SRM UNIVERSITY
(Under section 3 of UGC Act 1956)

FACULTY OF ENGINEERING AND TECHNOLOGY

CURRICULUM, PRE-REQUISITES / CO-REQUISITES CHART AND SYLLABUS FOR B.TECH

UNDER CHOICE BASED FLEXIBLE CREDIT SYSTEM

REGULATIONS 2015

(For students admitted from 2015-16 onwards)

Specialization: B. Tech - CHEMICAL ENGINEERING

Offering Department: Department of Chemical Engineering

Placed in the 32nd Academic Council Meeting held on 23rd July 2016

CONTENTS

STUDENT OUTCOMES

The curriculum and syllabus for B.Tech programs (2015) conform to outcome based teaching learning process. In general, ELEVEN STUDENT OUTCOMES (a-k) have been identified and the curriculum and syllabus have been structured in such a way that each of the courses meets one or more of these outcomes. Student outcomes describe what students are expected to know and be able to do by the time of graduation. These relate to the skills, knowledge, and behaviors that students acquire as they progress through the program. Further each course in the program spells out clear instructional objectives which are mapped to the student outcomes.

The student outcomes are:

(a) an ability to apply knowledge of mathematics, science, and engineering

(b) an ability to design and conduct experiments, as well as to analyze and interpret data

(c) an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability

(d) an ability to function on multidisciplinary teams

(e) an ability to identify, formulate, and solve engineering problems

(f) an understanding of professional and ethical responsibility

(g) an ability to communicate effectively

(h) the broad education necessary to understand the impact of engineering solutions in global, economic, environmental, and societal context

(i) a recognition of the need for, and an ability to engage in life-long learning

(j) a knowledge of contemporary issues

(k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

C-D-I-O Initiative

The CDIO Initiative (CDIO is a trademarked initialism for **Conceive** — **Design — Implement — Operate**) is an innovative educational framework for producing the next generation of engineers. The framework provides students with an education stressing engineering fundamentals set in the context of Conceiving — Designing — Implementing — Operating real-world systems and products. Throughout the world, CDIO Initiative collaborators have adopted CDIO as the framework of their curricular planning and outcome-based assessment.

In the syllabus, every topic has been classified under one or more of C-D-I-O so that students and faculty alike are clear about the scope of learning to take place under each one of the topics.

SYMBOLS AND ABBREVIATIONS

B	--	Courses under Basic Science and Mathematics
BT	--	Biotechnology Courses
C-D-I-O	--	Conceive-Design-Implement-Operate
CE	--	Civil Engineering Courses
CH	--	Chemical Engineering Courses
CS	--	Computer Science and Engineering Courses
CY	--	Chemistry Courses
Dept.	--	Department of Chemical Engineering
E	--	Courses under Engineering Sciences
EC	--	Electronics and Communication Engineering Courses
EE	--	Electrical and Electronics Engineering Courses
G	--	Courses under Arts and Humanities
IOs	--	Instructional Objectives
L	--	Laboratory / Project / Industrial Training Courses (e.g. 15CHXXXE)
LE	--	Language Courses
L-T-P-C	--	L- Lecture Hours Per Week T- Tutorial Hours Per Week P- Practical Hours Per Week C- Credits for a Course
MA	--	Mathematics Courses
ME	--	Mechanical Engineering Courses
NC	--	NCC- National Cadet Corps
NS	--	NSS – National Service Scheme
P	--	Professional Core Courses
PD	--	Personality Development Courses
PY	--	Physics Courses
SO/SOs	--	Student Outcomes (a-k)
SP	--	NSO- National Sports Organization
YG	--	Yoga Course

Course code structure

15CHXXXE	-	Elective Courses
15CHXXXL	-	Laboratory / Project / Industrial Training Courses
15CHXXXM	-	Courses with Multi Disciplinary Content

FACULTY OF ENGINEERING AND TECHNOLOGY, SRM UNIVERSITY

DEPARTMENT OF CHEMICAL ENGINEERING

B.TECH CHEMICAL ENGINEERING CHOICE BASED FLEXIBLE CREDIT SYSTEM (CBFCS) Curriculum Under Regulations 2015 (For students admitted from 2015-16 onwards)

L Lecture Hrs / Week | T Tutorial Hours / Week | C Credits | P Practical Hours / Week | L Laboratory Course | E Elective Courses | J Theory jointly with Lab | M Course with Multidisciplinary content

Category	Category - wise % of Credits	Year 1											Year 2										
		1st Semester					2nd Semester						1st Semester					2nd Semester					
		Course Code	Course Title	L	T	P	C	Course Code	Course Title	L	T	P	C	Course Code	Course Title	L	T	P	C	Course Code	Course Title	L	T	P	C
Arts & Humanities-G	8.33%		English	2	0	0	2	15LE102	Value Education	2	0	0	2	15LE201E	German Language - I	2	0	0	2	15LE207E	German Language - II	2	0	0	2
			Soft Skills - I	1	1	0	1	15PD102	Soft Skills - II	1	1	0	1	15LE202E	French Language - I					15LE208E	French Language - II				
		15LE101						15NC101	NCC- National Cadet Corps	0	0	1	1	15LE203E	Japanese Language - I					15LE209E	Japanese Language - II				
		15PD101						15NS101	NSS- National Service Scheme					15LE204E	Korean Language - I					15LE210E	Korean Language - II				
								15SP101	NSO- National Sports Organization					15LE205E	Chinese Language - I					15LE211E	Chinese Language - II				
								15YG101	Yoga					15PD201	Quantitative Aptitude & Logical Reasoning - I	1	1	0	1	15PD202	Verbal Aptitude	1	1	0	1
	15		Total	3	1	0	3		Total	3	1	1	4		Total	3	1	0	3		Total	3	1	0	3
Basic Sciences - B	17.22%	15MA101	Calculus And Solid Geometry	3	1	0	4	15MA102	Advanced Calculus And Complex Analysis	3	1	0	4	15MA202	Fourier Series, Partial Differential Equations and it's Applications	4	0	0	4	15MA206	Numerical Methods	4	0	0	4
		15PY101	Physics	3	0	0	3	15PY102L	Materials Science	2	0	2	3												
		15PY101L	Physics Laboratory	0	0	2	1	15CY102	Principles Of Environmental Science	2	0	0	2												
		15CY101	Chemistry	3	0	0	3																		
		15CY101L	Chemistry Laboratory	0	0	2	1																		
		15BT101	Biology For Engineers	2	0	0	2																		
	31		Total	11	1	4	14		Total	7	1	2	9		Total	4	0	0	4		Total	4	0	0	4
Engineering Sciences -E	8.33%	15CE101	Basic Civil Engineering	2	0	0	2	15ME101	Basic Mechanical Engineering	2	0	0	2												
		15EE101	Basic Electrical Engineering	2	0	0	2	15EC101	Basic Electronics Engineering	2	0	0	2												
		15ME105L	Engineering Graphics	1	0	4	3	15ME104L	Workshop Practice	0	0	3	2												
		15CS101L	Programming Laboratory	1	0	2	2																		
	15		Total	6	0	6	9		Total	4	0	3	6		Total	0	0	0	0		Total	0	0	0	0
Professional - Core -P	42.78%							15CY104	Material Technology	3	1	0	3	15CH201	Industrial Organic Chemistry	3	0	0	3	15CH207J	Physical And Analytical Chemistry	3	0	2	4
														15CH202	Chemical Process Calculations	4	0	0	4	15CH208	Basic Thermodynamics And Heat Transfer	4	0	0	4
														15CH203	Mechanical Operations	3	0	0	3	15CH209	Principles Of Mass Transfer	3	0	0	3
														15CH204	Chemical Engineering Fluid Mechanics	4	0	0	4	15CH210	Chemical Process Technology	4	0	0	4
														15CH205L	Technical Analysis And Instrumentation Laboratory	0	0	2	1	15CH211L	Mechanical Operations And Fluid Mechanics Laboratory - II	0	0	2	1
														15CH206L	Mechanical Operations And Fluid Mechanics Laboratory - I	0	0	2	1						
	77		Total	0	0	0	0		Total	3	1	0	3		Total	14	0	4	16		Total	14	0	4	16
Prof - Electives	10.00%																								
	18		Total	0	0	0	0		Total	0	0	0	0		Total	0	0	0	0		Total	0	0	0	0
Project / Seminar / Internship-P	10.00%																								
	18		Total	0	0	0	0		Total	0	0	0	0		Total	0	0	0	0		Total	0	0	0	0
Open Electives	3.33%																								
	6		Total	0	0	0	0		Total	0	0	0	0		Total	0	0	0	0		Total	0	0	0	0
Total	**180**		**Contact hours**	**20**	**2**	**10**	**26**		**Contact hours**	**17**	**3**	**6**	**22**		**Total contact hours**	**21**	**1**	**4**	**23**		**Total Contact hours**	**21**	**1**	**4**	**23**
				32						**26**						**26**						**26**			

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L	Lecture Hours / Week	T	Tutorial Hours / Week		C	Credits P Practical Hrs /	L	Laboratory Course		E	Elective Courses	J	Theory jointly with Lab		M	Course with Multidisciplinary content
	Year 3									Year 4						
	1st Semester					2nd Semester				1st Semester					2nd Semester	

Course Code	Course Title	L	T	P	C	Course Code	Course Title	L	T	P	C	Course Code	Course Title	L	T	P	C	Course Code	Course Title	L	T	P	C
15PD301	Communication and Reasoning Skills	1	1	0	1	15PD302	Quantitative Aptitude & Logical Reasoning - II	1	1	0	1												
	Total	1	1	0	1		Total	1	1	0	1		Total	0	0	0	0		Total	0	0	0	0
	Total	0	0	0	0		Total	0	0	0	0		Total	0	0	0	0		Total	0	0	0	0
	Total	0	0	0	0		Total	0	0	0	0		Total	0	0	0	0		Total	0	0	0	0
15CH301	Chemical Engineering Thermodynamics	3	0	0	3	15CH307	Transport Phenomena Fundamentals	3	0	0	3	15CH401J	Process Equipment Design And Drawing	2	0	2	3						
15CH302	Process Heat Transfer	4	0	0	4	15CH308	Process Dynamics, Control and Instrumentation	4	0	0	4	15CH402	Process Economics And Project Management	3	0	0	3						
15CH303	Mass Transfer Applications	3	0	0	3	15CH309	Reactor Analysis And Catalysis	3	0	0	3	15CH403J	Process Modeling And Simulation	2	0	2	3						
15CH304	Chemical Reaction Engineering	3	0	0	3	15CH310L	Heat And Mass Transfer Laboratory - II	0	0	2	1	15CH404M	Multi-Disciplinary Design	3	0	0	3						
15CH305J	Computational Techniques In Chemical Engineering	2	0	2	3	15CH311L	Chemical Reaction Engineering And Process Control Laboratory - I	0	0	2	1	15CH405L	Chemical Reaction Engineering And Process Control Laboratory - II	0	0	2	1						
15CH306L	Heat And Mass Transfer Laboratory - I	0	0	2	1																		
	Total	15	0	4	17		Total	10	0	4	12		Total	10	0	6	13		Total	0	0	0	0
	Department Elective - I	**3**	**0**	**0**	**3**		**Department Elective - II**	**3**	**0**	**0**	**3**		**Department Elective - III**	**3**	**0**	**0**	**3**		**Department Elective - V**	**3**	**0**	**0**	**3**
													Department Elective - IV	**3**	**0**	**0**	**3**		**Department Elective - VI**	**3**	**0**	**0**	**3**
	Total	3	0	0	3		Total	3	0	0	3		Total	6	0	0	6		Total	6	0	0	6
15CH390L	Industrial Training - I (To be done after IV semester)	0	0	2	1	15CH375L / 15CH380L / 15CH385L / 15CH490L	Minor Project - I / Seminar - I / MOOCs - I / Industrial Module - I	0	0	3	2	15CH376L / 15CH381L / 15CH386L / 15CH491L	Minor Project - II / Seminar - II / MOOCs - II / Industrial Module - II	0	0	3	2	15CH496L	Major Project	0	0	24	12
												15CH391L	Industrial Training - II (To be done after VI semester)	0	0	2	1						
	Total	0	0	2	1		Total	0	0	3	2		Total	0	0	5	3		Total	0	0	24	12
	Open Elective - I	3	0	0	3		Open Elective - II	3	0	0	3												
	As per list / as taken by the						As per list / as taken by the student																
	Total	3	0	0	3		Total	3	0	0	3		Total	0	0	0	0		Total	0	0	0	0
		22	**1**	**6**	**25**			**17**	**1**	**7**	**21**			**16**	**0**	**11**	**22**			**6**	**0**	**24**	**18**
	Total Contact hours	**29**					**Total contact hours**	**25**					**Total contact hours**	**27**					**Total contact hours**	**30**			

B.Tech Chemical Engineering (Regulations 2015)					
List of Department Electives					
COURSE CODE	**Course Title**	**L**	**T**	**P**	**C**
15CH351E	Renewable Energy Engineering	3	0	0	3
15CH352E	Introduction To Biochemical Principles	3	0	0	3
15CH353E	Energy Engineering And Technology	3	0	0	3
15CH354E	Polymer Technology	3	0	0	3
15CH355E	Fundamentals Of Membrane Processes	3	0	0	3
15CH356E	Industrial Pollution Prevention And Control	3	0	0	3
15CH357E	Environmental Engineering And Waste Management	3	0	0	3
15CH358E	Enzyme Engineering	3	0	0	3
15CH359E	Fuels And Combustion	3	0	0	3
15CH360E	Fertilizer Technology	3	0	0	3
15CH361E	Petroleum Refining Technology	3	0	0	3
15CH362E	Principles Of Desalination Technologies	3	0	0	3
15CH363E	Safety And Hazard Analysis In Process Industries	3	0	0	3
15CH364E	Air Pollution Control Engineering	3	0	0	3
15CH365E	Fine Chemicals Technology	3	0	0	3
15CH366E	Environmental Quality Monitoring And Analysis	3	0	0	3
15CH367E	Waste Water Treatment	3	0	0	3
15CH368E	Petrochemical Technology	3	0	0	3
15CH451E	Chemical Process Optimization	3	0	0	3
15CH452E	Equilibrium Stage Operations	3	0	0	3
15CH453E	Computational Fluid Dynamics	3	0	0	3
15CH454E	Biochemical Process Design	3	0	0	3
15CH455E	Microchemical Systems	3	0	0	3

Open electives: Each semester, a list of core and elective courses will be listed / delisted, by the Department under open electives, based on the availability of resources and demand.

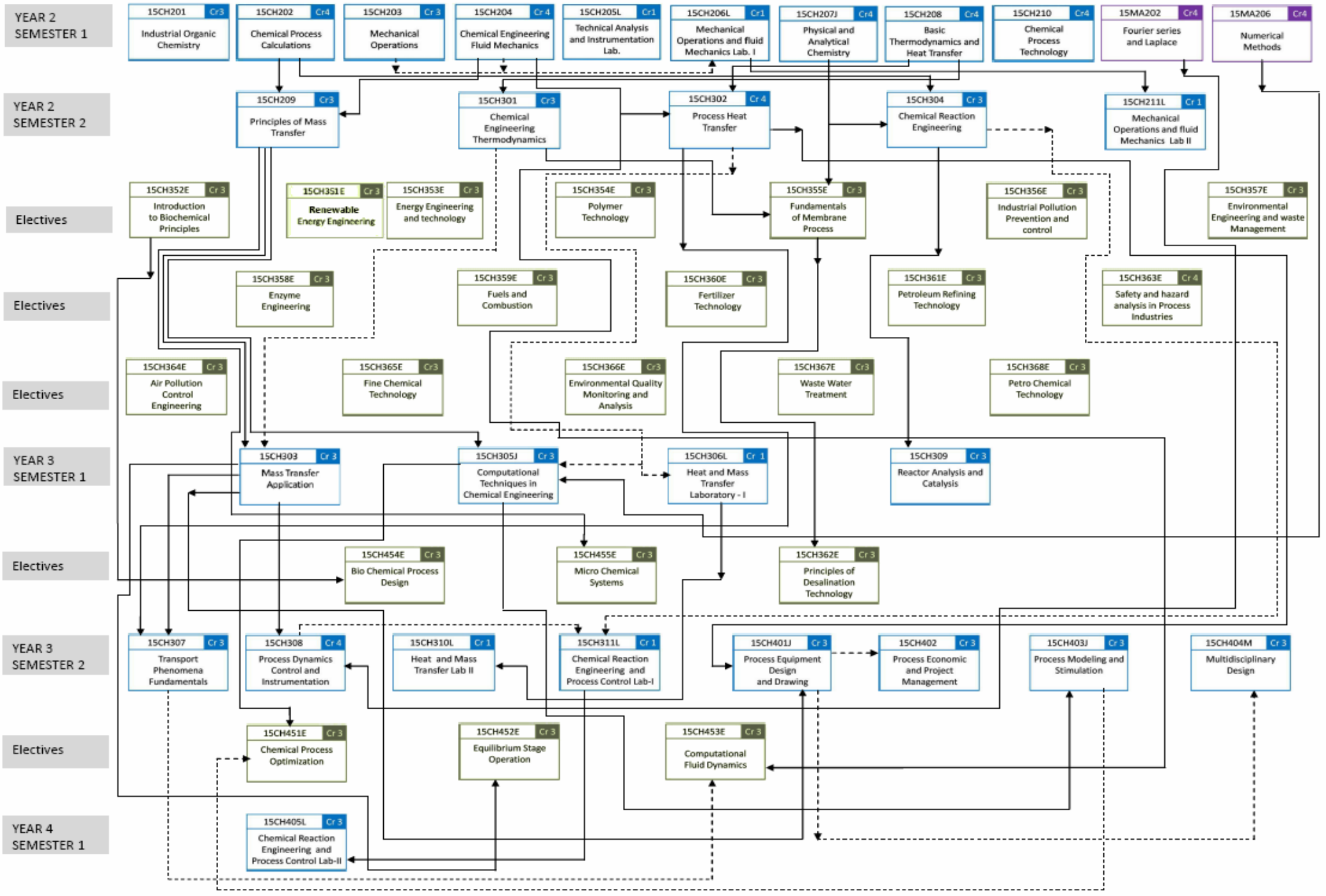
B.Tech Chemical Engineering (Regulations 2015)						
COURSES OFFERED TO OTHER DEPARTMENTS						
Course Code	**Course Title**	**L**	**T**	**P**	**C**	**Offered to**
15CH251	Basic Chemical Engineering	3	0	0	3	Biotechnology
15CH252	Chemical Engineering Principles - I	3	0	0	3	
15CH253	Chemical Engineering Principles - II	3	0	0	3	
15CH254L	Chemical Engineering Practice Laboratory - I	0	0	2	1	
15CH255L	Chemical Engineering Practice Laboratory - II	0	0	2	1	

LIST OF PRE-REQUISITES AND CO-REQUISITES

PROFESSIONAL - CORE					
Course Code	Course title	PRE-REQ 1	PRE-REQ 2	CO-REQ 1	CO-REQ 2
15CH206L	MECHANICAL OPERATIONS AND FLUID MECHANICS LABORATORY - I			15CH203	15CH204
15CH209	PRINCIPLES OF MASS TRANSFER	15CH202	15CH204		
15CH211L	MECHANICAL OPERATIONS AND FLUID MECHANICS LABORATORY - II	15CH206L			
15CH301	CHEMICAL ENGINEERING THERMODYNAMICS	15CH208			
15CH302	PROCESS HEAT TRANSFER	15CH204	15CH208		
15CH303	MASS TRANSFER APPLICATIONS	15CH209		15CH301	
15CH304	CHEMICAL REACTION ENGINEERING	15CH202	15CH207J		
15CH305J	COMPUTATIONAL TECHNIQUES IN CHEMICAL ENGINEERING	15MA206	15CH209	15CH302	
15CH306L	HEAT AND MASS TRANSFER LABORATORY - I			15CH302	15CH303
15CH307	TRANSPORT PHENOMENA FUNDAMENTALS	15CH302	15CH303		
15CH308	PROCESS DYNAMICS, CONTROL AND INSTRUMENTATION	15MA202	15CH303		
15CH309	REACTOR ANALYSIS AND CATALYSIS	15CH304			
15CH310L	HEAT AND MASS TRANSFER LABORATORY - II	15CH306L			
15CH311L	CHEMICAL REACTION ENGINEERING AND PROCESS CONTROL LABORATORY - I			15CH304	15CH308
15CH401J	PROCESS EQUIPMENT DESIGN AND DRAWING	15CH302	15CH303		
15CH402	PROCESS ECONOMICS AND PROJECT MANAGEMENT			15CH401J	
15CH403J	PROCESS MODELING AND SIMULATION	15CH305J			
15CH404M	MULTI DISCIPLINARY DESIGN			15CH401J	
15CH405L	CHEMICAL REACTION ENGINEERING AND PROCESS CONTROL LABORATORY - II	15CH311L			

LIST OF PROFESSIONAL ELECTIVES					
Course Code	Course title	PRE-REQ 1	PRE-REQ 2	CO-REQ 1	CO-REQ 2
15CH355E	FUNDAMENTALS OF MEMBRANE PROCESSES	15CH207J	15CH301		
15CH362E	PRINCIPLES OF DESALINATION TECHNOLOGIES	15CH355E			
15CH451E	CHEMICAL PROCESS OPTIMIZATION	15CH305J		15CH403J	
15CH452E	EQUILIBRIUM STAGE OPERATIONS	15CH303			
15CH453E	COMPUTATIONAL FLUID DYNAMICS			15CH307	
15CH454E	BIOCHEMICAL PROCESS DESIGN	15CH352E			
15CH455E	MICROCHEMICAL SYSTEMS	15CH209			

Courses offered to Biotechnology					
Course Code	Course title	PRE-REQ 1	PRE-REQ 2	CO-REQ 1	CO-REQ 2
15CH252	CHEMICAL ENGINEERING PRINCIPLES - I	15CH251			
15CH253	CHEMICAL ENGINEERING PRINCIPLES - II	15CH251			
15CH254L	CHEMICAL ENGINEERING PRACTICE LAB - I			15CH252	
15CH255L	CHEMICAL ENGINEERING PRACTICE LAB - II			15CH253	


YEAR 2 SEMESTER 1
15CH201 Cr3 Industrial Organic Chemistry
15CH202 Cr4 Chemical Process Calculations
15CH203 Cr 3 Mechanical Operations
15CH204 Cr 4 Chemical Engineering Fluid Mechanics
15CH205L Cr1 Technical Analysis and Instrumentation Lab.
15CH206L Cr1 Mechanical Operations and fluid Mechanics Lab. I
15CH207J Cr4 Physical and Analytical Chemistry
15CH208 Cr4 Basic Thermodynamics and Heat Transfer
15CH210 Cr4 Chemical Process Technology
15MA202 Cr4 Fourier series and Laplace
15MA206 Cr4 Numerical Methods
YEAR 2 SEMESTER 2
15CH209 Cr3 Principles of Mass Transfer
15CH301 Cr3 Chemical Engineering Thermodynamics
15CH302 Cr 4 Process Heat Transfer
15CH304 Cr 3 Chemical Reaction Engineering
15CH211L Cr 1 Mechanical Operations and fluid Mechanics Lab II
Electives
15CH352E Cr 3 Introduction to Biochemical Principles
15CH351E Cr 3 Renewable Energy Engineering
15CH353E Cr 3 Energy Engineering and technology
15CH354E Cr 3 Polymer Technology
15CH355E Cr 3 Fundamentals of Membrane Process
15CH356E Cr 3 Industrial Pollution Prevention and control
15CH357E Cr 3 Environmental Engineering and waste Management
Electives
15CH358E Cr 3 Enzyme Engineering
15CH359E Cr 3 Fuels and Combustion
15CH360E Cr 3 Fertilizer Technology
15CH361E Cr 3 Petroleum Refining Technology
15CH363E Cr 4 Safety and hazard analysis in Process Industries
Electives
15CH364E Cr 3 Air Pollution Control Engineering
15CH365E Cr3 Fine Chemical Technology
15CH366E Cr3 Environmental Quality Monitoring and Analysis
15CH367E Cr3 Waste Water Treatment
15CH368E Cr 3 Petro Chemical Technology
YEAR 3 SEMESTER 1
15CH303 Cr 3 Mass Transfer Application
15CH305J Cr 3 Computational Techniques in Chemical Engineering
15CH306L Cr 1 Heat and Mass Transfer Laboratory - I
15CH309 Cr 3 Reactor Analysis and Catalysis
Electives
15CH454E Cr 3 Bio Chemical Process Design
15CH455E Cr 3 Micro Chemical Systems
15CH362E Cr 3 Principles of Desalination Technology
YEAR 3 SEMESTER 2
15CH307 Cr 3 Transport Phenomena Fundamentals
15CH308 Cr 4 Process Dynamics Control and Instrumentation
15CH310L Cr 1 Heat and Mass Transfer Lab II
15CH311L Cr 1 Chemical Reaction Engineering and Process Control Lab-I
15CH401J Cr 3 Process Equipment Design and Drawing
15CH402 Cr 3 Process Economic and Project Management
15CH403J Cr 3 Process Modeling and Stimulation
15CH404M Cr 3 Multidisciplinary Design
Electives
15CH451E Cr 3 Chemical Process Optimization
15CH452E Cr 3 Equilibrium Stage Operation
15CH453E Cr 3 Computational Fluid Dynamics
YEAR 4 SEMESTER 1
15CH405L Cr 3 Chemical Reaction Engineering and Process Control Lab-II

15CH201	INDUSTRIAL ORGANIC CHEMISTRY	L	T	P	C
		3	0	0	3
Co-requisite:	NIL				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	P PROFESSIONAL CORE				
Course designed by	Department of Chemical Engineering				
Approval	32nd Academic Council Meeting 23rd July 2016				

PURPOSE	To acquire basic knowledge of the chemistry of important organic compounds that will provide the basis for their industrial production methods							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student would be able to								
1.	Organometallic Compounds: Understand the significance of these compounds and devise reactions for synthesis of various organic compounds	a						
2.	Understand the structure, classification and chemistry of an important class of organic compounds which find application in chemical processing industries: food, oils, fats and waxes	a						
3.	Understand the structure, classification and chemistry of an important class of organic compounds which find application in chemical processing industries: dyes and heterocyclic compounds used in pharmaceutical industries.	a						

Session	Description	Contact hours	C-D-I-O	IOs	Reference
UNIT I: REACTIONS AND REAGENTS		**9**			
1.	Organometallic compounds – Introduction, Nature and Properties	1	C	1	1
2.	Grignard reagents: Synthesis, Properties and Structure	2	C	1	1
3.	Nucleophilic Substitution and Addition Reactions	3	C	1	1
4.	Reactive Methylene Compounds: Acetoacetic Acid Ester and Malonic Acid Ester	3	C	1	1
UNIT II: CARBOHYDRATES		**9**			
5.	Carbohydrates I: Introduction, Classification, Monosaccharides Oligosaccharides, D and L notation, Configuration of Aldoses and Ketoses, Epimers, Fisher Projection, Haworth Projection of Monosaccharides, Anomers	3	C	2	1
6.	Carbohydrates II: Reactions - Alkylation, Acylation, Glycosides Anomeric Effect, Mutarotation, Ring Size Determination, Reducing and Non-Reducing Sugars, Types of Glycosidic linkages Polysaccharides: Starch and Cellulose	3	C	2	1
7.	Carbohydrates III: Reactions - Epimerization, Ene-diol Rearrangement, Reduction, Oxidation, Osazone Formation, Ruff's degradation, Killiani Fisher Synthesis	3	C	2	1
UNIT III: AMINO ACIDS, PEPTIDES AND PROTEINS		**9**			
8.	Introduction to Amino Acids, Peptides and Proteins Classification of Amino Acids: Proteogenic Alpha-Amino Acid Structure, Beta-Amino Acids etc. Acid-Base Properties: Zwitterionic Properties, Isoelectric Point, Separations: Electrophoresis, Ion-Exchange Chromatography, Reactions: Amino and Carboxylic Acid Groups Synthesis of Alpha- Amino Acids: Methods	6	C	2	1
9.	Peptides: Peptide Bond Structural of Peptides: Classification based on Primary, Secondary etc, Planarity of Peptide Bond Peptide Sequencing: Sanger, Edman, C-terminus Enzyme	2	C	2	1

	Based				
10.	Proteins: Structure-Property Relationship: Fibrous and Globular Peptides etc. Synthesis of Peptides and Proteins: Protection of Groups, Merrifield Solid-Phase Synthesis Method Denaturation of Proteins	1	C	2	1
UNIT IV: OILS, FATS, WAXES AND DYES		**9**			
11.	Introduction to Lipids Fatty Acids, Saturated and Unsaturated Fatty Acids, Cis and Trans Unsaturated Fatty Acids Waxes: Introduction	1	C	2	1
12.	Soaps, Detergents and Micelles Occurrence and Extraction of Oils, Fats and Waxes Physical and Chemical Reactions of Oils, Fats and Waxes Analysis of Oils, Fats and Waxes Uses of Oils, Fats and Waxes	2	C	2	1
13.	Dyes: Color Sensation Color and Chemical Constitution: Chromophore- Auxochrome Theory etc.	2	C	2	1
14.	Nomenclature, Classification and Synthesis of Dyes	4	C	2	1
UNIT V: HETEROCYCLIC COMPOUNDS AND PHARMACEUTICAL CHEMISTRY		**9**			
15.	Heterocyclic Compounds: Introduction and Nomenclature Structure-Activity and nomenclature: Definition of Heteroatom and Heterocyclic Compound	2	C	2	1
16.	Classification, Preparation and Properties of Heterocyclic compounds: Five member – Furan, Thiophene and Pyrolle Six member – Pyridine, Pyrimidine Fused Heterocyclic Compounds – Indole, Quinoline	5	C	2	1
17.	Synthesis of Antimalarial Drugs (Quinine, Primaquine, Chloroquine) and Antibacterial Drugs (Sulfanilamide, Sulphapyridine)	2	C	2	1
	Total contact hours	**45**			

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	Tewari K.S., Vishnoi N.K., A Text Book of Organic Chemistry, Vikas Publishing House Pvt. Ltd., New Delhi, 3rd Edition, 2006, ISBN-13: 9788125918578
	REFERENCE BOOKS/OTHER READING MATERIAL
2.	Morrison R.T., and Boyd R, "Organic Chemistry" 7thEdn., Pearson Education, 2010, ISBN-13: 9788131704813

Course nature				**Theory**			
Assessment Method – Theory Component (Weightage 50%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
					End semester examination Weightage :		**50%**

15CH202	CHEMICAL PROCESS CALCULATIONS	L	T	P	C
		4	0	0	4
Co-requisite:	NIL				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	P PROFESSIONAL CORE				
Course designed by	Department of Chemical Engineering				
Approval	32nd Academic Council Meeting 23rd July 2016				

PURPOSE	Preparing the students to formulate and solve material and energy balances for chemical process systems.

INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, the learner should be able to formulate and evaluate:								
1	Composition of mixtures	a	e					
2	Basic principles of stoichiometry and material balance	a	e	k				
3	Material balance with and without reactions	a	e	k				
4	Energy balance calculations	a	e	k				
5	Combined material and energy balance for simple process flow sheets	a	e	k				

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
UNIT I: BASIC CONCEPTS AND COMPOSITION OF MIXTURES		**12**			
1.	Units and dimensions	1	C	1	1
2.	Temperature, Pressure and concept of mole	2	C, D	1	1
3.	Predicting PVT properties of gases using ideal gas equation	2	C, D	1	1
4.	Composition of mixtures, Basis of calculations.	1	C	1	1
5.	Composition of gases based on mole, mass, volume and partial pressure Density of gas mixtures	2	C, D	1	1
6.	Solutions and their concentrations	2	C, D	1	1
7.	Problems	2	D	1	1
UNIT II: MATERIAL BALANCE FOR NON REACTIVE SYSTEMS		**13**			
8.	Basic concepts involved in material balance calculations	1	C	2, 3	1,2
9.	Material balance problems without chemical reactions: mixing	1	C	2, 3	1,2
10	Drying, crystallization	2	C,D	2, 3	1,2
11.	Material balance problems on membrane separation	1	C,D	2, 3	1,2
12.	Distillation and extraction.	2	C,D	2, 3	
13.	Partial saturation and humidity, types of humidity	1	C,D	2, 3	1,2
14.	Material balances involved in two-phase gas-liquid systems as in humidification and dehumidification.	2	C,D	2, 3	1,2
15.	Problems	3	D	2, 3	1,2
UNIT III: MATERIAL BALANCE FOR REACTIVE SYSTEMS		**13**			
16.	Chemical equation and stoichiometry	1	C	2, 3	1,2
17.	Limiting reactant, excess reactant, conversion, selectivity, yield	2	C,D	2, 3	1,2
18.	Material balances for processes with reactions.	3	C,D	2, 3	1,2
19.	Combustion as special case of material balance with reactions.	1	C	2, 3	1,2
20.	Fuels, types of fuel, flue gas, Orsat analysis, theoretical air, excess air	1	C	2, 3	1,2
21.	Analysis of products of combustion, calculation of excess air	2	C,D	2, 3	1,2
22.	Problems	3	D	2, 3	1,2
UNIT IV: ENERGY BALANCE		**11**			
23.	Thermo physics: Heat capacity, Kopp's rule	1	C	4	1,2

24.	Sensible heat, latent heat and enthalpy	1	C	4	1,2
25.	Energy balance for non-reactive systems	2	C,D	4	1,2
26.	Thermo chemistry: Standard Heat of formation, standard heat of combustion, Hess law	2	C	4	1,2
27.	Heat of reaction from heat of formation or combustion	2	C,D	4	1,2
28.	Enthalpy changes in reactions with different temperatures	2	C,D	4	1,2
29.	Theoretical flame temperature.	1	C,D	4	
UNIT V: MATERIAL BALANCE FOR MULTI UNIT SYSTEMS		**11**			
30.	Introduction to material balance for sequential processes.	1	C	5	1,2
31.	Basic concepts of recycle, bypass and purge streams.	1	C	5	1,2
32.	Material balances for systems with recycle stream.	3	C,D	5	1,2
33.	Material balances for non-reactive systems with bypass and purge stream.	2	C,D	5	1,2
34.	Material and energy balance analysis for multi-unit processes - Case studies with simple process flow sheets	4	D,I	5	1,2
	Total contact hours	**60**			

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	David M. Himmelblau, James B. Riggs "Basic Principles and Calculations in Chemical Engineering", 8thEdn., Pearson - Prentice Hall International
2.	B. I. Bhatt and S. B Thakore., "Stoichiometry", 5thEdn., Tata McGraw-Hill Publishing Company, New Delhi
3.	B. Lakshmikutty, K. V. Narayanan, "Stoichiometry and Process Calculations", PHI Publishers, Delhi
REFERENCE BOOKS/OTHER READING MATERIAL	
4.	Richard M. Felder, Ronald W. Rousseau, "Elementary Principles of Chemical Processes", 3rd Edition, John Wiley & Sons, Inc.

Course nature				**Theory**			
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
End semester examination Weightage:							**50%**

15CH203	MECHANICAL OPERATIONS	L	T	P	C
		3	0	0	3
Co-requisite:	NIL				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	P PROFESSIONAL CORE				
Course designed by	Department of Chemical Engineering				
Approval	32nd Academic Council Meeting 23rd July 2016				

PURPOSE	To impart knowledge on solid properties, handling, modification and separation of Solid-liquid.							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1	Learn characterization, handling, storage of solids and Screening	a	b					
2	Equip themselves familiar with principles of size reduction and size reduction equipments.	a	b					
3	Familiarize with the methods of separations based on motion of a particle through fluids.	a	b					
4	Equip themselves familiarize with filtration operations and industrial filters	a	b					
5	Expose to the concept of agitation and mixing	a	b					

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
UNIT I: CHARACTERIZATION AND HANDLING OF PARTICULATE SOLIDS		**9**			
1.	Characterization of solid particles, particle shape, particle size	1	C	1	1
2.	Mixed particle sizes and size analysis	1	C	1	1
3.	Specific surface of mixture, average particle size	1	C	1	1
4.	Screen analysis: standard screen series. Size measurements with fine particles.	2	C	1	1
5.	Screening, screening equipment: stationary screens and grizzlies, gyrating screens, vibrating screens, comparison of ideal and actual screens	1	C	1	1
6.	Balances over screen, screen effectiveness, capacity and effectiveness of screens	2	C	1	1
7.	Storage and Conveying of solids - Bunkers, silos, bins and hoppers, transportation of solids in bulk, conveyer selection, Belt conveyer, screw conveyer, bucket conveyer, pneumatic conveyer.	1	C	1	2,3
UNIT II: COMMINUTION OF SOLIDS (SIZE REDUCTION)		**9**			
8.	Purpose and Principles of comminution, energy and power requirements in comminution, crushing efficiency	1	C	2	1,2
9.	Empirical relationships: Rittinger's and Kick's laws. Bond crushing law and work index.	2	C,D	2	1,2
10.	Types of size reduction equipments, Crushers: jaw crushers, gyratory crushers	2	C	2	1,2
11.	Grinders: hammer mills and impactors, tumbling mills, action in tumbling mills.	2	C	2	1,2
12.	Ultrafine grinders: fluid energy mills. Cutting machines: knife cutters.	1	C	2	1,2
13.	Open-circuit and closed-circuit operation	1	C	2	1,2
UNIT III: SEPARATIONS BASED ON MOTION OF A PARTICLE THROUGH FLUIDS		**9**			
14.	Motion of particles in fluid, free settling, hindered settling, terminal settling velocity, settling under Stoke's law regime and Newton's law regime	2	C,D	3	1,3

15.	Gravity settling processes, gravity classifiers, sorting classifiers: sink-and-float methods, differential settling methods.	2	C	3	1,3
16.	Clarifiers and thickeners, flocculation, batch sedimentation, rate of sedimentation.	1	C	3	1,3
17.	Equipment for sedimentation: thickeners. Sedimentation zones in continuous thickeners. Clarifier and thickener design	2	C,D	3	1,3
18.	Centrifugal sedimentation,Froth Flotation	1	C	3	1,3
19.	Cyclones, hydrocyclones, centrifugal decanters.	1	C	3	1,3
UNIT IV: FILTRATION		**9**			
20.	Theory of filtration, Batch and continuous filters	1	C	4	1,2,3
21.	Filter media, filter aid, principles of cake filtration, pressure drop through filter cake	1	C	4	1,2,3
22.	Compressible and incompressible filter cakes, filter-medium resistance, Constant pressure filtration, constant rate filtration	2	C,D	4	1,2,3
23.	Continuous filtration	1	C,D	4	1,2,3
24.	Filtration equipments, principle and working of filter press, Vacuum leaf filter	1	C	4	1,2,3
25.	Continuous vacuum filter: principle and working of rotary drum filters	1	C	4	1,2,3
26.	Centrifugal filter: principle and working of suspended batch centrifuges	1	C	4	1,2,3
27.	Working principle of centrifugal filters.	1	C	4	1,2,3
UNIT V: AGITATION AND MIXING		**9**			
28.	Principles of agitation, agitation equipment	1	C	5	1
29.	Flow patterns, prevention of swirling, draft tubes	1	C	5	1
30.	Standard turbine design, power consumption	1	C,D	5	1
31.	Dimensional analysis: Buckingham's π theorem, power correlation, significance of dimensionless groups, effect of system geometry	2	C,D	5	1,3
32.	Calculation of power consumption in Newtonian liquids.	2	D	5	1
33.	Blending and mixing: blending of miscible liquids, blending in process vessels	1	C	5	1,2
34.	Mixing of liquids, mixing of solids, mixing of solids with liquids, selection of suitable mixers	1	C	5	1,2
	Total contact hours	**45**			

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1	McCabe, W.L., Smith, J.C., and Harriot, P., "Unit Operations in Chemical Engineering",7th Edition, McGraw-Hill, 2005.
2	Badger W.L. and Banchero J.T., "Introduction to Chemical Engineering", Tata McGraw Hill, 1997.
	REFERENCE BOOKS/OTHER READING MATERIAL
3	Foust, A. S., Wenzel, L.A., Clump, C.W., Naus, L., and Anderson, L.B., "Principles of Unit Operations", 2nd Edition, John Wiley & Sons, 2008.
4	Coulson. J.M, Richardson. J.F, Backhurst.. J.R. and Harker. J.M, "Coulson & Richardson's Chemical Engineering", Vol. II, 5th Edition, Butter worth Heinemann, Oxford, 2002.
5	Swain. A, Patra H, Roy. G K, "Mechanical Operations", Tata McGraw Hill, 2010.

Course nature				**Theory**			
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
					End semester examination Weightage :		**50%**

15CH204	CHEMICAL ENGINEERING FLUID MECHANICS	L	T	P	C
		4	0	0	4
Co-requisite:	NIL				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	P PROFESSIONAL CORE				
Course designed by	Department of Chemical Engineering				
Approval	32nd Academic Council Meeting 23rd July 2016				

PURPOSE	This course deals with behavior of fluids							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1	Nature of fluids andfluid flow phenomena	a	b					
2	Kinematics of flow	a	b					
3	Flow past immersed bodies	a	b					
4	Transportation of fluids	b	c					
5	The metering of fluids	c						

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
UNIT I: FLUID FLOW PHENOMENA		**12**			
1	Nature of fluids: incompressible and compressible, properties, hydrostatic equilibrium	2	C	1	1
2	Manometers, types of manometers	2	C,D	1	1,2
3	Potential flow, boundary layer, the velocity field, laminar flow	2	C	1	1
4	Newtonian and non-Newtonian fluids, Newton's-law of viscosity, turbulence, Reynolds number	2	C	1	1
5	Eddy viscosity, flow in boundary layers, laminar and turbulent flow in boundary layersrate equation.	2	C	1	1
6	Boundary-layer formation in straight tubes	2	C	1	1
UNIT II: KINEMATICS OF FLOW		**12**			
7	Streamlines and stream tubes	1	C	2	1
8	Bernoulli equation, pump work in Bernoulli equation.	2	C,D	2	1,2
9	Flow of incompressible fluids in conduits and thin layers	2	C	2	1
10	Friction factor, relationships between skin-friction parameters	2	C,D	1,2	1
11	Hagen-Poiseuille equation, hydraulically smooth pipe, von Karman equation, roughness parameter	3	C,D	1,2	1,2
12	Equivalent diameter, form friction losses in Bernoulli equation, couette flow.	2	C	1,2	1
UNIT III FLOW PAST IMMERSED BODIES		**12**			
13	Drag, drag coefficients, drag coefficients of typical shapes	2	C	2,3	1
14	Ergun equation	2	C,D	2,3	1
15	Terminal settling velocity, free and hindered settlings	2	C	2,3	1
16	Stokes' law, Newton's law, criterion for settling regime	2	C,D	2,3	1
17	Fluidization, and its types	2	C	3	1
18	Conditions for fluidization, minimum fluidization velocity	2	C,D	3	1
UNIT IV: TRANSPORTATION OF FLUIDS		**12**			
19	Introduction to: pipe and tubing, joint and fittings, stuffing boxes, mechanical seals	2	C,D	4	1,2
20	Gate valves and globe valves, plug cocks and ball valves, check valves.	2	C,D	4	1,2
21	Classification and selection of pumps, blowers and compressors.	2	C,D	2,4	1,2
22	Pumps: developed head, power requirement, suction lift	2	C	4	1

	and cavitation, NPSH				
23	Constructional features and working principle of single suction volute centrifugal pump	1	C,D	4	1
24	Constructional features and working principle of reciprocating pump	1	C,D	2,4	1,2
25	Characteristic curves of a centrifugal pump, comparison of devices for moving fluids, constructional features and working principle of jet ejectors	2	C,D	2,4	1,2
UNIT V: METERING OF FLUIDS		**12**			
26	Constructional features and working principles of venturi meter	2	C	5	1,2
27	Constructional features and working principles of orificemeter	2	C	5	1,2
28	Rotameters, pitot tube, target meters	2	C,D	2,5	1,2
29	Vortex-shedding meter, turbine meter, magnetic meters.	2	C,D	2,5	1,2
30	Application of Bernouli equation to venturi meter and orifice meter, flow rate calculations from the readings of venture meter, orifice meter and pitot tube	4	C,D	2,5	1,3
		60			

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1	McCabe, W.L., Smith, J.C., and Harriot, P., "Unit Operations in Chemical Engineering", 7th Edition, McGraw-Hill, 2005.
REFERENCE BOOKS/OTHER READING MATERIAL	
2	Coulson J.M., Richardson J.F., Backhurst J.R. and Harker J.M., "Coulson & Richardson's Chemical Engineering", Vol. I, 6th Edn., Butter worth Heinemann, Oxford, 1999.
3	Noel deNevers, "Fluid Mechanics for Chemical Engineers", 2nd Edn., McGraw Hill International Editions, 1991.
4	Fluid Mechanics, By Frank M. White, McGraw-Hill, 2003

Course nature				**Theory**			
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
End semester examination Weightage :							**50%**

15CH205L	TECHNICAL ANALYSIS AND INSTRUMENTATION LABORATORY	L	T	P	C
		0	0	2	1
Co-requisite:	NIL				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	P Professional Core				
Course designed by	Department of Chemical Engineering				
Approval	32nd Academic Council Meeting 23rd July 2016				

PURPOSE	To provide an adequate mastery of analytical methods used for the determination of industrial raw materials and finished product quality.							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to impact practical training on the analysis of								
1	Fine chemicals	b						
2	Environment samples	b						
3	Drugs and	b						
4	Quality assay of commercial products	b						

Sl. No.	Description of experiments	Contact hours	C-D-I-O	IOs	Reference
	Analysis of				
1	Oils and soap	3	I,O	4	1
2	Sugar	3	I,O	4	1
3	Fertilizer	3	I,O	4	1
4	Alloys	3	I,O	1	1
5	Ores	3	I,O	2	1
6	Drugs	3	I,O	1	1
7	Water	3	I,O	2	1
	Analysis of products with				
8	UV-Visible spectrophotometer, pH meter, Turbidity meter Turbidity	3	I,O	1-4	1
9	Flame photometer	3	I,O	1-4	1
10	Atomic absorption spectrophotometer	3	I,O	1-4	1
11	Gas chromatography	3	I,O	1-4	1
12	Multiple water analytical kit	3	I,O	1-4	1
	Total contact hours	**36**			

LEARNING RESOURCES	
Sl. No.	**REFERENCES**
1	Laboratory Manual

Course nature				**Practical**		
Assessment Method (Weightage 100%)						
In-semester	**Assessment tool**	Experiments	Record	MCQ/Quiz/Viva Voce	Model examination	**Total**
	Weightage	**40%**	**5%**	**5%**	**10%**	**60%**
				End semester examination Weightage :		**40%**

15CH206L	MECHANICAL OPERATIONS AND FLUID MECHANICS LABORATORY - I	L	T	P	C
		0	0	2	1
Co-requisite:	15CH203, 15CH204				
Prerequisite:	Nil				
Data Book / Codes/Standards	NIL				
Course Category	P Professional Core				
Course designed by	Department of Chemical Engineering				
Approval	32nd Academic Council Meeting 23rd July 2016				

PURPOSE	To develop skills in designing and conducting experiments related to applications of principles of mechanical operations							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1	Develop a sound working knowledge on size analysis, different types of crushing equipments	b						
2	Equip themselves familiar with design of thickeners	b						
3	Learn the practical knowledge on momentum losses in pipes, fittings and flow measurement using Orifice meter, Venturimeter, Rotameter	b						
4	Equip themselves familiar with Rotary drum filter	b						
5	Learn about the calculation of efflux time	b						

Sl. No.	Description of experiments	Contact hours	C-D-I-O	IOs	Reference
1.	Sieve analysis	3	I.O	1	1
2.	Screen effectiveness	3	I,O	1	1
3.	Size reduction ratio in Jaw Crusher	3	I,O	1	1
4.	Size reduction ratio in Ball mill	3	I,O	1	1
5.	Size reduction ratio and power consumption in Hammer mill	3	I,O	1	1
6.	Characteristics of batch Sedimentation	3	I,O	2	1,2
7.	Flow through pipes and fittings	3	I,O	3	1
8.	Flow measurement using orifice meter	3	I,O	3	1
9.	Flow measurement using venturi meter	3	I,O	3	1
10.	Flow measurement using Rota meter	3	I,O	3	1
11.	Efflux time	3	I,O	5	1
12.	Rotary drum filter	3	I,O	4	1,2
	Total contact hours	**36**			

LEARNING RESOURCES	
Sl. No.	**REFERENCES**
1	Laboratory Manual
2	McCabe, W.L., Smith, J.C., and Harriot, P., "Unit Operations in Chemical Engineering",7th Edition, McGraw-Hill, 2005.

Course nature			**Practical**			
Assessment Method (Weightage 100%)						
In-semester	**Assessment tool**	Experiments	Record	MCQ/Quiz/Viva Voce	Model examination	**Total**
	Weightage	**40%**	**5%**	**5%**	**10%**	**60%**
				End semester examination Weightage :		**40%**

15CH207J	PHYSICAL AND ANALYTICAL CHEMISTRY	L	T	P	C
		3	0	2	4
Co-requisite:	NIL				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	P Professional Core				
Course designed by	Department of Chemical Engineering				
Approval	32nd Academic Council Meeting 23rd July 2016				
PURPOSE	To acquire basic knowledge of chemical principles which form the foundation for understanding separation operations. Also, provides the basic information of the analytical tools which by itself is an indicator of separation methods.				

INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student would be able to								
1	Understand the physical and physico-chemical principles behind the behavior of fluids. Realize the situations where systems behave ideally – recognize the non -ideality and the reasons for such behavior.	a	b					
2	Estimation of properties useful for design of separation units.	e						
3	Realise the difference in behavior of different states of matter essential for separation operations.	c						
4	Know the principals of analytical instruments along with their limitations.	c						
5	Linkage of theory and practice in physical chemistry.	e						

Session	Description of Topic (Theory)	Contact hours	C-D-I-O	IOs	Reference
UNIT I: GASEOUS STATE		**9**			
1	Ideal - non ideal gases, mean free path, Knudsen flow, root mean-square-velocity - expansion & compressibility – collision number – diameter-frequency – mean free path – Knudsen gas	2	C	1-4	1-2
2	Transport properties – general equations – expressions for thermal conductivity, viscosity and collision number (derivation not required) – deviation of real gases from ideal state- equation of state for real gases – intermolecular forces dipole-dipole, induced dipole-induced dipole – Lennard-Jones potential.	3	C	1	1-2
3	Critical phenomenon – critical pressure, volume and temperature - PV diagram of CO_2 – law and principle of corresponding states- JT effect - liquefaction of gases.	3	C	1	1-2
4	Recap – linkage of various concepts and their relevance to unit operations.	1	C	1	1-2
UNIT II: LIQUID STATE		**9**			
5	Liquid state: Vapor pressure – surface tension – viscosity – solutions of non electrolytes - Raoult's law, ideal and non-ideal solutions, vapor pressure and boiling point diagrams of completely miscible binary solutions - completely immiscible liquids: steam distillation and its application.	3	C	2	1-2
6	Solubility of partially miscible liquids - upper and lower critical solution temperature, solubility of gases in liquids: factors affecting solubility, Henry's law.	3	C	2	1-2
7	Colligative Properties, concepts of vapor pressure lowering, osmosis and osmotic pressure, boiling point elevation, freezing point depression - determination of molecular weight from colligative properties - reverse osmosis - effect of association/dissociation on colligative properties	3	C	2	1-2

UNIT III: CHEMICAL EQUILIBRIUM AND PHASE RULE		**9**			
8	Chemical kinetics: order/molecularity of a reaction, reaction rate, integrated equations of rate laws for zeroth to n^{th} order, half time for all orders	3	C	4	1-2
9	Chemical Equilibrium: Free energy – law of mass action – derivation – law of Chemical equilibrium – meaning and relationship between K_p, K_c&, $K_{x,}$(derivations not required) - temperature dependence of Equilibrium constant - Van't Hoff Equation – pressure dependence of equilibrium constants – Le Chatelier's Principle and physical equilibria	3	C	4	1-2
10	Phase Equilibria : Definition of component, phase and degrees of freedom, derivation of phase rule, one component system (water and CO_2), triangular phase diagram - three component system (acetic acid, chloroform and water; two salts and water)	3	C,D, I,O	4	1-2
UNIT IV: SURFACE PHENOMENON AND PHOTOCHEMISTRY		**9**			
11	Introduction and properties of colloidal systems, gels and emulsions (no preparation) – electrical & electro-kinetic properties – concept of zeta potential – mobility of colloids -electrophoresis and electro-osmosis reaction	3	D,I	4	1-2
12	Sorption by solids – adsorption and chemi-sorption – applications of adsorption- factors influencing adsorption – effect of temperature and pressure – Freundlich, Langmuir and BET isotherms - distinguishing features – Determination of surface area types of adsorption isotherms	3	C	4	1-2
13	Laws of photochemistry, quantum efficiency, actinometry, photochemical reactions, photochemical rate law - determination of quantum yields - kinetics of hydrogen-chlorine reaction - primary and secondary processes – comparison with hydrogen-bromide	3	C	4	1-2
UNIT V: INSTRUMENTAL METHODSOF ANALYSIS:		**9**			
14	Terms associated with analytical techniques – accuracy/precision- common errors (system/manual) – calibration curves - basics of classification of instrumental methods - spectroscopy, electrochemical and chromatography, advantages and limitations of instrumental analysis - electro-magnetic (EM) spectrum – interaction of EM radiation with matter – laws of absorption – Generalities of optical methods (light source/ monochromator / sample introduction / detector / signal generator) - selection of techniques for quantitative/qualitative analysis	3	C	4	1-2
15	UV –Vis spectroscopy- instrumentation – measurements - applications - instrumentation and applications of IR spectroscopy - instrumentation and applications of emission and atomic absorption spectrophotometers	2	C	4	1-2
16	Gas Chromatography- types (GS and GL) - principles of gas chromatographic separations - description of instrument, role of components and working philosophy – examples for qualitative and quantitative analysis- advantages and limitations - principles of HPLC – instrument description – applications	3	C	4	1-2
17	Criteria for selection of techniques for quantitative/qualitative analysis	1	C	4	1-2
	Total contact hours	**45**			

Sl. No.	Description of experiments	Contact hours	C-D-I-O	IOs	Reference
1.	Conductometric Titration	3	C,D,I,O	1-4	1-2
2.	pH titration – end point detection	3	C,D,I,O	1	1-2
3.	CST determination for phenol water system	3	C,D,I,O	1	1-2
4.	Steam Distillation	3	C,D,I,O	1-4	1-2
5.	Adsorption studies – determination maximum adsorption capacity	3	C,D,I,O	1-4	1-2
6.	Adsorption – column studies – determination of break through	3	C,D,I,O	1-4	1-2
7.	Alkaline hydrolysis	3	C,D,I,O	1-4	1-2
8.	Acid Hydrolysis	3	C,D,I,O	1-4	1-2
	Total Contact Hours	**24**			

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1	Puri, Sharma and Pathania, Principles of Physical Chemistry, Vishal Publishing Co., 47th Ed, 2015, ISBN-13: 978-9382956785
	REFERENCE BOOKS/OTHER READING MATERIAL
2	Frank R. Foulkes, Physical Chemistry for Engineering and Applied Sciences, 2012, CRC Press, ISBN 9781466518469

Course nature		**Theory + Practical**					
Assessment Method – Theory Component (Weightage 50%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
						End semester examination Weightage :	**50%**
Assessment Method – Practical Component (Weightage 50%)							
In-semester	**Assessment tool**	Experiments	Record	MCQ/Quiz/Viva Voce	Model examination		**Total**
	Weightage	**40%**	**5%**	**5%**	**10%**		**60%**
						End semester examination Weightage :	**40%**

15CH208	BASIC THERMODYNAMICS AND HEAT TRANSFER	L	T	P	C
		4	0	0	4
Co-requisite:	NIL				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	P PROFESSIONAL CORE				
Course designed by	Department of Chemical Engineering				
Approval	32nd Academic Council Meeting 23rd July 2016				

PURPOSE	This course deals with i. the transformation of energy from one form to another and the limitations imposed on such transformations ii. the calculation and prediction of the energy related properties iii. different modes of heat transfer, their resistances, with emphasis on steady and unsteady state conduction.

INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, the learner should be able to:								
1	understand and analyze the basic concepts and laws of thermodynamics, as applied to various systems and processes	a	e	k				
2	understand and evaluate the volumetric and thermodynamic properties of fluids	a	e	k				
3	understand the various modes of heat transfer and evaluate the rate of heat transfer	a	e	k				
4	analyze steady state and unsteady state conduction and evaluate heat transfer coefficient.	a	e	k				

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
UNIT I: FIRST LAW OF THERMODYNAMICS AND P-V-T INTERACTIONS		**13**			
1	Introduction and Basic Concepts - Energy, System, Properties, Processes. Phase Rule. Equilibrium.	3	C	1	1
2	State and path functions.	1	C	1	1
3	First law of thermodynamics - energy balance for closed systems.	2	C, D	1	1
4	Enthalpy and first law for open systems. Limitations of I law.	3	C, D	1	1
5	PVT behavior of pure substances.	1	C	1	1
6	Ideal Gas Law. Formulations for process calculations involving an ideal gas: isothermal, isobaric, isochoric, adiabatic and polytropic process	3	C, D	1,2	1
UNIT II: EQUATION OF STATE AND SECOND LAW OF THERMODYNAMICS		**13**			
7	Equations of State (EOS). Van der Waals EOS and Cubic EOS	3	C,D	1,2	1
8	Virial EOS. Generalized compressibility charts. Principle of corresponding states	2	C,D	1,2	1
9	Second Law of Thermodynamics. Heat Engine and Heat Pump	2	C,D	1,2	1
10	Carnot cycle and Carnot equation.	2	C,D	1,2	1
11	Entropy. Mathematical statement of the second law	2	C,D	1,2	1
12	Entropy balance for open systems	1	C	1,2	1
13	Third law of thermodynamics.	1	C,D	1,2	1
UNIT III: THERMODYNAMIC PROPERTIES AND RELATIONSHIPS		**11**			
14	Fundamental properties	1	C	1,2	1
15	Maxwell relations and cyclic rules	2	C,D	1,2	1

16	Property relations for a homogeneous fluid of constant composition in a closed system.	2	C,D	1,2	1
17	Enthalpy, Entropy changes in terms of measurable properties.	2	C,D	1,2	1
18	Two-phase systems: temperature dependence of the vapor pressure of liquids, two-phase liquid/vapor systems.	2	C,D	1,2	1
19	Joule-Thomson expansion.	1	C	1,2	1
20	Thermodynamic diagrams.	1	C	1,2	1
UNIT IV: CONDUCTION HEAT TRANSFER		**12**			
21	Introduction to various modes of heat transfer	2	C	3,4	2
22	Concept of resistance to heat transfer.	1	C	3,4	2
23	Fourier's law of heat conduction	1	C	3,4	2
24	Effect of temperature on thermal conductivity	1	C,D	3,4	2
25	Steady state conduction and expression for heat flux through different geometry	2	C,D	3,4	2
26	Effective resistance for conduction through composite solids	2	C,D	3,4	2
27	Steady state conduction in bodies with heat sources - Shell balance approach.	3	C,D	3,4	2
UNIT V: HEAT TRANSFER COEFFICIENT		**11**			
28	Combined conductive and convective heat transfer - Heat Transfer Coefficient	2	C,D	3,4	2
29	Heat transfer between fluids separated by different solid walls.	2	C,D	3,4	2
30	Insulation, critical insulation thickness, applications	2	C,D	3,4	2
31	Heat transfer from Fins	1	C	3,4	2
32	Unsteady state heat conduction - Introduction	1	C	3,4	2
33	Unsteady state heat conduction - cartesian, cylindrical and spherical coordinate systems	3	C,D	3,4	2
	Total contact hours	**60**			

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1	Smith, J.M., Van Ness, H.C., and Abbott, M.M., "Introduction to Chemical Engineering Thermodynamics", 7th Edn., McGraw Hill
2	Holman J.P., "Heat Transfer" , 10thEdn., Tata McGraw Hill., New Delhi

Course nature				**Theory**			
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
					End semester examination Weightage :		**50%**

15CH209	PRINCIPLES OF MASS TRANSFER	L	T	P	C
		3	0	0	3
Co-requisite:	NIL				
Prerequisite:	15CH202,15CH204				
Data Book / Codes/Standards	NIL				
Course Category	P PROFESSIONAL CORE				
Course designed by	Department of Chemical Engineering				
Approval	32nd Academic Council Meeting 23rd July 2016				

PURPOSE	To provide the basic knowledge of mass transfer theories, principles and calculations related to absorption and humidification.							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the conclusion of the course,								
1.	The students will be able to understand basic principles of mass transfer and calculate mass transfer rates.	a	e					
2.	The students will be able to understand various theories of mass transfer, dimensionless numbers and calculate rates of mass transfer across fluid – fluid interfaces.	a						
3.	The students will be able to understand principles of gas absorption and design an ideal tray/packed tower.	a	c	e				
4.	The students will be able to understand humidification and dehumidification operations and design the cooling tower.	a	c	e				
5.	The students will be able to understand the principles of drying, different types of driers and calculate drying time for different periods.	a	b	e				

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
UNIT I: MASS TRANSFER AND DIFFUSION		**9**		1	
1.	Introduction to Mass Transfer operations.	1	C	1	1
2.	Diffusion, Types, Ficks law of Diffusion.	1	C	1	1
3.	Steady – state molecular diffusion in fluids at rest and in laminar flow, molecular diffusion in gases-steady state diffusion: of A through non diffusing B, equimolal counter diffusion in multicomponent mixtures.	3	C-D	1	1
4.	Molecular diffusion in liquids-steady state diffusion: of A through nondiffusing B, equimolal counter diffusion.	2	C-D	1	1
5.	Pseudo – steady state Diffusion.	1	C-D	1	3
6.	Effect of temperature and pressure on diffusivity.	1	C	1	1
UNIT II: MASS TRANSFER COEFFICIENTS AND INTERPHASE MASS TRANSFER		**9**			
7.	Mass transfer coefficients, Types, Relations between mass transfer coefficients.	2	C	2	1
8.	Dimensionless groups in mass transfer, Simultaneous momentum, heat and mass transfer	1	C	2	4
9.	Theories of mass transfer: film theory, penetration theory, surface-renewal Theory, Boundary layer theory.	2	C	2	1
10.	Interphase Mass Transfer:equilibrium between phases, concentration profile in interphase mass transfer, Two film theory.	2	C	2	1,3
11.	Mass transfer using Film Mass transfer Coefficients and Interface Concentrations.	1	C,D	2	1,3
12.	Overall Mass transfer Coefficients and Driving Forces. Relation between individual and overall mass transfer coefficient.	1	C,D	2	1,3
UNIT III: GAS ABSORPTION		**9**			
13.	Introduction, Packing Characteristics and types of tower packings. Characteristics of solvent.	2	C	3	1
14.	Contact between liquid and gas, pressure drop and limiting	1	C	3	2

	flow rates.				
15.	Material balances, limiting gas-liquid ratio.	1	C-D	3	2
16.	Rate of absorption, calculation of tower height, number of transfer units, height of transfer unit, alternate forms of transfer coefficients	3	C-D	3	2
17.	Absorption in plate columns: Determination of number of plates, Tray efficiencies. Height equivalent to a theoretical plate (HETP).	2	C-D	3	2
UNIT IV: HUMIDIFICATION		**9**			
18.	Definitions	2	C	4	1, 2
19.	Adiabatic saturator	1	C-D	4	2
20.	Wet-bulb temperature, theory of wet-bulb temperature, psychrometric line and Lewis relation	2	C-D	4	2
21.	Humidity chart, use of humidity chart	2	C	4	2
22.	Cooling towers	2	C	4	1,2,4
UNIT V: DRYING		**9**			
23.	Introduction, Importance of drying in processes, principles of drying, Basis, moisture contents	2	C	5	1,2
24.	Mechanism of drying and Rate of drying curve	2	C	5	1
25.	Calculation of drying time under constant drying conditions	2	C-D	5	1,2
26.	Classification of dryers, solids handling in dryers, equipments for batch and continuous drying processes	1	C	5	1,2
27.	Working principle of tray driers, rotary driers, spray driers, fluidized bed drier. Concept of freeze drying.	2	C	5	1,2
	Total contact hours	**45**			

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1	Robert E. Treybal, Mass-Transfer Operations, 3rd Edn., McGraw Hill Education (India) Edition, 2012 .
2	Warren L. McCabe, Julian C. Smith and Peter Harriott, Unit Operations of Chemical Engineering, 7th Edn., McGraw Hill Education (India) Edition, 2014 .
	REFERENCE BOOKS/OTHER READING MATERIAL
3	Christie John Geankoplis, Transport Processes and Separation Process Principles (Includes Unit Operations), 4thEdn., Pearson India Education Services Pvt. Ltd., 2015.
4	Binay K. Dutta, Principles of Mass transfer and Separation Processes, Prentice- Hall of India, New Delhi, 2007.

Course nature				**Theory**			
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
					End semester examination Weightage :		**50%**

15CH210	CHEMICAL PROCESS TECHNOLOGY	L	T	P	C
		4	0	0	4
Co-requisite:	NIL				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	P Professional Core				
Course designed by	Department of Chemical Engineering				
Approval	32nd Academic Council Meeting 23rd July 2016				

PURPOSE	This course helps the students to understand the various processes involved in chemical industries for the production of inorganic and organic chemicals							
INSTRUCTIONAL OBJECTIVES		STUDENT OUTCOMES						
At the end of the course, student will be able to								
1	Familiarize with the essential features of chemical process industries, which will enable the students to apply the concept of upstream and downstream processes associated in industrial production processes	c	g					
2	Improve their ability to read and abstract the process flow diagrams.	c	g					
3	Equip themselves familiar with different feed preparation, separation and purification steps involved in manufacture of organic and inorganic chemicals.	c	g					
4	Expose to the concept of unit operations and unit processes	c	g					

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
UNIT I: CHLOR-ALKALI INDUSTRIES		**11**			
1	Indian chemical industry - an overview	3	C	1	1,2
2	Manufacture of Chlor-Alkali chemicals: Products chart from Chlor-Alkali Industries	2	C	1	1,2,3
3	Manufacture of Soda Ash	2	C	1-4	1,2
4	Manufacture of Sodium bi-carbonate	2	C	1-4	1,2
5	Manufacture of Chlorine and Caustic Soda.	2	C	1-4	1,2,3
UNIT II: SULPHUR AND SILICATE INDUSTRIES		**12**			
6	Introduction to Sulphur Industries	2	C	1	1,2
7	Different sources of Sulphur and Mining of Sulphur	1	C	1-4	1,2,3
8	Manufacture of Sulphuric Acid	2	C	1-4	1,2,3
9	Manufacture of Alumina	1	C	1-4	1,2,3
10	Ceramic Industries and their products	2	C	1	1,2
11	Glass Industries and their products	2	C	1	1,2
12	Production of Cement – Lime stone beneficiation and Portland cement manufacture	2	C	1-4	1,2
UNIT III: FERTILIZERS AND ALLIED INDUSTRIES		**13**			
13	Overview of fertilizer manufacturing sectors in India	1	C	1	1,3
14	Nitrogen Industries: Manufacture of Synthetic Ammonia and Nitric Acid	2	C	1-4	1,2,3
15	Urea, Diammonium Phosphate, Nitrogenous Fertilizers.	2	C	1-4	1,2,3
16	Phosphorous Industries: Phosphate rock , Manufacture of Phosphorous and Phosphoric acid	3	C	1-4	1,2
17	Manufacture of Super phosphate and Triple super phosphate.	3	C	1-4	1,2
18	Potassium industries: Potassium chloride and potassium sulphate.	2	C	1-4	1,2
UNIT IV: NATURAL PRODUCTS		**13**			
19	Edible and essential oils Industries	4	C	1-4	1,2,3
20	Manufacture of soaps, detergents and glycerin	4	C	1-4	1,2
21	Pulp and Paper Industries: Introduction and Manufacture of Kraft Pulp, Paper. Soda recovery process	3	C	1-4	1,2,3
22	Manufacture of starch and its derivatives	1	C	1-4	1,2
23	Manufacture of sugar	1	C	1-4	1,2

UNIT V: SYNTHETIC ORGANIC CHEMICALS		11			
24	Methane and synthesis gas, ethylene, acetylene and propylene.	2	C	1-4	1,2,3
25	Aromatic chemicals - Benzene, toluene, xylene and naphthalene.	1	C	1-4	1,2,3
26	Manufacture of Methanol and Formaldehyde	2	C	1-4	1,2
27	Production of thermoplastic and thermo-setting resins: polyethylene and polypropylene	1	C	1-4	1,2,3
28	Phenolic and epoxy resins, polymers and their engineering applications	1	C	1-4	1,2
29	Polyamides, polyesters and acrylics from monomers	2	C	1-4	1,2
30	Manufacture of Viscose Rayon	1	C	1-4	1,2
31	Processes for the production of natural and synthetic rubber	1	C	1-4	1,2
	Total contact hours	**60**			

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1	Gopala Rao. M. and Marshall Sittig, "Dryden's Outlines of Chemical Technology", 3rd Edn., East-West Press, New Delhi, 2008.
2	George .T Austin, "Shreve's Chemical Process Industries", 5th Edn., McGraw-Hill International Editions, Singapore, 1984.
REFERENCE BOOKS/OTHER READING MATERIAL	
3	Chemical vol. I, II, III, & IV, Chemical Engineering Education Development Centre, IIT Madras, 1975-78.

Course nature				**Theory**			
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
End semester examination Weightage :							**50%**

15CH211L	MECHANICAL OPERATIONS AND FLUID MECHANICS LABORATORY - II	L	T	P	C
		0	0	2	1
Co-requisite:	15CH206L				
Prerequisite:					
Data Book / Codes/Standards	NIL				
Course Category	P PROFESSIONAL CORE				
Course designed by	Department of Chemical Engineering				
Approval	32nd Academic Council Meeting 23rd July 2016				

PURPOSE	To develop skills in designing and conducting experiments related to applications of principles of mechanical operations							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1	Equip themselves familiar with filter press, vacuum leaf filter	b						
2	Learn about the performance of cyclone separator, screw conveyor	b						
3	Equip themselves familiar with Air elutriator	b						
4	Calculate the crushing law constants	b						
5	Learn the practical knowledge on packed bed, fluidized bed	b						
6	Learn the flow measurement using V-notch, Pitot tube	b						
7	Equip themselves familiar with the performance characteristics of Centrifugal pump, Reciprocating pump	b						

Sl. No.	Description of experiments	Contact hours	C-D-I-O	IOs	Reference
1	Plate and frame filter press	3	I,O	1	1
2	Vacuum leaf filter	3	I,O	1	1
3	Air elutriator	3	I,O	3	1
4	Cyclone separator	3	I,O	2	1
5	Screw conveyor	3	I,O	2	1
6	Drop weight crusher	3	I,O	4	1
7	Pressure drop study in packed bed	3	I,O	5	1,2
8	Pressure drop study in fluidized bed	3	I,O	5	1,2
9	Performance characteristics study in single stage Centrifugal pump	3	I,O	7	1,2
10	Performance characteristics study in Reciprocating pump	3	I,O	7	1,2
11	Flow measurement using Pitot tube	3	I,O	6	1
12	Flow measurement using V-notch	3	I,O	6	1
	Total contact hours	36			

LEARNING RESOURCES	
Sl. No.	**REFERENCES**
1	Laboratory Manual
2	McCabe, W.L., Smith, J.C., and Harriot, P., "Unit Operations in Chemical Engineering", 7th Edition, McGraw-Hill, 2005.

Course nature				**Practical**		
Assessment Method (Weightage 100%)						
In-semester	**Assessment tool**	Experiments	Record	MCQ/Quiz/Viva Voce	Model examination	**Total**
	Weightage	**40%**	**5%**	**5%**	**10%**	**60%**
					End semester examination Weightage :	**40%**

15CH301	CHEMICAL ENGINEERING THERMODYNAMICS	L	T	P	C
		3	0	0	3
Co-requisite:	NIL				
Prerequisite:	15CH208				
Data Book / Codes/Standards	Steam Table				
Course Category	P PROFESSIONAL CORE				
Course designed by	Department of Chemical Engineering				
Approval	32nd Academic Council Meeting 23rd July 2016				

PURPOSE	This course helps the students to be proficient in applying thermodynamic principles to various chemical engineering processes involving energy flow, phase and reaction equilibrium.

INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be familiarized in:								
1.	The concept of partial molar properties of the system	a						
2.	Vapor / liquid equilibrium concept	a	e					
3.	The Concept of reaction equilibrium	a						
4.	Thermodynamics of flow processes	a	e					
5.	Refrigeration and liquefaction	a	e					

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
UNIT I: SYSTEMS OF VARIABLE COMPOSITIONS		**10**			
1.	Non-Ideal behavior:Fundamental property relation, Partial molar properties and their evaluation	2	C,D	1	1
2.	Gibbs Duhem's equation	1	C,D	1	1,3,4
3.	Fugacity and fugacity coefficient of pure substances and components in solution	3	C,D	1	1,3,4
4.	Generalized correlations for the fugacity coefficient	2	C,D	1	1,3,4
5.	Lewis Randall rule, Excess properties	2	C,D	1	1,3,4
UNIT II: INTRODUCTION TO VAPOR/LIQUID EQUILIBRIUM		**9**			
6.	Criteria for equilibrium between phases, chemical potential and fugacity, phase rule, Duhem's theorem	2	C	1-2	1,3,2
7.	Pxy and Txy diagrams for homogeneous systems	1	C	2	1,3,2
8.	Simple models for VLE, Raoult'slaw,Henry's Law	1	C	1-2	1,3
9.	Dew point and bubble point calculations with Raoult's law for binary mixtures	1	C,D	1-2	1,3,2
10.	VLE by modified Raoult's law, VLE from K-value correlations, flash calculations.	2	C,D	2	1
11.	Activity coefficient and its estimation from VLE data: Van Laar equation	1	C,D	2	1
12.	Margulus equation	1	C,D	2	1
UNIT III: CHEMICAL REACTION EQUILIBRIUM		**10**			
13.	Reaction coordinate	1	C,D	3	1,3,4
14.	Application of equilibrium criteria to chemical reactions	2	C	3	1,3,4
15.	Standard Gibbs-energy change and the equilibrium constant	1	C,D	3	1,3,4
16.	Effect of temperature on the equilibrium constant, evaluation of equilibrium constants	2	C,D	3	1,3,4
17.	Relation of equilibrium constants to composition: gas-phase reactions, liquid-phase reactions	2	C,D	3	1,3,4
18.	Equilibrium conversions for single reactions in homogeneous phase	2	C,D	3	1,3,4
UNIT IV: THERMODYNAMICS OF FLOW PROCESSES		**8**			
19.	Duct flow of compressible fluids: pipe flow, Nozzles	3	C,D	4	1,4
20.	Throttling process, Turbines.	1	C	4	1,4
21.	Compression processes: compressors, pumps,	1	C,D	4	1,4
22.	Introduction to ejectors.	1	C	4	1,4
23.	Power cycles, Rankine cycle.	1	C	4	1,4

24.	Otto engine, Diesel engine.	1	C	4	1,4
UNIT V: REFRIGERATION AND LIQUEFACTION		**8**			
25.	Principles of refrigeration, Carnot refrigerator,	2	C	5	1,3,4
26.	Vapor-compression cycle,	2	C	5	1,3,4
27.	Absorption refrigeration, heat pump.	1	C	5	1,3,4
28.	Liquefaction processes: Linde liquefaction process,	2	C	5	1,3,4
29.	Claude liquefaction process.	1	C	5	1,3,4
	Total contact hours	45			

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	Smith. J.M., Van Ness. H.C, and Abbott, M.M., "Introduction to Chemical Engineering Thermodynamics", 7th Edition., McGraw Hill International Edition, 2005.
	REFERENCE BOOKS/OTHER READING MATERIAL
2.	Sandler. S "Chemical, Biochemical and Engineering Thermodynamics", 4th Edition, Wiley India, 2006.
3.	Rao .Y.V.C, "Chemical Engineering Thermodynamics", University Press (I) Ltd., Hyderabad, 1997.
4.	Kyle,B.G"Chemical and Process Thermodynamics", 3rd Edition, Prentice Hall of India Pvt. Ltd., New Delhi, 20000.

Course nature				**Theory**			
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
End semester examination Weightage :							**50%**

15CH302	PROCESS HEAT TRANSFER	L	T	P	C
		4	0	0	4
Co-requisite:	NIL				
Prerequisite:	15CH204, 15CH208				
Data Book / Codes/Standards	NIL				
Course Category	P Professional Core				
Course designed by	Department of Chemical Engineering				
Approval	32nd Academic Council Meeting 23rd July 2016				

PURPOSE	This course deals with convective mode of heat transfer, radiation and heat transfer applications in process industries.							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, the learner should be able to:								
1	Understand and analyze the basic concepts of natural and forced convection as applied to various flows and geometry.	a	e	k				
2	Understand the application of heat transfer principles in heat exchanger design.	a	e	k				
3	Understand the principles of evaporation and evaporator design	a	e	k				
4	Analyze the principles of radiation heat transfer.	a	e	k				

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
UNIT I: CONVECTIVE HEAT TRANSFER		**13**			
1.	Concept of heat transfer by convection. Natural and forced convection	1	C	1	1,2
2.	Convective heat transfer in laminar and turbulent boundary layers.	1	C	1	1,2
3.	Theories of heat transfer and analogy between momentum and heat transfer.	2	C, D	1	1,2
4.	Application of dimensional analysis for convection	2	C, D	1	1,2
5.	Heat transfer coefficient calculation.	2	C,D	1	1,2
6.	Overall heat transfer coefficient. Relationship between individual and overall heat transfer coefficients**.**	2	C,D	1	1,2
7.	Heat transfer correlations for natural convection.	3	C,D	1	1,2
UNIT II: FORCED CONVECTION		**13**			
8.	Forced convection in different geometry.	3	C,D	1	1,2
9.	Mean temperature difference, LMTD	2	C,D	1	1,2
10.	Heat transfer to fluids without phase change	1	C	1	1,2
11.	Heat transfer in laminar and turbulent flow in circular pipes	3	C,D	1	1,2
12.	Heat transfer to fluids with phase change. Heat transfer from condensing vapors	2	C	1	1,2
13.	Boiling - Mechanism, correlations.	1	C	1	1,2
14.	Drop-wise and film-type condensation. Heat transfer coefficients calculation for film-type condensation.	1	C	1	1,2
UNIT III: HEAT EXCHANGERS		**12**			
15.	Typical heat exchange equipment	1	C	2	1,2
16.	Counter current and parallel-current flow	1	C,D	2	1,2
17.	Enthalpy balances in: heat exchanges, total condensers.	2	C,D	2	1,2
18.	Double pipe exchanger	2	C,D	2	1,2
19.	Shell and Tube exchangers. Heat-transfer coefficients in shell-and-tube exchanger	3	C,D	2	1,2
20.	Coefficients for crossflow, Correction of LMTD	1	C	2	1,2
21.	Effectiveness of Heat Exchangers.	1	C,D	2	1,2
22.	Compact Exchangers	1	C	2	1,2
UNIT IV: EVAPORATION		**11**			
23.	Introduction, Single- and multiple - effect operation	2	C	3	2

24.	Long tube vertical evaporators, Agitated-film evaporators	2	C	3	2
25.	Evaporator capacity and economy	1	C,D	3	2
26.	Boiling point elevation and Duhring's rule	1	C,D	3	2
27.	Enthalpy balances for single effect evaporator.	2	C,D	3	2
28.	Multiple effect evaporators	1	C,D	3	2
29.	Methods of feeding, capacity and economy of multiple effect evaporators	1	C,D	3	2
30.	Multiple effect calculations	1	D	3	2
UNIT V: RADIATION		**11**			
31.	Concept of thermal radiation, Basics of Radiative heat transfer	1	C	4	1,2
32.	Kirchoff's law, Stephen – Boltzman's law	1	C	4	1,2
33.	Emissive power, black body radiation	1	C	4	1,2
34.	Energy exchange between two large parallel planes	2	C,D	4	1,2
35.	Energy between two parallel planes of different emissivity.	2	C,D	4	1,2
36.	Radiation intercepted by a shield, spheres or cylinders with spherical or cylindrical enclosures	2	C,D	4	1,2
37.	Radiation energy to a completely absorbing receiver	2	C,D	4	1,2
	Total contact hours	**60**			

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1	Holman J.P, "Heat Transfer", 10thEdn., Tata McGraw Hill, New Delhi
2	Binay K Dutta, "Heat Transfer: Principles and Applications", PHI Publishers, Delhi

Course nature				**Theory**			
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
End semester examination weightage :							**50%**

15CH303	MASS TRANSFER APPLICATIONS	L	T	P	C
		3	0	0	3
Co-requisite:	15CH301				
Prerequisite:	15CH209				
Data Book / Codes/Standards	NIL				
Course Category	P PROFESSIONAL CORE				
Course designed by	Department of Chemical Engineering				
Approval	32nd Academic Council Meeting 23rd July 2016				

PURPOSE	To provide the basic knowledge & understanding of mass transfer principles, applications and calculations related to design of mass transfer equipments.							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the conclusion of the course,								
1.	The students will be able to understand basic principles of distillation, methods and types of distillation.	a	c	e				
2.	The students will be able to apply McCabe Thiele method for determination of number of stages in a distillation column.	a	c	e				
3.	The students will be able to calculate percentage recovery of solute and number of stages for liquid – liquid extraction operation.	a	c	e				
4.	The students will be able to list major types of adsorbents and crystallization equipments.	a	e					
5.	The students will be able to understand the principles of other separation processes.	a						

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
UNIT I: DISTILLATION		**8**		1	1,2
1.	Introduction to Distillation, principle , relative volatility	1	C	1	1,2
2.	Methods of distillation: flash ,batch	4	C-D	1	1,2,3
3.	Steam , vacuum distillation	2	C	1	1,2
4.	Continuous distillation	1	C	1	1,2
UNIT II: DESIGN OF DISTILLATION COLUMNS		**10**			
5.	Design of distillation column - McCabe-Thiele method	5	C-D	2	1,2
6.	Reflux ratio, total reflux, minimum reflux, optimum reflux, Fenske's equation,	2	C-D	2	1,2
7.	Introduction to Ponchon-Savarit method	1	C	2	1,2
8.	Azeotropic and extractive distillation , comparison	2	C	2	1,2
UNIT III: EXTRACTION & LEACHING		**10**			
9.	Introduction to liquid extraction , General principles of extraction, choice of solvent	1	C	3	1
10.	Working principle of extraction equipments: mixer-settlers, packed tower, agitated tower and pulsed column extractors.	2	C	3	1
11.	Percentage extraction calculation for single stage operations when liquids are insoluble.	1	C-D	3	1
12.	Percentage extraction calculation for multistage crosscurrent operations when liquids are insoluble.	2	C-D	3	1
13.	Minimum solvent rate and number of theoretical stages for continuous countercurrent, multistage extraction operation when liquids are insoluble.	3	C-D	3	1
14.	Introduction to Leaching, factors affecting leaching, Bollman extractor	1	C	3	1,2
UNIT IV: ADSORPTION & CRYSTALLIZATION		**9**			
15.	Introduction to adsorption, Characteristics of adsorbents, Commercial adsorbents and their application.	1	C	4	1,4

16.	Adsorption isotherms, Langmuir, Freundlich.	1	C	4	1,2
17.	Fixed bed adsorbers.	2	C	4	1,2
18.	Introduction to crystallization, Yield concept, methods of super saturation.	1	C	4	2,4
19.	Nucleation and Crystal growth.	1	C	4	2,4
20.	Crystallization equipment: Continuous vacuum crystallizer, Draft tube-baffle crystallizer & Swenson-walker crystallizer.	1	C	4	2,4
21.	Material and Energy balance calculations in crystallizers	2	C-D	4	2,4
UNIT V: MISCELLANEOUS SEPARATION PROCESSES		**8**			
22.	Membrane separation processes, Classification, Membrane modules	1	C	5	2,4
23.	Osmosis – Reverse Osmosis and its applications	2	C	5	2,4
24.	Dialysis - Electro Dialysis and its applications	1	C	5	2,4
25.	Ion Exchange principles, types and its applications	2	C	5	1,2
26.	Chromatography principles , types and its applications	2	C	5	1,2
	Total contact hours	**45**			

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1	Robert E. Treybal, Mass-Transfer Operations, 3rd Edn., McGraw Hill Education (India) Edition, 2012 .
2	Warren L. McCabe, Julian C. Smith and Peter Harriott, Unit Operations of Chemical Engineering, 7th Edn., McGraw Hill Education (India) Edition, 2014 .
	REFERENCE BOOKS/OTHER READING MATERIAL
3	Christie John Geankoplis, Transport Processes and Separation Process Principles (Includes Unit Operations), 4thEdn., Pearson India Education Services Pvt. Ltd., 2015.
4	Binay K. Dutta, Principles of Mass transfer and Separation Processes, Prentice- Hall of India, New Delhi, 2007.

Course nature				**Theory**			
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
End semester examination Weightage :							**50%**

15CH304	CHEMICAL REACTION ENGINEERING	L	T	P	C
		3	0	0	3
Co-requisite:	NIL				
Prerequisite:	15CH202, 15CH207J				
Data Book / Codes/Standards	NIL				
Course Category	P PROFESSIONAL CORE				
Course designed by	Department of Chemical Engineering				
Approval	32nd Academic Council Meeting 23rd July 2016				

PURPOSE	This course explains the kinetics of chemical reactions, basics of ideal reactor design, design for single and multiple reactions, temperature and pressure effects on equilibrium and reactor design.							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1	Understand the kinetics of chemical reactions	a	b					
2	Improve their ability in designing ideal reactors	a	b					
3	Comprehend design aspects for single reactions and multiple reactor system	a	b					
4	Familiarize product distribution and contacting pattern for multiple reactions	a	b					
5	Expose to the concept of thermodynamic aspect of chemical reactions	a	b					

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
UNIT I: BASICS OF REACTOR DESIGN		9			
1	Kinetics of homogeneous reactions	1	C	1	1
2	concentration-dependent term of a rate equation and temperature-dependent term of a rate equation	1	C	1	1
3	Predictability of reaction rate from theory	1	C	1	1
4	Interpretation of batch reactor data: constant-volume batch Reactor	3	C	1	1
5	Varying-volume batch reactor, temperature and reaction rate, search for a rate equation rate equation.	3	C	1	1
UNIT II: DESIGN OF IDEAL REACTORS		**9**			
6	Introduction to reactor design	2	C	2	1
7	Classification of ideal reactors for single reactions	1	C	2	1
8	Design of ideal batch reactor	2	C,D,I	1,2	1
9	Design of steady state mixed flow reactor	2	C,D,I	1,2	1
10	Design of steady state plug flow reactor	2	C,D,I	1,2	1
UNIT III: SINGLE REACTIONS AND MULTIPLE REACTOR SYSTEM		**9**			
11	Design for single reactions	1	C	1,3	1
12	Size comparison of single reactors	1	C	2,3	1
13	Plug flow reactors in series and in parallel	1	C	2,3	1
14	Equal size mixed flow reactors in series – first order reactions	2	C,D	2,3	1
15	Mixed flow reactors of different sizes in series and finding the conversion	1	C	3	1
16	Determining the best system for a given conversion	1	C	3	1
17	Best arrangement for reactors of different types in series	1	C	3	1
18	Performance equation for recycle reactor	1	C,D	3	1
UNIT IV: DESIGN FOR MULTIPLE REACTIONS		**9**			
19	Introduction to multiple reactions	1	C	4	1
20	Qualitative product distribution for parallel reactions	1	C	4	1
21	Contacting patterns for parallel reactions	2	C	2,4	1
22	Quantitative treatment for parallel reactions	1	C	4	1
23	Qualitative product distribution for series reactions	1	C	4	1
24	Contacting patterns for series reactions	1	C	2,4	1
25	Quantitative treatment – plug or batch reactor and mixed flow	2	C,D	2,4	1

	reactor				
UNIT V: TEMPERATURE AND PRESSURE EFFECTS		**9**			
26	Heat of reaction from thermodynamics; temperature effect	2	C	5	1
27	Equilibrium constant and conversion from thermodynamics	2	C	5	1
28	Optimum temperature progression, fractional conversion in adiabatic and non – adiabatic operation reactors	5	C,D	2,5	1
	Total contact hours	45			

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1	Octave Levenspiel, "Chemical Reaction Engineering", 3rd edition, John Wiley & Sons India edition, 2011.
	REFERENCE BOOKS/OTHER READING MATERIAL
2	Scott Fogler. H., "Elements of Chemical Reaction Engineering", 3rd edition, Prentice Hall of India, New Delhi, 2006.
3	Smith. J.M., "Chemical Engineering Kinetics", 3rd edition, McGraw Hill International Editions, New Delhi, 1981.
4	Ronald. W.Missen, Charles.A.Mions, Bradley.A.Saville, "Introduction to Chemical Reaction Operation and Kinetics", John Wiley and Sons, Singapore, 1999.

Course nature				**Theory**			
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
End semester examination Weightage :							**50%**

15CH305J	COMPUTATIONAL TECHNIQUES IN CHEMICAL ENGINEERING	L	T	P	C
		2	0	2	3
Co-requisite:	15CH302				
Prerequisite:	15MA206 15CH209				
Data Book / Codes/Standards	Steam table				
Course Category	P PROFESSIONAL CORE				
Course designed by	Department of Chemical Engineering				
Approval	32nd Academic Council Meeting 23rd July 2016				

PURPOSE	To acquire computational techniques to solve chemical engineering problems by using computers.

INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student would be able to								
1.	Understand the conservation of mass and energy equation	a						
2.	Familiarize the Algebraic Transcendental Equation, Linear Simultaneous Algebraic equations, Numerical Integration, Ordinary Differential Equations and Partial Differential Equations	a		d	e		k	
3.	Apply computational techniques to Chemical Engineering problems.			d			k	
4.	Provide the training to develop SCILAB program for solving the Chemical Engineering problems				e			

Session	Description of Topic (Theory)	Contact hours	C-D-I-O	IOs	Reference
UNIT I: NUMERICAL SOLUTION OF ALGEBRAIC TRANSCENDENTAL EQUATION		**6**			
1.	Review of iterative methods: Bisection, Regula-Falsi and Newton-Raphson methods	1	C	2	1
2.	Phase equilibrium problems and Equation of State	3	D,I	3	1,3
3.	Determination of Bubble and Dew points	1	D,I	3	1,3
4.	Minimum reflux ratio	1	D,I	3	1,4
UNIT II: NUMERICAL SOLUTION OF LINEAR SIMULTANEOUS ALGEBRAIC EQUATION		**6**			
5.	Review of Gauss-Siedel iteration method, Gauss Elimination method and Cramer's rule	1	C,D	2	1
6.	Material and energy balance concept	1	C,D	1	2
7.	Single stage and multiple stage extraction operations	2	D,I	1-3	1,4
8.	Cascade continuous stirred tank reactors	1	D,I	1-3	1,5
9.	Single and multiple effect evaporators	1	D,I	1-3	1,6
UNIT III: NUMERICAL INTEGRATION		**6**			
10.	Review of Trapezoidal rule and Simpson's rule	1	C	2	1
11.	Determination of drying time from batch drying data	1	D,I	2,3	1,4
12.	Determination of single and cascade plug flow reactor size	2	D,I	1-3	1,5
13.	Determination of batch kinetics from batch reactor data	1	D,I	1-3	1,5
14.	Curve fitting and linear regression in heat conduction problems	1	D,I	2,3	1,5
UNIT IV: NUMERICAL SOLUTION OF ORDINARY DIFFERENTIAL EQUATION		**6**			
15.	Review of Taylor series, Euler's method and Runge-Kutta method	1	C,D	2	1
16.	Unsteady state of mixing tank	1	D,I	1-3	1,2
17.	Concentration profile in a batch reactor using different numerical methods for solving the ODE	1	D,I	1-3	1,5
18.	Heat conduction problems	2	D,I	1-3	1,2,6
19.	Concentration profile along the reactor length in isothermal Plug Flow Reactor (PFR)	1	D,I	1-3	1,5
UNIT V: NUMERICAL SOLUTION OF PARTIAL		**6**			

DIFFERENTIAL EQUATION					
20.	Numerical methodology for solving the partial differential equation	1	C,D	2	1
21.	Unsteady state one dimensional heat transfer problem	1	D,I	1-3	1,7
22.	Steady state two dimensional heat transfer problems	2	D,I	1-3	1,7
23.	Unsteady state one dimensional mass transfer problem	2	D,I	1-3	1,7
	Total contact hours	30			

Sl. No.	Write programs using SCILAB for solving	Contact hours	C-D-I-O	IOs	Reference
1.	Linear Algebraic Equations: Gauss Seidel method	3	I,O	1	1
2.	Linear Algebraic Equations: Gauss Elimination method	3	I,O	5	1,2
3.	Polynomial root finding techniques: Newton Raphson Method	3	I,O	5	1,3
4.	Bubble point and dew point using thermodynamics iteration method	3	I,O	5	1,3
5.	Numerical Integration: Trapezoidal rule and Simpson 1/3 rule	3	I,O	5	1,5
6.	Ordinary Differential Equation: Euler's method	3	I,O	5	1,5
7.	Partial Differential Equation: Finite difference method	3	I,O	5	1,7
8.	Ordinary Differential Equation: R-K Method	3	I,O	5	1,5
	Total contact hours	24			

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	Steven C. Chapra and Raymond P. Canale, Numerical Methods for Engineers, sixth Edn., McGraw Hill
2.	Ismail Tosun, Modeling in Transport Phenomena – A Conceptual Approach, 2nd Edn., Elsevier Publications 2007
	REFERENCE BOOKS/OTHER READING MATERIAL
3.	Y.V.C. Rao, Chemical Engineering Thermodynamics, Universities press, 1997.
4.	Robert E. Treybal, Mass Transfer Operations, 3rd Edition, McGraw Hill, 1980
5.	H. Scott Fogler, Elements of Chemical Reaction Engineering, 4th Edition, Prentice Hall International Series
6.	Warren L. McCabe, Julian,C. Smith and Peter Harriott, "Unit Operation of Chemical Engineering", 7th Edn., McGraw Hill International Edition, New York, 2005.
7.	H. K. Versteeg and W. Malalasekera, An introduction to computational fluid dynamics – The finite volume method, Longman Group Ltd 1995.

Course nature					**Theory + Practical**		
Assessment Method – Theory Component (Weightage 50%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
					End semester examination Weightage :		**50%**
Assessment Method – Practical Component (Weightage 50%)							
In-semester	**Assessment tool**	Experiments	Record	MCQ/Quiz/Viva Voce	Model examination	**Total**	
	Weightage	**40%**	**5%**	**5%**	**10%**	**60%**	
					End semester examination Weightage :	**40%**	

15CH306L	HEAT AND MASS TRANSFER LABORATORY - I	L	T	P	C
		0	0	2	1
Co-requisite:	15CH302, 15CH303				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	P PROFESSIONAL CORE				
Course designed by	Department of Chemical Engineering				
Approval	32nd Academic Council Meeting 23rd July 2016				

PURPOSE	To develop skills in designing and conducting experiments related to principles and applications of Heat and Mass Transfer

INSTRUCTIONAL OBJECTIVES		STUDENT OUTCOMES						
At the end of the course, student will be able to								
1	Understand heat transfer mechanism	b	e					
2	Determine thermal conductivity & heat transfer coefficient	b	e					
3	Understand principles of Diffusion , Drying & Calculate Diffusivity , Mass transfer coefficient	b						
4	Verify Rayleigh , Fenske equation and understand steam distillation	b						
5	Handle Soxhlet apparatus and Determine percentage recovery of solute	b						

Sl. No.	Description of experiments	Contact hours	C-D-I-O	IOs	Reference
1.	Composite lagged pipe	3	I-O	1	1,2
2.	Thermal conductivity for solids	3	I-O	2	1,2
3.	Heat transfer by natural convection	3	I-O	2	1,2
4.	Heat transfer by forced convection	3	I-O	2	1,2
5.	Heat transfer by forced convection-Pin fin	3	I-O	2	1,2
6.	Determination of diffusivity	3	I-O	3	1,2
7.	Determination of mass transfer coefficient	3	I-O	3	1,2
8.	Drying characteristics	3	I-O	3	1,2
9.	Verification of Rayleigh equation for simple batch distillation.	3	I-O	4	1,2
10.	Verification of fenske equation for packed column distillation at total reflux condition.	3	I-O	4	1,2
11.	Determination of vapor efficiency for simple steam distillation.	3	I-O	4	1,2
12.	Estimation of percentage recovery of solute using Soxhlet apparatus.	3	I-O	5	1,2
	Total contact hours	36			

LEARNING RESOURCES	
Sl. No.	REFERENCES
1.	Laboratory Manual
2.	Warren L. McCabe, Julian C. Smith and Peter Harriott, Unit Operations of Chemical Engineering, 7th Edn., McGraw Hill Education (India) Edition, 2014 .

Course nature				Practical		
Assessment Method (Weightage 100%)						
In-semester	Assessment tool	Experiments	Record	MCQ/Quiz/Viva Voce	Model examination	Total
	Weightage	40%	5%	5%	10%	60%
				End semester examination Weightage :		40%

15CH307	TRANSPORT PHENOMENA FUNDAMENTALS	L	T	P	C
		3	0	0	3
Co-requisite:	NIL				
Prerequisite:	15CH302, 15CH303				
Data Book / Codes/Standards	Clark's Table, IS : 456-2000				
Course Category	P PROFESSIONAL CORE				
Course designed by	Department of Chemical Engineering				
Approval	32nd Academic Council Meeting 23rd July 2016				

PURPOSE	It makes the students to understand the fundamental phenomena, governing equations and the physics and mathematics of momentum, heat, and mass transfer in Chemical Engineering processes.

INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1	**U**nderstand the chemical and physical transport processes and their mechanism**.**	a						
2	Familiarize various aspects of velocity, temperature and concentration distribution in laminar and turbulent flow.	a						
3	To do heat, mass and momentum transfer analysis.	a	e					
4	Analyze industrial problems along with appropriate approximations and boundary conditions.	a	e					
5	Formulate the differential forms of the equations of change for momentum, heat and mass transfer problems for steady-state flows.	a	e					

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
UNIT I: VELOCITY DISTRIBUTION IN LAMINAR FLOW		**9**			
1	Introduction - Generalization of Newton's Law of Viscosity, Pressure and Temperature Dependence of Viscosity.	1	C	1	1
2	Introduction - Molecular Theory of the Viscosity of Gases at Low Density, Molecular Theory of the Viscosity of Liquids.	1	C	1	1
3	Shell Momentum Balances and Velocity Distributions in Laminar Flow: Shell momentum balances and boundary conditions, Flow of a falling film.	2	C-D	2-5	1, 2
4	Shell Momentum Balances and Velocity Distributions in Laminar Flow: Flow through a circular tube, Flow through an annulus	2	C-D	2-5	1, 2
5	Shell Momentum Balances and Velocity Distributions in Laminar Flow: Flow of two adjacent immiscible fluids, Laminar flow in a narrow slit	2	C-D	2-5	1, 2
6	Use of the equations of change to solve flow problems	1	I-O	4, 5	1, 2, 3, 4
UNIT II: EQUATION OF CHANGE FOR ISOTHERMAL PROCESS		**9**			
7	The equation of continuity, The equation of motion	3	C,D	3, 4	1, 2
8	The equations of change in terms of the substantial derivative	1	C,D	3	1
9	Use of the equations of change to solve flow problems	4	D,I,O	4, 5	1, 2
10	Dimensional analysis of the equations of change	1	D	3	1, 2
UNIT III: VELOCITY DISTRIBUTION IN TURBULENT FLOW AND INTERPHASE TRANSPORTINISOTHERMAL SYSTEMS		**9**			
11	Comparisons of laminar and turbulent flows	1	C	2, 3	1, 2
12	Time-smoothed equations of change for incompressible fluids	2	C	2, 3	1, 2
13	The time-smoothed velocity profile near a wall, Empirical expressions for the turbulent momentum flux	1	C, D	2, 3	1
14	Definition of friction factors, Friction factors for flow in tubes	2	C	2, 3	1
15	Friction factors for flow around spheres	1	C	2, 3	1, 2

16	Friction factors for packed columns	2	D, O	4, 5	1, 2, 3, 4
UNIT IV: ENERGY TRANSPORT		**9**			
17	Thermal Conductivity and the mechanisms of Energy Transport, Temperature and pressure dependence of Thermal conductivity	1	C	3	1, 2
18	Shell Energy Balances and Temperature Distributions in Solids and Laminar Flow: Shell energy balances; boundary conditions, Heat conduction with an electrical heat source	1	C, D	3, 4	1
19	Heat conduction with a nuclear heat source, Heat conduction through composite walls	2	C, D	3, 4	1, 2
20	Heat conduction in a cooling fin	1	C, D	3, 4	1
21	The Equations of Change for Non isothermal Systems: The energy equation, Special forms of the energy equation	2	C, D	3, 4	1
22	Steady state heat conduction problem	2	D, I	5	1, 2, 3, 4
UNIT V: MASS TRANSPORT		**9**			
23	Diffusivity and the Mechanisms of Mass Transport: Fick's law of binary diffusion (Molecular Mass Transport), Temperature and pressure dependence of diffusivities	1	C	3	1, 2
24	Concentration Distributions in Solids and in Laminar Flow : Shell mass balances; boundary conditions, Diffusion through a stagnant gas film	2	C, D	3, 4	1
25	Diffusion with a heterogeneous chemical reaction , Diffusion with a homogeneous chemical reaction	2	C, D	3, 4	1
26	Diffusion and chemical reaction inside a porous catalyst	1	C, D	3, 4	1
27	Equations of Change for Multicomponent Systems: The equations of continuity for a multicomponent mixture, Use of the equations of change for mixtures	1	C, D	3, 4	1, 2
28	Analogies between momentum, heat and mass transport	2	C	4	1, 2
	Total contact hours	45			

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1	Byron R.Bird., Warren E. Stewart and Edwin N. Lightfoot, "Transport Phenomena", 2nd edition, John Wiley & Sons, New York, 2007.
	REFERENCE BOOKS/OTHER READING MATERIAL
2	Christie John Geankoplis"Transport Processes and Separation Process Principles (Includes Unit Operations)", 4thEdition,Pearson Education, Prentice Hall, 2003.
3	James R. Welty., Charles E. Wicks.,Robert E. Wilson. and Gregory L. Rorrer "Fundamentals of Momentum, Heat, and Mass Transfer",5nd edition, John Wiley &Sons, New York, 2007.
4	Robert S. Brodkeyand Harry C.Hershey., Transport Phenomena - A Unified Approach,Volume 2,Brodkey Publishing, Columbus, 2001.

Course nature				**Theory**			
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
					End semester examination Weightage :		**50%**

15CH308	PROCESS DYNAMICS, CONTROL AND INSTRUMENTATION	L	T	P	C
		4	0	0	4
Co-requisite:	NIL				
Prerequisite:	15MA202, 15CH303				
Data Book / Codes/Standards	Clark's Table, IS : 456-2000				
Course Category	P PROFESSIONAL CORE				
Course designed by	Department of Chemical Engineering				
Approval	32nd Academic Council Meeting 23rd July 2016				

PURPOSE	This course enables the students to know about control methods and make the students knowledgeable in various types of measuring instruments used in chemical process industries.

INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1	Understand the importance of process control in industrial process plants.	a						
2	Understand the use of block diagrams & the mathematical basis for the design and stability of control systems.	a	e					
3	Understand the application of good instrumentation for the effective design of process control loops for process engineering plants.	a						
4	Draw a Process & Instrumentation Diagram and devise simple but effective plant wide control strategies using appropriate methods.	a	k					
5	Design and tune process controllers and specify the required final elements to ensure that well-tuned control is achieved.	a	k					

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
UNIT I: LINEAR OPEN LOOP SYSTEMS		**13**			
1	Basic Concepts of process control, Why process control, Modeling for process dynamics-mathematical tools for modeling, Laplace transform of simple functions, transforms of derivatives	2	C	1	1, 2
2	Solution of differential equations, inversion by partial fractions	2	C, D	2	1, 2
3	Physical examples of first-order systems	3	C,D,I	2	1, 2
4	Response of first-order systems	3	C,D,I	2	1, 2
5	Response of first- order systems in series	1	C,D,I	2	1, 2
6	Higher order systems: Second-order and transportation lag	2	C,D,I	2	1, 2
UNIT II: - LINEAR CLOSED LOOP SYSTEMS		**12**			
7	Introduction to controllers and final control element	1	C	3	1, 2
8	Principles of pneumatic and electronic controllers and mechanism of control system & block diagram	2	C	3	1, 2
9	Mechanism of controllers	3	C, D	5	1, 2
10	Mechanism of control valves	3	C, D	5	1, 2
11	Dynamic behavior of controllers	3	C, D	5	1, 2
UNIT III: STABILITY, FREQUENCY RESPONSE ANALYSIS AND DESIGN		**11**			
12	Concept of stability, definition of stability, stability criterion	1	C	1	1, 2
13	Stability for linear system: Routh-Hurwitz stability criterion	2	C, D	2	1, 2
14	Root locus diagram	3	C, D	2	1, 2
15	Design of control system using frequency response: Bode diagram-stability criterion, phase and gain margins	3	C, D	2	1, 2
16	Tuning of controller settings: Ziegler Nichols controller settings	2	C, D	2	1, 2
UNIT IV: CONTROL SCHEMES AND MICRO PROCESSOR		**12**			
17	Control systems with single loops: Feedback control systems with examples	2	C,D	3	2, 3, 5

18	Control systems with multiple loops: cascade control, selective control systems and split-range control with examples	4	C,D	3, 4	2, 3, 5
19	Feedforward and Ratio Control with examples	2	C,D	3, 4	2, 3, 5
20	Control of distillation column: control of composition and pressure	2	C,D	3, 4	2, 3, 5
21	Microprocessor-based controllers: Introduction to PLC's and DCS	2	C	4	2, 3, 5
UNIT V: MEASURING DEVICES		**12**			
22	Principles of measurements and classification of process control instruments	2	C	3	4
23	Temperature measuring instruments	2	C	3	2, 4
24	Liquid-level measuring instruments	2	C	3	4
25	Pressure measuring instruments	2	C	3	4
26	Composition measuring instruments	2	C	3	4
27	Measurements of viscosity, pH, concentration, thermal conductivity and humidity of gases.	2	C	3	4
	Total contact hours	60			

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1	Donald R. Coughanowr., Steven E. LeBlanc., "Process system Analysis & Control", 3rd edition., McGraw Hill, New york, 2009.
2	George Stephanopoulos, "Chemical Process Control: An Introduction to Theory and Practice", Prentice Hall, New Delhi, 1984.
REFERENCE BOOKS/OTHER READING MATERIAL	
3	Peter Harriott, "Process Control" Tata McGraw Hill, New Delhi, 1972.
4	Donald P. Eckman, "Industrial Instrumentation", Wiley Eastern Limited, 2004.
5	William L. Luyben, "Process modeling, simulation, and control for Chemical Engineers ", 2nd edition, McGraw Hill, New York, 1996.

Course nature		**Theory**					
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
					End semester examination Weightage :		**50%**

15CH309	REACTOR ANALYSIS AND CATALYSIS	L	T	P	C
		3	0	0	3
Co-requisite:	NIL				
Prerequisite:	15CH304				
Data Book / Codes/Standards	NIL				
Course Category	P PROFESSIONAL CORE				
Course designed by	Department of Chemical Engineering				
Approval	32nd Academic Council Meeting 23rd July 2016				

PURPOSE	This course explains the non ideal reactor behavior, kinetics and rate equation for solid catalyzed reactions, kinetics of fluid – particle reactions, fluid – particle reactor design and catalyst properties, preparation.

INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1	Understand the behavior of non ideal flow reactors	a	b					
2	Improve their ability in analyzing catalytic reaction and reactor design	a	b					
3	Explain the models and rate equation of fluid – particle reactions	a	b					
4	Familiarize design of reactors for fluid – particle reaction	a	b					
5	Expose the experimental methods for catalyst property calculation	a	b					

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
UNIT I: BASICS OF NON – IDEAL FLOW		**9**			
1	Residence time distribution – concept and reason for RTD	1	C	1	1
2	Pulse and step experiment for E curve	2	C	1	1
3	Conversion in non – ideal flow reactors	1	C	1	1
4	Dispersion model and tanks – in – series model	4	C,D	1	1,2
5	Chemical reaction and dispersion	1	C,D	1	1
UNIT II: SOLID CATALYZED REACTIONS		**9**			
6	characteristics of catalyst and factors affecting rate of catalytic reactions	1	C	2	1
7	Rate equation for surface kinetics – single site and dual site mechanism	2	C	2	2
8	Pore diffusion resistance combined with surface kinetics inside a cylindrical pore for first order reaction	2	C,D	2	1
9	Measures of catalytic reaction rates	1	C	2	1
10	Performance equation for plug flow and mixed flow reactors containing catalyst particles	1	C,D	2	1
11	Experimental methods for finding catalytic reaction rate	2	C,D	2	1
UNIT III: KINETICS OF FLUID – PARTICLE REACTIONS		**9**			
12	Behavior of reacting solid particles	1	C	3	1
13	Selection of a model	1	C	3	1
14	Shrinking core model for spherical particles of unchanging size; rate equation if diffusion through gas film controls	1	C,D	3	1
15	For spherical particles of unchanging size development of rate equation if diffusion through ash layer controls	1	C,D	3	1
16	For spherical particles of unchanging size rate equation if surface chemical reaction controls the overall rate	1	C,D	3	1
17	Rate of reaction for shrinking spherical particles if gas film diffusion controls	1	C,D	3	1
18	Rate of reaction for shrinking spherical particles if chemical reaction controls the rate	1	C,D	3	1
19	Limitations of the shrinking core model and determination of rate controlling step	2	C,D	3	1

UNIT IV: DESIGN OF REACTORS FOR FLUID – PARTICLE REACTIONS		**9**			
20	Types of contacting pattern in gas – solid operations	1	C	4	1
21	Fraction of reaction unconverted for a mixture of different size solid particles following plug flow pattern	1	C	4	1
22	Mixed flow of particles of a single unchanging size, uniform gas composition; fraction unconverted if gas film resistance controlling	1	C,D	1,4	1
23	Expression for fraction unconverted if surface chemical reaction and ash layer diffusion controls	1	C,D	1,4	1
24	Mixed flow of a size mixture of particles of unchanging size, uniform gas composition; fraction unconverted if gas film diffusion controls	2	C,D	1,4	1
25	Expression for fraction unconverted if surface chemical reaction and ash layer diffusion controls	2	C,D	1,4	1
26	Concept of instantaneous reactions and favorable contacting patterns	1	C	4	1
UNIT V: SOLID CATALYSTS		**9**			
27	Pertinent properties for a catalyst particle	1	C	5	3
28	Determination of surface area by gas adsorption method, void volume, solid density and pore – volume distribution (nitrogen gas desorption method and mercury penetration method)	4	C	5	3
29	Classification of catalysts, catalyst preparation methods, promoters and inhibitors and catalyst poisoning types	4	C	5	3
	Total contact hours	45			

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1	Octave Levenspiel, “Chemical Reaction Engineering”, 3rd edition, John Wiley & Sons India edition, 2011.
REFERENCE BOOKS/OTHER READING MATERIAL	
2	Scott Fogler. H., “Elements of Chemical Reaction Engineering”, 3rd edition, Prentice Hall of India, New Delhi, 2006.
3	Smith. J.M., “Chemical Engineering Kinetics”, 3rd edition, McGraw Hill International Editions, New Delhi, 1981.
4	Ronald. W.Missen, Charles.A.Mions, Bradley.A.Saville, “Introduction to Chemical Reaction Operation and Kinetics”, John Wiley and Sons, Singapore, 1999.

Course nature			**Theory**				
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
					End semester examination Weightage :		**50%**

15CH310L	HEAT AND MASS TRANSFER LABORATORY - II	L	T	P	C
		0	0	2	1
Co-requisite:	NIL				
Prerequisite:	15CH306L				
Data Book / Codes/Standards	NIL				
Course Category	P PROFESSIONAL CORE				
Course designed by	Department of Chemical Engineering				
Approval	32nd Academic Council Meeting 23rd July 2016				

PURPOSE	To develop skills in designing and conducting experiments related to principles and applications of Heat and Mass Transfer

INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Handle various types of heat exchangers	b	e					
2.	Design various heat exchangers	b	e					
3.	Understand the difference between single stage and multi stage leaching.	b						
4.	Construct phase Diagram for three component system	b						
5.	Understand and verify Freundlich Adsorption isotherm and determine VLE compositions	b						

Sl. No.	Description of experiments	Contact hours	C-D-I-O	IOs	Reference
1.	Stefan-Boltzmann Apparatus	3	I-O	1,2	1,2
2.	Emissivity apparatus	3	I-O	1,2	1,2
3.	Parallel and counter flow heat exchanger	3	I-O	1,2	1,2
4.	Shell and tube heat exchanger	3	I-O	1,2	1,2
5.	Drop wise and film wise condensation	3	I-O	1,2	1,2
6.	Estimation of percentage recovery of solute for single stage leaching.	3	I-O	3	1,2
7.	Estimation of percentage recovery of solute for multi stage leaching.	3	I-O	3	1,2
8.	Phase diagram for three component system.	3	I-,O	4	1,2
9.	Verification of Freundlich Adsorption isotherm.	3	I-O	5	1,2
10.	Determine Vapor liquid Equilibrium composition for a given system	3	I-O	5	1,2
	Total contact hours	30			

LEARNING RESOURCES	
Sl. No.	**REFERENCES**
1	Laboratory Manual
2	Warren L. McCabe, Julian C. Smith and Peter Harriott, Unit Operations of Chemical Engineering, 7th Edn., McGraw Hill Education (India) Edition, 2014 .

Course nature			**Practical**			
Assessment Method (Weightage 100%)						
In-semester	**Assessment tool**	Experiments	Record	MCQ/Quiz/Viva Voce	Model examination	**Total**
	Weightage	**40%**	**5%**	**5%**	**10%**	**60%**
					End semester examination Weightage :	**40%**

15CH311L	CHEMICAL REACTION ENGINEERING AND PROCESS CONTROL LABORATORY - I	L	T	P	C
		0	0	2	1
Co-requisite:	15CH304, 15CH308				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	L LABORATORY				
Course designed by	Department of Chemical Engineering				
Approval	32nd Academic Council Meeting 23rd July 2016				

PURPOSE	To develop skills in designing and conducting experiments to experimentally verify the concepts learnt in Chemical Reaction Engineering, Reactor analysis & catalysis and process dynamics, control & instrumentation courses

INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Calculate rate equation parameters based on kinetic data's	a	b					
2.	Apply design equation for batch and flow reactors	a	b					
3.	Control process parameters and understand the functional characteristics of controllers	a	b					

Sl. No.	Description of experiments	Contact hours	C-D-I-O	IOs	Reference
1.	Irreversible reaction in a Batch Reactor	3	I	1	1, 2
2.	Study of Semi batch reactor	3	I	2	1, 2
3.	Study of Tubular Flow Reactor	3	I	2	1,2
4.	Study of mixed flow Reactor	3	I	2	1,2
5.	Study of adiabatic reactor	3	I	2	1,2
6.	Current to pressure and pressure to current converter	3	I	3	1,3
7.	Step response of first order system	3	I	3	1,3
8.	Verifying the response of interacting level system	3	I	3	1,3
9.	Study of level controller and level transmitter	3	I	3	1,3
10.	P, PI, PID control of temperature control loop	3	I	3	1,3
	Total contact hours	30			

LEARNING RESOURCES	
Sl. No.	**REFERENCES**
1	Laboratory Manual
2	Octave Levenspiel, "Chemical Reaction Engineering", 3rd edition, John Wiley & Sons India edition, 2011.
3	George Stephanopoulos, "Chemical Process Control: An Introduction to Theory and Practice", Prentice Hall, New Delhi, 1984.

Course nature				**Practical**		
Assessment Method (Weightage 100%)						
In-semester	**Assessment tool**	Experiments	Record	MCQ/Quiz/Viva Voce	Model examination	**Total**
	Weightage	**40%**	**5%**	**5%**	**10%**	**60%**
					End semester examination Weightage :	**40%**

15CH375L and 15CH376L	MINOR PROJECT - I and MINOR PROJECT - II	L	T	P	C
		0	0	3	2
Co-requisite:					
Prerequisite:					
Data Book / Codes/Standards					
Course Category	P PROFESSIONAL				
Course designed by	Department of Chemical Engineering				
Approval	32nd Academic Council Meeting 23rd July 2016				

PURPOSE	To obtain an hands-on experience in converting a small novel idea / technique into a working model / prototype involving multi-disciplinary skills and / or knowledge and working in at team.							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able								
1.	To conceptualise a novel idea / technique into a product	c						
2.	To think in terms of multi-disciplinary environment		d					
3.	To understand the management techniques of implementing a project				k			
4.	To take on the challenges of teamwork, prepare a presentation in a professional manner, and document all aspects of design work.			g				

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	An Multidisciplinary project to be taken up by a team of maximum of ten students. Development of prototype product, a 3D model, simulation, blueprint for a larger project and any other development work are permitted. The contribution of the individuals in the project should be clearly brought out. A combined report is to be submitted. A presentation is to be made for the reviewers on the work done by the candidate.		C,D,I	1,2,3,4	
	Total contact hours				

Course nature		**Project – 100% internal continuous assessment**	
Assessment Method (Weightage 100%)			
In-semester	**Assessment tool**	Refer the table	**Total**
	Weightage	Refer the table below	**100%**
End semester examination Weightage :			**0%**

Assessment component	Expected outcome	Evaluators	Criteria or basis	Marks
Project proposal (Review – I)	A short presentation to be delivered on: • A brief, descriptive project title (2-4 words). This is critical! • The 3 nearest competitors (existing solutions) and price. • Team members name, phone number, email, department/degree program, and year. • A description of the product opportunity that has been identified. To include: Documentation of the market need, shortcomings of existing competitive products, and definition of the target market and its size. • Proposed supervisor / guide	Panel of reviewers	Viability / feasibility of the project Extent of preliminary work done.	**0**
Review II	• Mission Statement / Techniques • Concept Sketches, Design Specifications / Modules & Techniques along with System architecture • Coding	Panel of reviewers	Originality, Multi-disciplinary component, clarity of idea and presentation, team work, handling	**20**

			Q&A.	
Review III	• Final Concept and Model / Algorithm/ Technique • Drawings, Plans / programme output • Financial Model / costing • Prototype / Coding • Final Presentation and Demonstration	Panel of reviewers	Originality, Multi-disciplinary component, clarity of idea and presentation, team work, handling Q&A.	**50**
Final technical Report	A good technical report	Supervisor / Guide	Regularity, systematic progress, extent of work and quality of work	**30**
			Total	**100**

15CH380L and 15CH381L	SEMINAR - I and SEMINAR - II	L	T	P	C
		0	0	3	2
Co-requisite:	NIL				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	P PROFESSIONAL				
Course designed by	Department of Chemical Engineering				
Approval	32nd Academic Council Meeting 23rd July 2016				

PURPOSE	To enhance the disseminating skills of the student about the current and contemporary research work that are being carried out across the world.							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able								
1.	To understand the research methodology adopted by various researchers	h	i	j				
2.	To mathematically model a problem, critically analyse it and adopt strategies to solve	b	c	e				
3.	To understand and present a well documented research	e	g					

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	Guidelines for conducting 15CH380L/15CH381L Seminar for B.Tech 1. Upon registering for the course the student must identify a sub-domain of the degree specialization that is of interest to the student and start collecting research papers as many as possible. 2. After collecting sufficient number of research papers the student must peruse all the papers, meet the course faculty and discuss on the salient aspects of each and every paper. 3. The course faculty, after discussion with the student will approve TWO research papers that is appropriate for presentation. 4. The student must collect additional relevant reference materials to supplement and compliment the two research papers and start preparing the presentation. 5. Each student must present a 15-minute presentation on each of the approved research paper to the panel of evaluators. 6. The presenter must present one research paper within the first half of the semester (6 weeks) and another research paper in the next half of the semester (6 weeks) as per the schedule. 7. All other students registered for the course will form the audience. 8. The audience as well as the evaluators will probe the student with appropriate questions and solicit response from the presenter. 9. The presentation will be evaluated against 7 to 8 assessment criteria by 4 to 5 evaluators. 10. The score obtained through the presentations of TWO research papers will be converted to appropriate percentage of marks. This course is 100% internal continuous assessment.		C,D	1,2,3,4	
	Total contact hours				

Course nature		**100% internal continuous assessment.**		
Assessment Method (Weightage 100%)				
In-semester	**Assessment tool**	Presentation 1	Presentation 2	**Total**
	Weightage	**50%**	**50%**	**100%**
End semester examination Weightage :				**0%**

15CH385L and 15CH386L	MASSIVE OPEN ONLINE COURSES (MOOCs) - I and MASSIVE OPEN ONLINE COURSES (MOOCs) - II	L	T	P	C
		0	0	3	2
Co-requisite:	NIL				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	P PROFESSIONAL				
Course designed by	Department of Chemical Engineering				
Approval	32nd Academic Council Meeting 23rd July 2016				

PURPOSE	To offer students the opportunity to study with the world's best universities by integrating select MOOCs in a regular degree programme and providing students full credit transfer, as per university regulations, if they earn a "Verified / Completion Certificate" and take a proctored examination through a secure, physical testing center.

INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able								
1.	To apply the concepts, theories, laws, technologies learnt herein to provide engineering solutions.	f	h	i	j			

Course nature		**Online - 100% internal continuous assessment.**				
Assessment Method (Weightage 100%)						
In-semester	**Assessment tool**	Quiz	Assignment	Non-proctored / Unsupervised Tests	Proctored / Supervised Test	**Total**
	Weightage	**25%**	**25%**	**10%**	**40%**	**100%**
End semester examination Weightage :						**0%**

Registration process, Assessment and Credit Transfer:

1. Students can register for courses offered by approved global MOOCs platforms like edX, Coursera or Universities with which SRM partners specifically for MOOCs.
2. Annually, each department must officially announce, to the students as well as to the Controller of Examinations, the list of courses that will be recognised and accepted for credit transfer.
3. The department must also officially announce / appoint one or more faculty coordinator(s) for advising the students attached to them, monitoring their progress and assist the department in proctoring the tests, uploading the marks / grades, and collecting and submitting the graded certificate(s) to the CoE, within the stipulated timeframe.
4. Student who desires to pursue a course, from the above department-approved list, through MOOCs must register for that course during the course registration process of the Faculty of Engineering and Technology, SRM University.
5. The maximum credit limits for course registration at SRM will include the MOOCs course registered.
6. The student must periodically submit the marks / grades obtained in various quizzes, assignments, tests etc immediately to the Faculty Advisor or the Course Coordinator for uploading in the university's academic module.
7. The student must take the final test as a Proctored / Supervised test in the university campus.
8. The student must submit the "Certificate of Completion" as well as the final overall Marks and / or Grade within the stipulated time for effecting the grade conversion and credit transfer, as per the regulations. It is solely the responsibility of the individual student to fulfil the above conditions to earn the credits.
9. The attendance for this course, for the purpose of awarding attendance grade, will be considered 100% , if the credits are transferred, after satisfying the above (1) to (7) norms; else if the credits are not transferred or transferable, the attendance will be considered as ZERO.

15CH390L and 15CH391L	INTERNSHIP / INDUSTRIAL TRAINING - I and INTERNSHIP / INDUSTRIAL TRAINING - II	L	T	P	C
		0	0	2	1
Co-requisite:	NIL				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	P PROFESSIONAL CORE				
Course designed by	Department of Chemical Engineering				
Approval	32nd Academic Council Meeting 23rd July 2016				

PURPOSE	To provide short-term work experience in an Industry/ Company/ Organisation							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able								
2.	To get an inside view of an industry and organization/company				j			
3.	To gain valuable skills and knowledge				j			
4.	To make professional connections and enhance networking	f	g					
5.	To get experience in a field to allow the student to make a career transition			i				

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	1. It is mandatory for every student to undergo this course. 2. Every student is expected to spend a minimum of 15-days in an Industry/ Company/ Organization, during the summer vacation. 3. The type of industry must be NOT below the Medium Scale category in his / her domain of the degree programme. 4. The student must submit the "Training Completion Certificate" issued by the industry / company / Organisation as well as a technical report not exceeding 15 pages, within the stipulated time to be eligible for making a presentation before the committee constituted by the department. 5. The committee will then assess the student based on the report submitted and the presentation made. 6. Marks will be awarded out of maximum 100. 7. Appropriate grades will be assigned as per the regulations. 8. Only if a student gets a minimum of pass grade, appropriate credit will be transferred towards the degree requirements, as per the regulations. 9. It is solely the responsibility of the individual student to fulfill the above conditions to earn the credits. 10. The attendance for this course, for the purpose of awarding attendance grade, will be considered 100%, if the credits are transferred, after satisfying the above (1) to (8) norms; else if the credits are not transferred or transferable, the attendance will be considered as ZERO. 11. The committee must recommend redoing the course, if it collectively concludes, based on the assessment made from the report and presentations submitted by the student, that either the level of training received or the skill and / or knowledge gained is NOT satisfactory.		D, I,O	1,2,3,4	
	Total contact hours				

Course nature		**Training – 100% internal continuous assessment**		
Assessment Method (Weightage 100%)				
In-semester	**Assessment tool**	**Presentation**	**Report**	**Total**
	Weightage	**80%**	**20%**	**100%**
End semester examination Weightage :				**0%**

15CH401J	PROCESS EQUIPMENT DESIGN AND DRAWING	L	T	P	C
		2	0	2	3
Co-requisite:	NIL				
Prerequisite:	15CH302, 15CH303				
Data Book / Codes/Standards	Perry's Chemical Engineers Hand Book				
Course Category	P PROFESSIONAL CORE				
Course designed by	Department of Chemical Engineering				
Approval	32nd Academic Council Meeting 23rd July 2016				

PURPOSE	Enable the students to learn the methods and practices followed in the design of process equipment's and to draw the equipment's designed to scale.

INSTRUCTIONAL OBJECTIVES		STUDENT OUTCOMES						
At the end of the course, student would be able to								
1	Apply the methods and practices followed in the design of process equipment's and draw the process equipment's used in chemical industries	a	c					
2	Improve the ability of solving process design problems	e						
3	Expose to the concept of detailed design and drawing of chemical process equipment's	a						
4	Familiarize the role of process equipment design in chemical plant design	a	c	e				

Session	Description of Topic (Theory)	Contact hours	C-D-I-O	IOs	Reference
UNIT I: BASIC CONSIDERATION IN PROCESS EQUIPMENT DESIGN		**6**			
1.	Overview of syllabus, introduction to computer aided design of equipment's and Process flow sheeting.	1	C	1-4	1,4
2.	Introduction – General design procedure, materials of construction and design considerations.	1	C	1-4	1,2,3,4
3.	Pressure vessels - classification, applications and design considerations (factors influencing the design of vessels, design pressure, design temperature, factor safety and welding joint efficiency).	2	C	1	1,2,3,4
4.	Numerical problem on design of pressure vessel subjected to internal pressure.	2	C,D	1-4	1,2,3,6
UNIT II: ENCLOSURES, FLANGES, NOZZLES AND SUPPORTS		**6**			
5.	Various types of enclosures (heads or cover) used for the pressure vessels, classifications of enclosures and their applications. Numerical Problem on various types of enclosures.	2	C, D	1-4	1,2,3,6
6.	Types of flanges, nozzles and supports used for pressure vessel, selection criteria for flanges, nozzles and supports.	2	C	1	1,2,3,6
7.	Numerical problem on flanges, nozzles and supports.	2	C,D	1-4	1,2,3,6
UNIT III: REACTION/AGITATED VESSELS, BASKET CENTRIFUGE, GRAVITY THICKENER AND CYCLONE SEPARATOR		**6**			
8.	Introduction, classification and design consideration of reaction vessel.	1	C	1-4	1,2,3,4,5
9.	Numerical problem on the design of reaction/agitated vessel.	1	C,D	1-4	1,2,3,4,5
10.	Theory and numerical problem on the design of basket centrifuge	1	C,D	1-4	1,2,3,4,5
11.	Theory and numerical problem on the design of gravity thickener	1	C,D	1-4	1,2,3,4,5
12.	Theory and numerical problem on the design of Cyclone separator	2	C,D	1-4	1,2,3,4,5
UNIT IV: HEAT EXCHANGERS, EVAPORATORS AND CRYSTALLIZERS		**6**			3.6

13.	Introduction –types of heat exchangers and numerical problem on design of shell and tube heat exchanger	2	C,D	1-4	1,2,3,4,5
14.	Theory of evaporators and numerical problem on design of single effect evaporator	2	C,D	1-4	1,2,3,4,5
15.	Theory of crystallizers and numerical problem on the design of crystallizers	2	C,D	1-4	4,5
UNIT V: DISTILLATION COLUMN, ABSORPTION COLUMN AND ROTARY DRIER		**6**			
16.	Theory and design aspects of distillation column, numerical problem on the design of distillation for binary system	2	C,D	1-4	1,2,4,5
17.	Theory and design aspects of absorption column, numerical problem on the design of absorption column.	2	C,D	1-4	1,2,4,5
18.	Theory and design aspects of rotary drier. Numerical problem on the design of rotary drier.	2	C,D	1-4	1,2,4,5
	Total contact hours	30			

Sl. No.	Drawing of process equipment's	Contact hours	C-D-I-O	IOs	Reference
1.	Flow sheeting, pressure vessel, and enclosures.	3	D	1-4	4,5
2.	Flanges, nozzles and supports.	3	D	1-4	1,3,4,5,6
3.	Agitated vessel and basket centrifuge.	3	D	1-4	1,2,4,5
4.	Gravity thickener.	3	D	1-4	1
5.	Cyclone separator.	3	D	1-4	1
6.	Heat exchangers.	3	D	1-4	1,2,4,5
7.	Evaporators.	3	D	1-4	1,2,4,5
8.	Crystallizer.	3	D	1-4	1,2,4,5
9.	Distillation and absorber column.	3	D	1-4	1,2,4,5
10.	Rotary dryer.	3	D	1-4	4
	Total contact hours	30			

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	Sinnott. R.K, Coulson & Richardson's, "Chemical Engineering", Volume 6, 3rd Edn., Butterworth Heinemann, New Delhi, 1999.
2.	Perry. R.H., et al., Perry's, "Chemical Engineers Handbook," 7th Edn., McGraw Hill, NewYork, 1997.
	REFERENCE BOOKS/OTHER READING MATERIAL
3.	Bownell, L.E., and Young, E.M., "Process Equipment Design", Wiley Eastern, 1968.
4.	Joshi. M.V, and Mahajani. V.V, "Process Equipment Design," 3rd Edn., Macmillan India Limited, New Delhi, 1996
5.	Maidargi, Suresh C., "Chemical ProcessEquipment: Design and Drawing (Vol. I)" 2nd Edn. Prentice Hall India, 2015.
6.	Bhattacharyy, B C., "Introduction to Chemical Equipment Design: Mechanical Aspects", 1st Edn. CBS Publisher, 2012

Course nature		**Theory + Practical**					
Assessment Method – Theory Component (Weightage 50%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
					End semester examination Weightage :		**50%**
Assessment Method – Practical Component (Weightage 50%)							
In-semester	**Assessment tool**	Experiments	Record	MCQ/Quiz/Viva Voce	Model examination		**Total**
	Weightage	**40%**	**5%**	**5%**	**10%**		**60%**
End semester examination Weightage :							**40%**

15CH402	PROCESS ECONOMICS AND PROJECT MANAGEMENT	L	T	P	C
		3	0	0	3
Co-requisite:	15CH401J				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	P PROFESSIONAL CORE				
Course designed by	Department of Chemical Engineering				
Approval	32nd Academic Council Meeting 23rd July 2016				

PURPOSE	This course presents the economic principles as applied in chemical engineering							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Familiarize the concepts of time value of money	d	e					
2.	Improve their ability to preparebalance sheet and profit-loss statements	d	j					
3.	Expose the essential features of selection of alternatives in process plants.	e	h	k				
4.	Familiarize concepts of the economic balance and economic analysis of process plant	d	e					
5.	Expose the importance of project management for chemical engineers	d	j	k	f	g		

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
UNIT I - INTRODUCTION		**9**			
1.	Time value of money, Equivalence	2	C	1	1,2
2.	The concepts Equivalence	1	C	1	1,2,3
3.	Equations for economic studies and Equivalence	1	C	1	1,2
4.	Amortization	2	C	1	1,2
5.	Depreciation	2	C	1	1,2,3
6.	Depletion	1	C	1	1,2,3
UNIT II - BALANCE SHEET AND COST ACCOUNTING		**9**			
7.	Capital requirements for process plants	1	C	2	1,2
8.	Balance sheet	2	C	2	1,2
9.	Earnings, process and returns (Income statement)	1	C	2	1,2
10.	Economic production - break-even analysis charts	1	C	2	1,2
11.	Cost accounting - pre construction cost estimation	2	C	2	1,2
12.	Allocation of cost	2	C	2	1,2
UNIT III - ECONOMICS OF SELECTING ALTERNATIVE		**9**			
13.	Annual cost method	2	C	3	1,2,3
14.	Present worth method	2	C	3	1,2,3
15.	Replacement: Rate of return method	2	C	3	1,2,3
16.	Replacement: Pay out time method	3	C	3	1,2,3
UNIT IV - ECONOMIC BALANCE AND ECONOMIC ANALYSIS		**9**			
17.	Economic balance in batch operations	3	C	4	1,2
18.	Economic balance in cyclic and multiple equipment units	2	C	4	1,2
19.	Economic analysis of an operating plant- Appraisal value, Earning value, Stock and Bond Value	2	C	4	1,2
20.	Economic analysis of a proposed plant – Capital requirements	1	C	4	1,2
21.	Economic analysis of a proposed plant - Estimated annual returns	1	C	4	1,2
UNIT V – PROJECT MANAGEMENT FOR CHEMICAL ENGINEERS		**9**			
22.	Introduction to the topic of project management	2	C	5	1,4,5
23.	Scoping, planning and getting approvals prior to starting physical work	2	C	5	1,4,5
24.	Contracting for engineering and construction activities	2	C	5	1,4,5
25.	Project execution with regards to health, safety,	2	C	5	1,4,5

	environment, cost, quality and schedule				
26.	Special features of small projects	1	C	5	1,4,5
	Total contact hours	45			

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	Max. S,Peters and Klaus. D Timmerhaus, "Plant Design and Economics for Chemical Engineers", 5th Edn.,McGraw Hill International Editions, New York, 2004.
2.	Schweyer. H.E, "Process Engineering Economics", McGraw Hill, 1969
	REFERENCE BOOKS/OTHER READING MATERIAL
3.	F.C. Jelen and J.H. Black, "Cost and Optimization Engineering", McGraw Hill, 3rd Edn., 1992.
4.	Paul C. Dinsmore, PMP, Jeannette Cabanis-Brewin, "The AMA Handbook of Project Management",3rd Edn.,2011
5.	Peachey B., R. Evitts and Hill G.,"Project Management for Chemical Engineers", Trans IChemE, Part D, 2007

Course nature				**Theory**			
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
End semester examination Weightage :							**50%**

15CH403J	PROCESS MODELING AND SIMULATION	L	T	P	C
		2	0	2	3
Co-requisite:	NIL				
Prerequisite:	15CH305J				
Data Book / Codes/Standards	NIL				
Course Category	P PROFESSIONAL CORE				
Course designed by	Department of Chemical Engineering				
Approval	32nd Academic Council Meeting 23rd July 2016				

PURPOSE	To acquire modeling ability and solving mathematical equations as applied to the Chemical Engineering systems							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student would be able to								
1.	To understand the terms involved in Conservation of mass, momentum and energy equations	a		d	e		k	
2.	To understand the phase equilibrium, chemical equilibrium and chemical kinetics	a						
3.	Apply conservation of mass, momentum and energy equations to Engineering problems.			d			k	
4.	To provide the training to develop model equations for Chemical Engineering systems				e			
5.	To provide the training to solve the mathematical model equations using numerical techniques			d				

Session	Description of Topic (Theory)	Contact hours	C-D-I-O	IOs	Reference
UNIT I: BASIC CONCEPTS AND MOLECULAR AND CONVECTIVE TRANSPORT		**6**			
1.	Inventory rate equation of the conserved quantities	1	C	1	1-2
2.	Definitions – Steady state, Uniform, Equilibrium and Flux	1	C	1,2	1-2
3.	Mathematical formulation of the conserved quantities (Mass, Momentum and Energy equations)	1	C,D	1-3	1-2
4.	Molecular and Convective Transport term	3	C,D	1	1-2
UNIT II: RATE OF GENERATION TERM AND STEADY STATE MACROSCOPIC BALANCES		**6**			
5.	Rate of generation in Mass transport	2	C	1	1-2
6.	Rate of generation in Momentum transport	1	C,D	1	1-2
7.	Rate of generation in Energy transport	1	C	1	1-2
8.	Steady state macroscopic balances	2	C,D	1-3	1-2
UNIT III: UNSTEADY STATE MACROSCOPIC BALANCE		**6**			
9.	Pseudo-Steady-State-Approximation	1	C	1	1-2
10.	Conservation of Chemical Species, Momentum, Energy and total Mass	2	C,D	1-3	1-2
11.	Unsteady state Energy balance around a Continuous Stirred Tank	2	C,D	1-3	1-2
12.	Design of a spray tower for the granulation of melt	1	I	4	1,2
UNIT IV: MODELING OF CHEMICAL ENGINEERING SYSTEM - I		**6**			
13.	Continuous Stirred Tank Reactor (CSTR) with constant holdup	1	C,D	4	1
14.	Continuous Stirred Tank Reactor (CSTR) with Variable holdup	1	C,D	4	1
15.	Two Heated Tank	1	C,D	3,4	1
16.	Gas phase Pressurized CSTR	1	C,D	3,4	1
17.	Multi-Component Flash Drum	2	C,D	4	1
UNIT V: MODELING OF CHEMICAL ENGINEERING SYSTEM-II		**6**			
18.	Gravity Flow Tank	1	C,D	3,4	1

19.	Non-isothermal CSTR	1	C,D	4	1
20.	Ideal Binary Distillation Column	2	C,D	4	1
21.	Batch Reactor	2	C,D	4	1
	Total contact hours	30			

Sl. No.	Description of Simulations	Contact hours	C-D-I-O	IOs	Reference
1.	Determine the molar flux from the plate surface under steady state.	3	I,O	1	2
2.	Steady state simulation of coupled CSTR reactors.	3	I,O	5	1-5
3.	Steady state simulation of Gas Phase Pressurized CSTR	3	I,O	5	1-5
4.	Steady state simulation of Multi-component Flash Drum	3	I,O	5	1-5
5.	Dynamic simulations of Gravity Flow Tank	3	I,O	5	1-5
6.	Dynamic simulation of Non-isothermal CSTR	3	I,O	5	1-5
7.	Dynamic simulation of Ideal Binary Distillation column	3	I,O	5	1-5
8.	Dynamic simulation of Batch Reactor	3	I,O	5	1-5
	Total contact hours	24			

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	William L. Luyben, Process Modeling Simulation and Control for Chemical Engineers, 2nd Edn., McGraw Hill International Editions, New York, 1990.
2.	Ismail Tosun, Modeling in Transport Phenomena – A Conceptual Approach, 2nd Edn., Elsevier Publications 2007
3.	Steven C. Chapra and Raymond P. Canale, Numerical Methods for Engineers, 6th Edn., McGraw Hill International Editions, New York, 2010
REFERENCE BOOKS/OTHER READING MATERIAL	
4.	Davis M.E., Numerical Methods and Modeling for Chemical Engineers, Wiley, New York, 1984
5.	Mickley H.S., Sherwood T.K. and Reed C.E., Applied Mathematics in Chemical Engineering, McGraw Hill, New York, 1957

Course nature				**Theory + Practical**			
Assessment Method – Theory Component (Weightage 50%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
						End semester examination Weightage :	**50%**

Assessment Method – Practical Component (Weightage 50%)						
In-semester	**Assessment tool**	Experiments	Record	MCQ/Quiz/Viva Voce	Model examination	**Total**
	Weightage	**40%**	**5%**	**5%**	**10%**	**60%**
					End semester examination Weightage :	**40%**

15CH404M	MULTI-DISCIPLINARY DESIGN	L	T	P	C
		3	0	0	3
Co-requisite:	15CH401J				
Prerequisite:	NIL				
Data Book /Codes/Standards					
Course Category	P PROFESSIONAL CORE				
Course designed by	Department of Chemical Engineering				
Approval	32nd Academic Council Meeting 23rd July 2016				

PURPOSE	Students of any specialization at an undergraduate level learn courses related to various sub-domains (Multi-disciplinary) of their specialization individually. They are not exposed to understanding how the various multi-disciplinary fields interact and integrate in real life situations. It is very common that an expert in a particular domain models and designs systems or products oblivious of the impact of other subsystems. This lack of multi-disciplinary thinking is very blatantly visible when the students take up their major project during their final year. This course aims to develop appropriate skills on systemic thinking on how to identify and formulate a problem, decompose the problem into smaller elements, coneptualise the design, evaluate the conceptual design by using scientific, engineering and managerial tools, select, analyze and interpret the data, consideration of safety, socio-politico-cultural, risks and hazards, disposal, regional and national laws, costing and financial model and undertake documentation and finally presentation.

INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able								
1.	To subdivide a complex system into smaller disciplinary models, manage their interfaces and reintegrate them into an overall system model	a	c	e	f	i	l	
2.	To rationalize a system architecture or product design problem by selecting appropriate design variables, parameters and constraints	a	c	e	f	i	l	
3.	To design for value and quantitatively assess the expected lifecycle cost of a new system or product	a	c	e	f	i	l	
4.	To take on the challenges of teamwork, prepare a presentation in a professional manner, and document all aspects of design work.	a	c	e	f	i	l	

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
1	Introduction: Facilitating Multidisciplinary Projects		C,D,I,O	1,2,3,4	1
2	Identifying and formulating a problem				
3	System Modelling				
4	Thinking perspectives: Decomposition–Composition Thinking Hierarchical Thinking, Organizational Thinking, Life-Cycle Thinking, Safety Thinking, Risk Thinking, Socio-politico-cultural thinking, Environment thinking				
5	Decomposing a system – Identifying the major sub-systems				
6	Mathematical Modeling and Governing equations for each sub systems				
7	Objectives, Constraints and Design Variables				
8	Conceptual Design				
9	Collaborative Design – Disciplinary teams satisfy the local constraints while trying to match the global constraints set by the project coordinator.				
10	Tools for modeling, designing, analysis, data interpretation, decision making etc				
11	Design Analysis, evaluation and selection				
12	Costing and Financial model				
13	Documentation, reviewing and presentation				
	Total contact hours	**45**			

LEARNING RESOURCES	
Sl. No.	**REFERENCES**
1.	**Systems Design and Engineering: Facilitating Multidisciplinary Development Projects** G. Maarten Bonnema, Karel T. Veenvliet, Jan F. Broenink December 15, 2015, CRC Press ISBN 9781498751261

Course nature		**Predominantly Practice complimented by theory**				
Assessment Method (Weightage 100%)						
In-semester	**Assessment tool**	Review 1	Review 2	Review 3	Review 4	**Total**
	Weightage	**10%**	**25%**	**25%**	**40%**	**100%**
End semester examination Weightage :						**0%**

15CH405L	CHEMICAL REACTION ENGINEERING AND PROCESS CONTROL LABORATORY - II	L	T	P	C
		0	0	2	1
Co-requisite:	NIL				
Prerequisite:	15CH311L				
Data Book / Codes/Standards	NIL				
Course Category	P Professional Core				
Course designed by	Department of Chemical Engineering				
Approval	32nd Academic Council Meeting 23rd July 2016				

PURPOSE	To develop skills in designing and conducting experiments to experimentally verify the concepts learnt in Chemical Reaction Engineering, Reactor analysis & catalysis and process dynamics, control & instrumentation courses

INSTRUCTIONAL OBJECTIVES		STUDENT OUTCOMES						
At the end of the course, student will be able to								
1.	Calculate rate equation parameters based on kinetic data	a	b					
2.	Apply design equation for batch type and flow type of reactors	a	b					
3.	Understand the functional characteristics of various controllers and system response	a	b					

Sl. No.	Description of experiments	Contact hours	C-D-I-O	IOs	Reference
1.	Study of RTD in Tubular flow reactor	3	I	3	1,2
2.	Study of RTD in Mixed flow reactor	3	I	2	1, 2
3.	Study of Mixed flow reactor followed by Tubular flow reactor	3	I	2	1,2
4.	Study of Tubular flow reactor followed by Mixed flow reactor	3	I	2	1,2
5.	Study of cascade Mixed flow reactor	3	I	2	1,2
6.	Verifying the response of non-interacting level system	3	I	3	1, 3
7.	Control valve characteristics	3	I	3	1,3
8.	P, PD, PID control of pressure control loop	3	I	3	1, 3
9.	ON-OFF control of thermal process	3	I	3	1, 3
10.	Optimum Controller Tuning on Level Process control	3	I	3	1, 3
	Total contact hours	30			

LEARNING RESOURCES	
Sl. No.	**REFERENCES**
1	Laboratory Manual
2	Octave Levenspiel, “Chemical Reaction Engineering”, 3rd edition, John Wiley & Sons India edition, 2011.
3	George Stephanopoulos, "Chemical Process Control: An Introduction to Theory and Practice", Prentice Hall, New Delhi, 1984.

Course nature				Practical		
Assessment Method (Weightage 100%)						
In-semester	**Assessment tool**	Experiments	Record	MCQ/Quiz/Viva Voce	Model examination	**Total**
	Weightage	**40%**	**5%**	**5%**	**10%**	**60%**
					End semester examination Weightage :	**40%**

15CH490L and 15CH491L	INDUSTRIAL MODULE - I and INDUSTRIAL MODULE - II	L	T	P	C
		0	0	3	2
Co-requisite:	NIL				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	P PROFESSIONAL CORE				
Course designed by	Department of Chemical Engineering				
Approval	32nd Academic Council Meeting 23rd July 2016				

PURPOSE	To impart an insight into the current industrial trends and practices							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able								
1.	To obtain an insight into the current industrial trends and practices			j				
2.	To obtain an insight into the technologies adopted by industries			j				
3.	To obtain an insight into the technical problems encountered by the industries and the scope for providing solutions.		h					
4.	To network with industry	g						

Description of Topic	**Contact hours**	**C-D-I-O**	**IOs**	**Reference**
1. The department will identify and shortlist few emerging topics that are trending in industry. 2. The department will identify experts from industry who are willing to deliver modules on the shortlisted topics. 3. The identified expert will assist the department in formulating the course content to be delivered as a 30-hour module, prepare lectures notes, ppt, handouts and other learning materials. 4. The department will arrange to get the necessary approvals for offering the course, from the university's statutory academic bodies well before the actual offering. 5. The department must officially announce, to the students as well as to the Controller of Examinations, the list of courses that will be offered as industry module. 6. The department must also officially announce / appoint one or more faculty coordinator(s) for advising the students attached to them, monitoring their progress and assist the department in proctoring/supervising/assessment the quizzes, assignments, tests etc, uploading the marks, attendance etc, within the stipulated timeframe. 7. The Student who desires to pursue a course, from the above department-approved list, must register for that course during the course registration process of the Faculty of Engineering and Technology, SRM University. 8. The maximum credit limits for course registration at SRM will include the Industry Module also. 9. All academic requirements of a professional course like minimum attendance, assessment methods, discipline etc will be applicable for this Industry Module. 10. The course will be conducted on weekends or beyond the college regular working hours.		C,D,I,O	1,2,3,4	
Total contact hours	**30**			

Course nature		**100% internal continuous assessment.**					
Assessment Method – Theory Component (Weightage 50%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
End semester examination Weightage							**50%**

15CH496L	MAJOR PROJECT	L	T	P	C
		0	0	24	12
Co-requisite:					
Prerequisite:					
Data Book / Codes/Standards					
Course Category	P PROFESSIONAL CORE				
Course designed by	Department of Chemical Engineering				
Approval	32nd Academic Council Meeting 23rd July 2016				

PURPOSE	The Major Project experience is the culminating academic endeavour of students who earn a degree in their Undergraduate Programs. The project provides students with the opportunity to explore a problem or issue of particular personal or professional interest and to address that problem or issue through focused study and applied research under the direction of a faculty member. The project demonstrates the student's ability to synthesize and apply the knowledge and skills acquired in his/her academic program to real-world issues and problems. This final project affirms students' ability to think critically and creatively, to solve practical problems, to make reasoned and ethical decisions, and to communicate effectively.

INSTRUCTIONAL OBJECTIVES		STUDENT OUTCOMES						
At the end of the course, student will be able								
1.	To provide students with the opportunity to apply the knowledge and skills acquired in their courses to a specific problem or issue.	a	c		e	f		i
2.	To allow students to extend their academic experience into areas of personal interest, working with new ideas, issues, organizations, and individuals.	a	c		e	f		i
3.	To encourage students to think critically and creatively about academic, professional, or social issues and to further develop their analytical and ethical leadership skills necessary to address and help solve these issues.	a	c		e	f	h	i
4.	To provide students with the opportunity to refine research skills and demonstrate their proficiency in written and/or oral communication skills.	a	c		e	f	g	i
5.	To take on the challenges of teamwork, prepare a presentation in a professional manner, and document all aspects of design work.			d			g	

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	1. The Major project is a major component of our engineering curriculum: it is the culmination of the program of study enabling the students to showcase the knowledge and the skills they have acquired during the previous four years, design a product/service of significance, and solve an open-ended problem in engineering. 2. Each student must register to the project course related to his or her program 3. Major Project course consists of one semester and would be allowed to register only during the final year of study. 4. The Major Project may be initiated during the pre-final semester but will be assessed and credits transferred only during the last semester of study, upon completion of all other degree requirements. Generally the undergraduate major project is a team based one. 5. Each team in the major project course will consist of maximum of 5 students. 6. Each project will be assigned a faculty, who will act as the supervisor. 7. The project shall be driven by realistic constraints like that related to economic, environmental, social, political, ethical, health & safety, manufacturability and sustainability.		C,D,I,O	1,2,3,4,5	

	8. Each group must document and implement a management structure. Group leadership roles must be clearly identified including who has responsibility for monitoring project deliverables and group coordination. 9. A group project may be interdisciplinary, with students enrolled in different engineering degrees, or in Engineering plus other faculties such as Management, Medical and Health Sciences, Science and Humanities. 10. Each student team is expected to maintain a log book that would normally be used to serve as a record of the way in which the project progressed during the course of the session. 11. Salient points discussed at meetings with the supervisor (i.e., suggestions for further meetings, changes to experimental procedures) should be recorded by the student in order to provide a basis for subsequent work. 12. The logbook may be formally assessed; 13. The contribution of each individual team member will be clearly identified and the weightage of this component will be explicitly considered while assessing the work done. 14. A project report is to be submitted on the topic which will be evaluated during the final review. 15. Assessment components will be as spelt out in the regulations. 16. The department will announce a marking scheme for awarding marks for the different sections of the report. 17. The project report must possess substantial technical depth and require the students to exercise analytical, evaluation and design skills at the appropriate level.				
	Total contact hours				

Course nature		**Project – 100 % Internal continuous Assessment**			
Assessment Method (Weightage 100%)					
In-semester	**Assessment tool**	Review 1	Review 2	**Review 3**	**Total**
	Weightage	**10%**	**15%**	**20%**	**45%**
End semester examination	**Assessment Tool**	**Project Report**	**Viva Voce**		
	Weightage :	**25%**	**30%**		**55%**

15CH351E	RENEWABLE ENERGY ENGINEERING	L	T	P	C
		3	0	0	3
Co-requisite:	NIL				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	P PROFESSIONAL ELECTIVE				
Course designed by	Department of Chemical Engineering				
Approval	32nd Academic Council Meeting 23rd July 2016				

PURPOSE	This course helps the students to understand the technology involved in the production of energy from renewable resources

INSTRUCTIONAL OBJECTIVES		STUDENT OUTCOMES						
At the end of the course, student will be able to								
1	To emphasis the importance of renewable energy sources	a						
2	To familiarize various aspects of wind energy	a	b	c				
3	To familiarize various aspects of equipment's used to collect solar energy and various applications of solar energy	a	b	c				
4	To familiarize various aspects of Bio-energy	a	b	c				
5	Other renewable energy resources and hydrogen energy, storage , transmission, fuel cell	a	b	c				

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
UNIT I INTRODUCTION		**9**			
1.	India's energy demand and supply management, energy planning methodology and man power, information needs in energy planning	2	C	1	1,2
2.	Status of global and in India's renewable resources	2	C	1	1,2
3.	Energy resources of India ,economic development, energy cropping	2	C	1	1,2
4.	Energy needs for the future, Regional prospects and stresses.	2	C	1	1,2
5.	Conservation of energy	1	C	1	1,2
UNIT II WIND ENERGY		**9**			
6.	Wind energy	1	C	2	1
7.	Availability and special features of wind energy	2	C,D	2	1,2
8.	Types of wind mills	2	C,D	2	1,2
9.	The power from the wind , performance of wind mills	2	C,D	2	1,2
10.	Modern wind energy generators	1	C,D	2	1,2
11.	Wind power farms.	1	C	2	1
UNIT III SOLAR ENERGY		**9**			
12.	Principles and brief description of equipment's and simple applications in domestic and industrial sectors of solar energy	1	C	3	1,2
13.	Solar collectors , flat plate and dish type, concentrators	2	C,D	3	1,2
14.	Photo voltaic cell	2	C	3	1,2
15.	Solar pumping, refrigeration	2	C,D	3	1,2
16.	Solar power generation	1	C	3	1,2
17.	Solar drying, stills and cooking	1	C,D	3	1,2
UNIT IV BIO-ENERGY		**9**			
18.	Energy from biomass sources of biomass and energy conversion	2	C,D	4	1,2
19.	Energy from biomass by direction combustion.	1	C,D	4	1,2
20.	Pyrolysis, gasifiers	2	C,D	4	1,2
21.	Alcohol fermentation – by anaerobic digestion	2	C	4	1
22.	Constructional features and working principle of family biogas plant	2	C,D	4	1

UNIT V OTHER RENEWABLE AND HYDROGEN ENERGY		**9**			
23.	OTEC	1	C,D	5	1,2
24.	Wave energy, tidal energy	2	C,D	5	1,2
25.	Geothermal resources	2	C,D	5	1,2
26.	Hydrogen energy, storage	2	C,D	5	1,2
27.	Fuel cell technology	2	C,D	5	1,3
	Total Contact hours	45			

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	Rai. G.D. "Non Conventional Energy Sources", Khanna Publishers, New Delhi, 1999.
REFERENCE BOOKS/OTHER READING MATERIAL	
2.	Bansal..N.KManfredKleen Man and Michael Meliss"Renewable energy sources of conversion technology", TMH Publication
3.	Kothari. P, K C, Singal and RakeshRanjan, "Renewable Energy Sources and EmergingTechnologies", PHI Pvt. Ltd.,New Delhi, 2008

Course nature				**Theory**			
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
End semester examination Weightage :							**50%**

15CH352E	INTRODUCTION TO BIOCHEMICAL PRINCIPLES	L	T	P	C
		3	0	0	3
Co-requisite:	NIL				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	P | PROFESSIONAL ELECTIVE				
Course designed by	Department of Chemical Engineering				
Approval	32nd Academic Council Meeting 23rd July 2016				

PURPOSE	This subject puts emphasis on the basic engineering principles of biochemical process. it also highlights the modern application of biotechnological process and the role of chemical engineer in biotechnological industry.

INSTRUCTIONAL OBJECTIVES		STUDENT OUTCOMES						
At the end of the course, student will be able to								
1.	Study the chronological development of bio process technology	a						
2.	Develop skills of the students in the area of microbiology particularly to identify microbes and their structure	a						
3.	Study the various media for fermentation process	a						
4.	Teach the principle and kinetics of sterilization methods	a	e					
5.	Study the stoichiometry and energetics of cell growth and product formation	a	e					
6.	Evaluate the kinetics and mechanism of microbial growth	a	e					

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
UNIT I: FERMENTATION PROCESS		**9**			
1	Definition andchronological development of biochemical processes	2	C	1	1
2	Comparison of chemical and biochemical Processes	2	C	1	1
3	Isolation, preservation and improvement of industrially important micro- organisms	3	C	2	1
4	development of inocula for industrial fermentations	2	C	2	1
UNIT II: RAW MATERIALS AND MEDIA DESIGN		**9**			
5	Selection of good medium, medium requirements for fermentation processes	2	C	3	1
6	carbon, nitrogen, minerals, vitamins and other complex nutrients, oxygen requirements	3	C	3	1
7	Designing of media for fermentation processes	2	C	3	1
8	Types of media-simple, complex and crude media, design and usage of various commercial media for industrial fermentations.	2	C	3	1
UNIT III: STERILIZATION METHOD		**8**			
9	Types sterilization	2	C	4	1,3
10	Thermal death kinetics of micro organisms	3	C	4	1,3
11	Batch and continuous sterilization of liquidmedia	2	C	4	1,3
12	Filter sterilization methods	1	C	4	1
UNIT IV: METABOLIC STOICHIOMETRY		**10**			
13	Cell growth and product formation, elemental balances, degrees of reduction of substrate and biomass available, electron balances	4	C	5	2,3
14	Yield coefficient of biomass and product formation	2	C	5	2,3
15	Maintenance coefficients	2	C	5	2,3
16	Energetic analysis of microbial growth and product formation, oxygen consumption	2	C	5	2,3

UNIT V: GROWTH KINETIC		9			
17	Phases of cell growth in batch cultures	2	C	5,6	2,3
18	Simple unstructured kinetic models for microbial growth	2	C	5,6	2,3
19	Monod model,growth of filamentous organisms	3	C	5,6	2,3
20	Cell growth in continuous culture.	2	C	5,6	2,3
	Total contact hours	45			

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	Peter F.Stanbury, Allan Whitaker, "Principles of Fermentation Technology"2nd Edition, Butterworth – Heinemann (an imprint of Elsevier), 1995.
REFERENCE BOOKS/OTHER READING MATERIAL	
2.	Michael L.Shuler and FikretKargi, "Bioprocess Engineering Basic concepts", Prentice Hall, 1992.
3.	Bailey, J.E. and Ollis, D.F. "Biochemical Engineering Fundamentals" 2nd Edition, McGraw– Hill, 1988.

Course nature				**Theory**			
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
End semester examination Weightage :							**50%**

15CH353E	ENERGY ENGINEERING AND TECHNOLOGY	L	T	P	C
		3	0	0	3
Co-requisite:	NIL				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	P PROFESSIONAL ELECTIVE				
Course designed by	Department of Chemical Engineering				
Approval	32nd Academic Council Meeting 23rd July 2016				

PURPOSE	To motivate the students by highlighting the importance of energy technology and impart understanding of energy engineering concepts and energy generation principles.							
INSTRUCTIONAL OBJECTIVES		STUDENT OUTCOMES						
At the end of the course, student will be able to								
1	Understand energy challenges and principles involved in energy engineering	a						
2	Familiarize with energy conversion technologies	a						
3	Acquire knowledge of nuclear energy, its potential in energy generation and challenges	a						
4	Familiarize with energy storage and distribution technologies	a						
5	Get exposure to energy conservation methods and awareness of developing technologies	a	h	i				

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
UNIT I: FUNDAMENTALS OF ENERGY		**9**			
1	Energy overview: a brief history of energy technology, types of energy and their interconvert ability, energy chains, energy resources, energy demand-supply network	2	C	1	1,3
2	Energy and environment-climate change-global warming and greenhouse effect, application of carbon credit, Energy-water nexus	3	C	1	1,2,3
3	Review of essential thermodynamics and fluid mechanics principles for energy engineering	4	C	1	2
UNIT II: ENERGY CONVERSION TECHNOLOGIES		**9**			
4	Types of energy conversion plants for various primary energy sources, power plants with conventional energy sources	2	C	2	1,3
5	Steam and gas-turbine power plants, integrated coal gasification combined cycle power plant	2	C	2	1,3
6	Non-conventional energy sources-mhd generators - basics, principle, open cycle and closed cycle mhd technologies, materials, applications, advantages & disadvantages.	5	C	2	1,3
UNIT III: ENERGY FROM FISSION AND FUSION		**9**			
7	Basics of nuclear fission and fusion-mechanism, concept of binding energy	2	C	3	1,2,3
8	Nuclear fission reactors-thermal reactors, fast breeder reactors -design and operation	3	C	3	2
9	Nuclear fusion- D-T fusion reactor, Requirements for nuclear fusion, plasma confinement- magnetic confinement, inertial confinement	3	C	3	2
10	Current technologies in fission and fusion, Environmental and safety considerations	1	C	3	2
UNIT IV: ENERGY STORAGE AND DISTRIBUTION		**8**			
11	Energy storage systems: mechanical - pumped hydroelectric storage, compressed air, energy storage via flywheels	2	C	4	1,3
12	Electrical- battery, fuel cells, chemical-hydrogen and	2	C	4	1,3

	others				
13	Electromagnetic energy, Thermal energy- sensible heat, latent heat, Biological	2	C	4	1,3
14	Distribution of energy	2	C	4	1,3
UNIT V: ENERGY CONSERVATION AND DEVELOPING TECHNOLOGIES		**10**			
15	Principles of energy conservation, Energy conservation approach	2	C	5	1,2,3
16	Co-generation, waste heat utilisation, heat recuperators, heat regenerators, heat pipes, stirling engine, heat pumps	4	C	5	1,2,3
17	Renewable energy devices, Pressure retarded osmosis, Kalina cycle, Triboelectric generation, current technologies	4	C	5	1,2,3
	Total contact hours	45			

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1	Rai, G.D, Non-Conventional Sources of Energy, Khanna Publishers, New Delhi, 1999.
REFERENCE BOOKS/OTHER READING MATERIAL	
2	John Andrews and Nick Jelley, Energy Science: Principles, Technologies, and Impacts, 2nd edition, Oxford University Press, 2013.
3	Rao, S.andParulakar B.B., Energy Technology, Khanna Publishers, New Delhi, 1994.

Course nature				**Theory**			
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
					End semester examination Weightage :		**50%**

15CH354E	POLYMER TECHNOLOGY	L	T	P	C
		3	0	0	3
Co-requisite:	NIL				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	P PROFESSIONAL ELECTIVE				
Course designed by	Department of Chemical Engineering				
Approval	32nd Academic Council Meeting 23rd July 2016				

PURPOSE	This course deals with different types of fuels and technology involved in the production of energy from them. Also gives an introduction to conventional energy systems.							
INSTRUCTIONAL OBJECTIVES		STUDENT OUTCOMES						
At the end of the course, student will be able to								
1	Familiarize the polymers, polymerization techniques and behavior in polymers	a	b	h	i	k		
2	Familiarize the various types of thermoplastics, thermosetting and elastomers	a	h	i				
3	Familiarize the various polymer processing techniques for polymers, rubbers and fibers	a	h	i	k			
4	impart knowledge on various testing methods and characterization of polymers	a	b	h	i	k		
5	Impart knowledge on speciality polymers	a	h	i				

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
UNIT I – INTRODUCTION		**9**			
1	Classification of Polymers	2	C	1	1,2,3
2	Chemistry of Polymerization –addition, condensation, coordination polymerization –mechanism and kinetics	3	C	1	1,2,3
3	Molecular weight &Polydispersity	1	C	1	1,2,3
4	Crystallinity– polymer single crystals, spherulitesand glass transition temperature(tg)	2	C	1	1,2,3
5	Polymerization techniques - bulk, solution, suspension and emulsion polymerisation	1	C	1	1,2,3
UNIT II: THERMOPLASTICS,THERMOSETTING AND ELASTOMERS		**9**			
6	Thermoplastic polymers – poly-olefins – vinyl polymers –-polystyrene, pmma –pan	2	C	2	1,2,3
7	Thermoplastic polymers – teflon – polyamides – polycarbonates and their applications	2	C	2	1,2,3
8	Thermosetting polymers – phenolic resins —polyesters –epoxies – polyurethanes and their applications	2	C	2	1,2,3
9	Elastomers- natural rubber – isoprene rubber	1	C	2	1,2,3
10	Synthetic rubbers - Butadiene rubber- Butyl rubber- Styrene Butadiene Rubber	1	C	2	1,2,3
11	Chloroprene rubber- Nitrile rubber–- silicone rubber	1	C	2	1,2,3
UNIT III: POLYMER PROCESSING		**9**			
12	Processing of thermoplastics and thermosetting plastics – compounding and processing aids	1	C	3	1,2,3,5
13	Compression moulding - injection moulding – extrusion moulding	2	C	3	1,2,3,5
14	Blow moulding, rotational moulding, transfer moulding	2	C	3	1,2,3,5
15	Processing of Rubbers – vulcanisation, mastication – calendaring	2	C	3	1,2,3,5
16	Reaction injection moulding – solution casting – SMC and DMC	1	C	3	1,2,3,5
17	Fibre Spinning and Drawing	1	C	3	1,2,3,5
UNIT IV: TESTING & CHARACTERISATION OF		**10**			

POLYMERS					
18	Polymer characterization tests - melt flow index, capillary rheometer test, viscosity test, GPC	2	C	4	6
19	Thermal Analysis Techniques – DSC, TGA and TMA	2	C	4	6
20	Morphology - SEM,TEM, XRD	2	C	4	6
21	Mechanical properties- tensile test, impact test, hardness	2	C	4	6
22	Electrical properties –di-electric strength & di-electric constant	1	C	4	6
23	Thermal Properties-HDT,Vicat	1	C	4	6
UNIT V: SPECIALITY POLYMERS		**8**			
24	Poly-electrolytes and ionomers	1	C	5	2,4
25	Conducting polymers –electro-luminescent polymers	2	C	5	2,4
26	High temperature polymers and polymer blends	1	C	5	2,4
27	Polymer composites and nano-composites	1	C	5	2,4
28	Interpenetrating polymer networks	1	C	5	2,4
29	Liquid crystalline polymers	1	C	5	2,4
30	Biomedical polymers	1	C	5	2,4
	Total contact hours	45			

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1	V R Gowariker, Vasant R. Gowariker, N V Viswanathan,JayadevSreedhar,"Polymer Science", New Age International, 2nd Edition
2	Joel R.Fried, "Polymer Science and Technology", PHI, Eastern Economy Edition, 2nd Edition
REFERENCE BOOKS/OTHER READING MATERIAL	
3	Billmeyer F.W., Text book of Polymer Science, 3rd edn., Wiley, Singapore, 1984
4	R.W. Dyson, Speciality Polymers, Chapman and Hall, New York, 1987
5	D.H. Morton and Jones, Polymer Processing, Chapman and Hall, London, 1989.
6	Vishu Shah, "Handbook of Plastics Testing Technology", Wiley international publication
7	Maurice Morton, Rubber Technology, Van Nostrand Reinhold, New York, 2002

Course nature		**Theory**					
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
					End semester examination Weightage :		**50%**

15CH355E	FUNDAMENTALS OF MEMBRANE PROCESSES	L	T	P	C
		3	0	0	3
Co-requisite:	NIL				
Prerequisite:	15CH207J, 15CH301				
Data Book / Codes/Standards	NIL				
Course Category	P PROFESSIONAL ELECTIVE				
Course designed by	Department of Chemical Engineering				
Approval	32nd Academic Council Meeting 23rd July 2016				

PURPOSE	To acquire knowledge on membrane based separation processes.							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Realise the nature and potential of membrane processes	a						
2.	Understand the preparation of membranes and their configurations	a	c					
3.	Familiarise with different membrane processes and their characteristics	a						
4.	Design philosophy of desalination and water treatment systems.	a						
5.	Familiarize with developing membrane processes.	a						

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
UNIT I: INTRODUCTION		**8**			
1.	Introduction to membranes – Role of membrane processes as a unit operation in chemical engineering practice- types of membranes (porous / non porous : organic/inorganic: asymmetric,definition of a membrane process – types of membrane processes (pressure / electrical / concentration driven) - classification of membrane processes -driving force-membrane type relations	2	C	1-4	1-2
2.	Membrane preparation techniques/ Flat sheet / tubular/ hollow fibre or capillary / configuration of membranes / assembly techniques in different configurations/ Relative merits – limitations of configurations.	3	C	1	1-2
3.	Transport Mechanisms through membranes	3	C,D	1	1-2
UNIT II: PRESSURE DRIVEN PROCESSES		**10**			
4.	General features of Pressure Driven Membrane Processes – classification – comparison with general filtration- Micro-filtration(MF), Ultrafiltration (UF), Nano-Filtration (NF) – pore-size - performance relationship	1	C	2	1-2
5.	Ultra-filtration – basic features – configuration – mechanism of transport – operational aspects-applications	2	C,D	2	1-2
6.	Reverse Osmosis – basic principle – characteristics of membranes used –Nano-filtration – basic principle – comparative features of NF and RO – concentration polarization - transport mechanism and equations	3	D,I	2	1-2
7.	Performance characteristics of Reverse Osmosis and Nano-filtration – solute rejection - recovery- water flux – relationship amongst them –effect of temperature – performance of lab experiments – interpretation of lab data .- application of RO and NF	4	D,I	2	1-2
UNIT III: DESIGN APPROACH FOR MEMBRANE DESALINATION		**9**			
8.	Water Chemistry Aspects – water composition – relevance to RO design – ionic balance - scaling phenomenon- calculations –pretreatment unit operations & performance - membrane pretreatment	3	C, D	4	1-2
9.	System design requirements – fixing of recovery – membrane element / module – membrane element arrangement for improving recovery and capacity- pumps and energy recovery	4	C,D,I	4	1-2

	system – post treatment				
10.	Seawater/ brackish water desalination system design-demonstration – optimizing parameters – cleaning in place	2	C,D	4	1-2
UNIT IV: MEMBRANE PROCESSES (PREFERENTIAL SOLUTE TRANSPORT)		**9**			
11.	Electrically driven membrane processes – types of membranes used - electro-dialysis – process principle – working philosophy- energy consumption – applications to brackish water and seawater desalination – comparison RO and ED.- other applications	3	C	4	1-2
12.	Electro -electro dialysis , bipolar electrolysis – process principle and application	2	D,I	4	1-2
13.	Fuel Cell basic principle and importance – types of fuel cells – constructional aspects - challenges in making a sustainable fuel cell	3	D,I	4	1-2
14.	Dialysis, hemodialysis –Process principles and Applications.	1	D,I	4	1-2
UNIT V: DEVELOPING MEMBRANE PROCESSES & SYSTEMS AND MEMBRANE APPLICATIONS		**9**			
15.	Processes using latent energy for Desalination and Water Purification- Forward Osmosis – Membrane Distillation – process principles –membrane requirements - applications – pressure retarded osmosis – concept- potential application – challenges	3	D,I	4	1-2
16.	Pervaporation – gaseous separation through membranes – basic concepts – membrane used- applications – membrane contactors - applications	3	C	4	1-2
17.	Membrane bio reactor - Hybrid membrane systems – water recovery and reuse from effluent stream – zero-liquid discharge.	3	C	4	1-2
	Total contact hours	45			

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1	MEMBRANE SEPARATION PROCESES, KaushikNathPHI learning Pvt.Ltd., New Delhi ISBN - 978-81-203-3532-5, 2012
	REFERENCE BOOKS/OTHER READING MATERIAL
2	Kirk &Othmer : Encyclopedia of Chemical Enggineering

Course nature				**Theory**			
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
					End semester examination Weightage :		**50%**

15CH356E	INDUSTRIAL POLLUTION PREVENTION AND CONTROL	L	T	P	C
		3	0	0	3
Co-requisite:	NIL				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	P PROFESSIONAL ELECTIVE				
Course designed by	Department of Chemical Engineering				
Approval	32nd Academic Council Meeting 23rd July 2016				
PURPOSE	This course presents fundamentals of Industrial pollution prevention and control aspects towards sustainable developments				

INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Familiarize with the industrial activities and fates of industrial contaminants	a	b					
2.	Expose the concept of pollution prevention, control and sustainability development	a	b	i	j			
3.	Introduce the laws and regulations pertained to pollution prevention and control	a	b	i				
4.	Emphasize the significance of different industrial pollution	a	b					
5.	Expose the concepts of air pollution control and methods	a	b	i	j			
6.	Familiarize principles of industrial water treatment methods	a	b					

Session	**Description of Topic**	**Contact hours**	**C-D-I-O**	**IOs**	**Reference**
UNIT I:INTRODUCTION		**9**			
1.	Industrial activity and environment	2	C	1	1,2
2.	Fates of Industrial Contaminants	1	C	1	1,2,3
3.	Industrialization and sustainable development	2	C	1-2	1,2
4.	Sustainability strategies	2	C	1-2	1,2
5.	Barriers to sustainability	1	C	1-2	1,2,3
6.	Pollution prevention in achieving sustainability	1	C	1-2	1,2,3
UNIT II: ENVIRONMENTAL REGULATIONS		**9**			
7.	Prevention vs control of industrial pollution	2	C	2	1,2
8.	Environment policies and Regulations to encourage pollution prevention	3	C	2-3	1,2,5
9.	Environment friendly chemical processes	3	C	2-3	1,2,6
10.	Regulations for clean environment and implication for industries	1	C	2-3	1,2
UNIT III: POLLUTION		**9**			
11.	Definition of pollutant, types of pollution	1	C	4	1,2,5
12.	Air, water, land, noise- adverse effects of pollutants eco system and human health	2	C	4	1,2,5
13.	Need for effluent treatment and toxicity, control	3	C	4	1,2,5
14.	Water standards for portable, agricultural and left-off streams- air Standards for cities, industrial areas, resorts.	3	C	4	1,2,5
UNIT IV: AIR POLLUTION CONTROL METHODS		**9**			
15.	Introduction to particulate emission control	1	C	5	1,2,4
16.	Gravitational settling chambers- cyclone separators, fabric filters	2	C	5	1,2,4
17.	Electrostatic precipitators, wet scrubbers, absorbers	2	C	5	1,2,4
18.	Control of sulphur dioxide, oxides of nitrogen, carbon monoxide and hydrocarbons.	2	C	5	1,2,4
19.	Noise pollution measurements and its control.	2	C	5	1,2,4
UNIT V: PRINCIPLES OF WATER TREATMENT		**9**			
20.	Primary, secondary and tertiary treatments	3	C	6	1,3,6
21.	Advanced waste water treatments	3	C	6	1,3,6
22.	Recovery of metals from process effluents	3	C	6	1,3,6
	Total contact hours	45			

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1	Bishop.P, "Pollution Prevention: Fundamentals and Practice", McGraw Hill International Edn., McGraw Hill Book Co., Singapore, 2000
	REFERENCE BOOKS/OTHER READING MATERIAL
2	Freeman.H.M, "Industrial Pollution Prevention Hand Book", McGraw Hill, 1995
3	James. G. Mann and Liu.Y.A, "Industrial Water Reuse and Waste Water Minimization", McGraw Hill, 1999
4	Rose.G.R.D, "Air pollution and Industry", Van Nostrand Reinhold Co., NewYork 1972
5	Pandey.G.N and Carney.G.C, "Environmental Engineering", Tata McGraw Hill, New Delhi,1989
6	Kapoor.B.S, "Environmental Engineering", 3rd Edn., Khanna publishers,1997

Course nature				**Theory**			
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
End semester examination Weightage :							**50%**

15CH357E	ENVIRONMENTAL ENGINEERING AND WASTE MANAGEMENT	L	T	P	C
		3	0	0	3
Co-requisite:	NIL				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	P | PROFESSIONAL ELECTIVE				
Course designed by	Department of Chemical Engineering				
Approval	32nd Academic Council Meeting 23rd July 2016				

PURPOSE	This subject puts emphasis on the basic engineering principles of biochemical process. it also highlights the modern application of biotechnological process and the role of chemical engineer in biotechnological industry.

INSTRUCTIONAL OBJECTIVES		STUDENT OUTCOMES						
At the end of the course, student will be able to								
1	To study the Environmental management and social issues of environment	a						
2	to develop skills about waste water management methods	a						
3	To study the various solid waste management systems	a						
4	To study waste minimization in design and operation of plant	a						
5	To study the pollution preventionStrategies in industrial process	a						
6	To evaluate the case studies of waste management in chemical process industries	a						

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
UNIT I:INTRODUCTION		**9**			
1	Environmental management system	2	C	1	3
2	Pollution control acts in India, Indian standards,	2	C	1	4
3	Environment (protection) act 1986, Air (prevention and control of pollution) act 1981, Water (prevention and control of pollution) act 1974	3	C	1	4
4	Global environmental problems-Global warming- Acid rain, Ozone depletion.	2	C	1	4
UNIT II:WASTE WATER MANAGEMENT		**9**			
5	Waste water characteristics-Domestic-Industrial, Waste water management in India-standards for pollution control	2	C	2	1,2
6	Types of waste and applicable rules in India	3	C	2	1,2
7	Waste water disposal to rivers, lakes, coastal waters, land.	2	C	2	1,2
8	Treatment and disposal strategy, Strategies for control of pollution. Environmental impact assessment.	2	C	2	1,2
UNIT III:SOLID WASTE MANAGEMENT		**9**			
9	Source of solid waste, processing methods, clean liquid & gaseous fuel from waste.	2	C	3	1,5
10	Hazards management-Hazardous waste, waste management hierarchy, Hazardous waste treatment	3	C	3	1,5
11	Nuclear pollutants-Disposal principle,	2	C	3	5
12	Disposal practices, Disposal methods.	2	C	3	5
UNIT IV:WASTE MINIMIZATION AND POLLUTION PREVENTION		**10**			
13	Waste minimization programme -compilation of effluent streams inventory, Evaluation the waste streams, Screening of the alternativebalances	3	C	4,5	6
14	Design of new processes and operation-Development of new technology, conception of technology, Definition of Technology	3	C	4,5	6
15	Minimization at operation plants-Inventory management, raw material substitution, process design and operation, effecting volume reduction	2	C	4,5	6
16	Advantage of recycling, chemical alteration.Improvements	2	C	4,5	6

	in separation process and cleaning. Pollution prevention in storage operations.				
UNIT V:WASTE MANAGEMENT IN CHEMICAL PROCESS INDUSTRIES		**8**			
17	Case study - Petroleum refining industries, Mining industries,	2	C	6	5
18	Case study - Pharmaceutical industry, Agrochemical industries.	2	C	6	5
19	Monitoring of ambient environment, including air, water and land	2	C	6	1,5
20	Noise, liquid and solid waste management	2	C	6	1,5
	Total contact hours	45			

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1	Jerry A. Nathanson., Basic Environmental Technology.,(Fifth Edition) PHI learning private Limited, New Delhi.2008.
2	Soli J Arceivala, Shyam R Asolekar., Wastewater Treatment for pollution control and reuse., (Third Edition) Tata McGraw-Hill, 2007.
REFERENCE BOOKS/OTHER READING MATERIAL	
3	N.K.Uberai.,Environmental management.(Second edition), Excel Books, New Delhi, 2003.
4	K.Raghavannambiar, Text book of Environmental studies,(second edition), Ccitech Publications (India) Pvt.Ltd.
5	S.C.Bhatia., Environmental pollution and control in chemical process industries. (Second edition), Khanna publishers, New Delhi, 2009.
6	D.Srinivasan.,Environmental Engineering. PHI Learning private Limited, New Delhi.

Course nature				**Theory**			
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
					End semester examination Weightage :		**50%**

15CH358E	ENZYME ENGINEERING	L	T	P	C
		3	0	0	3
Co-requisite:	NIL				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	P PROFESSIONAL ELECTIVE				
Course designed by	Department of Chemical Engineering				
Approval	32nd Academic Council Meeting 23rd July 2016				

PURPOSE	The course aims to provide knowledge on enzymology and kinetics of enzyme. It also highlights the industrial applicationof various enzymes.

INSTRUCTIONAL OBJECTIVES		STUDENT OUTCOMES						
At the end of the course, student will be able to								
1	To introduce the basic concepts about enzymes and mechanism of enzyme action	a						
2	To familiarize various classification enzyme	a	e					
3	To study the kinetics of enzyme action in substrate and inhibiter	a	e					
4	To provide information about immobilized enzyme systems and kinetics	a						
5	To study the Enzyme deactivation mechanisms	a						
6	To study the application of various enzyme in developing industry	a						

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
UNIT I: ENZYMES ACTION		**9**			
1	Enzyme and its Classification	3	C	2	1
2	Mechanisms of enzyme action– concept of active site and energetic of enzyme substrate complex formation	2	C	1	1,2
3	specificity of enzyme action	2	C	1	1
4	principles of catalysis – collision theory, transition state theory	2	C	1	1
UNIT II: KINETICS OF ENZYME ACTION		**10**			
5	Kinetics of single substrate reactions; estimation of Michelis-Menten parameters	3	C	1,3	1,2,3
6	kinetics plots– multisubstrate reactions mechanisms	2	C	1,3	1
7	Inhibiter–types of inhibition mechanism–competitive	2	C	3	1,3
8	Uncompetitive and Noncompetitivemechanism–comparisation of mechanism.	3	C	3	1,3
UNIT III: ENZYME IMMOBILISATION TECHNOLOGY		**9**			
9	Types – adsorption, matrix entrapment, encapsulation, cross linking	3	C	4	1,2,3
10	covalent binding; advantages and disadvantages of different immobilization techniques	2	C	4	1,2,3
11	immobilization enzyme kinetics:effects of external mass-transfer resistance, analysis of intraparticle diffusion and reaction	2	C	1,4	2,3
12	simultaneous film and intraparticle mass-transfer resistances	2	C	4	2,3
UNIT IV: DEACTIVATION ENZYME KINETICS		**8**			
13	Enzyme kinetic for reversible enzyme modulator	2	C	5	2
14	the effect of pH and temperature on enzyme activity	2	C	5	2,3
15	Enzyme deactivation: mechanisms and manifestations of protein denaturation	2	C	5	2
16	deactivation models and kinetics	2	C	5	2
UNIT V: APPLICATIONS OF ENZYME		**9**			
17	Application of enzyme in analysis	2	C	6	1,2

18	Design of enzyme electrodes and their application as biosensors in industry	3	C	6	1,2
19	Application of hydrolytic enzyme- non-hydrolytic enzyme	2	C	6	1,2
20	Enzyme used in current and developing industry.	2	C	6	1,2,3
	Total contact hours	**45**			

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1	Palmer, Trevor "Enzymes : Biochemistry, Biotechnology, Clinical Chemistry", Affiliated East-West Press Pvt. Ltd., 2004
	REFERENCE BOOKS/OTHER READING MATERIAL
2	Bailey, J.E. and Ollis, D.F. "Biochemical Engineering Fundamentals" 2nd Edition, McGraw– Hill, 1988.
3	Michael L.Shuler and FikretKargi, "Bioprocess Engineering Basic concepts", Prentice Hall, 1992.

Course nature		**Theory**					
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
End semester examination Weightage :							**50%**

15CH359E	FUELS AND COMBUSTION	L	T	P	C
		3	0	0	3
Co-requisite:	NIL				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	P PROFESSIONALELECTIVE				
Course designed by	Department of Chemical Engineering				
Approval	32nd Academic Council Meeting 23rd July 2016				

PURPOSE	This course deals with different types of fuels and technology involved in the production of energy from them. Also gives an introduction to conventional energy systems.

INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1	To familiarize the various process of solid fuels	a	h	i	k			
2	To familiarize the liquid fuels and processes like crude oil distillation, cracking in the petroleum industries	a	h	i	k			
3	To familiarize the gaseous fuels and also to know about gasification, gasifiers	a	h	i	k			
4	To familiarize the general concepts of combustion in solid, liquid and gaseous fuelsand combustion calculations	a	b	c	h	i	k	
5	To familiarize the combustion equipments	a	h	i	k			

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
UNIT I – SOLID FUELS		**9**			
1	Introduction -– Solid fuels - Origin of Coal - Rank of coal – Composition - Analysis and Properties	2	C	1	1
2	Storage of Coal	1	C	1	1
3	Washing of coal	2	C	1	1
4	Pulverization – Briquetting	1	C	1	1
5	Carbonization of coal -Low Temperature and High Temperature	2	C	1	1
6	Hydrogenation and liquefaction of coal - Applications of coal	1	C	1	1
UNIT II: LIQUID FUELS		**9**			
7	Introduction – Liquid fuels - Origin of Petroleum – Composition - Classification of crude oil	1	C	2	1
8	Pretreatment process of crude	1	C	2	1
9	Processing of crude oil distillation -Single Stage, Two-Stage and Three-Stage	2	C	2	1
10	Crude oil breakdown processes - Cracking, Vis-breaking and Coking	3	C	2	1
11	Properties of petroleum products and application	2	C	2	1
UNIT III: GASEOUS FUELS		**9**			
12	Introduction – Gaseous fuels –Wood gas, Gobar gas, Sewage Gas, Natural gas – LPG	2	C	3	1
13	Manufacturing process of Water gas	1	C	3	1
14	Manufacturing process of Producer gas	1	C	3	1
15	Coal gas from coal Gasification process -Lurgi, Winkler and Kopper-Totzek process and	2	C	3	1
16	Second generation gasifiers	2	C	3	1
17	Oil gas from oil gasification process	1	C	3	1
UNIT IV: COMBUSTION STOICHIOMETRY		**9**			
18	Distinct features of combustion of solid, liquid and gaseous fuels	1	C	4	1,2
19	Determination of gross and net calorific value –Calorific value by Dulong's Formula	1	C,D	4	1,2
20	Stoichiometry- Mass basis and volume basis	2	C,D	4	1,2
21	Excess air calculation	2	C,D	4	1,2

22	Fuel and flue gas compositions – Calculations	2	C,D	4	1,2
23	Combustion processes -Stationary flame - Surface or flameless combustion – Submerged combustion - Pulsating and slow combustion -Explosive combustion	1	C	4	1,2
UNIT V: COMBUSTION EQUIPMENTS		**9**			
24	Combustion of solid fuels –Grate firing system	1	C	4,5	2
25	Pulverized fuel firing system- pulverized coal burners	2	C	4,5	2
26	Burners for liquid fuel combustion –Vaporising oil burners, atomizing oil burners	3	C	4,5	2,3
27	Burners used for gaseous fuels firing	2	C	4,5	2
28	Fluidized bed combustion of solid fuels	1	C	4,5	2,3
	Total contact hours	45			

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1	O.P. Gupta , "Fuels, Furnaces and Refractories" , Khanna Publishers, 6thEdition, 2014
2	S.P. Sharma and Chandramohan, "Fuels and Combustion", Tata McGraw-Hill, 1987
	REFERENCE BOOKS/OTHER READING MATERIAL
3	Civil Davies, Calculation in Furnace Technology, Pergamon Press.
4	Samir Sarkar, "Fuels and Combustion", Orient Longman, 3rd Edition

Course nature		**Theory**					
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
					End semester examination Weightage :		**50%**

15CH360E	FERTILIZER TECHNOLOGY	L	T	P	C
		3	0	0	3
Co-requisite:	NIL				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	P PROFESSIONALELECTIVE				
Course designed by	Department of Chemical Engineering				
Approval	32nd Academic Council Meeting 23rd July 2016				

PURPOSE	To provide an adequate mastery of leading practices and their Physio-chemical foundations involved in the production of various types of fertilizers.							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student willable to								
1	identify reactions and unit operations steps involved in the manufacturing of various fertilizers	a						
2	Characterize the fertilizers on the basis of different properties.	a						
3	Identify engineering problems in fertilizer manufacturing.	a	e					
4	Handle the fertilizers.	a						
5	Select appropriate synthetic fertilizer.	a						

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
UNIT I: INTRODUCTION		**9**			
1	Role of organic manures and Chemical Fertilizers,	2	C	1-4	1,2
2	Types of Chemical fertilizers,	2	C	1-4	1,2
3	Growth of fertilizer industry in India, their location,	2	C	1-4	1
4	Energy consumption in various fertilizer processes,	1	C	1-4	1
5	Materials of various fertilizer processes,	1	C	1-4	1
6	Materials of consumption in fertilizer industry.	1	C	1-4	1
UNIT II: NITROGENOUS FERTILIZERS		**9**			
7	Feed stock for production of Ammonia,	1	C	1-4	1,2
8	Natural gas, Associated gas, Coke oven gas,	2	C	1-4	1,2
9	Methods of Production, characteristics and specification, storage and handling - Ammonium sulphate, Ammonium Nitrate	2	C,D	1-5	1,2
10	Urea	2	C,D	1-5	1,2
11	Calcium Ammonia Nitrate,	1	C,D	1-5	1,2
12	Ammonium chlorides	1	C,D	1-5	1,2
UNIT III: PHOSPHATE FERTILIZERS		**9**			
13	Raw materials for the manufacture of Phosphate fertilizer - Phosphate Rock, Sulphur, Pyrites etc	1	C,D	1-4	1,3
14	Processes for the production of Sulfuric and Phosphoric acid	2	C,D	1-5	1,3
15	Phosphatic fertilizers - ground Rock Phosphate, Bone Meal	2	C,D	1-5	1,2
16	Methods of production, characteristics and specifications for single superphosphate,	2	C,D	1-5	1
17	Triple superphosphate	2	C,D	1-5	1
UNIT IV: POTASH FERTILIZERS		**9**			
18	Methods of production, Characteristics and specifications for complex fertilizers,	2	C,D	1-5	1
19	Methods of production of Ammonia phosphate sulphate, Di-ammonium phosphate and	2	C,D	1-5	1
20	Nitrophosphates.	1	C,D	1-5	1,2
21	NPK Fertilizers: Urea Ammonium Phosphate, Monoammonium Phosphate and	2	C,D	1-5	1,2
22	Various grades of NPK fertilizers produced in the country	2	C	1-4	1
UNIT V: MISCELLANEOUS FERTILIZER		**9**			
23	Mixed fertilizers, granulated mixtures,	2	C,D	1-5	1
24	Bio-fertilizers	2	C,D	1-5	3

25	Secondary & Micro Nutrients, Fluid Fertilizers,	2	C	1-5	1
26	Controlled release fertilizers	1	C	1-4	3
27	Pollution from fertilizer industry, solid, liquid and gaseous pollution standard laid down for them.	2	C	1-4	1
	Total contact hours	45			

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1	Hand book of Fertilizer Association of India, New Delhi, 1998
	REFERENCE BOOKS/OTHER READING MATERIAL
2	Slack A.V., Chemistry & Technology of Fertilizers, Interscience, New York, 1967
3	NPTEL Notes-IITM/Fertilizer Technology

Course nature		**Theory**					
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
					End semester examination Weightage :		**50%**

15CH361E	PETROLEUM REFINING TECHNOLOGY	L	T	P	C
		3	0	0	3
Co-requisite:	NIL				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	P PROFESSIONAL ELECTIVE				
Course designed by	Department of Chemical Engineering				
Approval	32nd Academic Council Meeting 23rd July 2016				

PURPOSE	This course explains thermal cracking, catalytic cracking and multi component distillation operations involved with petroleum refining industries, in addition to storage and transportation of petroleum products.

INSTRUCTIONAL OBJECTIVES		STUDENT OUTCOMES						
At the end of the course, student will be able familiarized in the								
1	Petroleum refining and thermal cracking processes	a	e					
2	Catalytic cracking and catalytic reforming processes	a						
3	Petroleum compounds treatment methods	a	e					
4	Production of fuels such as aviation gasoline, motor fuel, kerosene, jet fuel	a						
5	Storage and transportation of petroleum products	a						

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
UNIT I: - THERMAL CRACKING AND THERMAL REFORMING		**9**			
1	Origin occurrence of petroleum, Formation and Evaluation of Crude Oil.	2	C	1	1,2
2	Testing of Petroleum Products. Petroleum refining processes,	2	C	1	1,2
3	General processing, topping and vacuum distillations	2	C,D	1	1,2
4	Thermal cracking in vapor, liquid and mixed phase.	2	C	1	1,2
5	Overview of Refinery Products	1	C	1	1,2,3,4
UNIT II: - CATALYTIC CRACKING AND CATALYTIC REFORMING		**9**			
6	Catalytic cracking - houdry fixed bed, fluidized bed, T.C.C. Houder flow etc.	3	C,D	2	1,2,3,4
7	Catalytic reforming - conversion of petroleum gases into motor fuel with specialreference to alkylation,	3	C,D	2	1,2,3,4
8	Polymerization, hydrogenation and dehydrogenation.	3	C	2	1,2,3,4
UNIT III: TREATMENT TECHNIQUES		**9**			
9	Treatment Techniques:	2	C	3	1,2,3
10	Removal of Sulphur Compounds in all Petroleum Fractions to improve performance,	2	C,D	3	1,2,3
11	Destruction of Sulphur Compounds and Catalytic	2	C,D	3	1,2,3
12	Desulphurization, Solvent Treatment Processes,	2	C,D	3	1,2,3
13	Dewaxing, Clay Treatment and Hydrofining.	1	C,D	3	1,2,3
UNIT IV: PRODUCTION OF FUELS		**9**			
14	Production of aviation gasoline, motor fuel, kerosene,	3	C,D	4	1,2,3
15	diesel oil, tractor fuel and jet	3	C,D	4	1,2,3
16	fuel, hydrodesulfurisation, Lubricating oil manufacture,	2	C,D	4	1,2,3
17	Petroleum waxes andasphalts.	1	C	4	1,2,3
UNIT V: - STORAGE AND TRANSPORTATION		**9**			
18	Octane number, Cetane number, Diesel index, their determination and importance	3	C	5	1,2,4
19	Storage of petroleum products: tanks, bullets, special types of spheres etc.	3	C	5	1,2,4
20	Transportation of petroleum products: road, rail, sea and pipeline; Importance of pipeline transportation.	3	C	5	1,2,4

	Total contact hours	45

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1	BhaskaraRao. B.K., "Modern Petroleum Refining Process", 3rd Edn., Oxford & IBH, New Delhi, 1984
	REFERENCE BOOKS/OTHER READING MATERIAL
2	Nelson W.L. "Petroleum Refinery Engineering", 4th Edn., McGraw Hill, New York, 1958
3	Watkins. R. N. "Petroleum Refinery Distillations", 2nd Edition, Gulf Publishing Company, Texas, 1981.
4	Hobson. G. D. "Modern Petroleum Refining Technology", 4th Edition, Institute of Petroleum, U. K. 1973.

Course nature		**Theory**					
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
					End semester examination Weightage :		**50%**

15CH362E	PRINCIPLES OF DESALINATION TECHNOLOGIES	L	T	P	C
		3	0	0	3
Co-requisite:	NIL				
Prerequisite:	15CH355E				
Data Book / Codes/Standards	NIL				
Course Category	P PROFESSIONAL ELECTIVE				
Course designed by	Department of Chemical Engineering				
Approval	32nd Academic Council Meeting 23rd July 2016				

PURPOSE	To acquire knowledge on Desalination Technologies							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1	Understand the relevance and need for desalination	a						
2	Learn the science behind desalination	a	c					
3	Correlate the core curriculum to practical applications	a						
4	Understand the techniques and technologies of desalination	a						
5	Learn to select the right type of desalination system for a given location and purpose.	a						

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
UNIT I: INTRODUCTION		**9**			
1	Water Scenario around the world and India – need and relevance of desalination - water sources for desalination – typical seawater composition – brackish water compositional changes- contaminants: anthropogenic and geogenic- drinking water standards – WHO and Indian Standards – Mineral Water standards (indian)	3	C	1-4	1-7
2	Desalination –meaning and description – relation to natural components of desalination - general description- minimum energy requirement – review of fundamentals of physical chemistry aspects relevant to desalination, solution properties – estimating the minimum energy requirement - based concept of de-mixing – exergy - estimation from colligative properties - Performance assessment parameters for desalination for thermal and membrane	3	C	1	1,3,4,6
3	Different types of Desalination techniques basic resources required for desalination – energy options – relative characteristics of different types of energy options.	3	C,D	1	1,3,4,6
UNIT II: MEMBRANE DESALINATION		**9**			
4	General features of Pressure Driven Membrane Processes – classification –Micro-filtration(MF) Ultrafiltration (UF), Nano-Filtration (NF) – pore-size - performance relationship	1	C	2	1,3,4,6
5	Pretreatment System – Need and relevance – different unit operations including membrane pretreatment (UF) – scaling calculations – dosing systems – treated water quality monitoring – SDI concept.	2	C,D	2	1,3
6	Reverse Osmosis – basic principle – characteristics of membranes used –Nano-filtration – basic principle – comparative features of NF and RO – concentration polarization - transport mechanism and equations (no derivation required)- energy recovery	3	D,I	2	1,3,
7	Performance characteristics of Reverse Osmosis and Nano-filtration – solute rejection - recovery- water flux – relationship amongst them –effect of temperature – performance of lab experiments – interpretation of lab data .- application of RO and NF for desalination	3	D, I		

UNIT III: THERMAL DESALINATION		**9**			
8	Basic Components of thermal Desalination – Heat Source – Sensible heat vs latent heat for use in desalination – features of isothermal and adiabatic processes. Thermodynamic properties – pressure vs temperature for steam, change of latent, Cp and BPE with temperature. – corrosion of materials and normal material of construction.	3	C,D,I	4	2,5,7
9	Description of Flashing and Boiling: single effect evaporation and flashing – Need for multiple effects / stages – accessories for thermal desalination – ejectors – demisters - vacuum systems – pretreatment systems - Pumps	3	C,D,I	4	2,5,7,1
10	Principles of MSF/ MED : MED with TVC and MVC : Basic design considerations for thermal systems – operational features	3	C,D	4	2,5,7
UNIT IV:NON CONVENTIONAL DESALINATION SYSTEMS		**9**			3.6
11	Membrane based Systems :Electrodialysis, Membrane Distillation, Forward Osmosis.- Basic Principles – performance characteristics – Energy requirements – Challenges	3	C	4	7
12	Low temperature thermal desalination including ocean thermal energy and waste heat – Solar desalination including solar stills, solar thermal and solar photovoltaic – limitations and advantages.	3	D,I	4	1
13	Hybrid Desalination systems, combined power and water dual purpose plants – examples of working desalination plants.	3	D,I	4	4,5
UNIT V: SOCIETAL, COMMERCIAL, ECONOMICS AND ENVIRONMENTAL ASPECTS		**9**			
14	Selection of Desalination System – considerations based on capacity – local resources (including power, water etc.)– ultimate use – scale up – brackish water systems – considerations for societal cause / industrial water recycle	3	D,I	4	3,4
15	Economic Aspects of Desalination – water cost calculation – capital cost/operating costs – feasibility analysis-	3	C	4	4
16	Environmental issues –challenges – spent membrane disposal- discharge concentrated stream – use of concentrate stream – recovery of values.	3	C	4	2,3
	Total contact hours	45			

LEARNING RESOURCES	
Sl. No.	
	REFERENCE BOOKS/OTHER READING MATERIAL
1	Fundamentals of Salt Water Desalination: Hisham T. El-Dessouky and Hisham M. Ettouney, ISBN: 978-0-444-50810-2 Elsevier (2009)
2	A Desalination Primer: Introductory Book for Students and Newcomers to Desalination :K.S.Spiegler and Y.M. El-Sayed, ISBN 086689 034 3, Desalination Publications Elsevier (1994)
3	Kirk &Othmer :Encyclopaedia of Chemical Technology

Course nature				**Theory**			
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
					End semester examination Weightage :		**50%**

15CH363E	SAFETY AND HAZARD ANALYSIS IN PROCESS INDUSTRIES	L	T	P	C
		3	0	0	3
Co-requisite:	NIL				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	P PROFESSIONAL ELECTIVE				
Course designed by	Department of Chemical Engineering				
Approval	32nd Academic Council Meeting 23rd July 2016				

PURPOSE	This course helps the students to understand the various aspects of Industrial safety and occupational hazards existing in chemical industries.							
INSTRUCTIONAL OBJECTIVES		STUDENT OUTCOMES						
At the end of the course, student will be able to								
1	To familiarize Basics of Industrial Safety Management	a						
2	Various aspects of Chemical plant safety	a						
3	Various aspects of Industrial accidents and Fire safety	a						
4	Hazard identification techniques	a						
5	Various aspect of industrial hygiene and Occupational Health hazards, Safety legislation in chemical industries.	a						

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
UNIT I - INDUSTRIAL SAFETY MANAGEMENT		**9**			
1	Importance of Safety consciousness in Indian Chemical Industries - Development of Industrial Health and Safety,	2	C	1-5	1-2,5,6
2	Safety Organization –Polices-Culture -Planning- Promotion – Inspection –Rules- Responsibility – Supervision,	2	C	1	1,2,5
3	Safety Committee – role of safety functionaries,	1	C	1	1,2,5
4	Elements of work place Safety Program, Economic and Social Benefits from Safety Program-	2	C	1	1,2,5
5	Effective Safety Education and Training – Communication at various levels of production and operation, Safety slogans	2	C	1	1,2,5
UNIT II - CHEMICAL PLANT SAFETY		**9**			
6	Chemical process Industries - Setting and Layout of a Chemical plant,	1	C	2	1,2
7	Safety in transportation, storage and handling of hazardous chemicals,	1	C	2	1,2,5
8	Chemical process hazards and their control - First degree and second degree hazards. Lines of defense	1	C	2	1,2,5,
9	High pressure - High temperature operations – Case studies,	1	C	2	1,2,5
10	Emergency preparation: On-site and Offsite	1	C	2	1,2,5
11	Safety aspects of maintenance in chemical plant	1	C	2	1,2,5
12	Effective steps to implement safety procedures-Periodic Advice and checking to follow safety procedures and rules	1	C	2	5
13	Safe guarding of Machines – Ergonomics	1	C	2	5
14	Proper selection and replacement of handling equipment -Safe handling and operation of materials and machineries	1	C	2	1,2,3,5
UNIT III - ACCIDENT AND THEIR PREVENTION		**9**			
15	Definitions, H.W.Henrich, Frank bird & Multiple Causation theories of accident occurrences, Classification, Causes, Costs	1	C	3	1,2
16	Industrial accidents, Principles of Accident prevention, Accident prevention technique	1	C	3	1,2
17	Plant and Chemical job safety analysis, Accident proneness-vocational guidance	1	C	3	1,2,5,6
18	Safety performance measurement tools - FR. SR, (FSI), Safe-T-Score, Accident rate per 1000 workers,	1	C	3	1,2,4

19	Disabling injury index, Accident Compensation Statutes	1	C		3,4
20	Accident Investigation reporting and Analysis	1	C	3	5,6
21	Case studies	1	C	3	6
22	Conditions -Fire triangle- Classification of fires, Common causes of industrial fires, Fire protection systems- prevention	1	C	3	5,6
23	Case studies, Safety in Explosive	1	C	3	6
UNIT IV - HAZARD IDENTIFIATION TECHNIQUES		**9**			
24	Safety Appraisal - Risk Assessment -Hazard identification techniques with examples such as FMEA, CMA, Fault Tree Analysis	2	C	4	4
25	Preliminary Hazard Analysis (PHA), Hazard and operability (HAZOP) study	2	C	4	4
26	Quantitative risk analysis-Out line of methodology, Consequences analysis (Calculation of release rates of liquids under ambient pressure and liquids under pressure, Calculation of dispersion of released gases and vapors and platting of equal concentration contours)	1	C	4	4
27	Dow (Index) Fire and Explosion Index	2	C	4	5,6
28	System of Risk Analysis	1	C	4	5,6
29	Safety Audit.	1	C	4	5,6
UNIT V - INDUSTRIAL HYGIENE AND OCCUPATIONAL HEALTH HAZARDS		**9**			
30	Concepts - Industrial and Occupational health hazards, Housekeeping, human factors and error, stress at work,	1	C	5	1,2
31	Personnel protective equipments, Role of trade unions in Industrial safety and health	2	C	5	1,2,5
32	SAFETY AND LAW Introduction to ILO,	1	C	5	4
33	Safety legislation in India, Factories act 1948,	1	C	5	4
34	Employees welfare and legislation , Provisions relating to safety , health & environment in other important legislations	1	C	5	4
35	Indian boilers act and regulations, Indian electricity act and rules	1	C	5	4
36	Indian explosives act and rules, Mines act, Petroleum act and rules	1	C	5	4
37	Environmental protection act.	1	C	5	4
	Total contact hours	45			

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	Sharma. A M "Safety and Health in Industry" -A Hand book, BS Publications , 2009
2.	Fulekar. M.H, "Industrial Hygiene and Chemical Safety", I.K International Publishing house Pvt Ltd., 2006.
	REFERENCE
3.	Fawcett .H.H, and Wood .W.S, Safety and Accident Prevention in Chemical Operations, John Wiley & sons, U.S.A.,1965
4.	Willie Hammer &Dennis Price, Occupational safety management and Engineering, Prentice Hall, 2001
5.	William Handley, Industrial safety hand book, McGraw- Hill, 1969
6.	Daniel. A, Crowl& Joseph. F Louvar Chemical Process safety: fundamentals with applications, Prentice Hall international series

Course nature				**Theory**			
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
					End semester examination Weightage :		**50%**

15CH364E	AIR POLLUTION CONTROL ENGINEERING	L	T	P	C
		3	0	0	3
Co-requisite:	NIL				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	P PROFESSIONAL ELECTIVE				
Course designed by	Department of Chemical Engineering				
Approval	32nd Academic Council Meeting 23rd July 2016				

PURPOSE								
INSTRUCTIONAL OBJECTIVES This course makes the students knowledgeable in various safety methods used to control air pollution in chemical industries.		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Understand the Effect of pollution on Human Health and the necessity to control the pollutants.	a						
2.	Know how to Measure the Concentration of the pollutants by Models and Experiments	a						
3.	Different types of pollutants available and their control	a						
4.	Know how to Control the Oxides of Sulphur, Nirogen	a						
5.	Anayse the Effect of Pollutants on Atmosphere	a						

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
UNIT 1 EFFECT OF AIR POLLUTION		**9**			
1	Introduction to Air pollution Control : History Air pollution control	3	C	1	1
2	Air pollution effects : Effect of Air pollution on Human Health	3	C	1	1
3	Air pollution Control Laws and regulations, Air control Philosophies	3	C	1	1
UNIT 2 ESTIMATION OF CONCENTRATION OF POLLUTANTS		**9**			
4	Air pollution measurements, Emission Estimates : Representative Samples, Concentration determination, Standard Analytical Methods, Emission factor, Visible emission	3	C	2	1
5	Meteorology for Air pollution Control Engineers : Horizontal Atmospheric motion, Vertical Atmospheric Motion, Wind velocity and direction, Temperature Inversions, Fumigations, Stagnations	3	C	2	1
6	Air pollutant Concentration Models: Fixed – Box Models, Diffusion Models, Long Term Average Uses of Gaussian Plume Models, Multiple Cell Models, Receptor – Oriented and Source Oriented Air pollution Models	3	C	2	1
UNIT 3 AIR POLLUTION CONTROLLING EQUIPMENTS		**10**			
7	General ideas in Air Pollution Control: Minimizing Volumetric Flow rate and pressure drop – Efficiency, Penetration, Decontamination factor, Homogeneous and Non homogeneous Pollutants, Volume and Composition of Combustion Products	3	C	3	1,2
8	The nature of Particulate Pollutants : Primary and Secondary Particulates, Settling Velocity and Drag forces,Paricle Size Distribution Functions, Behavior of Particles in the Atmosphere	3	C	3	1,2
9	Control of Primary Particulates : Wall Collection devices, Dividing Collection Devices	4	C	3	1,2.3
UNIT 4 CONTROL OF OXIES OF SULPHUR, NITROGEN AND HYDROCARBONS, CARBON DI OXIDE		**9**		C	

10	Control of Volatile Organic Compounds (VOC): Vapour Pressure, Equilibrium VapourContent,Evaporation , VOCs, Control Alternatives	2	C	4	1,2
11	Control of Sulfur Oxides : Overview of Sulphur Problem, Removal of reduced Sulphur Compounds from Petroleum and Natural Gas streams,Removal of Sulphur dioxide from Rich,Lean Waste Gases Alternatives to "Burn and Then Scrub"	3	C	4	1,2
12	Control of Nitrogen Oxides : Overview of Nitrogen Oxides Problem, Control of Nitrogen Oxide Emissions	2	C	4	1,2
13	Control of Hydrocarbon and Carbon di oxide	2	C	4	1,2
UNIT 5 EFFECT OF AIR POLLUTANT TO ATMOSPHERE		**8**		C	
14	The motor Vehicle Problem : Overview of the problem of Air Pollution from Motor Vehicles, Internal Combustion Engines, Diesel Engines, Gas Turbine Engines	5	C	5	1
15	Air pollutants and Global Climate : Global Warming,Stratospheric Ozone Depletion and Chloroflurocarbons, Acid rains	3	C	5	1
	Total contact hours	45			

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1	Noel De Nevers "Air Pollution Control Engineering" Internationa Editions 1995 MaGraw – Hill,Inc.
2	Bhartia.S.C "Environmental Pollution and Control in Chemical Process Industries"
	References
3	Perry and Chilton (Editors) "Perry's Chemical Engineer's Hand book

Course nature				**Theory Elective**			
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
End semester examination Weightage :							**50%**

15CH365E	FINE CHEMICALS TECHNOLOGY	L	T	P	C
		3	0	0	3
Co-requisite:	NIL				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	P | PROFESSIONAL ELECTIVE				
Course designed by	Department of Chemical Engineering				
Approval	32nd Academic Council Meeting 23rd July 2016				

PURPOSE	This course explains the importance of fine chemicals, their formulation and manufacturing processes.							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1	Understand the basic fundamentals and various unit operation	a						
2	Provide the basic concepts and principles in designing of equipments	a	e					
3	Impart the knowledge of various parameters involved in the formulation and development of various dosage forms.	a						
4	Familiarize the concept of the pharmaceutical industrial manufacturing practices, quality attributes of pharmacy products	a	k					

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
UNIT – I INTRODUCTION OF FINE CHEMICALS AND BULK DRUGS		**10**			
1	Characteristic features of fine chemicals manufacture	1	C	1	1,2,6
2	Catalysis in fine chemistry, selectivity Engineering	1	C	1	1,2,6
3	Process development, separation methods, Production plants	1	C	1	1,2,6
4	Concept of fine and Bulk drugs and their manufacture	1	C	1	1,2,6
5	Evolution of process, Process selection: process profile analysis	1	C	1	1,2,6
6	Factors influencing Process choice: cleaner and safer technologies	1	C	1	1,2,6
7	The role of catalysis in waste minimization	1	C	1	1,2,6
8	Research and development strategies in pharmaceutical industries	1	C	1	1,2,6
9	Basic drug formulation, Radiopharmaceuticals	2	C	1	1,2,6
UNIT II : UNIT PROCESSES		**8**			
10	Chemical conversion processes- Alkylation, Carboxylation, Condensation & Cyclisation	3	C	1,4	2,4
11	Dehydration, Esterification , Halogenation	2	C	1,4	2,4
12	Oxidation, Sulfonation	1	C	1,4	2,4
13	Complex Chemical conversions	1	C	1,4	2,4
14	Industrial Fermentation products	1	C	1,4	2,4
UNIT III: BULK DRUGS		**9**			
15	Raw Materials	1	C,D	3	2,4,6
16	Production Techniques	1	C,D	3	2,4,6
17	Reaction Flow Sheet	1	C,D	3	2,4,6
18	Equipments	2	C,D	3	2,4,6
19	Utilities for the production of drugs below – Paracetamol, Aspirin, Ibuprofen , Diazepam, Darvon, Niacinamide , Chloramphenicol and Erythromycin, Antimicrobial agent.	4	C,D	3	2,4,6
UNIT lV: DRUGS FORMULATION DEVELOPMENT		**10**			
20	Formulation and Pre-formulation development – Solid and Semi-solid dosage forms	1	C,D,I	1,2	2
21	Tablet formulation techniques, Compressed tablets	1	C,D,I	1,2	2,6
22	Capsules	1	C,D,I	1,2	2,6

23	Polymers and Powder formulation	1	C,D,I	1,2	2,6
24	Milling process	1	C,D,I	1,2	2,6
25	Granulation Techniques –Wet and Dry Granulation	1	C,D,I	1,2	2
26	Coating techniques in drugs	1	C,D,I	1,2	2,6
27	Topical formulation –cutaneous and Inhaled	1	C,D,I	1,2	2,6
28	Polymeric nanoparticles formulation methods and Targeting	1	C,D,I	1,2	7
29	Microparticles synthesis for drug delivery system	1	C,D,I	1,2	7
UNIT V :PRODUCTION PLANTS		**8**			
30	Types of production plants-Dedicated ,multipurpose and mixed plants	2	C,D,O	4	1,3,5
31	Equipments in multipurpose plants-Reactors, filters ,centrifuges ,driers, extractors and evaporators	2	C,D,O	4	1,3,5
32	Production cost- capital investment costs, operating costs	1	C,D,O	4	1,2
33	Designing of batch plants-production planning and scheduling	2	C,D,O	4	1,2,5
34	Principles of good manufacturing practises	1	C,D,O	4	1,2
Total contact hours					45

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1	AndrzejCybulski , Jacob A. Moulijn , M.M. Sharma , Roger A. Sheldon "Fine Chemicals Manufacture: Technology and Engineering" Elseiver Science B.V, 2001
	REFERENCE BOOKS/OTHER READING MATERIAL
2.	Rawlins E.A, Bentleys Text Book of Pharmaceutics, A.I.T.B.S.Publisher& Distributors, Delhi, 1996
3.	Coulson and Richadson, "Chemical Engineering"Vol 6,3rd edition,Butterworth Heinemann, 2000.
4.	Shah, K.M., "Hand Book of Industrial Chemistry", Vol. I and II, Multi-Tech Publishing Co, 1999.
5.	Pandey, G.N., "A Text Book of Chemical Technology", Vol. II, Vikas Publishing House (P) Ltd., 2000.
6.	B.M. Mithal., "A textbook of Pharmaceutical formulation", published by vallabhprakashan, 15th reprint 2013, ISBN 81-85731-04-7
7.	Rebecca A.Bader, David., "Engineering Polymer systems for improved drug" Wiley publication, December 2013, ISBN: 979-1-118-09847-9

Course nature		**Theory**					
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
					End semester examination Weightage :		**50%**

15CH366E	ENVIRONMENTAL QUALITY MONITORING AND ANALYSIS	L	T	P	C
		3	0	0	3
Co-requisite:	NIL				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	P PROFESSIONAL ELECTIVE				
Course designed by	Department of Chemical Engineering				
Approval	32nd Academic Council Meeting 23rd July 2016				

PURPOSE	To motivate the students to understand the importance of environmental monitoring and familiarize with various analytical techniques used							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Understand importance of environmental monitoring, current norms, existing challenges and principles involved in various analytical techniques	a						
2.	Understand aspects of air quality monitoring and analytical methods	a						
3.	Understand aspects of water quality monitoring and analytical methods	a						
4.	Understand aspects of solid matter quality monitoring and analytical methods	a						
5.	Get exposure to practical case studies and awareness of developing technologies	a	h	i				

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
UNIT I: BASICS OF ENVIRONMENTAL QUALITY MONITORING AND ANALYSIS		**10**			
1.	Environment Overview: A brief history of environmental issues, Importance of environmental monitoring-air, water, soil. National and international norms and standards, Role of government, industry and public, policies and measures-carbon credit	3	C	1	1,4
2.	Analytical techniques for monitoring	3	C	1	1,4
3.	Essential principles involved in design of monitoring and analysis systems	4	C	1	1,4
UNIT II: AIR QUALITY		**9**			
4.	Air pollution-indoor, outdoor; major contaminants, standards and limits, major challanges	2	C	2	2,3
5.	Sampling methods	2	C	2	2,3
6.	Analytical techniques	5	C	2	2,3
UNIT III: WATER QUALITY		**9**			
7.	Water pollution, major contaminants, standards and limits	2	C	3	1,2,3
8.	Sampling methods	3	C	3	1,2,3
9.	Analytical techniques	3	C	3	1,2,3
10.	Zero liquid discharge	1	C	3	1,2,3
UNIT IV: SOIL QUALITY		**8**			
11.	Solid waste sources, contaminants, standards	2	C	4	1,4
12.	Sampling methods	3	C	4	1,4
13.	Analytical techniques	3	C	4	1,4
UNIT V: CASE STUDIES AND DEVELOPING TECHNOLOGIES		**9**			
14.	Case studies from chemical and allied industries	4	C	5	2.3,4
15.	In-line monitoring methods, point of use technologies	3	C	5	2.3,4
16.	Portable detection and analytical technologies	2	C	5	2.3,4
	Total contact hours	45			

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1	JanickArtiola, Ian L. Pepper, Mark L. Brusseau, Environmental Monitoring and Characterization, Elsevier Science & Technology Books, March 2004
REFERENCE BOOKS/OTHER READING MATERIAL	
2	P.K. Behera and S.K. Sahu, Environmental Monitoring and Analysis, Dominant Publishers And Distributors (1993), Vol. 2
3	Stanley Manahan, Stanley E. Manahan, Environmental Chemistry, Ninth edition, CRC Press, December 17, 2009
4	G.BruceWiersma, Environmental Monitoring, Lewis Publishers, 2004

Course nature				**Theory**			
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
End semester examination Weightage :							**50%**

15CH367E	WASTEWATER TREATMENT	L	T	P	C
		3	0	0	3
Co-requisite:	NIL				
Prerequisite:	NIL				
Course Category	P PROFESSIONAL ELECTIVE				
Course designed by	Department of Chemical Engineering				
Approval	32nd Academic Council Meeting 23rd July 2016				

PURPOSE	To goal of this course is to provide you with an overview of the theory and practice of water and wastewater treatment							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Describe different methods for wastewater treatment and environmental effects of wastewater	a						
2.	Introduce students to the unit operations and processes used in the advanced treatment of wastewater.	a	c					
3.	Know the five stages of wastewater treatment and alternative strategies for providing these levels of treatment	a						
4.	Introduce students to the current literature in advanced wastewater treatment	a						
5.	Learn issues involved in water reuse through discussion of case studies.	a	c	k				

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
UNIT 1 INTRODUCTION		**9**			
1.	Need for waste water treatment: water scenario - escalating demand – pollution of existing sources – Indian scenario.	1	C	1,4	1,2
2.	Waste water sources – industrial, agricultural & domestic – quantum of waste water produced by industries – comparison of world and Indian scenario.	2	C	1,4	1,2
3.	Assessment of waste water composition – General characteristics – Broad characteristics – TSS, TDS, BOD, COD, pH – Specific characteristics – detailed analysis for various ionic species, heavy metals and other identified pollutants.	2	C	1,4	1,2
4.	Philosophy of waste treatment: conventional dilute & disperse: current philosophy treat and dispose; future philosophy; recover and reuse. – Wealth from waste.	2	C	1,4	1,2
5.	Concept of common effluent treatment plants (CETP)	1	C	1,4	1,2
6.	Regulations for treatment – ALARA concept – pollution control board regulations.	1	C	1,4	1,2
UNIT II CONVENTIONAL TREATEMENT OF WASTE WATER		**10**			
7.	Primary – secondary - aim of the treatment. Particulate Removal (primary) - screens – filters – rapid & gravity filters.	1	C	1	1,5
8.	Secondary treatment - Aerobic treatment; Suspended growth aerobic treatment processes, Activated sludge process and its modifications.	2	C	1	1,5
9.	Attached growth aerobic processes, Tricking filters and Rotating biological contactors, Membrane biological reactor.	2	C	1	1,5
10.	Anaerobic treatment- Suspended growth, attached growth, fluidized bed and sludge blanket systems, Nitrification, denitrification, Phosphorus removal.	3	C	1	1,5
11.	Sludge Treatment -Thickening; Digestion; Dewatering; Sludge drying; Composting, Low cost wastewater systems-Ponds and Lagoons; Wetlands and Root-zone systems.	2	C	1	1,5
UNIT III INDUSTRIAL WASTE TREATMENT		**8**			

12.	Treatment of industrial waste water: Unit operations used: mechanical operations (macro particulate removal by settling /screen /filters).	3	C,D	2	1,2,3
13.	Chemically induced mechanical operations – coagulation – clarifiers – oxygenation –precipitation – adsorption – ion exchange and membrane processes.	3	C,D	2	1,2,3
14.	Removal of trace level pollutants – dis infection using chlorine – UV – UF.	2	C,D	2	1,2,3
UNIT IV WASTEWATER PROCESSES		8			
15.	General schemes adopted for treatment –synthesis of process flow sheet.	1	C	2,3	1,6
16.	Design Aspects – waste characterization – chemical composition - sequencing of unit operations - processes– operational aspects including batch and continuous systems.	3	C	2,3	1,6
17.	Volume reduction – concept of water recovery and recycle	2	C	2,3	1,6
18.	Fundamental aspects of pressure driven membrane processes – basic design aspects.	2	C	2,3	1,6
UNIT V WEALTH FROM WASTE		**10**			1,6
19.	Economic aspects of waste water treatment – both as a cost and value centre - need for integrating effluent treatment plant as unit of process plant.	2	C,D,O	5	1,4
20.	Batch vs. continuous operations – considerations based process characteristics and economics.	1	C,D,O	5	1,4
21.	Value recovery – need for value recovery (prevention hazard getting recycles or propagated through geo-hydrological cycle.	1	C,D,O	5	1,4
22	recycle& reuse of water of isolating the waste at source and treatment for better value recovery.	2	C,D,O	5	1,4
23	Zero Liquid Discharge Case studies : 1.Sewage treatment : recovery of water & Manure examples from CPCL 2. Industrial water treatment: paper / leather / chemical industries Recycle of water from spent streams – role of adsorption & membrane processes.	4	C,D,O	5	1,4
	Total contact hours	45			

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	Metcalf & Eddy, "Wastewater Engineering Treatment and Reuse", 4th Edn., Tata McGraw-Hill Publishing Company, New Delhi, 2003
REFERENCE BOOKS/OTHER READING MATERIAL	
2.	Arceivala S.J., "Waste Water Treatment for Pollution Control", Tata McGraw Hill, 1998
3.	Eckenfelder, W.W.Jr., "Industrial Water Pollution Control", 3rd edn., McGraw Hill, Boston, MA, 2000
4.	Eldridge, E.F, "Industrial Waste Treatment Practice", McGraw-Hill Book Company, Inc., New York, NY, 1942
5.	Grady, C. P. L. Jr., G. T. Daigger, and H. C. Lim., "Biological Wastewater Treatment", 2nd edn., Rev. and Expanded, Marceldekker, New York, 1999
6.	Eldridge, E.F, "Industrial Waste Treatment Practice", McGraw-Hill Book Company, Inc., New York, NY, 1942

Course nature				**Theory**			
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
					End semester examination Weightage :		**50%**

15CH368E	PETROCHEMICAL TECHNOLOGY	L	T	P	C
		3	0	0	3
Co-requisite:	NIL				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	P | PROFESSIONAL ELECTIVE				
Course designed by	Department of Chemical Engineering				
Approval	32nd Academic Council Meeting 23rd July 2016				

PURPOSE	This course helps the students to know about the various raw materials and manufacturing processes involved in the petrochemical industries.							
INSTRUCTIONAL OBJECTIVES		STUDENT OUTCOMES						
At the end of the course, student will be familiarized								
1	To identify suitable feedstock and predict potential growth of petrochemical industries	a						
2	In various aspects of production of olefin containing gases	a						
3	In various aspects of important intermediate material for petrochemical industries	a						
4	In various aspects of cracking and polymerization processes	a						
5	In the manufacturing methods of important petrochemicals	a						

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
UNIT I: INTRODUCTION		**9**			
1	Petro chemicals - Definition, overview of petrochemical,	3	C	1	1,2,5
2	Importance and growth potential of petrochemical in india	3	C	1	1,5
3	Economics and feedstock selection for petrochemical	3	C	1	1
UNIT II: OLEFIN GASES		**9**			
4	Reforming and cracking: Cracking of Naphtha and Feed stock gas for the production of C_2 and C_3 Compounds-	2	C	2	1,2,3,5
5	Ethylene, Acetylene, Propylene,	2	C,D	2	1,2,5
6	Isobutylene and Butadiene.	2	C,D	2	1,2,5
7	Ammonia, Alcohol	2	C,D	3	1,2,3,5
8	Synthesis gas	1	C,D	3	1,2,5
UNIT III: - INTERMEDIATES COMPOUNDS		**9**			
9	Production of intermediate chemicals: Acrylonitrile, ethylene oxide,	2	C,D	3	1,2,3,5
10	Propylene oxide, ethyl chloride,	2	C,D	3	1,2,3,5
11	Vinyl acetate and vinyl chloride.	2	C,D	3	1,2,5
12	Higher olefins: Benzene, toluene, xylene,	1	C,D	3	3,4
13	Phenol and Styrene	2	C,D	3	1,2,5
UNIT IV: - IMPORTANT PETROCHEMICALS		**9**			
14	Polymerization process: Plastics-Ethenicpolymers -polyvinyl chloride,	2	C,D	4,5	1,2,5
15	Polycondensationpolymers - phenol formaldehyde	1	C,D	4,5	1,2,5
16	Synthetic rubber-SBR, Polymeric Oils-Silicones	2	C,D	4,5	1,2,5
17	Synthetic fibers- polyesters- polyesters ribbon, Polyethylene Terephthalate	2	C,D	4,5	1,2,5
18	Polyamides-adpic acid, nylon 6,6	2	C,D	4,5	1,2,5
UNIT V: - INDUSTRIAL PETROCHEMICALS		**9**			
19	Agrochemicals,	2	C,D	4,5	3,5
20	synthetic detergents- through olefins, -from kerosene,	2	C,D	4,5	1,2,5
21	Carbon black-delayed coking,-fluid coking	2	C,D	4,5	1,2,5
22	Pharmaceuticals.	2	C,D	4,5	5
23	Concepts of quality and environmental pollution control in petrochemical industries.	1	C	5	1,2,5
	Total contact hours	45			

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1	BhaskaraRao. B.K, "A Text on Petroleum Chemicals", 4th Edn.,Khanna Publishers, New Delhi, 2007.
2	Steiner H. "Introduction to Petroleum Chemicals", Pergammon Press, 1992
REFERENCE BOOKS/OTHER READING MATERIAL	
3	Brownstein. A.M. "Trends in Petrochemical Technology", Petroleum Publishing Company, 1976.
4	Sittig, M. "Aromatic Hydrocarban, Manufacture and Technology", Noyes Data Corporation, 1976.
5	GopalaRao M. and Marshall Sittig. "Dryden's Outlines of Chemical Technology", 3rd Edn.,East-West Press, New Delhi, 1997.

Course nature		**Theory**					
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
					End semester examination Weightage :		**50%**

15CH451E	CHEMICAL PROCESS OPTIMIZATION	L	T	P	C
		3	0	0	3
Co-requisite:	15CH403J				
Prerequisite:	15CH305J				
Data Book / Codes/Standards	NIL				
Course Category	P PROFESSIONAL ELECTIVE				
Course designed by	Department of Chemical Engineering				
Approval	32nd Academic Council Meeting 23rd July 2016				

PURPOSE To impart the fundamentals of optimization methods in solving chemical engineering problems

INSTRUCTIONAL OBJECTIVES		STUDENT OUTCOMES						
At the end of the course, student will be able to familiarize								
1.	Basic concepts of optimization	a						
2.	Various models available for optimization	e						
3.	Applications of optimization in chemical process	k						

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
UNIT I: OPTIMIZATION		**9**			
1.	Introduction	1	C	1	1,2
2.	Formulation of objective functions	2	C	1	1,2
3.	Fitting models to data	2	C,D	1	1,2
4.	Classification of models	2	C	1	1,2
5.	Necessary and sufficient conditions for optimum.	2	C	1	1,2
UNIT II: MODELS		**9**			
6.	Unimodal, multimodal functions	2	C	2	1,2
7.	Analytical methods, Lagrange multiplier methods	2	C	2	1,2
8.	Direct methods; random, grid, Hooke's Nelder and mead methods;	2	C,D	2	1,2
9.	Powell's technique	1	C,D	2	1,2
10.	Indirect methods; gradient and conjugate gradient methods; secant methods	2	C,D	2	1,2
UNIT III: NUMERICAL METHODS		**9**			
11.	Newton's method, Quasi-Newton's method	3	C, D	2	1,2
12.	Secant methods	2	C, D	2	1,2
13.	region elimination methods	2	C, D	2	1,2
14.	Polynomial approximation: Quadratic and cubic interpolation techniques for optimum.	2	C, D	2	1,2
UNIT IV: LINEAR AND NON-LINEAR PROGRAMMING		**9**			
15.	Review on basic concepts of LP formulations;	3	C	2	1,2
16.	simplex methods;	3	C, D	2	1,2
17.	Integer, quadratic, geometric and dynamic programming	3	C, D	2	1,2
UNIT V: APPLICATIONS		**9**			
18.	Heat transfer and Energy conservation	2	C,I	3	1,2
19.	separation processes;	2	C, I	3	1,2
20.	fluid flow systems;	2	C, I	3	1,2
21.	reactor design and operation; large scale system	3	C, I	3	1,2
	Total contact hours	45			

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1	Edgar.T., Himmelblau, D.M., " Optimization of Chemical Process", McGraw-Hill Book Co., New York, 2001 ISBN-13 9780070393592
2	Reklaitis, G.V., Ravindran, A., Ragsdell, K.M., " Engineering Optimization", John Wiley, New York, 2006, ISBN-13 9780471558149
	REFERENCE BOOKS/OTHER READING MATERIAL
3	Bilies, W.E. Swain. J.J., "Optimization and Industrial Experimentation, Inter Science", New York, 1980.

Course nature				**Theory**			
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
End semester examination Weightage :							**50%**

15CH452E	EQUILIBRIUM STAGE OPERATIONS	L	T	P	C
		3	0	0	3
Co-requisite:	NIL				
Prerequisite:	15CH303				
Data Book /codes/Standards	NIL				
Course Category	P | PROFESSIONAL ELECTIVE				
Course designed by	Department of Chemical Engineering				
Approval	32nd Academic Council Meeting 23rd July 2016				

PURPOSE	To provide an adequate knowledge of equilibrium stage operations in chemical industries such as multicomponent multistage separation processes including distillation, absorption, extraction, and adsorption

INSTRUCTIONAL OBJECTIVES		STUDENT OUTCOMES						
At the end of the course, student will be able to		a						
1	Understand fundamental concepts of equilibrium-governed separation processes	a						
2	Understand the cascade configurations in chemical process systems	a						
3	Acquire knowledge of concepts involved in absorption and distillation	a						
4	Acquire knowledge of liquid-liquid extraction and solid-liquid extraction operations	a						
5	Understand principles of adsorption and its applications	a						

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
UNIT I: BASICS OF SEPARATION PROCESSES		**8**			
1	Overview of different separation processes, their characteristics, separating agents, separation factors, sequence of separations, Heuristics for separation schemes	3	C	1	1,2,3
2	Review of thermodynamics principles, phase equilibrium, ideal and non-ideal solutions, activity coefficients	2	C	1	1,2,3
3	Simple equilibrium processes, single equilibrium stage, checking phase condition of a mixture, flash calculations-binary and multicomponent systems	3	C	1	1,2,3
UNIT II: CASCADES		**9**			
4	Typical cascade configurations, hybrid systems, general approach to analysis of equilibrium governed operations	3	C	2	1,2,3,4
5	Mass transfer in stage-wise contact of two phases, Stage calculations for cocurrent, crosscurrent and countercurrent cascades, Kremser equation	6	C, D	2	1,2.3,4
UNIT III: ABSORPTION, STRIPPING AND DISTILLATION		**10**			
6	Equilibrium in a gas-liquid system, stage calculations for absorption and stripping	2	C	3	1,2, 3,4
7	Batch distillation-binary and multicomponent mixtures, Continuous multistage distillation of binary mixtures, multiple feed and product withdrawal	3	C, D	3	1
8	Multicomponent distillation, Key components, Approximate methods- Fenske-Underwood – Gilliland Method	3	C	3	1,2,3
9	Enhanced distillation- Extractive Distillation, Azeotropic Distillation, Reactive Distillation, use of triangular graphs, residue-curve mapsDistillation	2	C	3	1,2,3
UNIT IV: EXTRACTION		**9**			
10	Liquid-liquid extraction, solvent selection, ternary phase diagrams, single stage, multistage single section cascades, design calculations	5	C, D	4	1,3
11	Solid-liquid extraction, rate of solid-liquid extraction, calculations, supercritical fluid extraction	4	C	4	1,2,3,4
UNIT V: ADSORPTION		**9**			

12	Equilibrium Considerations, Kinetic and transport considerations	3	C	5	1,3
13	Adsorption in a fixed bed	4	C, D	5	1,3,4
14	Ion-exchange, chromatography	2	C	5	1
	Total contact hours	45			

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1	Dutta,B.K.,"Principles of Mass transfer and Separation Processes".Prentice-Hall of India,New Delhi (2007).
	REFERENCE BOOKS/OTHER READING MATERIAL
2	Treybal. R .E, "Mass Transfer Operations", 3rd Edition, McGraw Hill, 1980
3	J. D. Seader, Ernest J. Henley, D. Keith Roper, Separation process principles : chemical and biochemical operations, 3rd edn
4	Warren. L, Mccabe, Julian .C, Smith and peter Harriott, "Unit Operations of Chemical Engineering", 7th Edn., McGraw Hill International Edition, NewYork, 2005.

Course nature		**Theory**					
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
					End semester examination Weightage :		**50%**

15CH453E	COMPUTATIONAL FLUID DYNAMICS	L	T	P	C
		3	0	0	3
Co-requisite:	NIL				
Prerequisite:	15CH307				
Data Book / Codes/Standards	NIL				
Course Category	P PROFESSIONAL ELECTIVE				
Course designed by	Department of Chemical Engineering				
Approval	32nd Academic Council Meeting 23rd July 2016				

PURPOSE	To acquire computational ability in solving mathematical problems as applied to the chemical engineering.							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1	To solve the conservation laws (mass, momentum and energy) using finite volume method and apply to industrial engineering problems.	a	d	e				
2	To provide training to the engineering students to develop a Computational Fluid Dynamics code.	c	d	k				
3	To understand the flow and temperature field in engineering problems.	d						
4	Familiarize to solve the partial differential equations	d						

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
UNIT I: CONSERVATION LAWS OF FLUID MOTION		**9**			
1	Introduction about Computational Fluid Dynamics	1	C,D	1-4	1-5
2	Mass conservation in three dimensions	1	C,D	1	1-5
3	Momentum equation in three dimensions	2	C,D	1	1-5
4	Energy equation in three dimensions	1	C,D		1-5
5	Navier-Stokes equations for a Newtonian fluid	2	C,D	1	1-5
6	Differential and Integral forms of the general Transport equations and boundary conditions for compressible and incompressible flow	2	C,D	1	1-5
UNIT II: FINITE VOLUME METHOD FOR DIFFUSION PROBLEMS		**9**			
7	Finite volume method for one-dimensional steady state diffusion	2	C	2	1,2
8	One-dimensional Steady state diffusion Problems	5	C,D,I	2	1-5
9	Two dimensional steady state diffusion Problems	1	C,D	2	1
10	Three-dimensional steady state diffusion Problems	1	D	2	1-5
UNIT III: THE FINITE VOLUME METHOD FOR CONVECTIVE-DIFFUSION PROBLEMS		**10**			
11	One-dimensional Convective and Diffusion and the central differencing scheme	3	C,D	4	1
12	Properties of discretisation schemes: Conservativeness, Boundedness and Transportiveness	1	C	4	1
13	Assessment of the central differencing scheme for convective-diffusion problems	1	D,I	4	1
14	The upwind differencing scheme	2	C,D	4	1-5
15	Assessment of the upwind differencing scheme	1	D,I	4	1
16	The hybrid differencing scheme	1	C,D	4	1,2
17	Hybrid differencing scheme for multi-dimensional convective-diffusion	1	D,I	4	1-3
UNIT IV: SOLUTION ALGORITHM FOR PRESSURE-VELOCITY COUPLING IN STEADY STATE		**8**			
18	The staggered grid	1	C	4	1
19	The momentum equations	2	C,D	4	1
20	The SIMPLE algorithm	3	C,D	4	1
21	Assembly of a complete method	2	C,D	4	1

UNIT V: THE FINITE VOLUME METHOD FOR UNSTEADY FLOWS		**9**			
22	One-dimensional unsteady heat conduction – Explicit scheme	1	C,D	4	1-5
23	Crank-Nicolson scheme and fully implicit scheme	1	C,D	4	1
24	Tutorial in explicit and implicit schemes	4	I	4	1-5
25	Implicit method for Two and three dimensional problems	1	I	4	1
26	Solution procedure for unsteady flow calculations (transient SIMPLE)	2	C,D	4	1
	Total contact hours	45			

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1	H. K. Versteeg and W. Malalasekera, An introduction to computational fluid dynamics – The finite volume method, Longman Group Ltd 1995.
2	J.H. Ferziger and M. Peric, Computational Methods for Fluid Dynamics, Springer, 2002.
	REFERENCE BOOKS/OTHER READING MATERIAL
3	Hirch C., Numerical Computation of internal and external flows, Elesvier 2007.
4	Zikanov O., Essential Computational Fluid Dynamics, Wiley 2010.
5	Chung T.J., Computational Fluid Dynamics, Cambridge University press, 2003

Course nature				**Theory**			
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
					End semester examination Weightage :		**50%**

15CH454E	BIOCHEMICAL PROCESS DESIGN	L	T	P	C
		3	0	0	3
Co-requisite:	NIL				
Prerequisite:	15CH352E				
Data Book / Codes/Standards	NIL				
Course Category	P PROFESSIONAL ELECTIVE				
Course designed by	Department of Chemical Engineering				
Approval	32nd Academic Council Meeting 23rd July 2016				

PURPOSE	This subject puts emphasis on about stirred Tank reactors and configuration of various reaches, and processing of biological materials

INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1	To introduce the basic configuration of bioreactor and accessories	a						
2	To familiarize various types of bioreactors and its importance	a						
3	To study the scale-up bioreactor in industrial process	a						
4	To familiarize different types of instruments and controllers used in bioprocess industries	a	e					
5	To study the various stage of product recovery operation	a	e					
6	To provide information about various bioproducts synthesis process	a	e					

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
UNIT I: INTRODUCTION TO BIOREACTOR		**8**			
1	Basic principle of bioreactor, classification and their configurations	2	C	1	1,2
2	Analysis of batch, continuous flow, fed-batch bioreactors	2	C	1	1,2
3	Design and operation of novel Biochemical reactors - Air-lift loop reactors; Fluidized bed- Biochemical reactors	3	C	2	1,2
4	Design of immobilized enzyme reactors – packed bed, fluidized bed and membrane reactors.	1	C	2	1,2
UNIT II: BIOCHEMICAL REACTOR SCALE-UP		**10**			
5	Transport phenomena in Bioprocess systems	4	C	3	1
6	Regime analysis of Biochemical reactors processes	4	C	3	1,2
7	Correlations for oxygen transfer; Scale-up criteria for bioreactors based on oxygen transfer and power consumption.	2	C	3	1,2,3
UNIT III: INSTRUMENTATION CONTROL OF BIOREACTORS		**8**			
8	Measurement of physical and chemical parameters in bioreactors	2	C	4	1,2
9	Bioreactor sensor characterizes Temperature measurement control	3	C	4	1,2
10	Principles of dissolved oxygen measurement and control, principles of PH / redox measurement and control	2	C	4	1,
11	Deduction and prevention of foam, determination of biomass and application of biosensors.	1	C	4	1,2
UNIT IV: PRODUCT RECOVERY OPERATION		**10**			
12	Separation of Biomolecule- Cell disruption for product release – mechanical, enzymatic and chemical methods	2	C	5	1,2,3
13	Cells and solid particle separation- filtration and centrifugation	3	C	5	1,2,3
14	Product isolation- Adsorption, liquid-liquid extraction	3	C	5	1,2,3
15	Product purification- Chromatography	2	C	5	1,2,3
UNIT V: INDUSTRIAL BIOPROCESS TECHNOLOGY		**9**			

16	Aerobic process-citric acid and penicillin production	2	C	5,6	3
17	Anaerobic bioprocess- ethanol, lactic acid and acetone-butanol production.	3	C	5,6	3
18	Biopolymer production process- xanthan gum, PHB	2	C	5,6	3
19	Production of single cell protein and Vinegar.	2	C	5,6	3
	Total contact hours	45			

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	Bailey, J.E. and Ollis, D.F. "Biochemical Engineering Fundamentals" 2nd Edition, McGraw– Hill, 1988.
REFERENCE BOOKS/OTHER READING MATERIAL	
2.	Peter F.Stanbury, Allan Whitaker, "Principles of Fermentation Technology"2nd Edition, Butterworth – Heinemann (an imprint of Elsevier), 1995.
3.	Shuler, M.L. and Kargi, F. "Bioprocess Engineering: Basic Concepts", 2ndEdition, PHI,2002.

Course nature		**Theory**					
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
					End semester examination Weightage :		**50%**

15CH455E	MICROCHEMICAL SYSTEMS	L	T	P	C
		3	0	0	3
Co-requisite:	NIL				
Prerequisite:	15CH209				
Data Book / Codes/Standards	NIL				
Course Category	P PROFESSIONAL ELECTIVE				
Course designed by	Department of Chemical Engineering				
Approval	32nd Academic Council Meeting 23rd July 2016				

PURPOSE	To give basic understanding of engineering phenomena involved in microchemical systems and expose students to versatile applications of these systems in different areas of science and technology.

INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to		a						
1	Understand concept of lab-on-a-chip and its significance and relevance	a						
2	Understand fundamental transport processes relevant to micro scale devices	a						
3	Acquire knowledge of various microfabrication methods and relevant material science	a						
4	Get a basic knowledge of design, simulation, and experimental methods at microscale	a						
5	Get exposure to wide range of applications of microchemical systems	a						

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
UNIT I: INTRODUCTION TO MICROCHEMICAL SYSTEMS		**8**			
1	Introduction, concept of lab-on-a-chip, advantages, limitations, interdisciplinary approach	3	C	1	1
2	Range of applications- basic and applied areas of science and engineering	3	C	1	1
3	Scale out approach, commercialized technologies	2	C	1	1
UNIT II: TRANSPORT PHENOMENA AT MICROSCALE		**9**			
4	Concepts in microfluidics, Navier-Stokes equation, Multiphase flows, capillary action	3	C	2	1
5	Mixing and separation	3	C	2	1
6	Heat transfer in microchannels, electrokinetics	3	C	2	1
UNIT III: MICROFABRICATION TECHNIQUES		**9**			
7	Conventional and emerging techniques, photolithography, micromachining, etching	3	C	3	2, 3
8	Soft lithography	3	C	3	2,3
9	Materials in fabrication	3	C	3	2, 3
UNIT IV: DESIGN TO IMPLEMENTATION APPROACH		**9**			
10	Concepts and approach from design to realization, tools for design and simulation	2	C, D	4	1
11	Experimental methods and components-pumps, valves	2	C, D	4	1, 5
12	Measurements at microscale, Pressure, flow rate, temperature measurements	3	C,D	4	4, 5
13	Analytical techniques	2	C	4	4, 5
UNIT V: APPLICATIONS AND CASE STUDIES		**10**			
14	Miniaturized chemical systems, microreactors, drug delivery	3	C	5	1,5
15	Point-of-care devices, sensors, environmental monitoring, biomedical diagnostics	3	C	5	1,5
16	Energy generation devices, integrated systems, developing technologies	4	C	5	1,5
	Total contact hours	45			

LEARNING RESOURCES	
Sl.	**TEXT BOOKS**

No.	
1	Kirby, B.J., Micro- and Nanoscale Fluid Mechanics: Transport in Microfluidic Devices, Cambridge University Press, 2010.
	REFERENCE BOOKS/OTHER READING MATERIAL
2	Nguyen, N. T., Werely, S. T., Fundamentals and applications of Microfluidics, Artechhouse Inc., 2002
3	Madou, M. J., Fundamentals of Microfabrication, CRC press, 2002.
4	Tabeling, P., Introduction to microfluidics, Oxford University Press Inc., 2005
5	Colin, S., Microfluidics, John Wiley & Sons, 2009.

Course nature				**Theory**			
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
					End semester examination Weightage :		**50%**

15CH251	BASIC CHEMICAL ENGINEERING	L	T	P	C
		3	0	0	3
Co-requisite:	NIL				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	E Engineering Sciences	Offered to Bio Technology			
Course designed by	Department of Chemical Engineering				
Approval	32nd Academic Council Meeting 23rd July 2016				

PURPOSE	This course deals with formulation and solution of material balances on chemical process systems, and transformation of energy from one form to another.							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Understand the basic principle of process calculation	a						
2.	Understand the knowledge's about Chemical equations and material balances.	a	c					
3.	Basic concepts of Thermodynamics and first law can be understood	a						
4.	PVT behaviors of fluids and Ideal gas processes can be understood	a	c					
5.	Heat engines and Entropy concepts can be understood	a	c					

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
UNIT I: INTRODUCTION		**9**			1,2
1.	Units and dimensions, the mole unit, mole fraction (or percent) and mass fraction (or percent)	3	C	1-4	1,2
2.	analyses of a mixture, concentrations, basis of calculations	2	C	1	1,2
3.	predicting P-V-T properties of gases using the following equations of state: ideal gas law	2	C,D	1	1,2
4.	Van der Waals equation, calculation of density	2	C,D	1	1,2
UNIT II: CHEMICAL EQUATION AND MATERIAL BALANCES		**9**			
5.	Basics of chemical equation and stoichiometry, limiting reactant, excess reactant, conversion, selectivity, yield	4	C	2	1,2
6.	Basic concepts involved in material balance calculations	1	C,D	2	1,2
7.	material balance problems without chemical reactions: membrane separation, mixing, drying, crystallization	3	D,I	2	1,2
8.	Basic concepts of recycle, bypass and purge streams	1	D,I	2	1,2
UNIT III: FIRST LAW OF THERMODYNAMICS		**9**			
9.	Basic concepts: work, energy, heat, internal energy, extensive and intensive properties, state and path functions	3	C,D,I	4	3,4,5
10.	First law of thermodynamics, energy balance for closed systems, equilibrium, the reversible process, constant-v and constant-p processes	3	C,D,I	4	3,4,5
11.	enthalpy, heat capacity	2	C,D	4	3,4,5
12.	energy balances for steady-state flow processes	1	C,I	3	3,4,5
UNIT IV: VOLUMETRIC PROPERTIES OF PURE FLUIDS		**9**			3,4,5
13.	PVT behavior of pure substances, virial equations of state, the ideal gas	3	C	4	3,4,5
14.	equations for process calculations(for an ideal gas in any mechanically reversible closed-system process): isothermal process, isobaric process, isochoric process, adiabatic process, and polytropic process	3	D,I	4	3,4,5
15.	Application of the virial equations, introduction to cubic equations of state: van der Waals equation, Redlich/Kwong equation	3	D,I	4	3,4,5
UNIT V: SECOND LAW OF THERMODYNAMICS		**9**			
16.	Statements, heat engines, Carnot's theorem	3	D,I	4	3,4,5
17.	ideal-gas temperature scale; Carnot's equations, concept of	3	C	4	3,4,5

	entropy, entropy changes of an ideal gas undergoing a mechanically reversible process in a closed system				
18.	mathematical statement of the second law, entropy balance for open systems, statement of the third law of thermodynamics	3	C	4	3,4,5
	Total contact hours	45			

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	David M. Himmelblau, "Basic Principles and Calculations in Chemical Engineering", 6th Edn., Prentice-Hall of India, New Delhi, 1998.
2.	Bhatt B.I. and Vora S.M., "Stoichiometry", 3rd Edn., Tata McGraw-Hill Publishing Company, New Delhi,1996
3.	Smith, J.M., Van Ness, H.C., and Abbott, M.M., "Introduction to Chemical Engineering Thermodynamics",6th Edn., McGraw Hill International Edition, Singapore 2001
	REFERENCE BOOKS
4.	Rao Y.V.C, "Chemical Engineering Thermodynamics", University Press (I) Ltd.,Hyderabad, 1997
5.	Narayanan.K.V., "A Text book of Chemical Engineering Thermodynamics", 2006, PHI learning Pvt Ltd, New delhi

Course nature		**Theory**					
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
					End semester examination Weightage :		**50%**

15CH252	CHEMICAL ENGINEERING PRINCIPLES - I	L	T	P	C
		3	0	0	3
Co-requisite:	NIL				
Prerequisite:	15CH251				
Data Book / Codes/Standards	NIL				
Course Category	E Engineering Science	Offered to Bio Technology			
Course designed by	Department of Chemical Engineering				
Approval	32nd Academic Council Meeting 23rd July 2016				

PURPOSE	To acquire the knowledge of physical operations and momentum transfer concept in Biochemical Engineering.							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1	Understand the fundamentals of fluid flow phenomena		a					
2	Know and apply the concept of kinematics of flow and flow past immersed bodies			b	c		e	
3	Learn the knowledge about the fluid transportation and metering devices					d		
4	Understand the basic concepts of bulk handling of solids and filtration		a	b				
5	Learn and apply the concepts of agitation and mixing in fermenters				c		e	

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
1.	Introduction - Overview of Syllabus	1	-	-	--
UNIT I: FLUID FLOW PHENOMENA		**8**			
2.	Nature of fluids:Type of fluids and flow: incompressible and compressible, potential flow, Laminar and turbulent flow	2	C,D	1	1,4
3.	Hydrostatic equilibrium, manometers	2	C,O	1	1,4
4.	Newtonian and Non-Newtonian fluids: Newton's-law of viscosity	1	C	1	1,4
5.	Reynolds number and transition from laminar to turbulent flow, Critical velocity	1	D,O	1	1,4
6.	Boundary layer: Flat plate and straight tubes	2	C,D	1	1,4
UNIT II: KINEMATICS OF FLOW & FLOW PAST IMMERSED BODIES		**10**			
7.	Streamlines and stream tubes: equation of continuity-Bernoulli equation- pump work-Kinetic energy correction work in Bernoulli equation	2	C,D	2	1,2
8.	Equations of incompressible fluid: Hagen-Poiseuille equation, Darcy's law,	3	C,D,O	2	1,2
9.	Friction factors-Roughness Parametrs, Moody's Chart, Fannings Equation	1	D,O	2	1,2
10.	Drag & Lift forces, Terminal settling velocity, Pressure drop calculation through immobilized (Packed bed) and mobilized Bed (Fluidized bed)	4	C,D,I	2	1,2
UNIT III: TRANSPORTATION & METERING OF FLUIDS		**9**		2	
11.	Introduction to pipe and tubing- joint and fittings- stuffing boxes- mechanical seals- gate valves and globe valves-plug cocks and ball valves- check valves.	2	I,O	3	1,4,5
12.	Classification of pumps: Reciprocating and rotary pumps – Centrifugal pump– Pump characteristics– Fans- blowers and compressors–Steam jet ejector.	3	I,O	3	1,4,5
13.	Types of metering devices: Application of Bernouli	4	D,I,O	3	1,4,5

	equation to venture meter and orifice meter- flow rate calculations from the readings of venture meter, orifice meter, Rota meter and pitot tube.				
UNIT IV: HANDLING OF SOLIDS AND SEPARATION OF SOLIDS FROM FLUIDS		**9**			
14.	Size reduction machines-Jaw Crusher & Ball mill, Size analysis , Screen efficiency	2	I,O	4	1,2,3
15.	Filtration-Classification of filters, Cake filters: Batch Pressure filter: Plate and frame, Continuous Vacuum filter: Rotary drum , Filter media- Charecteristics and Types, filter aids filter, Centrifugal filter: suspended batch centrifuges	2	I,O	4	1,2,3
16.	Centrifugal Filter: principle and working of suspended batch centrifuges	1	I,O	4	1,2,3
17.	Principle of cake filtration-Pressure drop through filter cake- Incompressible and Compressible cake	3	C,D	4	1,2,3
18.	Constant pressure and constant rate filtration-Cake and medium resistance, Continuous Filtration	1	C,D	4	1,2,3
UNIT V: AGITATION AND MIXING OF LIQUIDS		**8**			
19.	Principles of agitation, agitation equipment, Standard turbine design	2	C,D	5	1,3
20.	flow patterns: prevention of swirling- draft tubes	2	C	5	1,3
21.	Dimensional analysis: Buckingham's Π theorem, significance of dimensionless groups- effect of system geometry	2	C,I	5	1,3
22.	Calculation of power consumption in Newtonian liquids	1	C,D	5	1,3
23.	Blending and Mixing- Mixers: types and selection	1	I,O	5	1,3
	Total contact hours	45			

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1	Warren L. Mccabe, Julian C. Smith and peter Harriott, "Unit Operations of Chemical Engineering", 7e Indian Edn., McGraw Hill, NewYork, 2014.
2	Coulson.J.M, Richardson.J.F, Backhurst.J.R and Harker.J.M, "Coulson & Richardson's Chemical Engineering", Vol. II, 5th Edn., Butter worth Heinemann, Oxford, 2002.
REFERENCE BOOKS/OTHER READING MATERIAL	
3	Anup K Swain, HemalataPatra ,Roy.G.K, "Mechanical operations", Tata -McGraw Hill, 2010.
4	Noel de Nevers, "Fluid Mechanics for Chemical Engineers", 3rd Edn., McGraw Hill International Editions, 2011
5	White.F.M, "Fluid Mechanics", 7thEdn, McGraw-Hill Inc, 2011.
6	Narayanan.C.L& Bhattacharya, "Mechanical Operatiosn for ChemicalEngineering", 1993.
7	Darby.R,"Chemical Engineering Fluid Mechanics", 2ndeditionMarcel Dekker, 2001.

Course nature			**Theory**				
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
					End semester examination Weightage :		**50%**

15CH253	CHEMICAL ENGINEERING PRINCIPLES - II			L	T	P	C
				3	0	0	3
Co-requisite:	NIL						
Prerequisite:	15CH251						
Data Book / Codes/Standards	NIL						
Course Category	E	Engineering Science	Offered to Bio Technology				
Course designed by	Department of Chemical Engineering						
Approval	32nd Academic Council Meeting 23rd July 2016						

PURPOSE	This course explains the fundamentals of heat and mass transfer operations.							
INSTRUCTIONAL OBJECTIVES		STUDENT OUTCOMES						
At the end of the course, student will be able to								
1	An ability to apply knowledge of mathematics, science and engineering	a						
2	An ability to indentify, formulate and solve engineering problems	e						
3	An ability to function on multidisciplinary teams	d						
4	An ability to use the techniques, skills and modern engineering tools necessary for engineering practice.	k						

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
UNIT – 1 MODES OF HEAT TRANSFER		**9**			
1	Fourier's law of heat conduction, effect of temperature on thermal conductivity	1	C	1	1,4
2	Steady-state conduction compound resistances in series- heat flow through a cylinder.	2	D	1,2	1,4
3	natural and forced convection- application of dimensional analysis for convection	3	C	4	1,4
4	heat transfer to fluids without phase change: heat transfer coefficient calculation for natural and forced convection	2	C-D-I	1	1,4
5	Basic concepts of radiation, examples and application	1	O	1	1,4
UNIT II - HEAT-EXCHANGE EQUIPMENT		**9**			
6	Typical Heat-Exchange Equipment	2	D	3	1,4
7	Energy Balance	2	C	1	1,4
8	Heat flux and heat transfer co-efficient	2	C-D	2	1,4
9	Multi pass exchangers	1	I	3	1,4
10	Fouling factors	2	D	2	1,4
UNIT III – DIFFUSION		**9**			
11	Steady state molecular diffusion in fluids at rest and in laminar flow	2	C	1	2,3
12	Molecular diffusion in gases-steady state diffusion: of A through non diffusing B- equimolal counter diffusion	3	C-I	1,2	2,3
13	Molecular diffusion in liquids-steady state diffusion: of A through nondiffusing B- equimolal counter diffusion.	3	C-I	1,2	2,3
14	Effect of temperature and pressure on diffusivity.	1	D	1	2,3
UNIT IV - DRYING & DISTILLATION		**9**			
15	Principles of drying- critical moisture content and falling-rate period	1	C	1	2,3
16	Calculation of drying time under constant drying conditions	2	C	1	2,3
17	Working principle of tray driers - rotary driers- spray driers.	2	D-I	3,4	2,3
18	Concept of freeze drying.	1	I-O	4	2,3
19	Basic concepts of various methods of distillation batch-continuous flash- steam- azeotropic and vacuum distillations.	1	C-I	4	2,3
20	Design calculations by McCabe-Thiele method	2	D-O	4	2,3
UNIT V MISCELLANEOUS PROCESSES		**9**			

21	Percentage extraction calculation for single stage and multistage crosscurrent operations when liquids are insoluble	3	D,O	1,2	2,3
22	Working principle of extraction equipments: mixer settlers-spray and packed extraction towers	1	D	3	2,3
23	General principles of leaching and industrial application	1	C	1	2,3
24	Adsorbents and adsorption processes- adsorption equipment: fixed bed adsorbers- gas-drying equipment. Pressure-swing adsorption- adsorption from liquids- adsorption isotherms.	2	C-I-O	3.4	2,3
25	Basic concepts of membrane separation process.	2	C-I	1	2,3
Total contact hours					45

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1	Warren L. Mccabe, Julian C. Smith and Peter Harriott, "Unit Operations of Chemical Engineering", 7thEdn., McGraw Hill Education(India) private Limited, New Delhi, 2005
2	Robert E. Treybal, "Mass-Transfer Operations", 3rd Edn., McGraw Hill International Ed., Singapore, 1980.
	REFERENCE BOOKS/OTHER READING MATERIAL
3	J. D. Seader, Ernest J. Henley, "Separation Process Principles",1stEdn, Spectrum publisher service, New York,1998
4	Kern. D.Q, "Process Heat Transfer", 2 ndEdn, McGraw-Hill Inc., US 1999.

Course nature		**Theory**					
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
End semester examination Weightage :							**50%**

15CH254L	CHEMICAL ENGINEERING PRACTICE LABORATORY – I	L	T	P	C
		0	0	2	1
Co-requisite:	15CH252				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	E Engineering Science	Offered to Bio Technology			
Course designed by	Department of Chemical Engineering				
Approval	32nd Academic Council Meeting 23rd July 2016				

PURPOSE	To develop skills in design and conducting experiments related to mechanical operations and momentum transfer applications in Bio-Chemical Engineering.							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Understand the fluid flow measurement and friction factor studies	a			e			
2.	Learn the Operating conditions of fluid transport machineries		b	d		j		
3.	Understand the particle size measuring techniques, Screen efficiency calculation	a					k	
4.	Understand the particle size modification techniques		b				k	
5.	Know the Fluid/Solid separation techniques	a					k	

Sl. No.	Description of experiments	Contact hours	C-D-I-O	IOs	Reference
1.	Introduction about the lab and demonstration	2	-	-	-
2.	Fluid flow measurement by using Venturi meter	2	D,I	1	1,2,3
3.	Fluid flow measurement by using Orifice meter	2	D,I	1	1,2,3
4.	Fluid flow measurement by using Rota meter	2	D,I	1	1,2,3
5.	Studies on Characteristics of Centrifugal Pump	2	C,D,O	1	1,2,3
6.	Studies on Characteristics of Reciprocating Pump	2	C,D,O	2	1,2,3
7.	Friction factor studies on straight pipes	2	C,I	2	1,2,3
8.	Pressure loss studies on bended pipes	2	C,I	1	1,2,3
9.	Particle Size Analysis	2	C,I	3	1,2,3
10.	Plate and frame filter Press	2	D,O	5	1,2,3
11.	Vacuum leaf Pressure Filter	2	D,O	5	1,2,3
12.	Rotary drum vacuum Filter	2	D,O	5	1,2,3
13.	Batch Sedimentation	2	C,D,O	5	1,2,3
14.	Size reduction of Particles (By Using Jaw Crusher or Drop weight Crusher or Ball mill or Hammer mill)	2	C,O	4	1,2,3
15.	Screen efficiency	2	C,I	3	1,2,3
	Total contact hours	30			

LEARNING RESOURCES	
Sl. No.	**REFERENCES**
1.	Laboratory Manual
2.	Warren.L.McCabe, Julian C. Smith and Peter Harriot., "Unit Operations of Chemical Engineering ", 7th Edition, Tata McGraw-Hill Education, New Delhi,2005.
3.	Christie J. Geankoplis, "Transport Processes and Unit Operations ", 3rd Edition, Prentice Hall India ltd, NewDelhi, 1993.

Course nature				**Practical**		
Assessment Method (Weightage 100%)						
In-semester	**Assessment tool**	Experiments	Record	MCQ/Quiz/Viva Voce	Model examination	**Total**
	Weightage	**40%**	**5%**	**5%**	**10%**	**60%**
					End semester examination Weightage :	**40%**

15CH255L	CHEMICAL ENGINEERING PRACTICE LABORATORY - II	L	T	P	C
		0	0	2	1

Co-requisite:	15CH253		
Prerequisite:	NIL		
Data Book / Codes/Standards	Heat and Mass Transfer Data Book, Kothandaraman, C.P.Subramanyan, S, New Age International Publisher, 2014		
Course Category	E	Engineering Science	Offered to Bio Technology
Course designed by	Department of Chemical Engineering		
Approval	32nd Academic Council Meeting 23rd July 2016		

PURPOSE	This course helps the students to experimentally verify the theoretical concepts they learnt in the course: Chemical Engineering Principles –II							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1	An ability to design and conduct experiments, as well as to analyse and interpret data	b						
2	An ability to apply knowledge of mathematics, science and engineering	a						

S.No.	Description of experiments	C-D-I-O	IOs	Reference
1	Composite lagged pipe	I-O	1,2	1,2
2	Heat transfer through lagged pipe	I-O	1,2	1,2
3	Natural and forced convection heat transfer	I-O	1,2	1,2
4	Stefan boltzman apparatus	I-O	1,2	1,2
5	Emissivity apparatus	I-O	1,2	1,2
6	Study of shell and tube heat exchanger	I-O	1,2	1,2
7	Extraction	I-O	1,2	1,3
8	Leaching	I-O	1,2	1,3
9	Batch adsorption	I-O	1,2	1,3
10	Drying characteristics	I-O	1,2	1,3
11	Diffusion	I-O	1,2	1,3
12	Distillation operation	I-O	1,2	1,3
	Total hours	30		

LEARNING RESOURCES	
Sl. No.	**REFERENCES**
1	Laboratory Manual
2	Warren L. Mccabe, Julian C. Smith and Peter Harriott, "Unit Operations of Chemical Engineering", 7thEdn., McGraw Hill Education(India) private Limited, New Delhi, 2005
3	Robert E. Treybal, "Mass-Transfer Operations", 3rd Edn., McGraw Hill International Ed., Singapore, 1980.

Course nature	**Practical**

Assessment Method (Weightage 100%)

In-semester	**Assessment tool**	Experiments	Record	MCQ/Quiz/Viva Voce	Model examination	**Total**
	Weightage	**40%**	**5%**	**5%**	**10%**	**60%**
					End semester examination Weightage :	**40%**