE ARTICULATION MATRIX:

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

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

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SEMESTER-V

U19CH501	MASS TRANSFER I	Category: PC			
		L	T	P	C
		3	0	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To learn and determine mass transfer rates under laminar and turbulent conditions and apply these concepts in the design of humidification columns, dryers and crystallisers.
- To develop knowledge for application of mass transfer principles.
- To impart the significance of mass transfer principles used in Chemical Engineering.

UNIT I MOLECULAR DIFFUSION 9

Introduction to mass transfer operations. Molecular diffusion in gases, liquids and solids. Diffusivity measurement and prediction; multi-component diffusion.

UNIT II CONVECTIVE TRANSFER AND INTERPHASE MASS TRANSFER 9

Eddy diffusion, concept of mass transfer coefficients, theories of mass transfer, different transport analogies, application of correlations for mass transfer coefficients, inter phase mass transfer, relationship between individual and overall mass transfer coefficients. NTU and NTP concepts, Stage-wise and differential contractors.

UNIT III HUMIDIFICATION OPERATIONS 9

Humidification – Equilibrium, humidity chart, adiabatic and wet bulb temperatures; humidification operations; theory and design of cooling towers, dehumidifiers and humidifiers using enthalpy transfer unit concept.

UNIT IV DRYING 9

Drying – Equilibrium. Classification of dryers, batch drying – Mechanism and time of cross through circulation drying, theoretical estimation of drying rate and time. Continuous dryers – material and energy balance. Advance drying techniques such as freeze drying, microwave drying

UNIT V CRYSTALLIZATION 9

A Crystal geometry. Equilibrium, yield and purity of products, theory of super saturation, nucleation and crystal growth, classification of crystallizers, design of batch crystallizers and continuous crystallizers.

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Total: 45 Periods

TEXT BOOKS:

1.Treybal, R. E., "Mass Transfer Operations", 3rd Edition, McGraw-Hill,1981.
2.Geankoplis, C.J., "Transport Processes and Unit Operations", 4th Edition, Prentice HallInc., NewJersey, 2003.

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REFERENCES:

1. McCabe, W.L., Smith, J.C., and Harriot, P., "Unit Operations in Chemical Engineering", 7th Edition., McGraw-Hill, 2005.
2. Coulson, J.M. and Richardson, J.F., "Chemical Engineering" Vol. I and II, 4th Edition, Asian Books Pvt. Ltd., India, 1998.
3. Seader J.D. and Henley E.J., "Separation Process Principles", 2nd Ed., John Wiley, 2006

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

COs	Statements	K-Level
CO1	Understand the fundamentals, types and mechanism of mass transfer operations	Apply
CO2	Understand the theories of mass transfer and the concept of inter-phase mass transfer	Understand
CO3	Understand the basics of humidification process and its application	Understand
CO4	Understand the concept and mechanism of drying operations	Understand
CO5	Formulate and solve material balances for unit operations such as humidification, drying and crystallization operations.	Apply

COURSE ARTICULATION MATRIX:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1	-	-	-	-	-	-	-	1	1	1
CO2	3	1	1	-	-	-	-	-	-	-	-	1	1	1
CO3	3	1	1	-	-	-	-	-	-	-	-	1	1	1
CO4	3	1	1	-	-	-	-	-	-	-	-	1	1	1
CO5	3	1	1	1	-	-	-	-	-	-	-	1	1	1
CO	3	1	1	1	-	-	-	-	-	-	-	1	1	1
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)						3: Substantial (High)				

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SEMESTER-V

U19CH502	CHEMICAL ENGINEERING THERMODYNAMICS II	Category: PC			
		L	T	P	C
		3	0	0	3

PRE–REQUISITES:

- Knowledge in Science, Mathematics and Chemical Engineering

COURSE OBJECTIVES:

This course enables the students to understand

- The behaviour of fluids under PVT conditions and also apply them for practical purpose
- The concepts of thermodynamics
- The principles of refrigeration and to evaluate their performance

UNIT I PROPERTIES OF SOLUTIONS 9

Partial molar properties, ideal and non-ideal solutions, standard states definition and choice, Gibbs-Duhem equation.

UNIT II PHASE EQUILIBRIA 9

Criteria for equilibrium between phases in multi component non-reacting systems in terms of chemical potential and fugacity, application of phase rule, vapour-liquid equilibrium, liquid-liquid equilibrium, ternary liquid-liquid equilibrium

UNIT III CORRELATION AND PREDICTION OF PHASE EQUILIBRIA 9

Thermodynamic consistency of phase equilibria, application of the correlation and prediction of phase equilibria in systems of engineering interest particularly to distillation and liquid extraction processes.

UNIT IV CHEMICAL REACTION EQUILIBRIA 9

Definition of standard state, standard free energy change and reaction equilibrium constant, calculation of equilibrium compositions for homogeneous chemical reactors, thermodynamic analysis of simultaneous reactions.

UNIT V REFRIGERATION 9

Principles of refrigeration, methods of producing refrigeration, evaluation of the performance of vapour compression and gas refrigeration cycles.

Contact Periods:

Lecture: 45 Periods Tutorial: –Periods Practical: – Periods Total: 45 Periods

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TEXT BOOKS:

1. Smith, J.M., VanNess, H.C., & Abbot M.C, "Introduction to Chemical Engineering Thermodynamics", McGraw Hill VII Edition 2004.
2. Narayanan K.V "A Text Book of Chemical Engineering Thermodynamics" Prentice Hall of India Pvt. Ltd. 2001

REFERENCES:

1. Hougen, O.A., Watson, K.M., and Ragatz, R.A., "Chemical Process Principles Part II", Thermodynamics, John Wiley, 1970.
2. Dodge, B.F., "Chemical Engineering Thermodynamics", McGraw-Hill, 1960.
3. Sandler, S.I., "Chemical and Engineering Thermodynamics", 2nd Edition, Wiley, 1989..

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

COs	Statements	K-Level
CO1	Apply mass balances to flow processes	Apply
CO2	Understand the entropy and enthalpy balances to flow processes	Understand
CO3	Implement the chemical reaction equilibria in engineering systems	Apply
CO4	Discuss about phase equilibria in engineering aspects	Analyze
CO5	Understand the principles of refrigeration	Understand

COURSE ARTICULATION MATRIX:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	-	-	2	-	-	-	-	1	-	-	1	2
CO2	3	2	-	-	2	-	-	-	-	1	-	-	1	2
CO3	3	2	-	-	2	-	-	-	-	1	-	-	1	2
CO4	3	2	-	-	2	-	-	-	-	1	-	-	1	2
CO5	3	2	-	-	2	-	-	-	-	1	-	-	1	2
CO	3	2	-	-	2	-	-	-	-	1	-	-	1	2
Correlation levels:	1: Slight (Low)				2: Moderate (Medium)					3: Substantial (High)				

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SEMESTER-V

U19CH503	CHEMICAL REACTION ENGINEERING	Category: PC			
		L	T	P	C
		3	1	0	4

PRE–REQUISITES:

- Basic knowledge about reaction mechanisms.

COURSE OBJECTIVES:

- To gain knowledge on different types of chemical reactors, the design of chemical reactors under isothermal and non-isothermal conditions.
- To enable the students to learn the gas-solid catalytic and non-catalytic reactors and gas-liquid reactors.
- To impart the knowledge of reaction rate theories and reaction mechanisms to derive expressions for rate equations mass and energy balances.

UNIT I CHEMICAL KINETICS & CHEMICAL REACTION ENGINEERING **9 + 3**

Broad outline of chemical reactors; rate equations; concentration and temperature dependence; development of rate equations for different homogeneous reactions. Industrial scale reactors.

UNIT II IDEAL REACTORS **9 + 3**

Isothermal batch, flow, semi-batch reactors; performance equations for single reactors; multiple reactor systems; multiple reactions.

UNIT III IDEAL FLOW AND NON-IDEAL FLOW **9 + 3**

RTD in non-ideal flow; non-ideal flow models; reactor performance with non-ideal flow

UNIT IV GAS-SOLID, GAS-LIQUID REACTIONS **9 + 3**

Resistances and rate equations; heterogeneous catalysis; reactions steps; resistances and rate equations.

UNIT V FIXED BED AND FLUID BED REACTORS **9 + 3**

G/L reactions on solid catalysis; trickle bed, slurry reactors; three phase-fluidized beds; reactors for fluid-fluid reactions; tank reactors.

Contact Periods:

Lecture: 45 Periods Tutorial: 15 Periods Practical: – Periods Total: 60 Periods

TEXT BOOKS:

1. Levenspiel O, "Chemical Reaction Engineering", Wiley Eastern Ltd., II Edition, 2000
2. Smith, J.M, "Chemical Engineering Kinetics", McGraw Hill, III Edition, 1981.

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REFERENCES:

1. Fogler.H.S., "Elements of Chemical Reaction Engineering", Prentice Hall of India Ltd., 3rd Edition, 2000
2. Froment. G.F. &K.B.Bischoff, "Chemical Reactor Analysis and Design", John Wiley and Sons, 1979
3. Missen R.W., Mims C.A., Saville B.A. Introduction To Chemical Reaction Engineering and Kinetics. John Wiley.1999

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

COs	Statements	K-Level
CO1	Design and conduct an experimental investigation in order to determine rate equations.	Analyze
CO2	Demonstrate an ability to solve material and energy balances in order to analyse the performance of a reactor.	Apply
CO3	Demonstrate an experimental data using standard statistical methods to establish quantitative results.	Apply
CO4	Gain knowledge on the selection of reactor for the required reaction	Understand
CO5	Gain the ability to determine experimentally the kinetics and rate constants of reactions in different types of reactors.	Understand

COURSE ARTICULATION MATRIX:

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

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

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SEMESTER-V

U19CH504	MATERIAL SCIENCE AND TECHNOLOGY	Category: PC			
		L	T	P	C
		2	0	0	2

PRE–REQUISITES:

- Knowledge in basic sciences and physics of materials

COURSE OBJECTIVES:

To enable the students to understand

- To the basics of metallurgy
- To the techniques of extraction from its ores
- To the method of operation of various converters and furnaces.

UNIT I MECHANICAL BEHAVIOUR 6

Stress- Strain diagram showing ductile and brittle behaviour of materials, Liner and non-linear elastic behaviour and properties, mechanical Properties in plastic range, Yield strength offset yield strength, ductility, ultimate tensile strength, toughness plastic deformation of single crystal by slip and twinning

UNIT II HEAT TREATMENT IN METALS 6

TTT curves, Continuous cooling curves, Annealing and its types, Normalizing, Hardening, Tempering, Martempering, Austemparing, hardenability, Surface hardening methods like Carburizing, Cyaniding Nitriding, flame hardening and induction hardening, age hardening of aluminum and copper alloys.

UNIT III SOLIDIFICATION AND PHASE DIAGRAM 6

Mechanism of solidification, Homogenous and Heterogeneous nucleation. Cristal Growth, Cast metal strictures, Phase diagram. Solid solutions Substitution and Interstitial solid solution, Hume rothary rule, Intermediate phase, construction of equilibrium diagram involving complete and partial solubility

UNIT IV COMPOSITE MATERIALS 6

Definition, classification, type of matrix materials and reinforcements, advantages and application of composites. Processing of FRP Composites: Layup and curing, fabricating process, open and closed mould process, hand layup technique; structural laminate bag molding, production procedures for bag molding; filament winding, pultrusion, pulforming, thermo-forming, injection molding, blow molding

UNIT V SMART MATERIALS 6

Piezoelectric Materials, Electrostrictive Materials, Magnetostrictive Materials, Magnetoelectric Materials. Magnetorheological Fluids, Electrorheological Fluids, Shape Memory Materials, Fiber-Optic Sensors.

Contact Periods:

Lecture: 30 Periods Tutorial: –Periods Practical: – Periods Total: 30 Periods

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TEXT BOOKS:

1. Materials Science and Engineering, William D. Callister Jr., John Wiley & Sons. Inc, 5th Edition, 2001.
2. Mechanics of Composite Materials, Second Edition, Autar K. Kaw, CRC Press, 2005.
3. Materials and Structures - M. V. Gandhi and B. So Thompson - Chapman & Hall, London; New York - 1992

REFERENCES:

1.An Introduction to Metallurgy; Alan Cottrell, Universities Press India Oriental Longman Pvt. Ltd., 1974.

2.Engineering Materials Science, W.C.Richards, PHI

3.Elements of Materials Science and Engineering, H. VanVlack, Addison- Wesley Edn., 1998

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

COs	Statements	K-Level
CO1	Appreciate the necessity of engineering materials, Smart Sensors and its applications in various field	Understand
CO2	Identify possible cause of failure due to fatigue and Creep	Understand
CO3	Demonstrate the knowledge of nucleation, Crystal growth, Solid solution and Phase diagrams	Apply
CO4	Appreciate the significance and applications of Various heat treatment processes.	Apply
CO5	Explain the definition and classification and fabrication processes of composite materials.	Analyze

COURSE ARTICULATION MATRIX:

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

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

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SEMESTER-V

U19CH504	CHEMICAL REACTION ENGINEERING LABORATORY	Category: PC			
		L	T	P	C
		0	0	4	2

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To analyze and performing the experiments, estimation of reaction kinetics, porosity and sphericity of catalyst.
- To find out the Residence time distribution and validation of adsorption isotherms
- To understand various types of reactors used in industries

LIST OF EXPERIMENTS

1. Batch Reactor.
2. Plug Flow Reactor.
3. Continuous Stirred Tank Reactor.
4. Packed Bed Reactor.
5. Combined CSTR and PFR.
6. Plug Flow Reactor with RTD
7. CSTR in series.
8. Temperature dependent kinetics set up.
9. Adiabatic Reactor.
10. Photochemical Reactor.

Contact Periods

Lecture: - Periods Tutorial: –Periods Practical: 60 Periods Total: 60 Periods

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COURSE OUTCOMES:

Upon completion of the course, the student will be able to

COs	Statements	K-Level
CO1	Determine the rate constant experimentally in a batch reactor.	Apply
CO2	Determine the conversion of a reaction in different reactors (batch, CSTR, PFR)	Analyze
CO3	Study of temperature dependence of rate constant	Analyze
CO4	Determine the non-ideal behaviour and residence time distribution in PFR and CSTR.	Analyze
CO5	Determine the conversion of reactor arranged in series	Apply

COURSE ARTICULATION MATRIX:

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

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

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SEMESTER-V

U19CA002	NUMERICAL APTITUDE AND VERBAL ABILITY - II	Category: EEC			
		L	T	P	C
		1	0	0	1

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To understand the concepts of number system, profit and loss and infer time, speed and distance
- To write sentences with appropriate grammatical structure in a professional context

UNIT I NUMBER SYSTEMS 3

Divisibility tests (Divisibility factor – Prime factor – Divisibility rules – Finding unit digit) – LCM & HCF (Listing multiples, Prime Factorization, Division method, etc.) – Number System (Numbers, Prime, Composite, Co-prime, numbers) – Percentage (Percentage – Fractions of percentages– Expenditure – Price – Consumption – Population – Depreciation)

UNIT II PROFIT AND LOSS 3

Profit, Loss & Discounts – (CP, SP, MP, Profit, Loss, Discount) – Ratio & Proportion (Compounded Ratio – Mean – Proportional – Componendo.– Dividendo – Directly proportional – Inversely proportional), Age problems (Various techniques to solve age problems)

UNIT III AVERAGES AND ALLIGATIONS 3

Averages (Simple average, weighted average) – Mixture and Alligations (Various techniques to solve mixtures and alligations) – Boats and streams (Downstream, upstream, average speed)

UNIT IV PERMUTATION AND COMBINATION 3

Time & work (Problems on time, work and effectively) – Permutations & combinations (Arrangements & selections, together and not together problems) – Probability (Coins, card, dice) Logarithms (Log function, common log, natural log, binary log, laws of logarithms) – Areas and volumes

UNIT V WRITING 3

Reading comprehension – Letter writing – Email writing – Creative writing – Resume building

Contact Periods:

Lecture: 15 Periods Tutorial: – Periods Practical: – Periods Total: 15 Periods

TEXT BOOKS:

1. "R S Aggarwal – Quantitative Aptitude for Competitive Examinations", 17th Edition S Chand Publishing, New Delhi, 2017
2. "R S Aggarwal – Objective General English", S Chand Publishing, New Delhi, 2017

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REFERENCES:

1. "R S Aggarwal - A Modern Approach to Verbal & Non-Verbal Reasoning", S Chand Publishing, New Delhi, 2017
2. "Abhijit Guha – Quantitative Aptitude for Competitive Examination", McGraw Hill Education (India) Private Limited, 5th Edition, 2015
3. "Arun Sharma – How to prepare for Quantitative Aptitude for CAT", 8th edition McGraw Hill Education, Chennai, 2018

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

COs	Statements	K-Level
CO1	Use basics of counting through permutation and combination for arrangement of tasks	Apply
CO2	Draft letters, emails and make notes with appropriate use of words	Understand

COURSE ARTICULATION MATRIX:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	-	-	-	-	-	-	-	-	-	3	-	-	-	-
CO	3	-	-	-	-	-	-	-	-	3	-	-	-	-
Correlation levels:	**1: Slight (Low)**		**2: Moderate (Medium)**						**3: Substantial (High)**					

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SEMESTER-VI

U19CH601	MASS TRANSFER II	Category: PC			
		L	T	P	C
		3	1	0	4

PRE–REQUISITES:

- Mass Transfer-I

COURSE OBJECTIVES:

- To impart the basic concept of conventional mass transfer operations.
- To learn the equilibrium characteristics of two phase mass transfer processes.
- To understand the hydrodynamics and modes of operations in mass transfer equipment.

UNIT I ABSORPTION **9+3**

Equilibrium and operating line concept in absorption calculations; types of contactors, design of packed and plate type absorbers; Operating characteristics of stage wise and differential contactors, concepts of NTU, HTU and overall volumetric mass transfer coefficients; multicomponent absorption; mechanism and model of absorption with chemical reaction; thermal effects in absorption process.

UNIT II DISTILLATION **9+3**

Design of Distillation -Stage-wise and continuous Differential contact operations- Design calculations using Ponchon-Savarit and Mc-Cabe Thiele Methods- Separation efficiency- Murphree Plate Efficiency, Point and overall efficiency interrelations- Reboilers and condensers- Open steam Distillation – Design of Packed bed distillation towers-HTU and NTUcalculations.

UNIT III LIQUID-LIQUID EXTRACTION **9+3**

Extraction- Theory, LLE for different systems, Effect of Pressure and Temperature on LLE- Solubility criteria- Design of Batch and continuous extraction towers for miscible and immiscible systems- Industrial Applications.

UNIT IV LEACHING **9+3**

Leaching-Theory, Mechanism, Types of leaching, Solid - Liquid equilibria- Design of Batch and continuous extractors- Equipments and industrial applications.

UNIT V ADSORPTION, ION EXCHANGE AND MEMBRANE SEPARATION PROCESSES **9+3**

Adsorption-Types of adsorption, nature of adsorbents-Adsorption hysteresis- Adsorption isotherms- Operation of adsorption columns- Design of Batch and continuous adsorbers. Principle of Ion exchange, techniques and applications. Solid and liquid membranes; concept of osmosis; reverse osmosis; electro dialysis; ultrafiltration.

Contact Periods:

Lecture: 45 Periods Tutorial: 15 Periods Practical: – Periods Total: 60 Periods

TEXT BOOKS:

1. A R.E. Treybal, "Mass Transfer Operations", 3rd Edn., McGraw Hill Book Co., New York, 1981.
2. N. Anantharaman and K.M.Meera Sheriffa Begum, "Mass Transfer Theory and Practice", Printice Hall of India Pvt. Ltd., New Delhi, 2013.

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REFERENCES:

1. M. Coulson and J.F. Richardson, "Chemical Engineering", Vol - II, 5th Edn., Pergamon Press, New York, 2002.
2. C.J. Geankopolis, "Transport Processes in Chemical Operations", 4th Edn., Prentice Hall of India, New Delhi, 2004.
3. W.L. Mccabe, J.C. Smith and P. Harriot, "Unit Operations in Chemical Engg.", 7th Edn., McGraw Hill Book Co., New York, 2004

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

COs	Statements	K-Level
CO1	Understand concept and determine the theoretical stages, number of transfer units and height requirements for a gas absorption process	Understand
CO2	Identify the suitable distillation techniques, determine the number of trays for stage wise contact and determine the height of the packed tower.	Apply
CO3	Apply the ternary equilibrium diagram concepts to determine the number of stages required for separation of liquid-liquid extraction process.	Apply
CO4	Describe core principles of leaching, setting up mass balances, use graphical methods to estimate the number of ideal stages in leaching operation.	Analyze
CO5	Understand the concept of adsorption techniques, various isotherms and ion exchange process.	Understand

COURSE ARTICULATION MATRIX:

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

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

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SEMESTER-VI

U19CH602	CHEMICAL PROCESS INDUSTRIES	Category: PC			
		L	T	P	C
		3	0	0	3

PRE–REQUISITES:

- Knowledge about Unit operations and Unit processes.

COURSE OBJECTIVES:

- To impart knowledge on various aspects of production engineering and make the student understand the practical methods of production in a chemical factory.
- To impart knowledge on various production units.
- To understand about the manufacturing process of various chemical products

UNIT I SULFUR, SULFURIC ACID AND CEMENT 9

Sulfur, Raw materials Sources, Mining and production of Sulfur – Sulfuric acid, Methods of production of Sulfuric acid – Contact process – Chamber process. Cement – properties of Cement – Methods of production – Overall factors for Cement industry.

UNIT II FERTILIZER INDUSTRY 9

Major Components of Fertilizer industries – Nitrogen industries, ammonia, nitric acid, urea – Phosphorus industries - Phosphorus, Phosphoric acid, Super Phosphate – Potassium chloride, Potassium Sulphate.

UNIT III PULP, PAPER, SUGAR AND STARCH INDUSTRIES 9

Pulp – Methods of production – Comparison of pulping processes. Paper – types of paper products, Raw materials, Methods of production. Sugar – Methods of production – by products of the Sugar industry – Starch – Methods of production, Starch derivations.

UNIT IV PETROLEUM AND PETRO CHEMICAL INDUSTRIES 9

Petroleum – Chemical Composition, Classification of crude petroleum, Petroleum Refinery products – Petroleum Conversion processes – Pyrolysis and Cracking, Reforming Polymerization, isomerization and Alkylation – petrochemicals – methanol, chloro methanol, Acetylene and ethylene, Isopropanol, Acrylonitrile, Butadiane – Chemicals from Aromatics - Benzene, Toluene and Xylene.

UNIT V FUEL AND INDUSTRIAL GASES 9

Fuel Gases – Producer gas, Water gas, Coke oven gas, Natural gas, Liquefied natural gas – Industrial gases – Carbon dioxide, hydrogen, nitrogen and oxygen.

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Total: 45 Periods

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TEXT BOOKS:

1. Dryden, C.E, Outlines of Chemical technology, II Ed., Affiliate East West press, 2003.
2. Moulin, J.A., M. Makkee, and Diepen, A.V., Chemical Process Technology, Wiley, 2001.

REFERENCES:

1. Austin, G.T., Shreve's , Chemical Process Industries, 5th ed., McGraw-Hill, 1998.
2. SrikumarKoyikkal, Chemical Process Technology and Simulation, PHI Learning Ltd
3. McCabe W.L, Smith, J C and Harriot. P "Unit operations in Chemical Engineering", McGraw Hill, VII Edition, 2005.

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

COs	Statements	K-Level
CO1	Integrate various courses such as chemistry, unit operations, mechanical operation, stoichiometry etc.,	Understand
CO2	Give the young chemical engineers some comprehension on various fields of production into which he will enter or with which he will be affiliated during the course of study or after completion of the study	Apply
CO3	Know about the manufacturing methods of chemicals used in chemical industry and apply into the chemical industries	Apply
CO4	Classify the chemical process industry into industrial categories of base, intermediate end-products and specialty chemicals manufacturers	Analyze
CO5	Know about how the major engineering problems in chemical industries	Understand

COURSE ARTICULATION MATRIX:

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

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

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SEMESTER-VI

U19CH603	PROCESS INSTRUMENTATION DYNAMICS AND CONTROL	Category: PC			
		L	T	P	C
		3	0	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To introduce the concept of Laplace Transform for solving differential equations
- To develop dynamic modeling of physical processes
- To analyze control system stability

UNIT I INSTRUMENTATION 9

Principles of measurements and classification of process instruments, measurement of temperature, pressure, fluid flow, liquid weight and weight flow rate, viscosity, pH, concentration, electrical and thermal conductivity, humidity of gases

UNIT II OPEN LOOP SYSTEMS 9

Laplace transformation and its application in process control. First order systems and their transient response for standard input functions, first order systems in series, linearization and its application in process control, second order systems and their dynamics; transportation lag

UNIT III CLOSED LOOP SYSTEMS 9

Closed loop control systems, development of block diagram for feed-back control systems, servo and regulatory problems, transfer function for controllers and final control element, transient response of closed-loop control systems and their stability

UNIT IV FREQUENCY RESPONSE 9

Introduction to frequency response of closed-loop systems, control system design by frequency response techniques, Bode diagram, stability criterion, tuning of controllers Z-N tuning rules, C-C tuning rules

UNIT V ADVANCED CONTROL SYSTEMS 9

Feedback control of systems with dead time and inverse response. Control systems with multiple loops. Advanced Control Schemes a) Feed forward b) ratio control. Control of distillation towers and heat exchangers

Contact Periods:

Lecture: 45 Periods Tutorial: - Periods Practical: – Periods Total: 45 Periods

TEXT BOOKS:

1. Coughnowr, D., "Process Systems Analysis and Control ", 3rd Edn., McGraw Hill, New York,2008
2. Stephanopoulos, G., "Chemical Process Control", Prentice Hall of India, 2003

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REFERENCES:

1. Dale E. Seborg, Thomas F. Edgar, Duncan A. Mellichamp , Process dynamics and control / -2nd ed. John Wiley & Sons, Inc
2. Marlin, T. E., " Process Control ", 2nd Edn, McGraw Hill, New York, 2000
3. Smith, C. A. and Corripio, A. B., "Principles and Practice of Automatic Process Control", 2nd Edn., John Wiley, New York, 1997

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

COs	Statements	K-Level
CO1	Understand the concepts of Laplace transform	Understand
CO2	Apply the first principles method to develop the transfer functions of the process	Apply
CO3	Ability to develop block diagram and analyze transient response of control schemes	Analyze
CO4	Ability to analyze stability of control systems and perform tuning of process controllers	Analyze
CO5	Understanding of advanced control systems and application of control systems in chemical processes	Apply

COURSE ARTICULATION MATRIX:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	-	-	-	-	-	-	-	-	1	2	1
CO2	3	2	1	-	-	-	-	-	-	-	-	1	1	1
CO3	3	2	1	-	-	-	-	-	-	-	-	1	1	-
CO4	3	2	1	-	-	-	-	-	-	-	-	1	1	1
CO5	3	2	1	-	-	-	-	-	-	-	-	1	1	-
CO	3	2	1	-	-	-	-	-	-	-	-	1	1	1
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)						3: Substantial (High)				

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SEMESTER-VI

U19CH604	PROCESS CONTROL LABORATORY	Category: PC			
		L	T	P	C
		0	0	4	2

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To determine experimentally the methods of controlling the processes
- To measure parameters using process simulation techniques
- To tune the process for better performance

LIST OF EXPERIMENTS

1.Response of Non-Interacting level system

2.Response of Interacting level system

3.Response of first order system

4.Response of second order system

5.Tuning of a level system

6.Tuning of a pressure system

7.Tuning of a thermal system

8.Characteristics of different types of control valves

9.Closed loop response of cascade control system

10.Flow co-efficient of control valves

Contact Periods:

Lecture: – Periods Tutorial: – Periods Practical: 60 Periods Total: 60 Periods

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COURSE OUTCOMES:

Upon completion of the course, the student will be able to

COs	Statements	K-Level
CO1	Understand the response of first and second systems	Understand
CO2	Understand the response of interacting and non-interacting systems	Understand
CO3	Understand the response of closed loop systems	Understand
CO4	Perform the tuning of flow, pressure and level system	Apply
CO5	Understand the characteristics of control valves	Understand

COURSE ARTICULATION MATRIX:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	-	2	-	-	-	-	-	-	1	1	-
CO2	3	2	1	-	2	-	-	-	-	-	-	1	1	-
CO3	3	2	1	-	2	-	-	-	-	-	-	1	1	1
CO4	3	2	1	-	2	-	-	-	-	-	-	1	1	1
CO5	3	2	1	-	2	-	-	-	-	-	-	1	1	-
CO	3	2	1	-	2	-	-	-	-	-	-	1	1	1
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)						3: Substantial (High)				

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SEMESTER-VI

U19CH605	MASS TRANSFER LABORATORY	Category: PC			
		L	T	P	C
		0	0	4	2

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To impart the practical experience for the students to apply the concepts of mass transfer principles
- To develop sound practical knowledge for students on different types of mass transfer equipments
- To estimate the mass transfer parameters.

LIST OF EXPERIMENTS

1. Separation of binary mixture using Simple distillation
2. Separation of binary mixture using Steam distillation
3. Separation of binary mixture using Packed column distillation
4. Measurement of diffusivity
5. Liquid-liquid extraction
6. Drying characteristics of forced draft dryer
7. Adsorption studies
8. Cross current leaching studies
9. Solid Liquid mass transfer studies
10. Water purification using ion exchange columns
11. Estimation of mass/heat transfer coefficient for cooling tower
12. Demonstration of Gas – Liquid absorption

Contact Periods:

Lecture: – Periods Tutorial: – Periods Practical: 60 Periods Total: 60 Periods

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

COs	Statements	K-Level
CO1	Determine the diffusivity practically and compare the results with the empirical correlations.	Understand
CO2	Estimate the mass transfer rate and mass transfer co-efficient	Understand
CO3	Evaluate the performance/calculate the parameters in different distillation processes	Apply
CO4	Evaluate the performance/calculate the parameters in leaching and extraction operations	Apply
CO5	Estimate the drying characteristics	Understand

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COURSE ARTICULATION MATRIX:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	-	2	-	-	-	-	2	-	-	1	1	-
CO2	3	3	-	2	-	-	-	-	2	-	-	1	1	-
CO3	3	3	-	2	-	-	-	-	2	-	-	1	1	-
CO4	3	3	-	2	-	-	-	-	2	-	-	1	1	-
CO5	3	3	-	2	-	-	-	-	2	-	-	1	1	-
CO	3	3	-	2	-	-	-	-	2	-	-	1	1	-
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)						3: Substantial (High)				

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SEMESTER-VII

U19CH702	PROCESS ENGINEERING ECONOMICS	Category: HSM			
		L	T	P	C
		3	0	0	3

PRE–REQUISITES:

- Knowledge in Chemical Engineering and Economics

COURSE OBJECTIVES:

At the end of the course, Students will understand

- The various fundamentals of economics
- The process development concepts
- The design consideration and cost estimation in chemical industry

UNIT I INTEREST AND PLANT COST 9

Time value of money - equivalence, Depreciation, Depletion, estimation of capital cost, Capital requirement for complete plant, cost indices, capital recovery.

UNIT II PROJECT PROFITABILTY AND FINANCIAL RATIOS 9

Estimation of project profitability, Investment alternatives, income statement and financial ratios, balance sheet preparation- problems.

UNIT III ECONOMIC BALANCE IN EQUIPMENTS 9

Essentials of economic balance, economic balance in batch operations, cyclic operations, economic balance for insulation, evaporation, heat transfer equipments .

UNIT IV PRINCIPLES OF MANAGEMENT 9

Principles of management, planning, organizing, staffing, coordinating, directing, controlling and communicating. Types of organizations, Management information systems

UNIT V PRODUCTION PLANNING CONTROL 9

Work measurement techniques, motion study, principles of time study, elements of production control, forecasting, planning, routing, scheduling, dispatching, inventory and control, role of control charts in production and quality control.

Contact Periods:

Lecture: 45 Periods Tutorial: - Periods Practical: – Periods Total: 45 Periods

TEXT BOOKS:

1. Peters and Timmerhaus, Plant design and Economics for Chemical Engineers, McGraw Hill 5th Edition, 2004.

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2. Ahuja K.K, Industrial management, Khanna publishers, New Delhi, 1985.

REFERENCES:

1. F.C. Jelen and J.H. Black, "Cost and Optimization Engineering", McGraw Hill, 3rd Edn., 1992

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

COs	Statements	K-Level
CO1	Understand the theory behind Inventory Control,	Understand
CO2	Know the Organization types and PPC	Understand
CO3	Integrate knowledge about financial statements	Understand
CO4	Discuss about depreciation accounting and other areas	Apply
CO5	Get an idea on the work measurement techniques	Analyze

COURSE ARTICULATION MATRIX:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	-	1	-	-	-	-	-	-	-	1	1
CO2	3	2	1	-	1	-	-	-	-	-	-	-	1	1
CO3	3	2	1	-	1	-	-	-	-	-	-	-	1	1
CO4	3	2	1	-	1	-	-	-	-	-	-	-	1	1
CO5	3	2	1	-	1	-	-	-	-	-	-	-	1	1
CO	3	2	1	-	1	-	-	-	-	-	-	-	1	1
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)						3: Substantial (High)				

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SEMESTER-VII

U19CH703	TOTAL QUALITY MANAGEMENT	Category: HSM			
		L	T	P	C
		3	0	0	3

PRE–REQUISITES:

- Basic knowledge in management

- **COURSE OBJECTIVES:**

At the end of the course, Students will understand

- The TQM tools and techniques
- The concepts involved in quality management system
- The customer oriented management techniques

UNIT I INTRODUCTION 9

Introduction - Need for quality - Evolution of quality - Definitions of quality - Dimensions of product and service quality - Basic concepts of TQM - TQM Framework - Contributions of Deming, Juran and Crosby - Barriers to TQM - Customer focus - Customer orientation, Customer satisfaction, Customer complaints, Customer retention.

UNIT II TQM PRINCIPLES 9

Leadership - Quality Statements, Strategic quality planning, Quality Councils - Employee

involvement - Motivation, Empowerment, Team and Teamwork, Recognition and Reward,

Performance appraisal - Continuous process improvement - PDCA cycle, 5S, Kaizen – Supplier partnership - Partnering, Supplier selection, Supplier Rating.

UNIT III TQM TOOLS AND TECHNIQUES I 9

The seven traditional tools of quality - New management tools - Six sigma: Concepts,

Methodology, applications to manufacturing, service sector including IT - Bench marking – Reason to bench mark, Bench marking process - FMEA - Stages, Types.

UNIT IV TQM TOOLS AND TECHNIQUES II 9

Quality Circles - Cost of Quality - Quality Function Deployment (QFD) - Taguchi quality loss function - TPM - Concepts, improvement needs - Performance measure

UNIT V QUALITY MANAGEMENT SYSTEM 9

Introduction—Benefits of ISO Registration—ISO 9000 Series of Standards—Sector-Specific Standards—AS 9100, TS16949 and TL 9000-- ISO 9001 Requirements—Implementation—Documentation—Internal Audits—Registration- ENVIRONMENTAL MANAGEMENT SYSTEM : Introduction—ISO 14000 Series Standards—Concepts of ISO 14001—Requirements of ISO14001—Benefits of EM

Contact Periods:

Lecture: 45 Periods Tutorial: - Periods Practical: – Periods Total: 45 Periods

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TEXT BOOKS:

1. Dale H.Besterfield et al, Total Quality Management, Third edition, Pearson Education Asia, Indian Reprint 2006
2. Shridhara Bhat K, Total Quality Management – Text and Cases, Himalaya Publishing House, First Edition 2002

REFERENCES:

1. Suganthi.L and Anand Samuel, "Total Quality Management", Prentice Hall (India) Pvt. Ltd., 2006.
2. Janakiraman. B and Gopal .R.K., "Total Quality Management – Text and Cases", Prentice Hall (India) Pvt. Ltd., 2006.

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

COs	Statements	K-Level
CO1	Get a clear understanding about the quality management system	Understand
CO2	Know the concepts of quality function deployment	Understand
CO3	Understand about FEMA techniques	Understand
CO4	Clear knowledge of TQM	Apply
CO5	Get an idea on the customer oriented work principles	Analyze

COURSE ARTICULATION MATRIX:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	-	1	-	-	-	-	-	-	-	1	1
CO2	3	2	1	-	1	-	-	-	-	-	-	-	1	1
CO3	3	2	1	-	1	-	-	-	-	-	-	-	1	1
CO4	3	2	1	-	1	-	-	-	-	-	-	-	1	1
CO5	3	2	1	-	1	-	-	-	-	-	-	-	1	1
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)						3: Substantial (High)				

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SEMESTER-VII

U19CH704	DESIGN AND SIMULATION LABORATORY	Category: PC			
		L	T	P	C
		0	0	4	2

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To predict the performance of the process
- To optimize the design and improve existing ones
- To simulate and improve the performance of the process

LIST OF EXPERIMENTS

1. Steady state simulation of Heat Exchanger using ASPEN PLUS/ HYSYS
2. Steady state simulation of a CSTR using ASPEN PLUS/
3. Steady state simulation of Flash vessel using ASPEN PLUS/ HYSYS
4. Steady state simulation of Distillation Column using ASPEN PLUS/ HYSYS
5. Steady state simulation of an Absorption column using ASPEN PLUS/ HYSYS
6. Dynamic simulation of Heat Exchanger using ASPEN PLUS/ HYSYS
7. Dynamic simulation of a CSTR using ASPEN PLUS/HYSYS
8. Dynamic simulation of Flash vessel using ASPEN PLUS/ HYSYS
9. Dynamic simulation of Distillation Column using ASPEN PLUS/ HYSYS
10. Dynamic simulation of an Absorption column using ASPEN PLUS/ HYSYS

Contact Periods:

Lecture: – Periods Tutorial: – Periods Practical: 60 Periods Total: 60 Periods

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

COs	Statements	K-Level
CO1	Build flow sheet models and summarize basic unit operations	Understand
CO2	Define facilities, materials, utilities and chemical reactions	Understand
CO3	Summarize physical properties	Understand
CO4	Link models to plant process data	Apply
CO5	Integrate Aspen Simulation Workbook with add in tools in MS Excel	Apply

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COURSE ARTICULATION MATRIX:

COs \ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	-	2	3	-	-	-	-	-	1	1	2	1
CO2	-	-	-	2	3	-	-	-	-	-	1	1	2	1
CO3	-	-	-	2	3	-	-	-	-	-	1	1	2	1
CO4	-	-	-	2	3	-	-	-	-	-	1	1	2	1
CO5	-	-	-	2	3	-	-	-	-	-	1	1	2	1
CO	-	-	-	2	3	-	-	-	-	-	1	1	2	1
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)						3: Substantial (High)				

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U19CHP01	INDUSTRIAL SAFETY	Category: PE			
		L	T	P	C
		3	0	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To give an idea about different hazards and other safety procedures to be followed in any industry.
- A comprehensive knowledge of industrial safety and occupational health will be immensely useful for the students from all fields
- To impart knowledge to the students about source of hazards and control techniques

UNIT I ACCIDENT STATISTICS 9

Introduction, safety program, engineering ethics, accident and loss statistics: acceptable risk, public perception, chemical hazards , toxic chemicals, dust, gases, fumes, vapours and smoke, the concept of threshold limits, acute and chronic exposure effects, personal monitoring, biological sampling, control measures.

UNIT II TOXICOLOGY 9

Industrial safety Chemical hazards classification, hazards due to fire, explosion, toxic chemicals and radiation. Toxicology Dose vs. Response, Effects of Toxicant on Human, Toxicants Entry Route, Models for Dose and Response Curves, TLV and PEL.

UNIT III BASICS OF FIRES AND EXPLOSION 9

Handling and storage of hazardous chemicals. Fire Triangle, Definitions, Flammability Characteristics of Liquid and Vapors, LOC and Inerting, Types of Explosions, Designs for Fire Prevention and Control.

UNIT IV RISK ASSESSMENT 9

Risk analysis Risk assessment, qualitative, reconnoitres, rapid and comprehensive risk assessment techniques: checklists, indices, HAZOP, maximum credible accident analysis, fault tree analysis, past accident analysis, FMEA (failure mode and effect analysis), quantitative risk assessment.

UNIT V CONTROL OF FIRE AND EXPLOSION 9

Protection systems Emergency preparedness: Fire and explosion. Fire hazards. Fire pyramid. Types of fires. Types of fire extinguishers and its handling. Types of built in extinguishing system. Fire-fighting techniques, Emergency procedures and types of alarm systems

Contact Periods:

Lecture: 45 Periods Tutorial: Periods Practical: Periods Total: 45 Periods

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TEXT BOOKS:

1. Crowl, Daniel A. and Louvar, Joseph F., Chemical process safety, Fundamentals with applications, 3rd Ed, Prentice Hall, 2015
2. Kletz, Trevor, Still going wrong, Case histories of process plant disasters and how they could have been avoided, Gulf Professional Publishing, 2003

REFERENCES:

1. Lees, F.P., Loss Prevention in Process Industries, Butterworths, NewDelhi, 3rd Edn., 2005
2. Buschmann, Loss Prevention and Safety Promotion in the Process Industries, Elsevier Scientific, New York.

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

COs	Statements	K-Level
CO1	Anticipate, recognize, and evaluate hazardous conditions and practices affecting people, property and the environment, develop and evaluate appropriate strategies designed to mitigate risk	Understand
CO2	Identify the hazardous element due to fire, radiation, electrical and atmospheric contaminants	Understand
CO3	Apply the knowledge on handling and storage of chemical hazards.	Apply
CO4	Analyze qualitative risk assessment using HAZOP, FMEA and fault tree analysis.	Analyze
CO5	Apply the safety principles to identify the fire hazards and its safety protecting system in practices.	Apply

COURSE ARTICULATION MATRIX:

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

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

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U19CHP02	ENZYME ENGINEERING	Category: PE			
		L	T	P	C
		3	0	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To provide students with a basic understanding of classification, nomenclature, mechanism and specificity of enzyme-coenzyme action, extraction, purification and characterization of enzymes
- To introduce and understand the mechanism of enzyme action ,protein folding and unfolding and their biological significances
- To demonstrate their basic knowledge and skill on the kinetics, mechanism and function of enzyme action and improve their self learning and understanding skills on biochemical engineering and promote employability in biotech research areas

UNIT I INTRODUCTION TO ENZYMES 9

Classification and nomenclature of enzymes. General properties of enzymes. Mechanism of enzyme action; concept of active site and energetics of enzyme substrate complex formation; specificity of enzyme action; principles of catalysis – collision theory, Transition state theory.

UNIT II ENZYME KINETICS 9

Kinetics of single substrate reactions: Michelis – Menten parameters, Lineweaver Burk plot, Turnover number, Kinetics of multi substrate reactions: mechanisms, ping-pong, random order, compulsory order, steady state kinetics. Types of enzyme inhibition, and Allosteric inhibition. Binding of ligands to proteins: Hill equation and adair equation. Sigmoidal kinetics: Monod Changeux Wyman model.

UNIT III PURIFICATION AND CHARACTERIZATION OF ENZYMES 9

Production and purification of crude enzyme extracts from plants, animals and microbial sources; methods of characterization of enzymes; development of enzymatic assays. Production of recombinant enzymes: serine protease, lysozyme.

UNIT IV ENZYME IMMOBILIZATION 9

Physical and chemical technique for enzyme immobilization – adsorption, matrix entrapment, encapsulation, cross-linking, covalent binding. Advantages and disadvantages of immobilized enzymes. Effect of biotic and abiotic factors on enzyme immobilization.

UNIT V INDUSTRIAL APPLICATIONS OF ENZYMES 9

Application of enzymes in food industry, medicine, environmental; design of enzyme electrodes and their applications, forensic science, Biotechnological applications of enzymes: synthesis of artificial enzymes.

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Total: 45 Periods

TEXT BOOKS:

1. Ashok Pandey, Enzyme Technology, Springer Science & Business Media, 2006
2. Guo Yong, Enzyme Engineering, Alpha Science International Ltd; 3rd edition,2013

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REFERENCES:

1. Palmer, T. and Bonner, P., "Enzymes: Biochemistry, Biotechnology and Clinical chemistry", Affiliated East – West Press Pvt. Ltd., New Delhi, India, 2008.
2.Voet, D. and Voet, G., "Biochemistry", Third Edition, John Wiley and Sons, Singapore, 2001.
3.Nicholas, Price, C. and Lewis Stevens, "Fundamentals of Enzymology", Oxford University Press Publication, New Delhi, India, 2001

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

COs	Statements	K-Level
CO1	Understand the concept of classification and mechanism of enzyme action	Understand
CO2	Apply the kinetics of multi substrate reactions: mechanisms, ping-pong, random order, compulsory order, steady state kinetics	Apply
CO3	Understand the production and purification of crude enzyme extracts	Understand
CO4	Understand the physical and chemical technique for enzyme immobilization	Understand
CO5	Understand the application of enzymes and synthesis of artificial enzymes	Understand

COURSE ARTICULATION MATRIX:

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

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

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U19CHP03	PETROLEUM REFINING OPERATIONS AND PETROCHEMICALS	Category: PE			
		L	T	P	C
		3	0	0	3

PRE–REQUISITES:

- Fluid Mechanics

COURSE OBJECTIVES:

- Introduction of various testing methods of crude oil and its products, and refining of crude oil
- Understanding the Mechanism of different Cracking operation
- Different treatment technology for sulphur removal and Manufacture of various petrochemicals

UNIT I CLASSIFICATION AND TESTING 9

Indian petroleum industry , prospects and future, Exploration, composition of crude and classification of crude oil, evaluation of crude oil and testing of petroleum products, refining of petroleum, atmospheric and vacuum distillation.

UNIT II CRACKING PROCESS 9

Thermal cracking, visbreaking, coking – catalytic cracking (FCC), hydrocracking. Cracking of naphtha and gas for the production of ethylene , propylene isobutylene and butadiene

UNIT III SWEETENING PROCESS 9

Treatment techniques for removal of sulphur compounds to improve performance, production and treatment of LPG, LNG technology, sweetening operations for gases including merox, ethanolamine, copper chloride, etc., storage and stability.

UNIT IV HYDRO-TREATMENT AND ASPHALT TECHNOLOGY 9

Product treatment processes - various solvent treatment processes, De-waxing,Clay treatment, hydro treatment and Hydro fining. Asphalt treatment process, air blowing of bitumen.

UNIT V PETROCHEMICALS 9

Isomerization, alkylation and polymerization, process types, chemistry, commercial processes, catalysts, production of petrochemicals like dimethyl terephathalate (DMT), ethylene glycol, synthetic glycerine, linear alkyl benzene (LAB), acrylonitrile, methyl methacrylate (MMA), vinyl acetate monomer, phthallic anhydride, maleic anhydride, phenol, acetone, methanol, formaldehyde, acetaldehyde and pentaerythritol, production of carbon black.

Contact Periods:

Lecture: 45 Periods Tutorial: Periods Practical: Periods Total: 45 Periods

TEXT BOOKS:

1. Nelson, W.L., petroleum refinery engineering, 4th edn., Mcgraw Hill, New york, 1995

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2. BhaskaraRao- B.K., modern petroleum refining processes, 6th edn., oxford and IBH publishing company, New Delhi, 2018

REFERENCES:

1. Ram Prasad, Petroleum Refining Technology, khanna publishers, 2010
2. C.S. Hsu and P.R. Robinson, Practical advances in petroleum processing: volume 1 & 2 by Springer publications, 2006.
3. G.N. Sarkar, Advanced Petroleum Refining, khanna publishers, 2008

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

COs	Statements	K-Level
CO1	Have a knowledge on the past, present and future of petroleum industry nationally and globally and Study the nature of crude oil components and understand the various process of refining.	Understand
CO2	Able to select process technique for corrosion prevention and minimize corrosion	Understand
CO3	Understand the process technology involved in production and storage of LPG and LNG from its raw material Acquire knowledge of process involved in converting crude oil to various products	Apply
CO4	Know the principles and technologies involved in Fluid catalytic cracking, hydro desulphurization and other processes in cracking of crude oil and gas.	Analyze
CO5	Sketch the flow-sheets for the manufacture of various industrially important petrochemicals	Apply

COURSE ARTICULATION MATRIX:

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

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

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U19CHP04	FOOD TECHNOLOGY	Category: PE			
		L	T	P	C
		3	0	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To impart knowledge of various areas related to Food processing and technology.
- To know different techniques used for the preservation offoods.
- To gain knowledge about the microorganisms, which spoil food and food borne diseases.

UNIT I CONSTITUENTS OF FOOD 9

Constituents of food – carbohydrates, lipids, proteins, water, vitamins and minerals, dietary sources, role and functional properties in food, contribution to organoleptic and textural characteristics.

UNIT II MICROORGANISMS ASSOCIATED WITH FOOD 9

Bacteria, yeasts and molds – sources, types and species of importance in food processing and preservation; fermented foods and food chemicals, single cell protein.

UNIT III FOOD AND ENERGY 9

Food and beverage fermentations, alcoholic beverages, dairy fermented products , vegetable fermentation-sauerkraut , conversion of biomass to energy , production of ethanol and methane from biomass.

UNIT IV FOOD PRESERVATION 9

Introduction to food preservation ,Objectives and techniques of food preservation, Use of preservative in foods: chemical preservative, biopreservatives.

UNIT V FOOD QUALITY AND MANAGEMENT 9

Sensory evaluation of food quality: appearance, textural, flavour factors, consumer safety, Organizations dealing with inspection, Certification and quality assurance, Food safety standards: WHO, FPO, FAO, MMPO, HACCP, GMP; Food adulteration.

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Total: 45 Periods

TEXT BOOKS:

1. Sivasankar, B. "Food Processing and Preservation" Sixth Edition, Prentice Hall of India Pvt. Ltd., New Delhi, India, 2009.
2. Frazier, W.C., Westhoff, D.C., "Food Microbiology" fourth Edition, Tata McGraw-Hill Publishing Company Ltd., New Delhi. India, 2008.

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REFERENCES:

1. James M .Jay, "Modern Food Microbiology" Fourth Edition, CBS Publishing Company Ltd., New Delhi, India, 2005.
2. L.E.Casida, Industrial Microbiology, New Age International (P) Ltd, 2005
3. John E Smith, Biotechnology, Cambridge University Press, 5th Edition, 2006

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

COs	Statements	K-Level
CO1	Understanding the constituents of food in various compositions	Understand
CO2	Impact of microorganisms in various type of foods	Understand
CO3	Conversion of biomass to energy and fermented products	Understand
CO4	Applications of chemical preservatives and bio preservatives	Apply
CO5	Evaluation of Food quality and management	Understand

COURSE ARTICULATION MATRIX:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1	-	-	-	-	1	1	-	1	2	1
CO2	3	1	1	-	-	-	-	1	1	1	-	1	2	1
CO3	3	1	1	-	-	-	-	1	1	1	-	1	2	1
CO4	3	1	1	-	-	-	-	1	1	1	-	1	2	1
CO5	3	1	1	1	-	-	-	-	1	1	-	1	2	1
CO	3	1	1	1	-	-	-	1	1	1	-	1	2	1
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)						3: Substantial (High)				

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U19CHP05	POLYMER SCIENCE AND ENGINEERING	Category: PE			
		L	T	P	C
		3	0	0	3

PRE–REQUISITES:

- Fluid Mechanics

COURSE OBJECTIVES:

- Understanding the basic concepts of polymer structure and properties
- To understand the Mechanism of various Polymerizations
- Different Manufacturing processes techniques and kinetics of various polymers,

UNIT I INTRODUCTION 9

Basic Concepts Concepts and classification of polymers, functionality , Number and weight average, sedimentation and viscosity average molecular weights, molecular weight and degree of polymerization, glass transition temperature, addition, condensation, step-growth and chain-growth polymerization, molecular weight estimation.

UNIT II POLYMER STRUCTURE 9

Polymer chains and their characterization, the science of large molecules - Basic concepts of polymer science. History of macromolecular science, molecular forces and chemical bonding in polymers. Polymer solutions. Criteria for polymer solubility, Conformations of dissolved polymer chains, Thermodynamics of polymer solutions, Phase separation in polymer solutions.

UNIT III POLYMERIZATION KINETICS 9

Polymerization Step-reaction (Condensation) polymerization - Classification of polymers and polymerization mechanisms, chemistry of step wise polymerization, kinetics and statistics of linear stepwise polymerizations. Radical chain (Addition) polymerization - chemistry of vinyl polymerization, laboratory methods in vinyl polymerization, steady state kinetics of vinyl radical polymerization. copolymerization - Kinetics of copolymerization, composition of copolymers, chemistry of copolymerization..

UNIT IV SYNTHETIC FIBRES 9

Properties of commercial polymers, Hydrocarbon plastics and elastomers - low density (branched) polyethylene, High density (linear) polyethylene, polypropylene, natural rubber and other polyisomers, rubbers derived from butadiene, other carbon chain polymers - polystyrene and related polymers, acrylic polymers, poly(vinyl esters) and derived polymers. Heterochain thermoplastics - Polyamides. Thermosetting resins - Phenolic resins, amino resins. .

UNIT V PLASTICS 9

Polymer processing Plastic Technology - Molding, other processing methods, fillers, plasticizers, and other additives. Fiber Technology - Textile and fabric properties, spinning, fiber after treatments. Elastomer technology - Compounding and elastomer properties, vulcanization, reinforcement.

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Contact Periods:

Lecture: 45 Periods Tutorial: Periods Practical: Periods Total: 45 Periods

TEXT BOOKS:

1. Charles E., Carraher Jr., Seymour/carraher's polymer chemistry, Seventh Edition, Crc Press, 2012.
2. Bhatnagar M.S., A Textbook of Polymers, Vol. 2, S.Chand and Company Ltd., 2012

REFERENCES:

1. Fried J.R., Polymer Science and Technology, Second Edition, Prentice Hall of India Pvt Ltd., 2003.
2. Billmeyer F.W., Textbook of Polymer Science, Third Edition, Wiley Interscience, 1984

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

COs	Statements	K-Level
CO1	The basic concepts of polymer science, thermodynamics, phase separations and conformational analysis.	Understand
CO2	Describe the physico-chemical, morphology, rheology and mechanical properties of bulk polymers by evaluating through respective experimentations.	Understand
CO3	Classify the polymers, polymerization techniques and perform the kinetic and statistical considerations of polymers.	Understand
CO4	Compare and analyze the properties and performance of commercial polymers.	Analyze
CO5	Develop the recent advancements and apply in polymeric processing techniques like molding, compounding and vulcanizing.	Apply

COURSE ARTICULATION MATRIX:

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

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

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U19CHP06	ARTIFICIAL INTELLIGENCE IN CHEMICAL ENGINEERING	Category: PE			
		L	T	P	C
		3	0	0	3

PRE–REQUISITES:

- Numerical computation, Algorithm and Programming language (Python, C programme etc.,)

COURSE OBJECTIVES:

- Study the concepts of Artificial Intelligence.
- Learn the methods of solving problems using Artificial Intelligence.
- Introduce the concepts of Expert Systems and machine learning.

UNIT I INTRODUCTION 9

Introduction–Definition - Future of Artificial Intelligence – Characteristics of Intelligent Agents– Typical Intelligent Agents – Problem Solving Approach to Typical AI problems.

UNIT II PROBLEM SOLVING METHODS 9

Problem solving Methods - Search Strategies- Uninformed - Informed - Heuristics - Local Search Algorithms and Optimization Problems - Searching with Partial Observations - Constraint Satisfaction Problems – Constraint Propagation - Backtracking Search - Game Playing - Optimal Decisions in Games – Alpha - Beta Pruning - Stochastic Games.

UNIT III KNOWLEDGE REPRESENTATION 9

First Order Predicate Logic – Prolog Programming – Unification – Forward Chaining-Backward Chaining – Resolution – Knowledge Representation - Ontological Engineering-Categories and Objects – Events - Mental Events and Mental Objects - Reasoning Systems for Categories - Reasoning with Default Information.

UNIT IV SOFTWARE AGENTS 9

Architecture for Intelligent Agents – Agent communication – Negotiation and Bargaining – Argumentation among Agents – Trust and Reputation in Multi-agent systems.

UNIT V APPLICATIONS & CHEMICAL ENGINEERING APPLICATIONS 9

AI applications – Language Models – Information Retrieval- Information Extraction – Natural Language Processing - Machine Translation – Speech Recognition – Robot – Hardware – Perception – Planning – Moving. Chemical Engineering Applications.

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Total: 45 Periods

TEXT BOOKS:

1. S. Russell and P. Norvig, Artificial Intelligence: A Modern Approachll, Prentice Hall, Third Edition, 2009.
2. Thomas Quantrille Y. Liu, Artificial Intelligence in Chemical Engineering, 1st Edition, 1992

REFERENCES:

1. Kevin Night and Elaine Rich, Nair B., Artificial Intelligence (SIE), Mc Graw Hill- 2008.

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2. Deepak Khemani, A First Course in Atificial Intelligence, Tata Mc Graw Hill, Education 2013.

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

COs	Statements	K-Level
CO1	Identify problems that are amenable to solution by AI methods	Apply
CO2	Identify appropriate AI methods to solve a given problem	Apply
CO3	Formalize a given problem in the language/framework of different AI methods	Understand
CO4	Implement basic AI algorithms	Understand
CO5	Design and carry out an empirical evaluation of different algorithms on a problem formalization, and state the conclusions that the evaluation supports.	Apply

COURSE ARTICULATION MATRIX:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	-	3	-	-	-	-	-	-	-	1	2
CO2	3	3	3	-	3	-	-	-	-	-	-	-	1	2
CO3	3	3	3	-	3	-	-	-	-	-	-	-	1	2
CO4	3	3	3	-	3	-	-	-	-	-	-	-	1	2
CO5	3	3	3	-	3	-	-	-	-	-	-	-	1	2
CO	3	3	3	-	3	-	-	-	-	-	-	-	1	2
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)						3: Substantial (High)				

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U19CHP07	WATER CONSERVATION AND MANAGEMENT	Category: PE			
		L	T	P	C
		3	0	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- The objective of the course is to provide the student with an understanding of the concepts and practices in Methodology of water conservation and water management
- To understand the various methods of water harvesting and Water resource development
- To understand the Different methods of water reuse and recycling and water management

UNIT I INTRODUCTION 9

Water and life, Management and conservation of water, Climate data, Conceptual models of runoff hydrograph, Dynamic models.

UNIT II WATER HARVESTING 9

Storage structures. Percolation Tanks, Yield from catchments, Diversion of runoff, Ponds and reservoirs, Earth embankments.

UNIT III WATER RESOURCES PLANNING 9

Statement of objectives. Data requirements. Project formulation. Environmental considerations in planning, Systems analysis. Pitfalls in project planning. Conservation and augmentation of water resources. Multipurpose projects. Functional requirements in multi-purpose project. Compatibility of multipurpose uses. Application of water resources systems engineering to practical problems.

UNIT IV RECYLING AND REUSE 9

Recycling and reuse of water- Multiple uses of water – Reuse of water in agriculture – Low cost waste water treatment technologies - Economic and social dimensions - Packaged treatment units – Reverse osmosis and desalination in water reclamation.

UNIT V WATER MANAGEMENT 9

Water quality management- Principles of water quality – Water quality classification – Water quality standards - Water quality indices – TMDL Concepts – Water quality models.

Contact Periods:

Lecture: 45 Periods Tutorial: Periods. Practical: Periods Total: 45 Periods

TEXT BOOKS:

1. R.K. Liniley and Franzini, Water Resources Engineering, McGraw-Hill Book Co.2005
2. Hall and Dracup, Water Resources Systems Engineering,McGraw Hill Book Co,2007

REFERENCES:

1. George Tchobanoglous, Franklin Louis Burton, Metcalf & Eddy, H. David Stense, Wastewater Engineering: Treatment and Reuse, McGraw-Hill, 2002.

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2. Suresh. R, Soil and water conservation engineering, Standard publication, Newdelhi, 2007
3. Chatterjee, S. N., Water Resources Conservation and Management, Atlantic Publishers, 2008

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

COs	Statements	K-Level
CO1	To understand the Various methods of conservation of water and different models.	Understand
CO2	To understand the Different Methods of water Harvesting.	Understand
CO3	Plan and design Conservation and augmentation of water resources,water harvesting and groundwater recharge structures	Apply
CO4	Students able to understand the different methodology of treatment of waste water.	Understand
CO5	Analyzing the complex issues in water management.	Analyze

COURSE ARTICULATION MATRIX:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	-	-	2	2	-	-	-	-	-	-	-	-
CO2	2		-	-	2	-	-	-	-	-	-	-	-	-
CO3	2	2	-	-	2	2	1	2	-	-	-	-	-	-
CO4	2	-	-	-	2	-	-	-	-	-	-	-	-	-
CO5	3	-	-	-	2	2	-	-	-	-	-	-	-	-
CO	1	2	-	-	2	2	1	2	-	-	-	-	-	-
Correlation levels:	1: Slight (Low)				2: Moderate (Medium)					3: Substantial (High)				

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U19CHP08	PROBLEM SOLVING AND PYTHON PROGRAMMING	Category: PE			
		L	T	P	C
		3	0	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To learn basics of computers and problem solving techniques.
- To understand syntax and semantics of python programming.
- To develop simple python programs.

UNIT I –COMPUTER BASICS AND PROBLEM SOLVING STRATEGIES **(9)**

Introduction to Computers: Characteristics, Classification, Applications, Components- Hardware and Software- Algorithms - Algorithmic building blocks - Notations: Pseudo code, Flow chart, Programming language -Programming Paradigms - Computational thinking.

UNIT II –LANGUAGE BASICS **(9)**

Python interpreter and interactive mode - Tokens - Data types –Numbers and math functions - Input and Output operations - Comments - Reserved words - Indentation- Operators and expressions- Precedence and associativity- Type conversion- Debugging - Common errors in Python – Classes and objects.

UNIT III –CONTROL STATEMENTS, FUNCTIONS AND MODULES **(9)**

Selection/Conditional branching statements - Iterative statements - Functions: Function Definition and Function call, Variable scope and Lifetime, Return statement, Lambda functions or Anonymous functions, Recursion- Modules and Packages.

UNIT IV – PYTHON DATA STRUCTURES **(9)**

Strings: Slicing, Immutability, Built-in string methods and functions-Regular expressions - List: Creation, Accessing values, Slicing, - Tuples: Creation, Operations on tuples-Sets: Creation, Operations - Dictionaries: operations and methods.

UNIT V – EXCEPTION AND FILE HANDLING **(9)**

Exceptions: Errors and Exceptions, Handling exception, Built-in and User-defined exceptions - Files: Types, Operations: Open, Read, Write, Close.

TOTAL: 45

TEXT BOOKS:

1. ReemaThareja, "Python programming: Using problem solving approach", Oxford Press, 2017.
2. Robert Sedgewick, Kevin Wayne, Robert Dondero, "Introduction to Programming in Python: An Inter-disciplinary Approach". Pearson India Education Services Pvt. Ltd., 2016.

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REFERENCES:

1. Allen B. Downey, "Think Python: How to Think Like a Computer Scientist", 2nd edition, Updated for Python 3, Shroff/O'Reilly Publishers, 2016 (http://greenteapress.com/wp/think-python/)
2. Ashok NamdevKamthane and Amit Ashok Kamthane, "Programming and Problem Solving with Python", McGrawHill Education, 2018.

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

COs	Statements	K-Level
CO1	Interpret computer basics and algorithmic solutions for a given problem.	Understanding
CO2	Demonstrate the usage of data types, operators and expressions in python programming.	Applying
CO3	Design python programs using functions, modules and packages.	Applying
CO4	Develop programs using python data structures.	Applying
CO5	Demonstrate the usage of exceptions and file handling.	Applying

COURSE ARTICULATION MATRIX:

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

Note: 1: Low, 2: Medium, 3: High

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U19CHP09	OIL AND GAS ENGINEERING	Category: PE			
		L	T	P	C
		3	0	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- Various sources of oil and gas nationally and globally.
- To study the various exploration techniques of Oil and Gas.
- Understanding the Storage and Separation Mechanism of Oil and Gas and Transportation.

UNIT I RESERVOIR 9

Petroleum Reserve Estimation Reserve categories, proven and unproven reserve, type of reserve, prognostic reserves, commercial reserves, balance reserve. Reserve estimation: volumetric method, material balance method, decline curve analysis, numerical simulation techniques, Monte Carlo approach etc.

UNIT II EXPLORATION 9

Drilling Introduction to on-shore and offshore drilling operations, onshore drilling techniques, cable tool drilling, rotary drilling, vertical drilling, Directional drilling, Horizontal drilling, Offshore drilling rigs, drilling accessories components, drilling fluid circulation system, functions of drilling fluids, Mud parameters

UNIT III OIL AND GAS SEPARATION 9

Oil and Gas separators: Principal of separation, Types of separators, their description. Various control and vessel internals, Oil and gas gravitational separator, Vertical two and three phase separator, Horizontal three phase separator etc.

UNIT IV STORAGE OF PETROLEUM PRODUCTS 9

Classification of inflammable liquids, Classification of storage tank, Floating roof tank, Fixed roof tank, Semi buried tank, Import/export loss, Breathing losses, Hazards and non-hazards area, and underground storage tank etc.

UNIT V TRANSPORTATION 9

Transportation of oil and natural gas by rail, road and pipeline, Various type of pipelines, Pipe line automation, Lease Automatic Custody Transfer units, SCADA, Batch transport of petroleum products, Multiproduct pipelines, Product handling, Pumping cycle, Interface , Problems in waxy crude, Role of flow behaviour etc.

Contact Periods:

Lecture: 45 Periods Tutorial: Periods Practical: Periods Total: 45 Periods

TEXT BOOKS:

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1. Andrew Palmer., Introduction to Petroleum Exploration and Engineering, World Scietific, (2017).
2. Introduction To Petroleum Engineering by John R Fanchi, John Wiley, 2016.

REFERENCES:

1. J. H. Gary, G. E. Handwork and M. J. Kaiser, Petroleum Refining: Technology and Economics, Fifth Edition, CPR Press, Taylor and Francis Group, (2007).
2. Conaway C.F., "The Petroleum Industry: A Non- Technical Guide", Penn Well, (1999).

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

COs	Statements	K-Level
CO1	The students develop the knowledge base about the development of oil and gas fields and technological innovations in exploration and drilling etc.	Understand
CO2	The students understand the different drilling methodologies for crude oil production.	Understand
CO3	The students understand the separation methodologies oil and gas.	Understand
CO4	The students understand the storage mechanism of crude oil and gas.	Understand
CO5	Different method of Transportation of crude oil and gas.	Understand

COURSE ARTICULATION MATRIX:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	2	-	-	-	-	-	-	-	-	-	-	-	-
CO3	2	3	-	-	-	-	-	-	-	-	-	-	-	-
CO4	2	2	-	-	-	-	-	-	-	-	-	-	-	-
CO5	2	2	-	-	-	-	-	-	-	-	-	-	-	-
CO	2	2	-	-	-	-	-	-	-	-	-	-	-	-
Correlation levels:	1: Slight (Low)		2: Moderate (Medium)					3: Substantial (High)						

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U19CHP10	COMPUTER APPLICATIONS IN CHEMICAL ENGINEERING	Category: PE			
		L	T	P	C
		3	0	0	3

PRE–REQUISITES:

- MS Office, Basic Computer Skills

COURSE OBJECTIVES:

- To obtain skills in creating database retrieval of data
- To solve Mathematical models through linear and Non-linear Programming
- To obtain skills in preparing plant layout

UNIT I INTRODUCTION 9

Review on Programming languages, Basic, Fortran, Review on operating system commands

UNIT II SPREAD SHEETS 9

Application in Density, molecular weight, mole and percentage compositions, Empirical and Molecular formula calculations, Heat of mixing, Gas laws, Vapour pressure, Chemical Kinetics calculations

UNIT III SPREAD SHEETS (DATA ANALYSIS) 9

Application in data processing, Statistical analysis of data, Regression. Analysis of variance, Interpolation, Graphical representations of various Chemical Engineering problem both in laboratory exercise and core subjects such as Mechanical operation, Reaction Engineering, Distillation etc

UNIT IV DATABASE 9

Design and developments of simple databases on Chemical and Physical properties of substances. Retrieval and Database in report, query and other formats, Interfacing with other software. Preparation of Material and energy Balances preparation of plant layout Introduction to frequency response of closed-loop systems, control system design by frequency response techniques, Bode diagram, stability criterion, tuning of controllers Z-N tuning rules, C-C tuning rules

UNIT V MATHEMATICAL PROGRAMMING 9

Design and developments of simple databases on Chemical and Physical properties of substances. Retrieval and Database in report, query and other formats, Interfacing with other software. Preparation of Material and energy Balances preparation of plant layout

Contact Periods:

Lecture: 45 Periods Tutorial: - Periods Practical: – Periods Total: 45 Periods

TEXT BOOKS:

1. Hanna, O.T. Scandell, O.C. Computational Methods in Chemical Engineering, Prentice Hall,1995
2. R.K. Taxali, T.K. dBase IV made simple, Tata McGraw-Hill 1991

REFERENCES:

1. Jerry, O., Breneman, G.L. Spreadsheet Chemistry, Prentice Hall, Englewood Cliffs, 1991
2. Myers, A.L. Seider W.D. Introduction to Chemical engineering and Computer Calculations
3. Bequette. B.W, "Process Dynamics": Modelling, Analysis and Simulation," Prentice Hall (1998)

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COURSE OUTCOMES:

Upon completion of the course, the student will be able to

COs	Statements	K-Level
CO1	Understand the programming languages and operating system commands	Understand
CO2	Able to create spread sheets for empirical and molecular formula calculations	Understand
CO3	Analyze data using spread sheets for various chemical engineering problems	Analyze
CO4	To design simple databases on chemical and physical properties of substances using software	Analyze
CO5	Understand dynamic Programming in Chemical Engineering through PC based programs	Understand

COURSE ARTICULATION MATRIX:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	2	1	-	2	-	-	-	-	-	-	1	2	1
CO2	1	2	1	-	2	-	-	-	-	-	-	1	1	1
CO3	1	2	1	-	2	-	-	-	-	-	-	1	1	-
CO4	1	2	1	-	2	-	-	-	-	-	-	1	1	1
CO5	1	2	1	-	2	-	-	-	-	-	-	1	1	-
CO	1	2	1	-	2	-	-	-	-	-	-	1	1	-
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)						3: Substantial (High)				

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U19CHP11	PROFESSIONAL ETHICS IN ENGINEERING	Category: PE			
		L	T	P	C
		3	0	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- Create an awareness on Engineering Ethics
- Know about Human Values
- Insist Moral and Social Values and Loyalty and to appreciate the rights of others

UNIT I HUMAN VALUES 9

Morals, values and Ethics – Integrity – Work ethic – Service learning – Respect for others – Living peacefully – Caring – Sharing – Honesty – Courage –Self confidence – Character – Spirituality – Introduction to Yoga and meditation for professional excellence and stress management.

UNIT II ENGINEERING ETHICS 9

Senses of 'Engineering Ethics' – Variety of moral issues – Types of inquiry – Moral dilemmas – Moral Autonomy –Models of professional roles - Theories about right action – Self-interest – Customs and Religion

UNIT III ENGINEERING AS SOCIAL EXPERIMENTATION 9

Engineering as Experimentation – Engineers as responsible Experimenters – Codes of Ethics .

UNIT IV SAFETY, RESPONSIBILITIES AND RIGHTS 9

Safety and Risk – Assessment of Safety and Risk – Risk Benefit Analysis and Reducing Risk - Respect for Authority – Collective Bargaining –Professional Rights – Employee Rights – Intellectual Property Rights (IPR) – Discrimination.

UNIT V GLOBAL ISSUES 9

Multinational Corporations – Environmental Ethics – Computer Ethics– Engineers as Managers – Consulting Engineers –Moral Leadership –Code of Conduct – Corporate Social Responsibility.

Contact Periods:

Lecture: 45 Periods Tutorial: - Periods Practical: – Periods Total: 45 Periods

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TEXT BOOKS:

1. Mike W. Martin and Roland Schinzinger, "Ethics in Engineering", Tata McGraw Hill, New Delhi, 2003.
2. Govindarajan M, Natarajan S, Senthil Kumar V. S, "Engineering Ethics", Prentice Hall of India, New Delhi, 2004.

REFERENCES:

1. John R Boatright, "Ethics and the Conduct of Business", Pearson Education, New Delhi, 2003
2. Edmund G Seebauer and Robert L Barry, "Fundamentals of Ethics for Scientists and Engineers", Oxford University Press, Oxford, 2001.
3. Laura P. Hartman and Joe Desjardins, "Business Ethics: Decision Making for Personal Integrity and Social Responsibility" Mc Graw Hill education, India Pvt. Ltd.,New Delhi, 2013.

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

COs	Statements	K-Level
CO1	To realize the responsibilities in the society	Understand
CO2	To discuss the ethical issues related to engineering	Apply
CO3	Apply ethic principles in society	Apply
CO4	Analyze to know how to implement the basic rights.	Analyze
CO5	To get a clear idea about the global issues	Understand

COURSE ARTICULATION MATRIX:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	-	-	1	-	-	-	-	-	-	-	1	1
CO2	3	2	-	-	1	-	-	-	-	-	-	-	1	1
CO3	3	2	-	-	1	-	-	-	-	-	-	-	1	1
CO4	3	2	-	-	1	-	-	-	-	-	-	-	1	1
CO5	3	2	-	-	1	-	-	-	-	-	-	-	1	1
Correlation levels: 1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)														

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U19CHP12	COMPREHENSION I	Category: PE			
		L	T	P	C
		3	0	0	3

PRE–REQUISITES:

- Knowledge in Chemical engineering core courses.

UNIT I ENGINEERING MATHEMATICS I 9

Linear Algebra: Matrix algebra, Systems of linear equations, Eigen values and eigenvectors.

Calculus: Functions of single variable, Limit, continuity and differentiability, Taylor series, Mean value theorems, Evaluation of definite and improper integrals, Partial derivatives, Total derivative, Maxima and minima, Gradient, Divergence and Curl, Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equations (linear and nonlinear), Higher order linear differential equations with constant coefficients, Cauchy's and Euler's equations, Initial and boundary value problems, Laplace transforms, Solutions of one dimensional heat and wave equations and Laplace equation.

UNIT II ENGINEERING MATHEMATICS II 9

Complex variables: Complex number, polar form of complex number, triangle inequality.

Probability and Statistics: Definitions of probability and sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Poisson, Normal and Binomial distributions, Linear regression analysis.

Numerical Methods: Numerical solutions of linear and non-linear algebraic equations. Integration by trapezoidal and Simpson's rule. Single and multi-step methods for numerical solution of differential equations.

UNIT III PROCESS CALCULATIONS AND THERMODYNAMICS 9

Steady and unsteady state mass and energy balances including multiphase, multi component, reacting and non-reacting systems. Use of tie components; recycle, bypass and purge calculations; Gibb's phase rule and degree of freedom analysis.

First and Second laws of thermodynamics. Applications of first law to close and open systems. Second law and Entropy. Thermodynamic properties of pure substances: Equation of State and residual properties, properties of mixtures: partial molar properties, fugacity, excess properties and activity coefficients; phase equilibria: predicting VLE of systems; chemical reaction equilibrium.

UNIT IV FLUID MECHANICS AND MECHANICAL OPERATIONS 9

Fluid statics, Newtonian and non-Newtonian fluids, shell-balances including differential form of Bernoulli equation and energy balance, Macroscopic friction factors, dimensional analysis and similitude, flow through pipeline systems, flow meters, pumps and compressors, elementary

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boundary layer theory, flow past immersed bodies including packed and fluidized beds, Turbulent flow: fluctuating velocity, universal velocity profile and pressure drop.

Particle size and shape, particle size distribution, size reduction and classification of solid particles; free and hindered settling; centrifuge and cyclones; thickening and classification, filtration, agitation and mixing; conveying of solids.

UNIT V HEAT TRANSFER 9

Steady and unsteady heat conduction, convection and radiation, thermal boundary layer and heat transfer coefficients, boiling, condensation and evaporation; types of heat exchangers and evaporators and their process calculations. Design of double pipe, shell and tube heat exchangers, and single and multiple effect evaporators.

Contact Periods:

Lecture: 45 Periods Tutorial: - Periods Practical: – Periods Total: 45 Periods

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U19CHP13	MODERN SEPARATION TECHNIQUES	Category: PE			
		L	T	P	C
		3	0	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- Gain knowledge about recent separation methods
- Gain knowledge about various techniques used for separation
- To know about advanced mass transfer operations

UNIT I BASICS OF SEPARATION PROCESS 9

Review of Conventional Processes, Recent advances in Separation Techniques based on size, surface properties, ionic properties and other special characteristics of substances, Process concept, Theory and Equipment used in cross flow Filtration, cross flow Electro Filtration, Surface based solid – liquid separations involving a second liquid.

UNIT II MEMBRANE SEPARATIONS 9

Types and choice of Membranes, Plate and Frame, tubular, spiral wound and hollow fibre Membrane Reactors and their relative merits, commercial, Pilot Plant and Laboratory Membrane permeators involving Dialysis, Reverse Osmosis, Nanofiltration, Ultra filtration and Micro filtration, Ceramic- Hybrid process and Biological Membranes.

UNIT III SEPARATION BY ADSORPTION 9

Types and choice of Adsorbents, Adsorption Techniques, Dehumidification Techniques, Affinity Chromatography and Immuno Chromatography, Recent Trends in Adsorption.

UNIT IV INORGANIC SEPARATIONS 9

Controlling factors, Applications, Types of Equipment employed for Electrophoresis,Di-electrophoresis, Ion Exchange Chromatography and Electrodialysis, EDR, Bipolar Membranes.

UNIT V OTHER TECHNIQUES 9

Separation involving Lyophilisation, Pervaporation and Permeation Techniques for solids, liquids and gases, zone melting, Adductive Crystallization, other Separation Processes, Supercritical fluid Extraction, Oil spill Management, Industrial Effluent Treatment by Modern Techniques.

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Total: 45 Periods

TEXT BOOKS:

1. Lacey, R.E. and S.Looeb – Industrial Processing with Membranes Wiley – InterScience, N.Y.1972
2. King, C.J. Separation Processes, Tata McGraw–Hill Publishing Co. Ltd., 1982.

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REFERENCES:

1. King, C. J., "Separation Processes", Tata McGraw Hill, 1982
2. Roussel, R. W., "Handbook of Separation Process Technology", John Wiley, New York, 1987.
3. Nakagawal, O. V., "Membrane Science and Technology"' Marcel Dekkar, 1992

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

COs	Statements	K-Level
CO1	Understand about modern separation techniques use in the industry	Understand
CO2	Analyze the separation processes for selecting optimal process for new and innovative applications.	Analyze
CO3	Apply the latest concepts like super critical fluid extraction, evaporation, lyophilisation etc., in Chemical process industries	Apply
CO4	Understand Innovative techniques of controlling and managing oil spills	Understand
CO5	Ability to exhibit the skill to develop membrane processes, adsorption process and inorganic separation process	Understand

COURSE ARTICULATION MATRIX:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	2	2	3	-	-	1	-	-	-	-	3	3
CO2	2	1	2	2	3	-	-	1	-	-	-	-	3	3
CO3	2	1	2	2	3	-	-	1	-	-	-	-	3	3
CO4	2	1	2	2	3	-	-	1	-	-	-	-	3	3
CO5	2	1	2	2	3	-	-	1	-	-	-	-	3	3
CO	2	1	2	2	3	-	-	1	-	-	-	-	3	3
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)						3: Substantial (High)				

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U19CHP14	PROCESS MODELING AND SIMULATION	Category:PE			
		L	T	P	C
		3	0	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To give an overview of various methods of process modelling
- To understand different computational techniques for simulation
- To know about process modeling and simulation in chemical engineering concepts.

UNIT I INTRODUCTION 7

Introduction to modeling and simulation, classification of mathematical models, conservation Equations and auxiliary relations.

UNIT II STEADY STATE LUMPED SYSTEMS 9

Degree of freedom analysis, single and network of process units, systems yielding linear and nonlinear algebraic equations, flow sheeting – sequential modular and equation oriented approach, tearing, partitioning and precedence ordering, solution of linear and non-linear algebraic equations.

UNIT III UNSTEADY STATE LUMPED SYSTEMS 9

Analysis of liquid level tank, gravity flow tank, jacketed stirred tank heater, reactors, flash and Distillation column, solution of ODE initial value problems, matrix differential equations, simulation of closed loop systems.

UNIT IV STEADY STATE DISTRIBUTED SYSTEM 7

Analysis of compressible flow, heat exchanger, packed columns, plug flow reactor, solution of ODE boundary value problems.

UNIT V UNSTEADY STATE DISTRIBUTED SYSTEM & OTHERMODELING APPROACHES 13

Analysis laminar flow in pipe, sedimentation, boundary layer flow, conduction, heat exchanger, heat transfer in packed bed, diffusion, packed bed adsorption, plug flow reactor, hierarchy in model Development, classification and solution of partial differential equations. Empirical modeling, Parameter estimation, population balance and stochastic modeling.

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Total: 45 Periods

TEXT BOOKS:

1. Ramirez, W.; "Computational Methods in Process Simulation ", 2nd Edn., Butterworth's Publishers, New York, 2000
2. Luyben, W.L., "Process Modeling Simulation and Control ", 2nd Edn, McGraw-Hill Book Co.,1990.

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REFERENCES:

1. Felder, R. M. and Rousseau, R. W., "Elementary Principles of Chemical Processes", JohnWiley, 2000
2. Franks, R. G. E., "Mathematical Modeling in Chemical Engineering", John Wiley, 1967
3. Amiya K. Jana, "Process Simulation and Control Using ASPEN", 2nd Edn, PHI Learning Ltd(2012

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

COs	Statements	K-Level
CO1	Understand the development of process models	Understand
CO2	Apply the computational techniques to solve process models	Apply
CO3	Analyze empirical modelling and population balance	Analyze
CO4	Analyze steady and unsteady state distributed system	Analyze
CO5	Understand the simulation of closed loop systems	Understand

COURSE ARTICULATION MATRIX:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	3	3	-	-	-	-	-	-	-	3	3
CO2	3	3	3	3	3	-	-	-	-	-	-	-	3	3
CO3	3	3	3	3	3	-	-	-	-	-	-	-	3	3
CO4	3	3	3	3	3	-	-	-	-	-	-	-	3	3
CO5	3	3	3	3	3	-	-	-	-	-	-	-	3	3
CO	3	3	3	3	3	-	-	-	-	-	-	-	3	3
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)						3: Substantial (High)				

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U19CHP15	CHEMICAL METALLURGY	Category: PE			
		L	T	P	C
		3	0	0	3

PRE–REQUISITES:

- Basic knowledge in Chemical engineering concepts and metals.

COURSE OBJECTIVES:

At the end of the course, Students will understand

- To the basics of metallurgy
- To the techniques of extraction from its ores
- To the method of operation of various converters and furnaces

UNIT I PYRO METALLURGY 9

Classification of ores, basics of pyro metallurgy, calcination, roasting, and types of roasting, thermodynamics of extraction

UNIT II STEPS OF METALLURGY 9

Sintering, Pelletisation and Smelting, basic principles with examples, Slags, classification, properties and uses

UNIT III HYDRO METALLURGY 9

Hydrometallurgy: advantages, and disadvantages, principles and types of leaching, solution, purification by ion exchange and solvent extraction, cementation

UNIT IV EXTRACTION PROCESSES 9

Extraction of Iron from ores – Operation of Coke Ovens, Blast Furnaces, Sintering Plants, Pig Casting Machine. Slag removal and Disposal. Steel Making Processes – Bessemer convertor, Open Hearth Furnaces and LD convertor. Alloy Steel Production

UNIT V NON FERROUS METALS 9

Extraction of nonferrous metals from ores– Copper, Aluminium, Lead and Zinc. Electro Metallurgy of extraction and refining.

Contact Periods:

Lecture: 45 Periods Tutorial: - Periods Practical: – Periods Total: 45 Periods

TEXT BOOKS:

1. Elements of Metallurgy by D. Swarup.1988
2. Bequette. B.W, "Process Dynamics": Modelling, Analysis and Simulation," Prentice Hall ,1998

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REFERENCES:

1. Introduction to Metallurgy by A.R. Bailey,1987
2. Franks, R. G. E., "Mathematical Modeling in Chemical Engineering", John Wiley, 1967

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

COs	Statements	K-Level
CO1	Decide which sequence of metallurgical processes should be applied for the production of a specific metal.	Understand
CO2	Know the various extraction and processing techniques	Understand
CO3	Consider alternative processes for production of a metal from its mineral	Understand
CO4	Apply principles to chemical systems and processes	Apply
CO5	Design metallurgical processes considering the materials, reactors, temperatures and other factors	Analyze

COURSE ARTICULATION MATRIX:

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

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

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U19CHP16	FLUIDIZATION ENGINEERING	Category: PE			
		L	T	P	C
		3	0	0	3

PRE–REQUISITES:

- Knowledge in Chemical Engineering

COURSE OBJECTIVES:

At the end of the course, Students will learn about

- The design aspects of fluidized beds.
- The industrial applications of fluidized bed systems
- To become familiar with the concept of heat and mass transfer in fluidized systems.

UNIT I BASICS OF FLUIDIZATION 9

Packed bed – Velocity – Pressure drop relations – Correlations of Ergun, Kozney karman Development of fluidization from fixed bed.

UNIT II FLUIDIZED BED TYPES 9

Minimum fluidization conditions – Expanded bed– Moving solids and dilute phase

UNIT III DESIGN ASPECTS 9

Channelling – Bed expansion in liquid– Solid fluidizations. Design aspects of fluidized bed systems

UNIT IV HEAT AND MASS TRANSFER IN FLUIDIZED BEDS 9

Heat and mass transfer in fluidized bed systems – Industrial applications of fluidized bed systems.

UNIT V OTHER TYPES OF FLUIDIZATION 9

Single stage and multistage fluidization – Collection of fines – Use of cyclones.

Contact Periods:

Lecture: 45 Periods Tutorial: - Periods Practical: – Periods Total: 45 Periods

TEXT BOOKS:

1. Levenspiel, "Fluidization Engineering", 2nd Edition, Butterworth – Heinmann, 1991.
2. Robert H. Perry and Don W. Green, "Perry's Chemical Engineer's Hand Book", 7th Edition, Mc Graw Hill – International, 1997Munson, B. R., Young, D.F., Okiishi, T.H. "Fundamentals of Fluid Mechanics", 5th Edition", John Wiley, 2006

REFERENCES:

1. Rowe and Davidson, "Fluidization", Academic Press ,1971.
2. Leva, M., "Fluidization", McGraw Hill Book Co, 1959.

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3. Wen-Ching Yang., "Handbook of Fluidization and Fluid-Particle Systems", Marcel Dekker Inc, 2003.

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

Cos	Statements	K-Level
CO1	understand the fluidization phenomenon	Understand
CO2	apply various correlations involved in the fluidization engineering	Apply
CO3	know the behavior of fluidized beds	Understand
CO4	apply the industrial applications.of fluidized systems	Apply
CO5	analyze the design aspects of fluidized bed systems	Analyze

COURSE ARTICULATION MATRIX:

Pos / Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	-	-	1	-	-	-	-	1	-	-	1	1
CO2	2	2	-	-	1	-	-	-	-	1	-	-	1	1
CO3	2	2	-	-	1	-	-	-	-	1	-	-	1	1
CO4	2	2	-	-	1	-	-	-	-	1	-	-	1	1
CO5	2	2	-	-	1	-	-	-	-	1	-	-	1	1
CO	2	2	-	-	1	-	-	-	-	1	-	-	1	1
Correlation levels: 1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)														

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U19CHP17	INSTRUMENTAL METHODS OF ANALYSIS	Category: PE			
		L	T	P	C
		3	0	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVE:

Upon studying the course, the student will be able to

- Gain knowledge of electromagnetic radiation, types of spectra, AAS and AES.
- Understand basics of UV-Visible, Infra-Red spectroscopic techniques in the engineering field.
- Acquire knowledge of chromatography and thermal analysis techniques.

UNIT – I : ATOMIC SPECTROSCOPY 8

Electromagnetic radiation - Characteristics of electromagnetic radiation, types of energy, representation of spectrum, types of spectra, differences between molecular and atomic spectrum. Atomic Absorption Spectroscopy (AAS) - principle, instrumentation, applications, Atomic Emission Spectroscopy (AES) – theory, flame photometry- principle, instrumentation, applications.

UNIT – II : UV -VISIBLE SPECTROSCOPY 11

Introduction, characteristics of UV-Visible spectra, chromophore and auxochrome, electronic excitation – intensity of bands – selection rules - laws of photometry – correlation of electronic absorption with molecular structure - conjugated systems – systems of extended conjugation – aromatic systems – Woodward -Fieser rules for dienes (butadiene) and α,β- unsaturated ketones.

UNIT – III : IR -SPECTROSCOPY 9

Introduction, selection rules, molecular vibrations - force constant - band assignments, finger print region - Instrumentation - applications – Interpretation of IR spectra in identification of common functional groups.

UNIT – IV : CHROMATOGRAPHY 10

Introduction, definition, principles of chromatography, sorption mechanisms - differential migration, partition and adsorption phenomena, classification of different chromatographic methods.

Column chromatography: Principle, general aspects, chromatographic media, nature of forces between adsorbent and solutes, eluents, (mobile phase) and applications.

Thin Layer Chromatography: Principle, chromatographic media-coating materials, applications, activation of adsorbent, sample development, solvent systems, development of chromatoplate, types of development, visualization methods, documentation, applications.

Gas and High-Performance Liquid Chromatography: Theory, instrumentation and its applications

UNIT – V : THERMAL ANALYSIS TECHNIQUES 7

Introduction - Thermo Gravimetric Analysis (TGA)- principle- instrumentation – applications - thermal dehydration and decomposition of calcium oxalate, Differential Scanning Colorimetry (DSC) - principle- instrumentation – applications - finger print of pure compound and phase transition, Differential Thermal Analysis (DTA)- principle- instrumentation – applications - decomposition of calcium oxalate.

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TEXT BOOKS:

1.P. C. Jain and Monika Jain, Engineering Chemistry, Dhanpat Rai Publishing Company. Pvt. Ltd., New Delhi, 2015.

2.P.S. Kalsi, "Spectros copy of Organic Compounds", New age international Pvt. Ltd., 6th Edition, 2007.

REFERENCES:

1. William Kemp, Organic Spectroscopy, Macmillan, 1991.

2. O.G. Palanna, Engineering Chemistry, McGraw Hill Education India Pvt. Ltd., Chennai, 2nd Edition, 2017.

3. S. Vairam, P. Kalyani and Suba Ramesh, Engineering Chemistry, Wiley India Pvt. Ltd., New Delhi, 2nd Edition, 2014.

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

COs	Statements	K-Level
CO1	Apply the knowledge of the instrumentation, theory and application of atomic spectroscopic techniques.	Applying
CO2	Utilize the fundamental knowledge on the instrumentation and theory of UV-Visible spectroscopy.	Understanding
CO3	Explain the importance of Infra-red spectroscopy and its applications.	Understanding
CO4	Outline the various techniques involved in separation and purification using chromatographic techniques.	Understanding
CO5	Discuss the theory, instrumentation and applications of TGA, DTA and DSC.	Understanding

COURSE ARTICULATION MATRIX:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	-	-	-	2	-	-	-	-	1	-	-
CO2	3	2	1	-	-	-	2	-	-	-	-	1	-	-
CO3	3	2	1	-	-	-	2	-	-	-	-	1	-	-
CO4	3	2	1	-	-	-	2	-	-	-	-	1	-	-
CO5	3	2	1	-	-	-	2	-	-	-	-	1	-	-
CO	3	2	1	-	-	-	2	-	-	-	-	1	-	-
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)				3: Substantial (High)						

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U19CHP18	PROCESS PLANT UTILITIES	Category: PE			
		L	T	P	C
		3	0	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To understand about plant utilities like steam, compressed air etc.
- To understand about important of utilities
- To know about fuel and waste disposal

UNIT I IMPORTANT OF UTILITIES 9

Hard and Soft water, Requisites of Industrial Water and its uses. Methods of water Treatment such as Chemical Softening and Demineralization, Resins used for Water Softening and Reverse Osmosis. Effects of impure Boiler Feed Water.

UNIT II STEAM AND STEAM GENERATION 9

Properties of Steam, problems based on Steam, Types of Steam Generator such as Solid Fuel Fired Boiler, Waste Gas Fired Boiler and Fluidized Bed Boiler. Scaling and Trouble Shooting. Steam Traps and Accessories.

UNIT III REFRIGERATION 9

Refrigeration Cycles, Methods of Refrigeration used in Industry and Different Types of Refrigerants such as Monochlorodifluro Methane, Chlorofluro Carbons and Brins. Refrigerating Effects and Liquefaction Processes.

UNIT IV COMPRESSED AIR 9

Classification of Compressor, Reciprocating Compressor, Single Stage and Two Stage Compressor, Velocity Diagram for Centrifugal Compressor, Silp Factor, Impeller Blade Shape. Properties of Air – Water Vapors and use of Humidity Chart. Equipment used for Humidification, Dehumidification and Cooling Towers.

UNIT V FUEL AND WASTE DISPOSAL 9

Types of Fuel used in Chemical Process Industries for Power Generation such as Natural Gas, Liquid Petroleum Fuels, Coal and Coke. Internal Combustion Engine, Petrol and Diesel Engine. Waste Disposal.

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Total: 45 Periods

TEXT BOOKS:

1. Eckenfelder, W. W, Jr. "Industrial Water Pollution Control" McGraw-Hill: New York, 1966
2. P. L. Ballaney, "Thermal Engineering", Khanna Publisher New Delhi, 1986

REFERENCES:

1. P. N. Ananthanarayan, "Basic Refrigeration & Air conditioning", Tata McGraw Hill, NewDelhi, 2007.

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2. Jack Broughton, 'Process Utility Systems - Introduction to Design Operation and Maintenance', Institution of Chemical Engineers, UK,1994.
3. Perry R. H. Green D. W. "Perry's chemical Engineer's Handbook", McGraw Hill, NewYork, 2007

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

COs	Statements	K-Level
CO1	Understand the importance of health, safety and the environment in process industries	Understand
CO2	Understand about steam, power, water, air is extensively used in process industries	Understand
CO3	Know about efficient operation is imperative for economic and safe operation is essential for the survival of industries	Understand
CO4	Understand about fuels and waste management	Understand
CO5	Integrate with utilities used in the industries	Analyze

COURSE ARTICULATION MATRIX:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	2	-	-	-	1	2	1	2	2	-	-	2	2
CO2	1	2	-	-	-	1	2	1	2	2	-	-	2	2
CO3	1	2	-	-	-	1	2	1	2	2	-	-	2	2
CO4	1	2	-	-	-	1	2	1	2	2	-	-	2	2
CO5	1	2	-	-	-	1	2	1	2	2	-	-	2	2
CO	1	2	-	-	-	1	2	1	2	2	-	-	2	2
Correlation levels:	1: Slight (Low)					2: Moderate (Medium)						3: Substantial (High)		

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U19CHP19	COMPREHENSION II	Category: PE			
		L	T	P	C
		3	0	0	3

PRE–REQUISITES:

- Knowledge in Chemical engineering core courses.

UNIT I MASS TRANSFER 9

Fick's laws, molecular diffusion in fluids, mass transfer coefficients, film, penetration and surface renewal theories; momentum, heat and mass transfer analogies; stage-wise and continuous contacting and stage efficiencies; HTU & NTU concepts; design and operation of equipment for distillation, absorption, leaching, liquid-liquid extraction, drying, humidification, dehumidification and adsorption

UNIT II CHEMICAL REACTION ENGINEERING 9

Theories of reaction rates; kinetics of homogeneous reactions, interpretation of kinetic data, single and multiple reactions in ideal reactors, non-ideal reactors; residence time distribution, single parameter model; non-isothermal reactors; kinetics of heterogeneous catalytic reactions; diffusion effects in catalysis.

UNIT III INSTRUMENTATION AND PROCESS CONTROL 9

Measurement of process variables; sensors, transducers and their dynamics, process modeling and linearization, transfer functions and dynamic responses of various systems, systems with inverse response, process reaction curve, controller modes (P, PI, and PID); control valves; analysis of closed loop systems including stability, frequency response, controller tuning, cascade and feed forward control..

UNIT IV PLANT DESIGN AND ECONOMICS 9

Principles of process economics and cost estimation including depreciation and total annualized cost, cost indices, rate of return, payback period, discounted cash flow, optimization in process design and sizing of chemical engineering equipments such as compressors, heat exchangers, multistage contactors

UNIT V CHEMICAL TECHNOLOGY 9

Inorganic chemical industries (sulfuric acid, phosphoric acid, chlor-alkali industry), fertilizers (Ammonia, Urea, SSP and TSP); natural products industries (Pulp and Paper, Sugar, Oil, and Fats); petroleum refining and petrochemicals; polymerization industries (polyethylene, polypropylene, PVC and polyester synthetic fibers).

Contact Periods:

Lecture: 45 Periods Tutorial: - Periods Practical: – Periods Total: 45 Periods

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U19CHP20	PIPING AND INSTRUMENTATION IN CHEMICAL PLANTS	Category: PE			
		L	T	P	C
		3	0	0	3

PRE–REQUISITES:

- Knowledge on Fluid mechanics and Instrumentation

COURSE OBJECTIVES:

- To impart knowledge on piping technology and instrumentation on pipelines
- To introduce the concept of Laplace Transform for solving differential equations
- To develop dynamic modeling of physical processes

UNIT I FUNDAMENTALS OF PIPING ENGINEERING 9

Definitions, Piping Components their introduction, applications. Piping MOC, Budget Codes and Standards, Fabrication and Installations of piping

UNIT II PIPE HYDRAULICS AND SIZING 9

Pipe sizing based on velocity and pressure drop consideration cost, least annual cost approach, pipe drawing basics, development of piping general arrangement drawing, dimensions and drawing of piping

UNIT III PLOT PLAN 9

Development of plot plan for different types of fluid storage, equipment layout, process piping layout, utility piping layout. Stress analysis -Different types of stresses and its impact on piping, methods of calculation, dynamic analysis, and flexibility analysis

UNIT IV PIPING SUPPORT 9

Different types of support based on requirement and its calculation

UNIT V INSTRUMENTATION 9

Final Control Elements; measuring devices, instrumentation symbols introduction to process flow diagram (PFD) and piping & instrumentation diagram (P&ID)

Contact Periods:

Lecture: 45 Periods Tutorial: - Periods Practical: – Periods Total: 45 Periods

TEXT BOOKS:

1. Piping Handbook, 6 th edition, M.L. Nayyar, P.E., Mc Graw-Hill, Inc
2. Piping Design Handbook edited by Johan J McKetta, CRC Press, 1992

REFERENCES:

1. Luyben, W. L.," Process Modeling Simulation and Control for Chemical Engineers, McGraw Hill, 1990
2. Marlin, T. E., " Process Control ", 2nd Edn, McGraw Hill, New York, 2000
3. Smith, C. A. and Corripio, A. B., "Principles and Practice of Automatic Process Control", 2nd Edn., John Wiley, New York, 1997

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COURSE OUTCOMES:

Upon completion of the course, the student will be able to

COs	Statements	K-Level
CO1	Understand fundamentals of piping engineering	Understand
CO2	Apply the concepts of pipe hydraulics and sizing	Apply
CO3	Able to develop the plot plan for different types of fluid storage	Understand
CO4	Analyze the piping support based on requirement and its calculation	Analyze
CO5	Understand the process flow diagram and instrumentation	Understand

COURSE ARTICULATION MATRIX:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	2	1	-	-	-	-	-	-	-	-	-	1	1
CO2	1	2	1	-	-	-	-	-	-	-	-	-	1	1
CO3	1	2	1	-	-	-	-	-	-	-	-	-	1	1
CO4	1	2	1	-	-	-	-	-	-	-	-	-	1	1
CO5	1	2	1	-	-	-	-	-	-	-	-	-	1	1
CO	1	2	1	-	-	-	-	-	-	-	-	-	1	1
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)						3: Substantial (High)				

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U19CHP21	TRANSPORT PHENOMENA	Category: PE			
		L	T	P	C
		3	0	0	3

PRE–REQUISITES:

- Fluid Mechanics, Mass Transfer, Heat Transfer, Vector Calculus

COURSE OBJECTIVES:

- To develop a fundamental knowledge of the physical principles that governs the transport processes
- To understand the mathematical formulation of the conservation principles
- To develop analogies among transport processes

UNIT I TRANSPORT PHENOMENA BY MOLECULAR MOTION 9

Vectors/Tensors, Newton's law of viscosity, Newtonian & Non-Newtonian fluids, rheological models, Temperature, pressure and composition dependence of viscosity, Kinetic theory of viscosity, Fourier's law of heat conduction, Temperature, pressure and composition dependence of thermal conductivity, Kinetic theory of thermal conductivity, Fick's law of diffusion, Temperature, pressure and composition dependence of diffusivity, Kinetic theory of diffusivity

UNIT II ONE DIMENSIONAL MOMENTUM TRANSPORT 9

Shell Momentum balances, boundary conditions, velocity profiles, average velocity, momentum flux at the surfaces, of Newtonian and non-Newtonian for flow of a falling film, flow through circular tube, slits, flow through an Annulus, Adjacent flow of two Immiscible fluids. Equations of Change (Isothermal), equation of continuity, equation of motion, equation of energy (isothermal) their applications in fluid flow problems

UNIT III ONE DIMENSIONAL HEAT TRANSPORT 9

Shell energy balances, boundary conditions, temperature profiles, average temperature, energy fluxes at surfaces for different types of heat sources such as electrical, nuclear viscous and chemical, Equations of change (non-isothermal), equation of motion for forced and free convection, equation of energy (non-isothermal)

UNIT IV ONE DIMENSIONAL MASS TRANSPORT 9

Shell mass balances, boundary conditions, concentration profiles, average concentration, mass flux at surfaces for Diffusion through stagnant gas film, Diffusion with homogeneous and heterogeneous chemical reaction, Diffusion in to a falling liquid film, Diffusion and chemical reaction in porous catalyst and the effectiveness factor, equation of continuity for binary mixtures, equation of change to set up diffusion problems for simultaneous heat and mass transfer

UNIT V TRANSPORT IN TURBULENT AND BOUNDARY LAYER FLOW 9

Turbulence phenomena; phenomenological relations for transfer fluxes; time smoothed equations of change and their applications for turbulent flow in pipes; boundary layer theory; laminar and turbulent hydrodynamics thermal and concentration boundary layer and their thicknesses; analysis of flow over flat surface

Contact Periods:

Lecture: 45 Periods Tutorial: - Periods Practical: – Periods Total: 45 Periods

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TEXT BOOKS:

1. R. B. Bird, W.E. Stewart, E.W. Lightfoot, Transport Phenomena, 2nd Revised Edition, John Wiley, 2007
2. Robert, S Brodkey, Harry C. Hershey, "Transport Phenomena A Unified Approach", Brodkey Publishing 2003

REFERENCES:

1. C. J. Geankoplis, Transport Processes and Separation Process Principles, Prentice- Hall Inc., 4th Edition 2003
2. C. O. Bennett, J. O. Myers, Momentum, Heat and Mass Transfer, 2nd International Student Edition Mc-Graw Hill, 1983
3. R. Welty, R.W. Wilson, and C.W.Wicks, Rorer G.E, Wilson R.W. "Fundamentals of Momentum Heat and Mass Transfer", 5th Edition, John Wiley, New York, 2007

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

COs	Statements	K-Level
CO1	Understand the molecular motion in transport phenomena	Understand
CO2	Apply the one dimensional momentum transport	Apply
CO3	Analyze the one dimensional heat transport	Analyze
CO4	Understand the one dimensional mass transport	Analyze
CO5	Analyze the turbulence phenomena and their applications for turbulent flow in pipes	Apply

COURSE ARTICULATION MATRIX:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	-	-	-	-	-	-	-	-	1	2	1
CO2	3	2	1	-	-	-	-	-	-	-	-	1	1	1
CO3	3	2	1	-	-	-	-	-	-	-	-	1	1	-
CO4	3	2	1	-	-	-	-	-	-	-	-	1	1	1
CO5	3	2	1	-	-	-	-	-	-	-	-	1	1	-
CO	3	2	1	-	-	-	-	-	-	-	-	1	1	1
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)						3: Substantial (High)				

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U19CHP22	BIOCHEMICAL ENGINEERING	Category: PE			
		L	T	P	C
		3	0	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To impart the basic concepts of biochemical engineering
- To develop understanding about biochemistry and bioprocesses
- To analysis oxygen transfer and power consumption

UNIT I MICROBIAL GROWTH AND PURIFIACATION 9

Introduction to Bioscience: Types of Microorganisms: Structure and function of microbial cells. Fundamentals of microbial growth, batch and continuous culture. Isolation and purification of Enzymes from cells. Cell Growth Measurement.

UNIT II METABOLISM AND BIO-ENERGITICS 9

Functioning of Cells and Fundamental Molecular Biology: Metabolism and bio-energetics, Photosynthesis, carbon metabolism, EMP pathway, tricarbocyclic cycle and electron transport chain, aerobic and anaerobic metabolic pathways. Synthesis and regulation of biomolecules, fundamentals of microbial genetics, role of RNA and DNA.

UNIT III ENZYME KINETICS AND IMMOBILIZATION 9

Enzyme kinetics: Simple enzyme kinetics, Enzyme reactor with simple kinetics. Inhibition of enzyme reactions. Other influences on enzyme activity. Immobilization of enzymes. Effect of mass transfer in immobilised enzyme particle systems. Industrial applications of enzymes.

UNIT IV FERMENTOR DESIGN AND MODEL 9

Cell kinetics and fermenter design: Growth cycle for batch cultivation, Stirred-tank fermenter, Multiple fermenters connected in series. Cell recycling. Structured Model.

UNIT V OXYGEN TRANSFER RATE AND POWER CONSUMPTION 9

Determination of volumetric mass transfer rate of oxygen from air bubbles and effect of mechanical mixing and aeration on oxygen transfer rate, heat transfer and power consumption. Multiphase bioreactors and their applications.

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Total: 45 Periods

TEXT BOOKS:

1. J. E. Bailey and D. F. Ollis. " Biochemical Engineering Fundamentals", 2nd Edn., McGraw Hill, New York , 1986.
2. Trevan, Boffey, Goulding and Stanbury," Biotechnology", Tata McGraw Hill Publishing Co., New Delhi, 1987.

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REFERENCES:

1. H. W. Blanch and D. S. Clark, "Biochemical Engineering", Marcel Dekker, Inc., New York, 1996.
2. M. L. Shuler and F. Kargi, "Bio Process Engineering: Basic concepts", 2nd Edn., Prentice Hall of India, New Delhi, 2002.
3. Missen, R.W., Mims, C.A. and Saviile, B.A., "Introduction to Chemical Engineering and Kinetics", John Wiley and Sons, New Delhi, 1999.

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

COs	Statements	K-Level
CO1	Fundamentals of microbial growth, batch and continuous culture	Understand
CO2	Metabolism and bio-energetics, Synthesis and regulation of biomolecules.	Understand
CO3	Enzyme kinetics: Simple enzyme kinetics, Enzyme reactor with simple kinetics. Inhibition of enzyme reactions.	Understand
CO4	Cell kinetics and fermenter design	Apply
CO5	Oxygen transfer rate and Power consumption	Apply

COURSE ARTICULATION MATRIX:

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

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

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U19CHP23	DRUGS AND PHARMACEUTICAL TECHNOLOGY	Category: PE			
		L	T	P	C
		3	0	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To provide the basic knowledge on functional group identification, chemical bonding with their mechanism
- To provide the basic knowledge of principles involved in the identification and estimation of Pharmaceutical substances.
- To understand the properties and principles of medicinal agents that originates from organic and inorganic sources and their application in pharmaceutical industry.

UNIT I PHARMACEUTICALS, BIOLOGICS AND BIOPHARMACEUTICALS 9

Introduction to pharmaceutical products, Biopharmaceuticals and pharmaceutical biotechnology, Biopharmaceuticals: current status and future prospects, Pharmaceuticals of animal origin, Pharmaceutical substances of plant origin, Pharmaceutical substances of microbial origin, Drug discovery

UNIT II DRUG CHARACTERISTICS AND KINETICS 9

Diffusion and dissolution, kinetics and drug stability, Viscosity and rheology, Polymer science and applications.

UNIT III THE DRUG MANUFACTURING PROCESS 9

International pharmacopoeia, The manufacturing facility, Cleaning, decontamination and sanitation (CDS), Documentation, Specifications, Records, Additional production systems: yeasts, Fungal production systems, Transgenic animals, Transgenic plants, Immunological approaches to detection of contaminants,Pyrogen detection, Validation studies

UNIT IV BLOOD PRODUCTS AND THERAPEUTIC ENZYMES 9

Platelets and red blood cells, Blood substitutes, Tissue plasminogen activator (tPA), Urokinase, Staphylokinase, Antibodies, vaccines and adjuvants, Therapeutic application of monoclonal antibodies, Traditional vaccine preparations, Toxoids, antigen-based and other vaccine preparations, Oil-based emulsion adjuvant.

UNIT V BIOPHARMACEUTICALS 9

Various categories of therapeutics like vitamins, laxatives, analgesics, contraceptives, antibiotics, hormones and biologicals.

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Total: 45 Periods

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TEXT BOOKS:

1. Alfred N. Martin, "Physical Chemical and Biopharmaceutical Principles in the Pharmaceutical Sciences", 6th Edn., Lippincott Williams & Wilkins, 2006.
2. David B. Troy, Paul Beringer, "Remington: The Science and Practice of Pharmacy", 21st Edn., Lippincott Williams & Wilkins, 1984.

REFERENCES:

1. Sidney James Carter, "Cooper and Gunn's Tutorial Pharmacy", CBS Publishers & Distributors, 1986.
2. Gareth Thomas. Medicinal Chemistry. An introduction. John Wiley. 2000
3. Katzung B.G. Basic and Clinical Pharmacology, Prentice Hall of Intl. 1995.

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

COs	Statements	K-Level
CO1	Acquire basic knowledge of preformulation and formulation of drugs, pharmaceutical unit operations and manufacturing, packaging and quality control of pharmaceutical dosage forms.	Understand
CO2	Acquire a knowledge on pharmaceutical unit operations and manufacturing, packaging and quality control of pharmaceutical dosage forms.	Understand
CO3	Trained to conceptualize, design, build up, maintain and operate various industrial processes and machineries involved in the process.	Understand
CO4	Understand and apply the various processing and manufacturing techniques.	Understand
CO5	Formulate a pure drug substance into a dosage form.	Apply

COURSE ARTICULATION MATRIX:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1	-	-	-	-	1	1	-	1	2	1
CO2	3	1	1	-	-	-	-	1	1	1	-	1	2	1
CO3	3	1	1	-	-	-	-	1	1	1	-	1	2	1
CO4	3	1	1	-	-	-	-	1	1	1	-	1	2	1
CO5	3	1	1	1	-	-	-	-	1	1	-	1	2	1
CO	3	1	1	1	-	-	-	1	1	1	-	1	2	1
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)					3: Substantial (High)					

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U19CHP24	NANOSCIENCE AND NANOTECHNOLOGY	Category: PE			
		L	T	P	C
		3	0	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To develop knowledge on nanomaterials synthesis
- To develop knowledge on characterization of various techniques
- To know the applications of nanomaterials

UNIT I INTRODUCTION TO NANOMATERIALS 9

Introduction to nanoscience and nanotechnology: definition of nanomaterials, properties of nanoscale, synthesis of nanomaterials: top down and bottom up approaches – mechanical alloying and mechanical ball milling. Chemical approaches – Sol-gel method, spray pyrolysis, precipitation and electro spraying. Physical approaches – vapour deposition, CVD and pulsed laser deposition.

UNIT II CHARACTERIZATION TECHNIQUES 9

X-ray diffractometer (XRD), Four Transform Infrared Spectroscopy (FTIR), Scanning Electron Microscopy (SEM), Transmission Electron Microscopy (TEM), Energy Dispersive Spectroscopy (EDAX), Atomic Force Microscopy (AFM) and particle size analyzer.

UNIT III NANOTECHNOLOGY IN AGRICULTURE AND ENVIRONMENT 9

Nanotechnology in agriculture: Precision forming, smart delivery system, Insecticides using nanotechnology, Potential of nano-fertilizers. Nanotechnology in environment – nanomaterials and nanomembranes in waste water treatment.

UNIT IV NANOTECHNOLOGY IN HEALTHCARE AND FOOD INDUSTRY 9

Drug delivery: nanoscale devices for drug delivery, micelles for drug delivery, targeting, bioimaging. Nanotechnology in food industry: packaging, food processing, food safety and bio-security. Contaminant detection, smart packaging.

UNIT V NANOTECHNOLOGY IN TEXTILE AND COSMETICS 9

Nanofibre preparation: Electrospinning, Controlling morphologies of nanofibres, Tissue engineering application. Cosmetics: Formulation of gels, Shampoos, Hair-conditioners (Micellar self-assembly and its manipulation) – Sun-screen dispersions for UV protection using Titanium Oxide, Colour cosmetics.

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Total: 45 Periods

TEXT BOOKS:

1. Guozhong C, (2004), Nanostructures and Nanomaterials: synthesis, properties and applications, World Scientific.

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2. Zhen Guo and Li Tan, (2009), Fundamentals and Applications of Nanomateials, Artech House.

REFERENCES:

1. M.A. Shah and Tokeer Ahmad (2010), Principles of Nanoscience and Nanotechnology, Alpha Science International Ltd.
2. Edelstein A S, Cammaratra R C, (1998), Nanomaterials: Synthesis, Properties and Applications, Second Edition, CRC Press.
3. Charles P Poole and Frank J Owens (2003), Introduction to Nanotechnology, Wiley inter-science.

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

COs	Statements	K-Level
CO1	Describe the various synthesis materials of nanomaterials	Understand
CO2	Apply various techniques for characterization nanomaterials	Understand
CO3	Analyze and evaluate the synthesized nanomaterials in agriculture, textile and cosmetics	Analyze
CO4	Analyze and evaluate the synthesized nanomaterials in healthcare, food and environment	Analyze
CO5	Analyze and evaluate the synthesized nanomaterials in biomedical applications	Analyze

COURSE ARTICULATION MATRIX:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	-	-	-	-	1	2	1	1	-	-	-	2	3
CO2	1	-	-	-	-	1	2	1	1	-	-	-	2	3
CO3	1	-	-	-	-	1	2	1	1	-	-	-	2	3
CO4	1	-	-	-	-	1	2	1	1	-	-	-	2	3
CO5	1	-	-	-	-	1	2	1	1	-	-	-	2	3
CO	1	-	-	-	-	1	2	1	1	-	-	-	2	3
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)						3: Substantial (High)				

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U19CHP25	COMPUTATIONAL FLUID DYNAMICS	Category: PE			
		L	T	P	C
		3	0	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To make the students to demonstrate competence in setting up computational fluid dynamics models for some industrially important applications.
- This technical competence in building and conducting CFD simulations is a skill which enhances employability.
- To know about recent software tool techniques used in fluid flow operations.

UNIT I CONSERVATION LAWS AND TURBULENCE MODELS 9

Governing equations of fluid flow and heat transfer –mass conservation, momentum and energy equation, differential and integral forms, conservation and non-conservation form. Characteristics of turbulent flows, time averaged Navier Strokes equations, turbulence models-one and two equation, Reynolds stress, LES and DNS.

UNIT II FINITE DIFFERNCE APPROXIMATION 9

Mathematical behaviour of PDE, finite difference operators, basic aspects of discretization by FDM, explicit and implicit methods, error and stability analysis.

UNIT III FINITE VOLUME METHOD 9

Diffusion problems – explicit and implicit time integration; Convection-diffusion problems – properties of discretisation schemes, central, upwind, hybrid, QUICK schemes; Solution of discretised equations.

UNIT IV FLOW FIELD COMPUTATION 9

Pressure velocity coupling, staggered grid, SIMPLE algorithm, PISO algorithm for steady and unsteady flows.

UNIT V GRID GENERATION 9

Physical aspects, simple and multiple connected regions, grid generation by PDE solution, grid generation by algebraic mapping.

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Total: 45 Periods

TEXT BOOKS:

1. Anderson, J. D., "Computational Fluid Dynamics: The Basics with Applications", McGraw-Hill, 1995.
2. Fletcher, C. A. J., "Computational Techniques for Fluid Dynamics", Springer Verlag, 1997.

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REFERENCES:

1. Versteeg, H.K. and Malalasekera, W., "An Introduction to Computational Fluid Dynamics: The Finite Volume Method", Pearson Education Ltd., 2007.
2. Chung T.J Computational Fluid Dynamics Cambridge University Press, 2003.
3. Taylor, C and Hughes, J.B. "Finite Element Programming of the NavierStock Equation", Pineridge Press Limited, U.K., 1981.

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

COs	Statements	K-Level
CO1	Get hands-on experience with a commercial CFD program	Understand
CO2	Know about CFD software tools	Understand
CO3	Apply mathematical applications in simulation tools	Apply
CO4	Understand advanced fluid flow operations in the computational domain	Understand
CO5	Apply the software tools in chemical engineering equipment design	Understand

COURSE ARTICULATION MATRIX:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	3	3	-	-	-	-	2	-	-	2	3
CO2	3	3	2	3	3	-	-	-	-	2	-	-	2	3
CO3	3	3	2	3	3	-	-	-	-	2	-	-	2	3
CO4	3	3	2	3	3	-	-	-	-	2	-	-	2	3
CO5	3	3	2	3	3	-	-	-	-	2	-	-	2	3
CO	3	3	2	3	3	-	-	-	-	2	-	-	2	3
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)						3: Substantial (High)				

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U19CHP26	FERMENTATION ENGINEERING	Category: PE			
		L	T	P	C
		3	0	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To Learn the basics of the various aspects of microbiology and biosystems
- Impart experimental design thinking capability in relation to various fermenter configurations, modes of operation, growth kinetics and product recovery
- Extrapolate the design thinking skills to bio related processes with chemical engineering background

UNIT I FERMENTATION AND ITS TYPES 9

Development of fermentation process – range of processes under fermentation, Types of Fermentation.

UNIT II MICROBIAL GROWTH KINETICS 9

Microbial growth - Batch, Continuous and types of fed batch culture – design and kinetics.Comparison of the modes of culture

UNIT III INDUSTRIAL MICROORGANISM 9

Industrial microorganisms - isolation, preservation and improvement of strains; Storage methods and improvement strategies.

UNIT IV MEDIA FORMULATION 9

Media formulation - energy, carbon and nitrogen sources, micro nutrients; oxygen requirements; Other non-nutrient and functional components. Effects of media composition on penicillin production; Media optimization.

UNIT V MEDIA STERLIZATION AND DESIGN 9

Preparation of media and air for pure culture fermentation; Media sterilization - Batch and continuous sterilization processes; Sterilization of fibrous filters and their design; Development of inocula - processes involving yeast, bacterial, fungi; Aseptic inoculation of plant fermentations.

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Total: 45 Periods

TEXT BOOKS:

1. Stanbury P.F., Whitaker A., Steve H., Principles of Fermentation Technology, 3rd ed., Butterworth-Heinemann, USA, 2017
2. El-Mansi E., Bryce C.F.A, Arnold L.D., Allman A.R., Fermentation Microbiology and Biotechnology, 2nd ed., CRC Press, USA, 2007.

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REFERENCES:

1. Ashok P, Christian L, Carlos R.S., Advances in Fermentation Technology, 1st ed., Asiatech Publishers Inc., India, 2008.
2. Presscott, D., "Industrial Microbiology", CBS Publishers, New Delhi, 1999.
3. Rhodes A and Pletcher. D.L: Principles of Industrial Microbiology, 3rd ed., Pergamon Press, UK, 1977.

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

COs	Statements	K-Level
CO1	Understand the importance of fermentation with reference to industrial microbiology	Apply
CO2	Summarize kinetics prevalent in microbial processes	Understand
CO3	Understand the process to select and manage microorganisms from natural source to fermentation	Understand
CO4	Interpret the acquired knowledge on fermenter configuration for different types of cells and enzymes	Understand
CO5	Design of fermentor and the downstream processing of fermentation products .Create innovative applications for fermentation technologies for novel products.	Understand

COURSE ARTICULATION MATRIX:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1	-	-	-	-	1	1	-	1	2	1
CO2	3	1	1	-	-	-	-	1	1	1	-	1	2	1
CO3	3	1	1	-	-	-	-	1	1	1	-	1	2	1
CO4	3	1	1	-	-	-	-	1	1	1	-	1	2	1
CO5	3	1	1	1	-	-	-	-	1	1	-	1	2	1
CO	3	1	1	1	-	-	-	1	1	1	-	1	2	1
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)						3: Substantial (High)				

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U19CHP27	CORROSION ENGINEERING	Category: PE			
		L	T	P	C
		3	0	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- Understanding of basic concepts of Corrosion, Corrosion in different materials
- Corrosion Electrochemistry, Corrosion Thermodynamics, Kinetics and Applications.
- Corrosion evaluation and corrosion in steel materials, Methods and Materials to prevent the Corrosion

UNIT I INTRODUCTION TO CORROSION 9

Introduction and Scope: Corrosion, definition, Wet and dry corrosion, mechanisms, Electro-chemical principles and aspects of corrosion, Faradays laws, specific conduction, specific resistance, Transport number. mobility etc., various forms of corrosion.

UNIT II THERMODYNAMIC AND KINETICS 9

Thermodynamic aspects of corrosion, equilibrium potential, Nernst equation for electrode potential, EMF series, over voltage, application of Nernst equation to corrosion reactions, calculation of Corrosion Rates. Corrosion rate expression.

UNIT III CORROSION AND ITS TYPES 9

Polarization and Corrosion potentials, reference electrodes for corrosion measurements, types of polarization, concentration, activation and resistance polarizations, Tafel equation, Tafel constant, Evans diagrams, anodic control, cathodic control. Mixed control: Fourbaix diagram for Fe-H2O system, galvanic corrosion, uniform attack, pitting corrosion, dezincification, cavitation erosion. Fretting corrosion, inter-granular and stress corrosion cracking, some remedial measures.

UNIT IV CORROSION MECHANISM AND TESTING 9

High temperature oxidation, pilling bed-worth ratio, mechanisms of oxidation, corrosion testing Procedures evaluation. Corrosion of iron and steel in aqueous media, effect of velocity, temperature and composition of media.

UNIT V PREVENTION OF CORROSION 9

Prevention techniques, modification of the material, alloying, appropriate surface or core treatment, chemical and mechanical methods of surface treatment. Coatings, metallic, non-metallic linings, cathodic protection, passivity and anodic protection.

Contact Periods:

Dr. S. Ramachandran, M.Tech., Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407.

Lecture: 45 Periods Tutorial: Periods Practical: Periods Total: 45 Periods

TEXT BOOKS:

1. Mars Fontana, Corrosion Engineering, McGraw-Hill Publication, (2008). 3rd ed.2003.
2. Uhling H H and Revie R W, Corrosion & Corrosion Control, , John Wiley & sons.2001.

REFERENCES:

1. Pierre Roberge, Handbook of Corrosion Engineering, McGraw-Hill Publication

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

COs	Statements	K-Level
CO1	Solve problems involving various types of corrosion	Apply
CO2	Select corrosion resistant materials for a given application	Understand
CO3	Able to select technique for corrosion prevention and minimize corrosion	Apply
CO4	Students shall understand how to prevent the corrosion and able to Estimate the rate of corrosion	Apply
CO5	Selection of materials for corrosion prevention, how to alter the environment for minimal rate of corrosion, different protection techniques and coating to prevent corrosion	Analyze

COURSE ARTICULATION MATRIX:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	-	-	2	2	-	-	-	-	-	-	-	-
CO2	3	2	-	-	2	2	-	-	-	-	-	-	-	-
CO3	3	-	2	2	2	2	-	-	-	-	-	-	-	-
CO4	3	-	2	2	2	-	-	-	-	-	-	-	-	-
CO5	3	-	2	2	2	-	-	-	-	-	-	-	-	-
CO	3	2	2	2	2	2	-	-	-	-	-	-	-	-
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)						3: Substantial (High)				

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U19CHO28	SUPPLY CHAIN MANAGEMENT	Category: PE			
		L	T	P	C
		3	0	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To understand about the product Life cycle and factors affecting the supply chain.
- To impart knowledge in Risk management in source freight, transportation networks.
- To understand about the network design in Supply chain Management and Risk Management in transportation.

UNIT I INTRODUCTION TO SUPPLY CHAIN 9

Supply Chain, Objectives & Stages, power of SCM - Process views of a supply chain - Strategic planning, Achieving a strategic fit in a supply chain and factors affecting the strategic fit - Value chain, supply chain flow lines - Understanding a product, Product life cycle, Fishers classification of products - Effective and efficient supply chain - case studies on products.

UNIT II SUPPLY CHAIN PROCESS 9

Forecasting in supply chain, forecast error distribution order quantity and reorder point characteristics & components of forecasting - time series methods of forecasting, Demand Management in MPC - MTS - ATO - MTO. Inventory, role of cycle inventory, economies of scale to exploit fixed costs, Economies of scale to exploit quantity discounts, Short term discounting and trade promotions Managing multi-echelon cycle inventory - Bullwhip effect - Product substitution, Postponement.

UNIT III PRODUCT PROCUREMENT & TRANSPORTATION 9

Procurement process, EOQ - Sourcing in a supply chain - deciding factors for in-house or outsourcing -Supplier selection - auctions and negotiations, risk management in sourcing Freight management, Transportation networks, Milk run, Cross Docking, tailored transportation, 3PL - 4 PL, Risk management in transportation.

UNIT IV DESIGNING A SUPPLY CHAIN 9

Supply chain drivers - Supply chain performance measures - SCOR Model - Network design in a supply chain, factors influencing design, Framework for network design network, models for facility location and capacity allocation - Uncertainty in network design - Discounted cash flow analysis, Decision trees in evaluating network design - Distribution, factors influencing distribution, design options for a distribution network.

UNIT V INFORMATION TECHNOLOGY IN SUPPLY CHAIN 9

Lean Supply Chain, agile supply chain, Dynamic supply chain design, Impact of technology on SCM, Key trends in SCM, IT in supply chain coordination and design - MRP, ERP, CRM, ISCM - Performance metrics.Discussion on supply chain adopted by primary industrial sectors and case studies.

Contact Periods:

Lecture: 45 Periods Tutorial: Periods Practical: Periods Total: 45 Periods

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TEXT BOOKS:

1. Ayers J., "Hand Book of Supply Chain Management", The St. Lencie Press/ APICS Series on Resource Management, 2000.

REFERENCES:

1. Burt N.D., Dobler. W.D. and Starling L.S., "World Class Supply Chain Management, The Key to Supply Chain Management", Tata McGraw Hill Publishing Company Limited, 2005.
2. Chopra S., Meindl P. and Kalra, D.V., "Supply Chain Management, Strategy, Planning and Operation", Pearson Education, Inc., 2008
3. Monczka R., Trent R. and Handfield R., "Purchasing and Supply Chain Management", 3rd edition, Thompson Learning Inc., 2007.

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

COs	Statements	K-Level
CO1	Outline the manufacturing and product life cycle management process involved in a product.	Understand
CO2	Formulate the forecasting methods and inventory modelling	Understand
CO3	Estimate the right procurement and logistics strategy based on the supply chain and product criterion requirements.	Analyze
CO4	Design and analyze the right supply chain structure for the product along with distribution network	Apply
CO5	Produce the supply chain network diagram incorporating supply chain strategy and competitive strategies involving material and information flow lines	Understand

COURSE ARTICULATION MATRIX:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	2	-	-	-	-	-	-	-	-
CO2	3	-	-	--	-	2	-	-	-	-	-	-	-	-
CO3	2	2	-	-	-	2	-	-	-	-	-	-	-	-
CO4	2	2	-	-	-	2	-	-	-	-	-	-	-	-
CO5	2	2	-	-	-	2	-	-	-	-	-	-	-	-
CO	2	2	-	-	-	2	-	-	-	-	-	-	-	-
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)					3: Substantial (High)					

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U19CHP29	INDUSTRIAL MANAGEMENT	L	T	P	C
		3	0	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To understand the strategic planning and effective and efficient supply chain.
- About the organizational behavior and group dynamics.
- To understand the concept of SWOT analysis.

UNIT I INTRODUCTION TO MANAGMENT 9

Management - Definition – Functions – Evolution of Modern Management – Scientific Management Joint Stock Companies – Co-operative Enterprises – Public Sector Undertakings, Corporate Frame Work – Share Holders – Board of Directors – Committees – Chief Executive –Trade Union..

UNIT II FUNCTIONS OF MANAGEMENT 9

Planning – Nature and Purpose – Objectives – Strategies – Policies and Planning Premises – Decision Making – Organizing –Organizational culture, Staffing - selection and training – Placement – Performance appraisal – Career Strategy – Organizational Development. Leading – Managing human factor – Leadership – Communication, Controlling.

UNIT III ORGANIZATIONAL BEHAVIOUR 9

Definition – Organization – Managerial Role and functions – Organizational approaches, Individual behaviour – causes – Environmental Effect – Behavior and Performance, Job Satisfaction, Learning and Behavior – Learning Curves, Work Design and approaches

UNIT IV GROUP DYNAMICS 9

Group Behavior – Groups – Contributing factors – Group Norms, Communication – Process – Barriers to communication – Effective communication, Organization centralization and decentralization – Formal and informal – Organizational Structures – Organizational Change and Development – Change Process – Resistance to Change – Culture and Ethics

UNIT V MODERN CONCEPTS 9

Management by Objectives (MBO), Management by Exception (MBE), Strategic Management - Planning for Future direction – SWOT Analysis – Information technology in management – Decisions support system –Activity Based Management (ABM).

Contact Periods:

Lecture: 45 Periods Tutorial: Periods Practical: Periods Total: 45 Periods

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TEXT BOOKS:

1. Herald Knottz and Heinz Weihrich, "Essentials of Management", Tata McGraw Hill Education Pvt. Ltd., 2010.
2. Stephen P. Robbins, "Organization Behaviour", Pearson Education Inc., 13 edition, 2010

REFERENCES:

1. Ties, AF, Stoner and R.Edward Freeman, "Management" Prentice Hall of India Pvt. Ltd. New Delhi 110 011, 1992
2. Joseph J, Massie, "Essentials of Management" Prentice Hall of India Pvt. Ltd. 1985.
3. Tripathi. P.C. & P.N. Reddy, "Principles of Management", Tata McGraw Hill, 2006

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

COs	Statements	K-Level
CO1	Gain knowledge on the basic management principles to become management professional	Understand
CO2	To understand the modern concepts of management	Understand
CO3	To understand about the organizational structures in detail	Understand
CO4	Implement the performance appraisal in their working system	Apply
CO5	Manage human behaviour and leadership qualities	Understand

COURSE ARTICULATION MATRIX:

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

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

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		L	T	P	C
U19CHP30	SUSTAINABILITY ENGINEERING	3	0	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- The principles for balancing social, economic and environmental dimensions of development
- The associated international and national frameworks
- The environment quality indices

UNIT I INTRODUCTION 9

Status of environment – Environmental, Social and Economical issues – Need for sustainability – Nine ways to achieve sustainability – population, resources, development and environment.

UNIT II CHALLENGES OF SUSTAINABLE DEVELOPMENT AND GLOBAL ENVIRONMENTAL ISSUES 9

Concept of sustainability – Factors governing sustainable development – Linkages among sustainable development- Environment and poverty – Determinants of sustainable development – Case studies on sustainable development – Population, income and urbanization – Health care – Food, fisheries and agriculture – Materials and energy flows.

UNIT III SUSTAINABLE DEVELOPMENT INDICATORS 9

Need for indicators – Statistical procedures – Aggregating indicators – Use of principal component analysis – Three environmental quality indices.

UNIT IV ENVIRONMENTAL MANAGEMENT STANDARDS 9

ISO 14000 series, Life Cycle Analysis (LCA) - Scope and Goal, Bio-mimicking, Environment Impact Assessment (EIA) - Procedures of EIA in India

UNIT V SUSTAINABLE HABITAT 9

Basic concepts of sustainable habitat, Green buildings, green materials for building construction, material selection for sustainable design, green building certification, Methods for increasing energy efficiency of buildings.

Contact Periods:

Lecture: 45 Periods Tutorial: Periods Practical: Periods Total: 45 Periods

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TEXT BOOKS:

1. Sayer, J. and Campbell, B., "The Science of Sustainable Development: Local Livelihoods and the Global Environment" (Biological Conservation, Restoration &Sustainability), Cambridge University Press, London, 2003.
2. Kirkby, J., O"Keefe P. and Timberlake, "Sustainable Development", Earth scan Publication, London, 1993.

REFERENCES:

1. Jennifer A. Elliott, "An introduction to sustainable development". London: Routledge: Taylor and Francis group, 2001.
2. Low, N. Global ethics and environment. London: Routledge. 1999.
3. Douglas Muschett, Principles of Sustainable Development, St. Lucie Press, 1997

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

COs	Statements	K-Level
CO1	Describe the national and global environmental issues	Understand
CO2	Understand the economic and social issues	Understand
CO3	Know he principles of different sustainable development frameworks	Understand
CO4	Apply the sustainable development principles during the planning of developmental activities	Apply
CO5	Have knowledge about green building and green materials	Understand

COURSE ARTICULATION MATRIX:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	-	1	-	-	-	-	-	-	-	1	-
CO2	3	2	2	-	1	-	-	-	-	-	-	-	1	-
CO3	3	2	2	-	1	-	-	-	-	-	-	-	1	-
CO4	3	2	2	-	1	-	-	-	-	-	-	-	1	-
CO5	3	2	2	-	1	-	-	-	-	-	-	-	1	-
CO	3	2	2	-	1	-	-	-	-	-	-	-	1	-
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)						3: Substantial (High)				

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U19CHP31	PULP AND PAPER TECHNOLOGY	Category: PE			
		L	T	P	C
		3	0	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To apply basic concepts of pulp and paper technology to produce paper
- To the reactions and unit operations steps appropriately in manufacturing of paper
- To perform various chemical tests to monitor quality of raw material, output quality and influent/effluent

UNIT I BASICS OF PULP AND PAPER TECHNOLOGY 9

Pulp and paper industry, Consumption pattern of paper, Cellulose raw material, Problems and scope of pulp and paper industries in India

UNIT II PULP 9

Pulping process: Sulphite pulping, Semi-chemical pulping, Mechanical and Thermo- mechanical pulping, Secondary fibber pulping, R.A.G. pulping,Dissolving pulp, Kraft pulping process, Comparison of different types of pulps, Black liquor recovery process.

UNIT III PAPER 9

Types of paper products, Various raw materials: Fibrous and Non- Fibrous, Wet process for paper Manufacture, Fourdrinier machine, Economics of paper industry.

UNIT IV CELLULOSE AND LIGNIN CHEMICALS 9

Properties of cellulose, Preparation of chemical cellulose, Lignin chemicals: Types, properties of Di-methyl sulphides and Di- methyl sulfoxide, Applications of cellulose and Lignin chemicals.

UNIT V WASTE DISPOSAL TECHNIQUES 9

Pollution potentials of Indian pulp and paper industry, Characteristics of Industrial Lignin water, Bio-technical approach for pollution, Enzymology for Lignin waste treatment

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Total: 45 Periods

TEXT BOOKS:

1. Rao, M.Gopal, Sitting, Marshall Dryden's outlines of Chemical, Affilated East-West Press Pvt. Ltd. 3rd Edition
2. Austin, George T., Shreves' Chemical Process Industries, McGraw-Hill Education India Pvt. Ltd - New Delhi, 5th Edition

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REFERENCES:

1. Bhatia, S.C. Environmental Pollution and Control in Chemical Process Industries, Second Edition 2011
2. Trivedi, R.K. Pollution Management in Industries, Environmental Publication, Karad, India
3. U Biermann,
4. Christopher J. Handbook of Pulping and Papermaking ISBN-13: 978- 0120973620

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

COs	Statements	K-Level
CO1	Understating the paper and pulp technology	Understand
CO2	Pulping process analysis with different types	Understand
CO3	Wet process application of paper products	Apply
CO4	Applications of cellulose and Lignin chemicals	Understand
CO5	Pollution potentials of Indian pulp and paper industry and waste disposal techniques.	Understand

COURSE ARTICULATION MATRIX:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2
CO1	3	2	1	1	-	-	-	-	-	-	-	-	-	-
CO2	3	1	1	-	-	-	-	-	-	-	-	-	-	-
CO3	3	1	1	-	-	-	-	-	-	-	-	-	-	-
CO4	3	1	1	-	-	-	-	-	-	-	-	-	-	-
CO5	3	1	1	1	-	-	-	-	-	-	-	-	-	-
CO	3	1	1	1	-	-	-	-	-	-	-	-	-	-
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)						3: Substantial (High)				

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U19CHP32	ENERGY TECHNOLOGY	Category: PE			
		L	T	P	C
		3	0	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- Students will gain knowledge about different energy sources.
- Students will gain knowledge about energy conservation.
- To know about biomass energy sources.

UNIT I ENERGY 8

Introduction to energy – Global energy scene – Indian energy scene - Units of energy, conversion factors, general classification of energy, energy crisis, energy alternatives.

UNIT II CONVENTIONAL ENERGY 8

Conventional energy resources, Thermal, hydel and nuclear reactors, thermal, hydel and nuclear power plants, efficiency, merits and demerits of the above power plants, combustion processes, fluidized bed combustion.

UNIT III NON-CONVENTIONAL ENERGY 10

Solar energy, solar thermal systems, flat plate collectors, focusing collectors, solar water heating, solar cooling, solar distillation, solar refrigeration, solar dryers, solar pond, solar thermal power generation, solar energy application in India, energy plantations. Wind energy, types of windmills, types of wind rotors, Darrieus rotor and Gravian rotor, wind electric power generation, wind power in India, economics of wind farm, ocean wave energy conversion, ocean thermal energy conversion, tidal energy conversion, geothermal energy.

UNIT IV BIOMASS ENERGY 10

Biomass origin - Resources – Biomass estimation. Thermochemical conversion – Biological conversion, Chemical conversion – Hydrolysis & hydrogenation, solvolysis, biocrude, biodiesel power generation gasifier, biogas, integrated gasification.

UNIT V ENERGY CONSERVATION 9

Energy conservation - Act; Energy management importance, duties and responsibilities; Energy audit – Types methodology, reports, instruments. Benchmarking and energy performance, material and energy balance, thermal energy management.

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Total: 45 Periods

Dr. S. Ramachandran, M.Tech.,Ph.D.
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TEXT BOOKS:

1. Rao, S. and Parulekar, B.B., Energy Technology, Khanna Publishers, 2005
2. Rai, G.D., Non-conventional Energy Sources, Khanna Publishers, New Delhi, 1984.

REFERENCES:

1. Nagpal, G.R., Power Plant Engineering, Khanna Publishers, 2008
2. Energy Management, Paul W.O'Callaghan McGraw – Hill, 1993
3. Nejat Vezirog, Alternate Energy Sources, IT, McGraw Hill, New York

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

COs	Statements	K-Level
CO1	Understand conventional energy sources, non- conventional energy sources,	Understand
CO2	Develop design parameters for equipment to be used in chemical process industries	Analyze
CO3	Understand energy conservation in process industries	Understand
CO4	Get knowledge about energy conservation	Understand
CO5	Know about biomass energy sources	Understand

COURSE ARTICULATION MATRIX:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	-	-	-	-	3	3	1	1	-	-	-	2	-
CO2	1	-	-	-	-	3	3	1	1	-	-	-	2	-
CO3	1	-	-	-	-	3	3	1	1	-	-	-	2	-
CO4	1	-	-	-	-	3	3	1	1	-	-	-	2	-
CO5	1	-	-	-	-	3	3	1	1	-	-	-	2	-
CO	1	-	-	-	-	3	3	1	1	-	-	-	2	-
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)						3: Substantial (High)				

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U19CHP33	FERTILIZER TECHNOLOGY	Category: PE			
		L	T	P	C
		3	0	0	3

PRE–REQUISITES:

- Knowledge in Chemical process industries and Chemical Technology

COURSE OBJECTIVES:

To enable the students to

- learn the fertilizer manufacturing including new or modified fertilizer products
- Understand the practical methods of production in a chemical factory.
- Learn about the importance of nutrients

UNIT I OVERVIEW OF FERTILIZER 9

Synthetic fertilizers, Classification of fertilizers, Role of essential Elements in plant Growth, Macro elements and Micro elements, Application of fertilizers considering Nutrient, Balance and types of crop. Development of fertilizer industry; Fertilizer production and consumption in India; Nutrient contents of fertilizers; Secondary nutrients

UNIT II NITROGENOUS FERTILIZERS 9

Physical & Chemical properties, applications, Synthesis gas by Catalytic partial oxidation, Steam Hydrocarbon reforming, Ammonia converters: Design aspect of Single bed and multi-bed converter, Kellogg process and Haldor Topsoe process, Storage and Transportation of Ammonia : Chemical, physical properties and applications, Manufacturing of Nitric Acid by Pressure ammonia oxidation process and Intermediate pressure ammonia oxidation process.

UNIT III POTASSIUM FERTILIZERS 9

Physical, chemical properties and uses of Potassium Chloride, Potassium nitrate, Potassium sulphate, Manufacturing of potassium chloride from sylvinite, Preparation of Potassium nitrate, Potassium sulphate.

UNIT IV MISCELLANEOUS FERTILIZER 9

Manufacturing of NPK, Ammonium Sulphate Phosphate (ASP), Calcium Ammonium Nitrate(CAN) .

UNIT V BIO FERTILIZERS 9

Biofertilizers, Types of Biofertilizers, Nitrogen fixing Biofertilizers, Phosphate-solubilizing Biofertilizers, Preparation of a Biofertilizers.

Contact Periods:

Lecture: 45 Periods Tutorial: - Periods Practical: – Periods Total: 45 Periods

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KPRIET
LEARN BEYOND

TEXT BOOKS:

1. Hand book of Fertilizer Association of India, New Delhi, 1998.
2. Slack A.V., Chemistry & Technology of Fertilizers, Interscience, New York, 1967.

REFERENCES:

1. Austin G. T, Shreve's Chemical Process Industries, 5th edition, Mc. Graw Hill Publications,2003.
2. Pandey & Shukla, Chemical Technology, Volume I & II, 2nd Edition, Vani Books Company,1997.
3. N S Subba Rao, Bio fertilizers in Agriculture, Oxford & IBH Publishing Company,1998.

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

COs	Statements	K-Level
CO1	Understand the classification of fertilizers and its application	Understand
CO2	Understand the physical and Chemical properties, applications, Synthesis gas by Catalytic partial oxidation, Steam Hydrocarbon reforming, Ammonia converters	Understand
CO3	Identify the manufacturing of potassium chloride from sylvinite, Preparation of Potassium nitrate, Potassium sulphate	Understand
CO4	Analyze the manufacturing of NPK and Ammonium Sulphate Phosphate	Analyze
CO5	Analyze the Biofertilizer and preparation of Biofertilizer	Analyze

COURSE ARTICULATION MATRIX:

Pos / Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	-	-	1	-	-	-	-	-	-	-	1	1
CO2	3	2	-	-	1	-	-	-	-	-	-	-	1	1
CO3	3	2	-	-	1	-	-	-	-	-	-	-	1	1
CO4	3	2	-	-	1	-	-	-	-	-	-	-	1	1
CO5	3	2	-	-	1	-	-	-	-	-	-	-	1	1
CO	3	2	-	-	1	-	-	-	-	-	-	-	1	1
Correlation levels:	1: Slight (Low)		2: Moderate (Medium)				3: Substantial (High)							

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U19CHP34	APPLICATIONS OF MEMBRANE PROCESS	Category: PE			
		L	T	P	C
		3	0	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To know about applications of reverse osmosis, ultra filtration and microfiltration.
- To know about applications of gas separation and pre evaporation.
- To know about ion exchange, electro dialysis and medical applications.

UNIT I INTRODUCTION TO MEMBRANE SCIENCE AND TECHNOLOGY 11

Introduction, Historical Development of Membranes, Types of Membranes, Membrane Processes. Solution-diffusion Model, Structure–Permeability Relationships in Solution-diffusion Membranes, Pore-flow Membranes. Isotropic Membranes, Anisotropic Membranes, Metal Membranes and Ceramic Membranes, Liquid Membranes, Hollow Fiber Membranes, Membrane Modules. Boundary Layer Film Model, Determination of the Peclet Number.

UNIT II REVERSE OSMOSIS 9

Membranes and Materials, Reverse Osmosis Membrane Categories, Membrane Selectivity, Membrane Modules, Membrane Fouling Control, Membrane Cleaning, Applications.

UNIT III ULTRAFILTRATION AND MICROFILTRATION 9

Characterization of Ultrafiltration Membranes, Concentration Polarization and Membrane Fouling, Membrane Cleaning, Membranes and Modules, Applications. Microfiltration and its Applications.

UNIT IV GAS SEPARATION AND PERVAPORATION 8

Gas separation: Membrane Materials and Structure, Membrane Modules, Applications. Pervaporation: Membrane Materials and Modules, Applications.

UNIT V ION EXCHANGE, ELECTRODIALYSIS AND MEDICAL APPLICATIONS 8

Chemistry of Ion Exchange Membranes, Transport in Electrodialysis Membranes, Applications. Medical applications: Hemodialysis, Blood Oxygenators, Controlled Drug Deliver.

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Total: 45 Periods

TEXT BOOKS:

Dr. S. Ramachandran, M.Tech.,Ph.D.
Professor & Head
Department of Chemical Engineering
KPR Institute of Engineering & Technology
Arasur, Coimbatore - 641 407.

1. Membrane Technology and Applications, 2nd Ed., by Richard W. Baker, John Wiley & Sons, 2000.
2. Water Treatment Membrane Processes, by American Water Works Association Research Foundation, McGraw-Hill, 1996.

REFERENCES:

1. Microltration and Ultraltration, by Leos J. Zeeman and Andrew L. Zydney, Marcel Dekker, Inc., 1996.
2. Sustainable Water for the Future: Water Recycling versus Desalination, eds.: Isable Escobar, Andrea Schafer, Elsevior, 2010.
3. Basic Principles of Membrane Technology, 2nd Ed., by Marcel Mulder, Kluwer Academic Publishers, 2000

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

COs	Statements	K-Level
CO1	Understand about an overview of membrane technology	Understand
CO2	Know about various membrane technologies and their applications.	Understand
CO3	Interpret the applications of membrane technologies with the industry.	Understand
CO4	Know about various types of membranes used in industry	Understand
CO5	Serve the water purification industry.	Apply

COURSE ARTICULATION MATRIX:

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

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

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LEARN BEYOND

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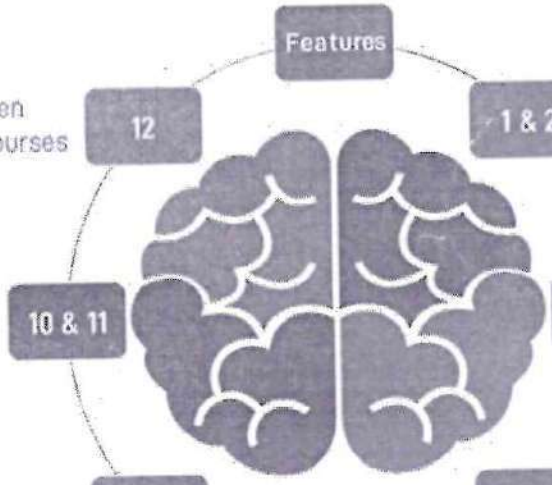
Curriculum Features



Aligned with AICTE Model Curriculum
Minimum Credits to be Earned – 165

Theory Courses Integrated with Laboratory
Track Based Professional Electives

Mandatory Internship / Industrial Training
Mini Project, Project and Technical Seminar

Design Thinking Course

Fast Track System
Industry Based One Credit

MOOC and Value-Added Courses
Hindi and Foreign Language Courses

Interdisciplinary / Open Elective / Liberal Arts Courses

KPR Institute of Engineering and Technology
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NBA Accredited
(CSE, ECE, EEE, MECH, CIVIL)