1.1.3

List of Employability/ Entrepreneurship/ Skill Development Courses with Course Contents

Colour Codes		
Name of the Subjects	Yellow	
Employability Contents	Green	
Entrepreneurship Contents	Light Blue	
Skill Development Contents	Pink	

List of Courses Focus on Employability/ Entrepreneurship/ Skill Development

Department : *Chemical Engineering*

Programme Name : *B.Tech.*

Academic Year : 2022-23

List of Courses Focus on Employability/ Entrepreneurship/Skill Development

Sr. No.	Course Code	Name of the Course
01.	CSUATE5	Computer Programming
02.	CSUALES5	Computer Programming Laboratory
03.	IPUALL2	ENGINEERING WORKSHOP PRACTICES
04.	PEUALS2	SPORTS AND YOGA
05.	ELUBTH1	ENGLISH FOR COMMUNICATION
06.	CH203TPC02	Fluid Mechanics
07.	CH203PPC02	Fluid Mechanics Lab
08.	CH203TPC01	Material And Energy Balance Calculations
09.	CH204TBS07	Numerical Methods In Chemical Engineering
10.	CH204PBS03	Numerical Methods In Chemical Engineering Lab
11.	CH204TPC05	Particle And Fluid Particle Processing
12.	CH204PPC03	Particle And Fluid Particle Processing Lab
13.	CH204TPC06	Process Instrumentation
14.	CH204PPC04	Process Instrumentation Lab
15.	CH204THS02	Business Communication And Presentation Skill
16.	CH305TPC07	Heat Transfer
17.	CH305PPC05	Heat Transfer Lab
18.	CH305TPC08	Mass Transfer-I
19.	CH306PPC07	Mass Transfer Lab
20.	CH305TPC09	Chemical Reaction Engineering-I
21.	CH305PPC06	Chemical Reaction Engineering Lab
22.	CH306TPC11	Mass Transfer-II
23.	CH306TPC12	Process Dynamics And Control
24.	CH305TPC10	Process Equipment Design-I
25.	CH306TPE32	Fuel Combustion Energy Technology
26.	CH305TPE21	INORGANIC CHEMICAL TECHNOLOGY

27.	CH306TPE31	ORGANIC CHEMICAL TECHNOLOGY
28.	CH306TPC13	CHEMICAL REACTION ENGINEERING-II
29.	CH07TPC14	Process Equipment Design-II
30.	CH07TPC15	Chemical Reaction Engineering-II
31.	CH07TPE43	New Separation Processes
32.	CH07PPC11	Minor Project
33.	CH07PPC12	SEMINAR
34.	CH08TPC17	Process Equipment Design-III
35.	CH08TOE42	Project Engineering, Economics And Management
36.	CH08PPC13	Project
37.	CH07TPE41	Petroleum Refinery Engineering
38.	CH08TPE51	Petrochemical Technology
39.	CH07TOE32	Water Conservation And Management
40.	CH08TOE41	Optimization Techniques
41.	CH07TOE31	Process Modeling And Simulation
42.	CHPATT1	ADVANCED HEAT TRANSFER
43.	CHPATT2	ADVANCED REACTION ENGINEERING
44.	CHPATT3	ADVANCED PROCESS CONTROL
45.	CHPATP2	CHEMICAL ENGINEERING COMPUTATION LAB
56.	CHPBTP1	CHEMICAL REACTOR DESIGN
47.	CHPBTP2	COMPUTATIONAL FLUID DYNAMICS
48.	CHPALT1	ADVANCED CHEMICAL ENGINEERING LAB
49.	CHPBTP5	ENGLISH FOR RESEARCH PAPER WRITING
50.	CHPBTP4	DISSERTATION STAGE-I
51.	CHPCPT1	DISSERTATION STAGE-II

Scheme and Syllabus

SCHOOL OF STUDIES OF ENGINEERING AND TECHNOLOGY

Scheme of Teaching and Evaluation 2022-2023 (As per NEP-2020)
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
(Effective from the Academic Year 2022–2023)

I-SEMESTER BTech Mechanical/IP/Chemical/Civil Engineering

S.N.	Course Code	Course Title	Teaching Hours/week			Examination				Credits
			Theory lectures	Tutorial	Practical/ Drawing	Examination in Hours	CIA Marks	SEA Marks	Total Marks	
			L	T	P					
1	AMUATB1	Engineering Mathematics - A	3	1	-	03	40	60	100	4
2	CYUATB3	Engineering Chemistry	3	-	-	03	40	60	100	3
3	ECUATE4	Basic Electrical and Electronics Engineering	3	-	-	03	40	60	100	3
4	FOUATC2	Environmental Science and Ecology	2	-	-	03	40	60	100	2
5	CSUATE5	Computer Programming	3	-	-	03	40	60	100	3
6	LAUATC1	Indian Constitution	1	-	-	01	50	-	50	1
7	CYUALB3	Engineering Chemistry Laboratory	-	-	2	03	25	25	50	1
8	CSUALE5	Computer Programming Laboratory	-	-	2	03	25	25	50	1
9	IPUALL2	Engineering Workshop Practices	-	-	2	03	25	25	50	1
10	PEUALS2	Sports and Yoga	-	-	2		25	25	50	1
		Total	**15**	**1**	**08**	**25**	**350**	**400**	**750**	**20**

Note: AM:Mathematics, PP:Physics, ME: Mechanical Engineering, IP: Industrial & Production Engineering, CE: Civil Engineering, CS: Computer Sc. & Engg., IT: Information Technology, PE: Physical Education, FO: Forestry, LA: Law, NS: NSS, U: Undergraduate, T: Theory, L: Laboratory,

BASIC SCIENCE (B)	ENGINEERING SCIENCE (E)	SKILL ENHANCEMENT COURSE (L)	HUMANITIES SCIENCE (H)	MANDATORY COURSE (C)	EXTRA-CURRICULAR ACTIVITIES (S)
1. Mathematics – A 2. Physics 3. Chemistry 4. Mathematics - B	1. Engineering Mechanics 2. Introduction to Information Technology 3. Basic Electrical Engineering 4. Basic Electrical and Electronics Engineering 5. Computer Programming 6. Basic Communication Engineering	1. Engineering Graphics 2. Engineering Workshop Practices	1. English for communication 2. Human Values and Ethics	1. Indian Constitution 2. Environmental Science & Ecology	1. NSS 2 Sports and Yoga

SCHOOL OF STUDIES OF ENGINEERING AND TECHNOLOGY

Scheme of Teaching and Evaluation 2022-2023 (As per NEP-2020)
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
(Effective from the Academic Year 2022–2023)

II-SEMESTER BTech Mechanical/IP/Chemical/Civil Engineering

S.N.	Course Code	Course Title	Teaching Hours/week			Examination				Credits
			Theory lectures	Tutorial	Practical/ Drawing	Examination in Hours	CIA Marks	SEA Marks	Total Marks	
			L	T	P					
1	AMUBTB4	Engineering Mathematics-B	3	1	-	03	40	60	100	4
2	PPUBTB2	Engineering Physics	3	1	-	03	40	60	100	4
3	ITUBTE2	Introduction to Information Technology	3	-	-	03	40	60	100	3
4	ELUBTH1	English for Communication	3	-	-	03	40	60	100	3
5	CEUBTE1	Engineering Mechanics	3	-	-	03	40	60	100	3
6	ME UBTH2/CH UBTH2/ IP UBTH2/CEUBTH2	Human Values and Ethics	1	-	-	02	50	-	50	1
7	PPUBLB2	Engineering Physics Laboratory	-	-	2	03	25	25	50	1
8	CEUBLE1	Engineering Mechanics Laboratory	-	-	2	03	25	25	50	1
9	MEUBLL1	Engineering Graphics	1	-	3	03	25	25	50	3
10	NSUBLS1	NSS	-	-	2	01	25	25	50	1
		Total	**17**	**2**	**09**	**27**	**350**	**400**	**750**	**24**

Note: AM:Mathematics, PP:Physics, ME: Mechanical Engineering, IP: Industrial & Production Engineering, CE: Civil Engineering, CS: Computer Sc. & Engg., IT: Information Technology, PE: Physical Education, NS: NSS, U: Undergraduate, T: Theory, L: Laboratory,

BASIC SCIENCE (B)	ENGINEERING SCIENCE (E)	SKILL ENHANCEMENT COURSE (L)	HUMANITIES SCIENCE (H)	MANDATORY COURSE (C)	EXTRA-CURRICULAR ACTIVITIES (S)
1. Mathematics – A 2. Physics 3. Chemistry 4. Mathematics - B	1. Engineering Mechanics 2. Introduction to Information Technology 3. Basic Electrical Engineering 4. Basic Electrical and Electronics Engineering 5. Computer Programming 6. Basic Communication Engineering	1. Engineering Graphics 2. Engineering Workshop Practices	1. English for communication 2. Human Values and Ethics	1. Indian Constitution 2. Environmental Science & Ecology	1. NSS 2.Sports and Yoga

SCHOOL OF STUDIES OF ENGINEERING & TECHNOLOGY
GURU GHASIDAS VISHWAVIDYALAYA, BILASPUR (C.G.)
(A Central University Established by the Central University Ordinance 2009, No. 3 of 2009)

SCHEME FOR EXAMINATION (Effective from Session 2021-22)

B.TECH. (FOUR YEAR) DEGREE COURSE, CHEMICAL ENGINEERING

SECOND YEAR, THIRD SEMESTER (AICTE-NEW)

S. No.	Subject Code	Subject Name	Periods			Evaluation Scheme			Credits
						Sessional			
	THEORY		L	T	P	IA	ESE	TOTAL	
01.	CH203TBS05	Biology	3	0	0	30	70	100	3
02.	CH203TBS06	Mathematics-III	3	1	0	30	70	100	4
03.	CH203TPC01	Material and Energy Balance Calculations	3	1	0	30	70	100	4
04.	CH203TPC02	Fluid Mechanics	3	1	0	30	70	100	4
05.	CH203TPC03	Thermodynamics-I	3	0	0	30	70	100	3
	PRACTICAL								
01.	CH203PPC01	Chemical Engineering Lab-I	0	0	3	30	20	50	1.5
02.	CH203PPC02	Fluid Mechanics Lab	0	0	3	30	20	50	1.5
		Total	15	3	6			600	21

SCHOOL OF STUDIES OF ENGINEERING & TECHNOLOGY
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(A Central University Established by the Central University Ordinance 2009, No. 3 of 2009)

SCHEME FOR EXAMINATION (Effective from Session 2021-22)
B.TECH. (FOUR YEAR) DEGREE COURSE, CHEMICAL ENGINEERING
SECOND YEAR, FOURTH SEMESTER (AICTE-NEW)

S. No.	Subject Code	Subject Name	Periods			Evaluation Scheme			Credits
	THEORY					Sessional			
			L	T	P	IA	ESE	TOTAL	
01.	CH204THS02	Business Communication and Presentation Skill	3	0	0	30	70	100	3
02.	CH204TBS07	Numerical Methods in Chemical Engineering	3	1	0	30	70	100	4
03.	CH204TPC04	Thermodynamics-II	3	0	0	30	70	100	3
04.	CH204TPC05	Particle and Fluid Particle Processing	3	1	0	30	70	100	4
05.	CH204TPC06	Process Instrumentation	3	1	0	30	70	100	4
	PRACTICAL								
01.	CH204PBS03	Numerical Methods in Chemical Engineering lab	0	0	2	30	20	50	1
02.	CH204PPC03	Particle and Fluid Particle Processing lab	0	0	3	30	20	50	1.5
03.	CH204PPC04	Process Instrumentation Lab	0	0	3	30	20	50	1.5
		Total	15	3	8			650	22

IA – Internal Assessment ESE - End Semester Examination Total Credits : 22

Total Marks – 650 Total Periods / week - 26

BoS held on 01.10.2021 B. Tech. (Chemical Engg.)- II Year w.e.f : Session 2021-22

SCHOOL OF STUDIES OF ENGINEERING & TECHNOLOGY
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SCHEME FOR EXAMINATION (Effective from session 2022-23)
B. TECH. (FOUR YEAR) DEGREE COURSE, CHEMICAL ENGINEERING
THIRD YEAR, FIFTH SEMESTER (AICTE-NEW)

S. No.	Subject Code	Subject Name	Periods			Evaluation Scheme			Credits
	THEORY					Sessional			
			L	T	P	IA	ESE	TOTAL	
01.	CH305TPC07	Heat Transfer	3	1	0	30	70	100	4
02.	CH305TPC08	Mass Transfer-I	3	1	0	30	70	100	4
03.	CH305TPC09	Chemical Reaction Engineering-I	3	1	0	30	70	100	4
04.	CH305TPC10	Process Equipment Design-I	3	1	0	30	70	100	4
05.	CH305TPE1X		3	0	0	30	70	100	3
06.	CH305TPE2X		3	0	0	30	70	100	3
	PRACTICAL								
01.	CH305PPC05	Heat Transfer Lab	0	0	3	30	20	50	1.5
02.	CH305PPC06	Chemical Reaction Engineering Lab	0	0	3	30	20	50	1.5
		Total	18	4	6	240	460	700	25

IA – Internal Assessment ESE - End Semester Examination Total Credits – 25

Total Marks – 700 Total Periods / week - 28

SCHOOL OF STUDIES OF ENGINEERING & TECHNOLOGY
GURU GHASIDAS VISHWAVIDYALAYA, BILASPUR (C.G.)
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SCHEME FOR EXAMINATION (Effective from session2022-23)

B. TECH. (FOUR YEAR) DEGREE COURSE, CHEMICAL ENGINEERING

THIRD YEAR, SIXTH SEMESTER (AICTE)

S. No.	Subject Code / THEORY	Subject Name	Periods			Evaluation Scheme			Credits
						Sessional			
			L	T	P	IA	ESE	TOTAL	
01.	CH306TPC11	Mass Transfer-II	3	1	0	30	70	100	4
02.	CH306TPC12	Process Dynamics and Control	3	1	0	30	70	100	4
03.	CH306TPC13	Chemical Reaction Engineering-II	3	1	0	30	70	100	4
04.	CH306TPE3X		3	0	0	30	70	100	3
05.	CH306TMC02	Essence of Indian Knowledge Tradition	3	0	0	30	70	100	3
06.		Open Elective	3	0	0	30	70	100	3
	PRACTICAL								
01.	CH306PPC07	Mass Transfer Lab	0	0	3	30	20	50	1.5
02.	CH306PPC08	Process Dynamics and Control Lab	0	0	3	30	20	50	1.5
		Total	18	3	6	240	460	700	24

IA – Internal Assessment
Total Marks – 700

ESE - End Semester Examination
Total Periods / week - 27

Total Credits – 24

SCHOOL OF STUDIES OF ENGINEERING & TECHNOLOGY
GURU GHASIDAS VISHWAVIDYALAYA, BILASPUR (C.G.)
(A Central University Established by the Central University Ordinance 2009, No. 3 of 2009)

DEPARTMENT OF CHEMICAL ENGINEERING

List of Professional Elective Courses (Fifth and Sixth Semester)

S.No.	Semester	Course No.	Subjects
01.	V	CH305TPE11	Engineering Materials
02.		CH305TPE12	Polymer Technology
01.	V	CH305TPE21	Inorganic Chemical Technology
02.		CH305TPE22	Fluidization Engineering
01.	VI	CH306TPE31	Organic Chemical Technology
02.		CH306TPE32	Fuel Combustion Energy Technology

SCHOOL OF STUDIES OF ENGINEERING & TECHNOLOGY
GURU GHASIDAS VISHWAVIDYALAYA, BILASPUR (C.G.)
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SCHEME FOR EXAMINATION (Effective from Session 2021-22)

B.TECH.-(FOUR YEAR) DEGREE COURSE, CHEMICAL ENGINEERING

FINAL YEAR, SEVENTH SEMESTER (AICTE)

S. No.	Subject Code	Subject Name	Periods			Evaluation Scheme			Credits
						Sessional			
	THEORY		L	T	P	IA	ESE	TOTAL	
01.	CH07TPC14	Process Equipment Design - II	3	1	0	30	70	100	4
02.	CH07TPC15	Chemical Reaction Engineering - II	3	1	0	30	70	100	4
03.	CH07TPC16	Transport Phenomena	3	1	0	30	70	100	4
04.	CH07TPE4X		3	0	0	30	70	100	3
05.	CH07TOE3X		3	0	0	30	70	100	3
	PRACTICAL								
01.	CH07PPC11	Minor Project	0	0	3	30	20	50	1.5
02.	CH07PPC12	Seminar	0	0	3	30	20	50	1.5
		Total	15	3	6			600	21

IA – Internal Assessment
Total Marks – 600

ESE - End Semester Examination
Total Periods / week - 24

Total Credits : 21

B. Tech. Chemical Engineering Final Year

w.e.f : Session 2021-22

BoS held on 23.07.2021

SCHOOL OF STUDIES OF ENGINEERING & TECHNOLOGY
GURU GHASIDAS VISHWAVIDYALAYA, BILASPUR (C.G.)
(A Central University Established by the Central University Ordinance 2009, No. 3 of 2009)

SCHEME FOR EXAMINATION (Effective from Session 2021-22)

B.TECH. (FOUR YEAR) DEGREE COURSE, CHEMICAL ENGINEERING

FINAL YEAR, EIGHTH SEMESTER (AICTE)

S. No.	Subject Code	Subject Name	Periods			Evaluation Scheme			Credits
						Sessional			
	THEORY		L	T	P	IA	ESE	TOTAL	
01.	CH08TPC17	Process Equipment Design - III	3	1	0	30	70	100	4
02.	CH08TPE5X		3	0	0	30	70	100	3
03.	CH08TOE4X		3	0	0	30	70	100	3
	PRACTICAL								
01.	CH08PPC13	Project	0	0	8	70	30	100	4
		Total	9	1	8			400	14

IA – Internal Assessment
Total Marks – 400

ESE - End Semester Examination
Total Periods / week - 18

Total Credits : 14

B. Tech. Chemical Engineering Final Year

w.e.f : Session 2021-22

BoS held on 23.07.2021

SCHOOL OF STUDIES OF ENGINEERING & TECHNOLOGY
GURU GHASIDAS VISHWAVIDYALAYA, BILASPUR (C.G.)
(A Central University Established by the Central University Ordinance 2009, No. 3 of 2009)
DEPARTMENT OF CHEMICAL ENGINEERING

List of Professional Elective Courses (Seventh and Eighth semester) (AICTE)

S. No.	Semester	Course No.	Subject
01.	VII	CH07TPE41	Petroleum Refinery Engineering
02.		CH07TPE42	Polymer Technology-I
03.		CH07TPE43	New Separation Processes
04.	VIII	CH08TPE51	Petrochemical Technology
05.		CH08TPE52	Polymer Technology-II
06.		CH08TPE53	Design and Development of Catalyst

List of Open Elective Courses (Seventh and Eighth semester) (AICTE)

S. No.	Semester	Course No.	Subject
01.	VII	CH07TOE31	Process Modelling & Simulation
02.		CH07TOE32	Water Conservation & Management
03.	VIII	CH08TOE41	Optimization Techniques
04.		CH08TOE42	Project Engineering Economics & Management

SYLLABUS	(SEMESTER-I)	Periods/ Week			Internal Assessment (IA)				ESE	Grand Total	Credits
Subject Code:	CSUATE5	L	T	P	CT-1	CT-II	Attendance & Assignments	TOTAL	60	100	03
Subject:	COMPUTER PROGRAMMING	3	-	-	15	15	10	40			

Course Objectives:

- To understand the basic of Idea ofAlgorithm.
- To understand the programing concept of Arithmetic expressions and BasicAlgorithms
- To learn the Functions and Structure ofarray.

Course Content:

UNIT-1: Introduction to Programming
Introduction to components of a computer system (disks, memory, processor, where a program is stored and executed, operating system, compilers etc.) -
Idea of Algorithm:steps to solve logical and numerical problems. Representation of Algorithm: Flowchart/Pseudo code with examples.From algorithms to programs; source code, variables (with data types) variables and memory locations,Syntax and Logical Errors in compilation, object and executablecode.

UNIT-2: Arithmetic expressions and precedence
Conditional Branching and Loops, Writing and evaluation of conditionals and consequent branching Iteration and loops, **Arrays** (1-D, 2-D), Character arrays and strings

UNIT-3: Basic Algorithms
Searching,concept of binary search etc, Basic Sorting Algorithms Bubble sort etc,Finding roots of equations, introduction of Algorithm complexity

UNIT-4: Function
Functions (including using built in libraries), Parameter passing in functions, call by value, passing arrays to functions: idea of call by reference binary search etc.
Recursion functions Recursion, as a different way of solving problems. Example programs, such as, Finding Factorial, Fibonacci series, etc.

UNIT -5: Structure
Structures, Defining structures and Array of Structures
Pointers Idea of pointers, defining pointers, Use of Pointers in self-referential structures, notion of linked list (no implementation)

Course Outcomes- At the end of the course students will be able to
- Develop the algorithm and programmers for various applications using Arithmetic expressions, arrays, pointers andFunctions.

Textbooks/References:

1. Byron Gottfried, Schaum's Outline of Programming with C,McGraw-Hill
2. E. Balaguruswamy, Programming in ANSI C, TataMcGraw-Hill
3. Brian W. Kernighan and Dennis M. Ritchie, the C Programming Language, Prentice Hall of India

SYLLABUS	(SEMESTER-I)	Periods/ Week			INTERNAL ASSESSMENT (IA)			ESE	Grand total	Credits
Subject Code:	CSUALE5	L	T	P	IA	MSE	TOTAL			
Subject:	COMPUTER PROGRAMMING LABORATORY	-	-	2	25	--	25	25	50	01

Course Learning Objectives:

- To learn the Branching and logical expressions andLoops
- To learn the Arrays andFunction
- To understand the Numerical methods andRecursion

Course Content:

The laboratory should be preceded or followed by a tutorial to explain the approach or Algorithm to be implemented for the problem given.

Tutorial 1: Problem solving using computers:
Lab1: Familiarization with programming environment

Tutorial 2: Variable types and type conversions:
Lab 2: Simple computational problems using arithmetic expressions

Tutorial 3: Branching and logical expressions:
Lab 3: Problems involving if-then-else structures

Tutorial 4: Loops, while and for loops:
Lab 4: Iterative problems e.g., sum of series

Tutorial 5: 1D Arrays: searching, sorting:
Lab 5: 1D Array manipulation

Tutorial 6: 2D arrays and Strings
Lab 6: Matrix problems, String operations

Tutorial 7: Functions, call by value:
Lab 7: Simple functions

Tutorial 8 &9: Numerical methods (Root finding, numerical differentiation, numerical Integration):
Lab 8 and 9: Programming for solving Numerical methods problems

Tutorial 10: Recursion, structure of recursive calls
Lab 10: Recursive functions

Tutorial 11: Pointers, structures and dynamic memory allocation
Lab 11: Pointers and structures

Course Outcomes- At the end of the course students will be able to

- Utilization of Branching and logical expressions and Loops, Arrays and Function and Numerical methods and Recursion for writing the programmes for various engineering applications

SYLLABUS	(SEMESTER-I)	Periods/ Week			INTERNAL ASSESSMENT (IA)			ESE	Grand total	Credits
Subject Code:	IPUALL2	L	T	P	IA	MSE	TOTAL	25	50	01
Subject:	ENGINEERING WORKSHOP PRACTICES	-	-	2	25	--	25			

Course objectives:

- To impart student knowledge on various hand tools for usage in engineering applications.
- Be able to use analytical skills for the production of components.
- Design and model different prototypes using carpentry, sheet metal and welding.
- Make electrical connections for daily applications.
- To make student aware of safety rules in working environments.

Course Content:

1. Study of M/C tools in lathe machine
   Demonstration of different operations of lathe machine
   Practice of facing plain turning, taper turning etc

2. Study of Carpentry tools, equipments and different jobs
   Practice of Lap joints, Butt joints, T-Lab joints

3. Practice of Lap joint, Butt Joint, T-joint

4. Preparation of ¥ shape, square shape, work pieces as per the given specification

5. Replacement of fuse, condenser of fan/motor and fan regulator;
   Installation of switch board with wiring;
   Concepts of measuring instruments.

6. Identification of various electronics components and their terminals;
   Study of logic gates AND, OR, XOR and NOT, NAND, NOR;
   Study of Basic ICs.

Course Outcomes: At the end of the course students will be able to:

- Make half lap joint, Dovetail joint and Mortise &Tenonjoint
- Produce Lap joint, Tee joint and Butt joint using Gas welding
- Prepare trapezoidal tray, Funnel and T-joint using sheet metal tools
- Make connections for controlling one lamp by a single switch, controlling two lamps by a single switch and stair casewiring

Textbooks/References:

1. Hajra Choudhury S.K., Hajra Choudhury A.K. and Nirjhar Roy S.K., "Elements of WorkshopTechnology", Vol. I 2008 and Vol. II 2010, Media promoters and publishersprivate limited,Mumbai.
2. Kalpakjian S. And Steven S. Schmid, "Manufacturing Engineering and Technology", 4th edition, Pearson Education India Edition,2002.
3. Gowri P. Hariharan and A. Suresh Babu, "Manufacturing Technology – I" Pearson Education, 2008. (iv)Roy A. Lindberg, "Processes and Materials of Manufacture", 4thedition, PrenticeHallIndia, 1998.
4. Rao P.N., "Manufacturing Technology", Vol. I and Vol. II, Tata Mc-Graw Hill House,2017.

SPORTS & YOGA

SYLLABUS	(SEMESTER-I)	Periods/ Week			INTERNAL ASSESSMENT (IA)			ES Assessment	Grand total	Credits
Subject Code:	PEUALS2	L	T	P	Attendance	Activities	TOTAL			
Subject:	SPORTS AND YOGA	-	-	2	5	20	25	25	50	01

Physical Fitness Tests

- AAHPER youth fitness test
- Cooper's 12 Minute run-walk test

General Introduction of games and sports

Fundamental skills, history and development of the following games and sports:

- Athletics
- Batminton
- Basketball
- Cricket
- Football
- Hockey
- Handball
- Kabaddi
- Kho-kho
- Volley-ball
- Yoga

Note:

1. Each student will have to clear one of the physical fitness tests by the end of the semester.
2. One project is to be prepared by the students at least for two games.

References:

1. Barron H M, McGhee R (1997) A Practical Approach to Measurement in Physical Education.
2. Kansal D K (1996), Test and Measurement in sports and physical education, New Delhi, D V S Publication

SYLLABUS	(SEMESTER-II)	Periods/ Week			Internal Assessment (IA)				ESE	Grand Total	Credits
Subject Code:	ELUBTH1	L	T	P	CT-1	CT-II	Attendance & Assignments	TOTAL	60	100	03
Subject:	ENGLISH FOR COMMUNICATION	3	0	-	15	15	10	40			

Course Learning Objectives

- To build up word power, to brush up the knowledge of English grammar, to develop good writing and speaking skills in the students

Course Content:

Unit 1: -Vocabulary Building
The concept of Word Formation, Root words from foreign languages and their use in English, Acquaintance with prefixes and suffixes from foreign languages in English to form derivatives. Synonyms, antonyms, and standard abbreviations.
Unit 2: -Basic WritingSkills
Sentence Structures, Use of phrases and clauses in sentences, Importance of proper punctuation, Creating coherence, Organizing principles of paragraphs in documents, Techniques for writing precisely
Unit 3: -Identifying Common Errors inWriting
Subject-verb agreement, Noun-pronoun agreement, Misplaced modifiers, Articles, Prepositions, Redundancies,Clichés
Unit 4: -Nature and Style of sensibleWriting
Describing, Defining, Classifying, Providing examples or evidence, Writing introduction and conclusion.
Unit 5: -WritingPractices
Comprehension, Précis Writing, Essay Writing.

Oral Communication (This unit involves interactive practice sessions in LanguageLab)
ListeningComprehension
Pronunciation, Intonation, Stress andRhythm
Common Everyday Situations: Conversations andDialogues
Communication atWorkplace
Interviews
Formal Presentations

Course Outcome:

At the end of the course students will be ablelearn a lot of new words. They also learnt the particularities and peculiarities of English grammar. As a result, they could speak and write English with theleast possible error

Textbooks/References:

1. Practical English Usage. Michael Swan. OUP.1995.
2. Remedial English Grammar. F.T. Wood. Macmillan.2007 (iii)On Writing Well. William Zinsser. Harper Resource Book.2001
3. Study Writing. Liz Hamp-Lyons and Ben Heasly. Cambridge University Press.2006.
4. Communication Skills. Sanjay Kumar and PushpLata. Oxford University Press.2011.
5. Exercises in Spoken English. Parts. I-III. CIEFL, Hyderabad. Oxford UniversityPress

CH203TPC01 Material and Energy Balance Calculations [L:3, T:1, P:0]

Objectives:

The course will serve as a basis for all further chemical engineering courses that are part of the curriculum.

Unit I : Introductory concepts of units, physical quantities in chemical engineering, Dimensionless groups, "basis" of calculations Gases, Vapours and Liquids: Equations of state, Vapour pressure, Clausius Clapeyron equation, Cox chart, Duhring's plot, Raoult's law.

Unit II : Humidity and saturation, humid heat, humid volume, dew point, humidity chart and its use.

Unit III : Material Balance: Introduction, solving material balance problems without chemical reaction, material balances with recycle, bypass and purge, material balance with chemical reaction, concept of stoichiometry and mole balances, examples, including combustion.

Unit IV : Energy Balance: open and closed system, heat capacity, calculation of enthalpy changes.

Unit V : Energy balances with chemical reaction, heat of reaction, heat of combustion.

Suggested Text Books:

1. S. N. Saha, "Chemical Process Engineering Calculation", Dhanpat Rai Publication Co. (Pvt.) Ltd., New Delhi
2. B. I. Bhatt & S. M. Vora, "Stoichiometry", Tata McGraw Hill Publishing Co. Ltd.

Suggested References Books:

1. R. M. Felder & R. W. Rousseau, "Elementary Principles of Chemical Processes", John Wiley & Sons.
2. O. A. Hougen, K. M. Watson & R. A. Ragatz, "Chemical Process Principles, Part I Material & Energy Balances", CBS Publishers & Distributors.
3. D. M. Himmelblau & J. B. Riggs, "Basic Principles and Calculations in Chemical Engineering", Pearson India Education Services.
4. V. Venkataramani, N. Anantharaman, K. M. Begum & S. Meera, "Process Calculations", Prentice Hall of India.
5. D. C. Sikdar, "Chemical Process Calculations", Prentice Hall of India.

Outcomes:

Students completing the course will

- Develop mastery over process calculations relevant to Chemical Engineering Processes
- Be able to handle elementary flow-sheeting, material and energy balance calculations
- Be able to solve problems based on without and with chemical reactions, and involving concepts like recycle, bypass and purge.
- Be familiar with equations of state and properties of gases and liquids, including phase transition.

CH203TPC02 **Fluid Mechanics** **[L:3, T:1, P:0]**

Objectives:

The objective of this course is to introduce the mechanics of fluids (fluid statics and fluid dynamics), relevant to Chemical Engineering operations. The course will impart the knowledge of basic concepts of kinematics of flow, different forces on fluids, flow visualization, flow measurement, flow transportation and types of flow.

Unit I : Fluid Static & Applications: Hydrostatic equilibrium, hydrostatic equilibrium in centrifugal field and its applications in chemical engineering like manometers decanters. Fluid Flow Process: velocity gradient and shear, types of fluids, concept of viscosity, kinematic viscosity, nature of flow- laminar, turbulent, Reynolds number, boundary layer formation and separation.

Unit II : Basic Equations for Fluid Flow: Mass balance & momentum balance equations, Bernoulli's equation without and with corrections for solid boundaries, kinetic energy, friction factor, pump work.

Unit III : Incompressible Fluids : Flow through pipes, flow characteristics- shear stress, friction factor, laminar flow for newtonian fluids, Hagen Poiseuille equation, laminar flow for non-newtonian liquids, turbulent flow through pipes and close channels and its characteristic equations, friction factor and its dependence on roughness, Reynolds number, friction factor for flow through channels of non-circular cross section – concept of equivalent diameter, frictional losses due to sudden change in velocity or direction of flow; expansion, contraction, effect of fittings, flow of liquids in thin layers.

Unit IV : Transportation of Fluids: pipe fitting like bends, elbows, flanges, tee and different types of valves, seals for moving parts, pumps, NPSH, power requirement, types of pumps – centrifugal & positive displacement, trouble shooting in operation – priming & cavitation, characteristic curves – head / capacity / power / efficiency, capacity- head flow and head work relationship, metering of fluids: variable head meters- venturi meter & orifice meter, variable area meter – rotameter, insertion meters – pitot tube.

Unit V : Differential analysis: mass and momentum balances, Navier-Stokes equation, unidirectional flow, viscous flow, Stokes law, skin drag and pressure drag, potential flow, potential function, solution of Laplace equation.

Suggested Text Books :

1. M. White, Fluid Mechanics, Tata-McGraw Hill.
2. V. Gupta & S. K. Gupta, Fundamentals of Fluid Mechanics, New Age International.
3. W. L. McCabe, J. C. Smith & P. Harriot, Unit Operations of Chemical Engineering, McGraw-Hill International Edition.

4. O. Wilkes, Fluid Mechanics for Chemical Engineers, Prentice Hall of India.
5. R. W. Fox, P. J. Pritchard & A. T. McDonald, Introduction to Fluid Mechanics, Wiley-India.
6. R. Welty, C. E. Wicks, R. E. Wilson, G. Rorrer, Fundamentals of Momentum, Heat and Mass Transfer, Wiley.

Suggested References Books :

1. B. R. Munson, D. F. Young, T. H. Okiishi & W. W. Huebsch, Wiley-India.
2. R. L. Panton, Incompressible Flow, Wiley-India.
3. R. B. Bird, W. E. Stewart & E. N. Light foot, Transport Phenomena, Wiley India.

Outcomes :

- Velocity profiles by simplification of equations of motion in simple 1-D flows
- Boundary layer thicknesses, friction factor, pressure drop, power requirements in single phase flow in pipes
- Two phase gas/liquid pressure drop
- Power requirements, NPSH requirements of pumps

Students should be able to :
- Communicate properly, write technical letters and reports.
- Present reports and seminars in an attractive way.

CH204TBS07 Numerical Methods in Chemical Engineering [L:3, T:1, P:0]

Objectives:

The objective of this subject is to introduce students to numerical methods used to solve engineering problems, in particular chemical engineering problems, using numerical methods and computer programming.

Unit I : Introduction of errors and their analysis, types of errors, numerical problems on error analysis, curve fitting: method of least squares, fittings of straight line and parabola and by method of moments.

Unit II : Numerical Solution of Algebraic and Transcendental Equations: Secant method, Regula-falsi Method, Newton Raphson method, solution of a system of simultaneous linear algebraic equations direct method: Gauss elimination method, iterative methods, Gauss Seidel iterative method.

Unit III : The Calculus of Finite Differences: Finite differences, difference formula, operators and relation between operators, inverse operator, interpolation with equal intervals: - Newton's forward and backward interpolation formula, interpolation with unequal intervals: - Lagrange's interpolation.

Unit IV : Numerical Differentiation and Integration: Numerical differentiation Newton's forward and backward difference interpolation formula. Numerical Integration: Trapezoidol rule, simpson's $1/3^{rd}$ and $3/8^{th}$ rule, Boole's rule, Weddle rule.

Unit V: Numerical solution of ordinary differential equation: Taylor series method, Euler's method, Modified Euler method Range's method Runge-Kutta method.

Books Recommended:

1. Jain & Iyngar, Numerical Methods for Scientific and Engineering Computations.
2. G. S. Rao, Numerical Analysis.
3. B. S. Grewal, Numerical Methods in Engineering and Science.
4. H. K. Das, Advance Engineering Methods.
5. V. Rajaraman, Computer Oriented Numerical Methods

Outcomes:

After successful completion of this course students will be able to solve chemical engineering problems involving linear and non-linear equations and solve ordinary differential equations.

- Evaluate the equilibrium constant for chemical reactions.

CH204TPC05 Particle and Fluid Particle Processing [L:3, T:1, P:0]

Objectives :

Objective of this course is to introduce students to the numerous industrial operations dealing with the particulate solids, their handling in various unit operations, and those in which particle fluid interactions are important. The course addresses fundamentals of fluid-particle mechanics, such as the notion of drag, and builds on those fundamentals to develop design concepts for various industrial processes like packed bed operation, fluidized operations, sedimentation, filtration, separation of solids and fluids, etc. Industrial applications are discussed. The course is concluded with an introduction to colloidal systems, soft materials and nanoparticles. Applications of these novel systems are discussed.

Unit I: Solids Properties, Handling, Mixing : Introduction: Relevance of fluid and particle mechanics, and mechanical operations, in chemical engineering processes. Solid particle characterization: Particle size, shape and their distribution, Screen analysis, standard screens; Relationship among shape factors and particle dimensions; Specific surface area; Measurement of surface area. Mixing and storage of Solids: Types of important mixers like kneaders, dispersers, masticaters, roll mills, muller mixer, pug mixer, blender, screw mixer etc., mixing index.

Unit II: Storage and Transportation, Size Reduction : Types of storage equipments, Bin, Silo, Hoper, etc. Transport of fluid-solid systems: mechanical conveying, pneumatic and hydraulic conveying. Major equipment's- Crushers, grinders, ultrafine grinders, laws of communition, Close circuit and open circuit grinding.

Unit III: Fluid Solid Separation : Sedimentation: Elutraition, Classification and sedimentation, Free Settling, hindered settling, flow of solids through fluid, Stoke's law, Richardson-Zaki equation, design of settling tanks. Centrifugal separation, design of cyclones and hydro cyclones, filter bags, venturi scrubber, electrostatic precipitator.

Unit IV: Mechanical Separation and Filtration : Industrial screen; their capacity and effectiveness. Types of filtration, principle of filtration, plate and frame filter, leaf filter, rotary drum filter, etc.

Unit V: Fluidization : Fluidization: Fluidized bed, minimum fluidization velocity, pressure drop etc. Types of fluidization: Particulate fluidization, Bubbling fluidization, Applications of fluidization. Packed bed: Void fraction, superficial velocity, channelling, Ergun equation and its derivation, Kozeny Carman equation, Darcy's law and permeability, Blaine's apparatus.

Suggested Text Books :

1. W. McCabe, J. Smith, J. & P. Harriott, Unit Operations of Chemical Engineering,

Outcomes:

Students will be able to

- Calculate pressure drop in fixed and fluidized beds.
- Know the significance and usage of different particulate characterization parameters, and equipment to estimate them.
- Describe Size reduction energy requirements, estimate performance of equipment, selection and sizing of equipment.
- Analyse filtration data and select systems based on requirements, estimate filtration area for given requirements, understand filter aids and their usage.

CH204TPC06 **Process Instrumentation** [L:3, T:1, P:0]

Objectives:

This course is to introduce students to learn the basics of instrumentation and handling the process variables, course address fundamentals & amp; operation of different measuring devices such as temperature, level, pressure, flow, pH, humidity and compositions. Course introduced to impart basic knowledge of transmitters, transducers, control valves, digital and analog components related to PLC, DCS.

Unit I : Instruments Characteristics: Introduction to process variables, static and dynamic characteristics of instruments, and their general classification, elements of measuring system and their functions.

Unit II: Transmitters & amp; Transducers: Signal transmission, transmitters, electronic, pneumatic, transducers.

Unit III: Measuring Instruments : Principles, construction and operations of instruments for the measurement of various process variables such as temperature, pressure, flow, liquid level, humidity, viscosity and composition.

Unit IV: Controllers & amp; Regulators : Principles and construction of electro- pneumatic controllers, multiplexers, final control elements such as pneumatic control vale, stepper motor.

Unit V: Data Acquisition & amp; Analysis : Introduction to data acquisition system and intelligent instruments, instrumentation of process equipment such as distillation column, heat exchanger etc.

Text Books:

1. S. K. Singh, Industrial Instrumentation and Control, McGraw-Hill.
2. William C. Dunn, Fundamentals of Industrial Instrumentation and Process Control, McGrawHill.

References Books:

1. D. Patranabis, Principles of Industrial Instrumentation, Tata McGraw-Hill Publishing Co. Ltd.
2. T. G. Beckwith, R. D. Marangoni & J. H. Lienhard, Mechanical Measurements, Addison Wesley.
3. R. K. Jain, Mechanical and Industrial Measurements, Khanna Publishers, New Delhi
4. C. D. Johnson, Process Control Instrumentation Technology, Pearson Education, Inc.

Outcomes :

Students will be well-familiar with instrumentation and automation as relevant to modern chemical plant operation.

CH203PPC02 **Fluid Mechanics Lab** **[L:0, T:0, P:3]**

Objectives :

The objective of this course is to give the students the practical exposure of the theory and concepts of the subject fluid mechanics. The course will provide the knowledge of different flow meters and pressure measurement through the experiments. It will also help in understanding the theoretical concepts through experiments.

List of experiments:

1. To determine the coefficient of discharge of the given venturimeter.
2. To determine the coefficient of discharge of the orifice meter connected in between a pipe line.
3. To determine the coefficient of discharge of the Rotameter.
4. To determine the velocity of the flowing fluid and coefficient of the given pitot tube.
5. Study and verification of the Bernoulli's theorem.
6. Experimental determination of hydraulic coefficients.
7. To measure the pressure using manometer.
8. To determine the type of flow and Reynold's number through Reynold's experiment.

* Any other experiments may be added further, if needed.

Outcomes :

- The students will be able to visualise the concepts.
- The students will understand about different components of the flow system.
- The students will be able to operate different meters.
- The students will be able to measure and calculate different flow parameters.

CH204THS02 Business Communication and Presentation Skill [L:3, T:0, P:0]

Objectives:

To develop the communication skills like writing technical letters, reports and presentation skills.

Contents:

Unit I : Business communication covering, role of communication in information age; concept and meaning of communication; skills necessary for technical communication; communications in a technical organization; barriers to the process of communication.

Unit II : Style and organization in technical communication covering, listening, speaking, reading and writing as skills; objectivity, clarity, precision as defining features of technical communication; various types of business writing: letters, reports, notes, memos; language and format of various types of business letters; language and style of reports; report writing strategies; analysis of a sample report.

Unit III : Communication and personality development covering, psychological aspects of communication, cognition as a part of communication; emotional intelligence; politeness and etiquette in communication; cultural factors that influence communication; mannerisms to be avoided in communication; language and persuasion; language and conflict resolution.

Unit IV : Language laboratory emphasizing listening and comprehension skills; reading skills; sound structure of English and intonation patterns;

Unit V : Oral presentation and professional speaking covering, basics of English pronunciation; elements of effective presentation; body language and use of voice during presentation; connecting with the audience during presentation; projecting a positive image while speaking; planning and preparing a model presentation; organizing the presentation to suit the audience and context; basics of public speaking; preparing for a speech

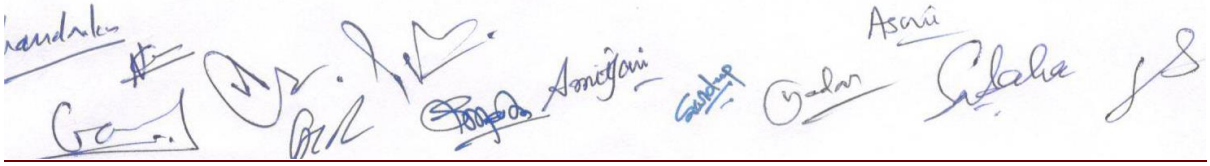
Suggested Text Books :

1. Fred Luthans, Organizational Behaviour, McGraw Hill
2. Lesikar & petit, Report writing for Business
3. M. Ashraf Rizvi, Effective Technical Communication, McGraw Hill
4. Wallace & masters, Personal Development for Life and Work, Thomson Learning

Suggested Reference Books :

1. T. M. Farhathullah, Communication skills for Technical Students
2. Michael Muckian, John Woods, The Business letters Handbook
3. Herta A. Murphy, Effective Business Communication
4. MLA Handbook for Writers of Research Papers

Outcomes :



CH204THS02 Business Communication and Presentation Skill [L:3, T:0, P:0]

Objectives:

To develop the communication skills like writing technical letters, reports and presentation skills.

Contents:

Unit I : Business communication covering, role of communication in information age; concept and meaning of communication; skills necessary for technical communication; communications in a technical organization; barriers to the process of communication.

Unit II : Style and organization in technical communication covering, listening, speaking, reading and writing as skills; objectivity, clarity, precision as defining features of technical communication; various types of business writing: letters, reports, notes, memos; language and format of various types of business letters; language and style of reports; report writing strategies; analysis of a sample report.

Unit III : Communication and personality development covering, psychological aspects of communication, cognition as a part of communication; emotional intelligence; politeness and etiquette in communication; cultural factors that influence communication; mannerisms to be avoided in communication; language and persuasion; language and conflict resolution.

Unit IV : Language laboratory emphasizing listening and comprehension skills; reading skills; sound structure of English and intonation patterns;

Unit V : Oral presentation and professional speaking covering, basics of English pronunciation; elements of effective presentation; body language and use of voice during presentation; connecting with the audience during presentation; projecting a positive image while speaking; planning and preparing a model presentation; organizing the presentation to suit the audience and context; basics of public speaking; preparing for a speech

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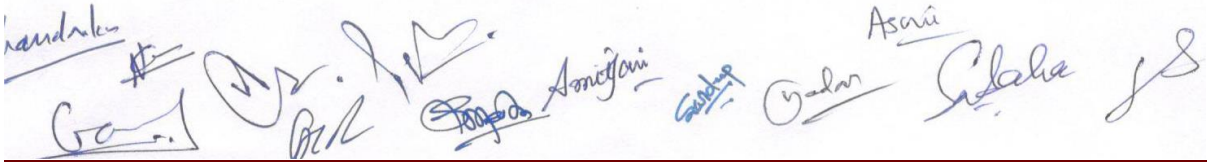
3. Herta A. Murphy, Effective Business Communication
4. MLA Handbook for Writers of Research Papers

Outcomes :



CH204PPC03 Particle and Fluid Particle Processing Lab [L:0, T:0, P:3]

Objectives:

1. To understand the working and importance of various mechanical operations used in process industry.
2. To apply principles of basic sciences and chemical engineering for designing various size reduction, size separation and filtration equipment.

List of Experiments

1. To verify laws of crushing for crushing solid particles in Jaw crusher.
2. To verify laws of crushing for crushing solid particles in roll crusher.
3. To verify laws of crushing for crushing solid particles in Ball mill.
4. To find out the Effectiveness of Triple deck Vibrating Screen.
5. To determine the average diameter of a mixture of solid particles of different size using sieve analysis.
6. To determine the collection efficiency at different flow rate for separating dust particles from air.
7. To study the working of continuous Rotary Vaccum Drum Filter.
8. To determine the filter medium resistance and specific cake resistance of plate and frame filter press.

* Any other experiments may be added further, if needed.

Outcomes:

At the end of the laboratory course students will be able to :

1. Apply the principles of unit operations through experimentation and
2. Demonstrate the ability to understand the various mechanical operation equipment used in chemical and allied process industry.

CH204PPC04 **Process Instrumentation Lab** **[L:0, T:0, P:3]**

Objectives:

To help the student to enhance their knowledge of different process measuring instruments that used in industry

Content:

1. Study of Mercury in glass thermometer with different temperature range.
2. Study the characteristics of various flow measuring instruments
3. Study the characteristics LVDT, Strain gauge
4. Study the characteristics of Level meter, pH meter, Density meter
5. Study the characteristics of different thermocouples & RTD sensors.
6. Determination of transient response of bimetallic thermocouple.
7. Determination of dissolved oxygen using DO meter.
8. Concentration analysis of gas-liquid chromatograph.
9. Concentration analysis using U-V-visible Photo-spectrometer & to study its principle of operation.
10. Measurement of Humidity using hair hygrometer & to study its principle.
11. Pressure measurement using different pressure gauges, U-tube manometer, pressure transducer and study of their characteristics.

* Any other experiments may be added further, if needed.

Outcomes:

Practical experiences and soft skills associated with this course, the student able to demonstrate the following industry oriented COs associated with course.

1. Able to understand the characteristics of instrument for various chemical processes.
2. Able to understand the temperature measuring instruments in chemical industry.
3. Able to understand the pressure, Level, pH etc. various measuring instruments in chemical industry.
4. Measure the flow and level using various measuring instruments in chemical industry.

B.Tech. V Semester

CH305TPC07 **Heat Transfer** **[L:3, T:1, P:0]**

Objectives

1. To provide a fundamental understanding of heat transfer by conduction, convection and radiation.
2. To understand the fundamental laws, their correlations, and applications.
3. To study the general design of heat exchanger, evaporator, and condenser.

Contents:

Unit-I: Introduction to three modes of heat transfer, Derivation of heat balance equation- steady one-dimensional solution for conduction heat transfer in Cartesian, cylindrical and spherical geometry, concept of conduction and film resistances, critical insulation thickness, lumped system approximation and Biot number, approximate solution to unsteady conduction heat transfer by the use of Heissler charts.

Unit-II: Heat convection, boundary layers, Forced convection, Natural convection, Dimensionless parameters for forced and free convection heat transfer, Correlations for forced and free convection, Approximate solutions to laminar boundary layer equations (momentum and energy), Estimating heat transfer rates in laminar and turbulent flow situations using appropriate correlations for free and forced convection.

Unit-III: Interaction of radiation with materials, definitions of radiative properties, Stefan Boltzmann's law, black and gray body radiation, Calculation of radiation heat transfer between surfaces using radiative properties, view factors and the radiosity method.

Unit-IV: Heat Transfer Equipment: Types of heat exchangers, General design of parallel and counter-current, Double pipe and Shell and Tube heat exchanger, Analysis and design of heat exchangers using both LMTD and ε- NTU methods, Similarity between heat and mass transfer.

Unit-V: Heat Transfer with phase change: Evaporation- Types of evaporators and fields of their applications, Single and multiple effect evaporators: their design and operation, Vapour recompression, Heat transfer from condensing vapours, Heat transfer to boiling liquids. Boiling and Condensation heat transfer, Pool boiling curve

Text Books :

1. Unit Operations of Chemical Engineering by W. L. McCabe, J. C. Smith and P. Harriot, McGraw Hill Education.
2. A Heat Transfer Textbook, Third Edition, by John H. Lienhard IV and John H. Lienhard V, Phlogiston Press, Cambridge, Massachusetts, U.S.A.

Reference Book:

1. Fundamentals of Momentum, Heat and Mass Transfer by J. R. Welty, C. E. Wicks, R. E. Wilson and G. L. Rorrer, John Wiley & Sons.
2. Principles of Heat Transfer, Seventh Edition, by Frank Kreith, Raj M. Manglik, Mark S. Bohn, Global Engineering, Cengage Learning, Stamford, USA.
3. Fundamentals of Heat and Mass Transfer, Frank P. Incropera, David P. Dewitt, Theodore L. Bergman, Adrienne S. Lavine, John Wiley & Sons; 6th edition.
4. Heat Transfer-A Practical Approach, Yunus A. Cengel, McGraw Hill, Second Edition.

Course Outcome:

Students would be able to

1. Analyze the steady state and unsteady state heat transfer by conduction.
2. Calculate heat transfer coefficients for forced and natural convection.
3. Explain and calculate the heat transfer by radiation.
4. Design and analyze the double pipe and shell and tube heat exchanger performance for co-current and counter-current flows.
5. Analyze the heat transfer equipment involving phase change.

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CH305TPC08 **Mass Transfer-I** **[L:3, T:1, P:0]**

Objectives

1. To provide the understanding of mass transfer operations and equipments.
2. To impart the understanding of separation processes such as diffusion, distillation and absorption.

Contents:

Unit-I: Constitutive laws of diffusion: unsteady state diffusion, molecular diffusion in gases and liquids, Diffusion velocities. Convective mass transfer, interphase mass transfer and mass transfer coefficients, mass transfer correlations.

Unit-II: Phase Equilibria: Vapor-liquid equilibrium curves and boiling point diagram, Volatility, Solubility of gases. Enthalpy-concentration diagrams. Equilibrium Stage Operations Principles, Determination of number of ideal stages for two-component systems by graphical and absorption factor methods.

Unit-III: Flash distillation, differential distillation, steam distillation, Azeotropic distillation and Extractive distillation, Continuous distillation with rectification, Reflux ratio, Minimum reflux ratio, calculation of number of plats – Lewis sorel method, McCabe Thiele method.

Unit-IV: Fenske equation, Optimum reflux ratio, Analysis of fractionating column by enthalpy concentration diagram method, Plate efficiencies, Packed Column, Height Equivalent to Theoretical Plate.

Unit-V: Gas Absorption: Design of packed towers, Principles of absorption, Rate of absorption, Two film theory, Overall coefficients, HTU method, Interrelation between heat transfer, momentum transfer and mass transfer.

Suggested Text Books :

1. Principles of Mass Transfer and Separation Processes by B. K. Dutta, PHI Learning Private Limited.
2. Mass Transfer Operations by R. E. Treybal, McGraw Hill.
3. Diffusion - Mass Transfer in Fluid Systems by E.L. Cussler, Cambridge University Press.
4. Principles of Unit Operations by A. S. Foust, A. L. Wenzel, C. W. Clump, L. Maus and L. B. Anderson, John Wiley & Sons.

Course Outcome:

Students would be able to

1. Explain the basics of mass transfer and related laws.
2. Identify the concepts of phase equilibrium in mass transfer related problems.
3. Understand the molecular diffusion phenomena and binary separation principles of distillation and absorption operation.

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4. Solve problems related to distillation, diffusion and absorption and mass transfer equipment.
5. Design plate /packed column for adsorption and distillation operation.

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CH305TPC09 Chemical Reaction Engineering-I [L:3, T:1, P:0]

Objectives

To impart the knowledge of the kinetics and thermodynamics of single and multiple reaction and the effect of temperature and pressure on reaction systems.

Contents:

Unit-I: Kinetics of Homogeneous Reactions: Kinetics and thermodynamics of chemical reactions, Kinetics of homogenous reactions rate theories, Analysis of rate equations.

Unit-II: Interpretation of Batch Reactor Data: Irreversible reactions, Total pressure method of kinetic studies, Analysis of complex rate equations, Complex reactions, Chain reactions, Variable volume reactions, Rate constants and equilibrium.

Unit-III: Ideal Reactor for Single Reaction: Ideal batch reactors, Steady state mixed flow reactor, Steady state plug flow reactor, Size comparison of single reactors, Multiple-reactor system.

Unit-IV: Design for Multiple Reaction: Introduction to multiple reaction, Qualitative treatment of product distribution and reactor size for parallel reactions, Reversible first order reactions in series, Favourable contacting patterns for irreversible reactions in series (First order &followed by first order).

Unit-V: Temperature and Pressure Effects: Single reaction, General graphical design procedure, Optimum temperature progression, Heat effects- adiabatic and non-adiabatic operations.
Multiple reactions: Temperature and vessel size for maximum production.

Suggested Text Books :

1. Chemical Reaction Engineering by O. Levenspiel, John Wiley & Sons.
2. Elements of Chemical Reaction Engineering by H. S. Fogler, Prentice Hall.
3. Chemical and Catalytic Reaction Engineering by J. J. Carberry, Dover Publications.
4. Chemical Reactor Analysis and Design by G. F. Froment, K. B. Bischoff and J. D. Wilde, Wiley.

Reference Book:

1. Reaction Kinetics for Chemical Engineers by S. M. Walas, Butterworths Publishers.

Course Outcome:

Students would be able to

1. Develop rate of reaction for homogeneous reactions.
2. Interpret batch reactor data and design ideal reactors for single and multiple reactions.
3. Describe different aspects of design for multiple reactions.
4. Explain the effect of temperature and pressure on reaction rate.

CH305TPC10 Process Equipment Design-I [L:3, T:1, P:0]

Objectives

To impart knowledge of various process pressure vessel
To understand the various supports which used in pressure vessel
To understand the chemical engineering principles applicable to mechanical process design for various pressure vessels and standard codes for design of chemical plant equipment.

Contents:

Pressure and Storage Vessels: Design of pressure and storage vessels and their supports. End closures, Flat plates, Flanged, Dished, Hemispherical, Ellipsoidal and conical ends.

Suggested Text Books :

1. Introduction to Chemical Equipment Design (Mechanical Aspects) by B.C. Bhattacharya, Chemical Engineering Education Development Center.
2. Process Equipment Design by L.E. Brownell and E.H. Young.
3. Design of Process Equipment Design by M.V. Joshi and V.V. Mahajan, MacMillan, India
4. Chemical Engineering by J. M. Coulson and J. F. Richardson, Vol-I, MacMillan, Newyork.
5. Process Equipment Design by S.D. Dawande, Dennet & Co.

Reference Books:

1. Perry's Chemical Engineers' Handbook by D. W. Green and R. H. Perry, McGraw Hill Publication.
2. IS Codes.

Course Outcome:

Students would be able to

1. Determine the various parameter of pressure vessel
2. Design of different kind of closure used in pressure vessel
3. Understand the design of storage vessels and their supports.

CH305TPE21 **Inorganic Chemical Technology** **[L:3, T:0, P:0]**

Objectives

To develop the abilities required for production, processing, flowsheeting and Environmental effects of inorganic chemical Industries.

Contents:

Unit-I: Sulfur and Sulfur Chemicals : Sulfur, Sulfuric acid, SCSA, DCDA processes, Sodium thiosulfate, Alums.
Marine Chemical Industries : Common salt, Chemicals from sea bittern.

Unit-II: Industrial Gases and Selected Inorganic Chemicals : Manufacture and use of Hydrogen, Carbon dioxide, Acetylene, Oxygen, Nitrogen and inert gases, Inorganic chemicals: Barium, boron, chromium, lithium, manganese.

Unit-III: Fertilizers : Status of industry, Grading and classification of fertilizers, Raw materials, Hydrogen production, Fixation of nitrogen, Synthesis, Ammonia based fertilizers, Phosphoric acid, Phosphatic and other fertilizers: SSP, TSP, UAP, DAP and nitro-phosphate, Potash fertilizers, NPK, Corrosion problems and Materials of construction, Bio-fertilizers.

Unit-IV: Soda Ash : Manufacturing, Special materials of construction, Solvay and modified Solvay process, Environmental consideration, Corrosion problems and materials of construction.
Chlor Alkali Industry : Electrochemistry of brine electrolysis, Current efficiency, Energy efficiency, Diaphragm cells, Mercury cells, Mercury pollution and control, Caustic soda, Chlorine, Hydrochloric acid, Corrosion problems and materials of construction

Unit-V: Cement, Glass and Refractory: Manufacturing, Environmental consideration, Corrosion problems, Engineering problems and materials of construction.

Suggested Text Books :

1. R.N. Shreve & I. A. Brink, "Chemical Process Industries"
2. Chem Tech I, II, III, IV- IIT. Madras
3. Dryden Co. M. G. Rao and M. Sitting, "Outlines of Chemical Technology".

Course Outcome:

Students would be able to

1. Impart the basic concepts of chemical technology
2. Develop understanding about unit process and unit operations in various industries.
3. Describe the processes involved in manufacturing of various inorganic chemicals and various chemical reactions involved in the process.
4. Draw the process flow diagrams and understand the major engineering problems encountered in the processes.
5. Explain important process parameters such as raw materials, environmental considerations, MOC etc.

BOS held on 14/06/2022

CH305PPC05 **Heat Transfer Lab** **[L:0, T:0, P:3]**

Objectives

To provide the knowledge of working of heat transfer equipment and the application of heat transfer correlations.

Content:

1. Determine the dirt factor of a parallel and counter flow double pipe heat exchanger.
2. Determination of dirt factor of a shell and tube heat exchanger.
3. Study of thermal conductivity of a metal bar.
4. Calculation and comparison of heat transfer coefficient for drop-wise and film-wise condensation.
5. Study the unsteady state heat transfer.

Outcomes:

Students would be able to

1. Handle the heat transfer equipment and calculate the heat transfer coefficients.
2. Apply the heat transfer correlations for calculating the heat transfer rate.

CH305PPC06 Chemical Reaction Engineering Lab [L:0, T:0, P:3]

Objectives

To impart knowledge on kinetics and design of reactors.

Contents:

1. Kinetic studies in a Batch reactor.
2. Kinetic studies in a Plug flow reactor.
3. Kinetic studies in a CSTR.
4. Kinetic studies in a PFR.
5. Study of temperature dependence of rate constant

Course Outcome:

Students would be able to

1. Get a sound working knowledge on different types of reactors.
2. Maintain the kinetic parameters of various reactions.
3. Use the batch reactor data to determine the order of reactions.
4. Use the relevant parameters for the design of reactors.
5. To select suitable reactor for various applications.

BOS held on 14/06/2022

CH306TPC11 **Mass Transfer-II** **[L:3, T:1, P:0]**

Objectives

1. To provide basic knowledge of fundamental mass transfer operations and mechanisms.
2. To understand the mass transfer in LLE, leaching, drying, crystallization, adsorption and humidification operation.

Contents:

Unit-I: Humidification Operations: Definitions, Humidity chart and its use in measurement of humidity and calculations of humidification operations, Adiabatic humidification, Design of Cooling Towers.

Unit-II: Leaching: Equipment, Principles of leaching, Calculation of number of ideal stages, Stage efficiency

Unit-III: Liquid- Liquid Extraction: Equipment, Principles of extraction, Panchon-Savorit method, Counter-current extraction using reflux application of McCabe method, Extraction in packed and spray column.

Unit-IV: Crystallization: Principles, yield of crystals, Super solubility curve, Crystal growth, Equipment and application of principles to design.
Adsorption: Fixed bed adsorbers, break through; Ion-Exchange.

Unit-V: Drying: Equipment, Principles, Mechanism and theory of drying, Calculation of drying time.

Suggested Text Books :

1. Principles of Mass Transfer and Separation Processes by B. K. Dutta, PHI Learning Private Limited.
2. Mass Transfer Operations by R. E. Treybal, McGraw Hill.
3. Diffusion - Mass Transfer in Fluid Systems by E.L. Cussler, Cambridge University Press.
4. Principles of Unit Operations by A. S. Foust, A. L. Wenzel, C. W. Clump, L. Maus and L. B. Anderson, John Wiley & Sons.

Course Outcome:

Students would be able to

1. Explain the basics of humidification, drying, leaching, crystallization and adsorption.
2. Identify the mechanisms of mass transfer, formulate rate equations.
3. Solve problems related to humidification, drying, leaching and crystallization.
4. Design equipment for humidification, drying, leaching and crystallization.

CH306TPC12 **Process Dynamics and Control** **[L:3, T:1, P:0]**

Objectives

1. To provide fundamental knowledge on process control strategies.
2. To impart knowledge on a theoretical analysis of open loop and closed loop systems.

Contents:

Unit-I: Process Control : Importance of process control in chemical plants and systems, Various types of Control systems viz. open loop and closed loop control, feedback and feed forward control, servo and regulator control; Importance of dynamic behaviour of processes in process control, Physical and block diagram representation of control system, Use of Laplace transformation in analysis of control systems.

Unit-II: Simple System Analysis: Laplace transformation and transfer function, Block diagrams, Linearization, First and higher order systems, Interacting and non-interacting systems, Distributed and lumped parameters systems, Dead time.

Unit-III: Linear Open Loop Systems: Response of first order, second order and higher order systems, Linearization of non-linear systems, Transportation lag. Linear Closed Loop Systems: Study of various control system and their components viz. controllers, final control elements, Measuring instruments, Closed loop transfer functions, Transient response of simple control system, Stability criterion and analysis.

Unit-IV: Root Locus, Stability Criterion and Transient Response: Transient response analysis form root locus, Application of root locus to control system, Routh stability criterion.

Unit-V: Frequency Response Analysis: Design of control system by frequency response, Closed loop response by frequency response, Frequency response technique: Phase margin and gain margin, Bode stability criterion; Nyquyist stability criterion, Controller tuning: Ziegler-Nichols method, Cohen-Coon method, Introduction to advanced controllers: cascade control, feed forward control, Introduction to artificial intelligence.

Suggested Text Books :

1. Process Systems Analysis and Control by D.R. Coughanowr and S. LeBlanc, McGraw-Hill.
2. Process Dynamics and Control by D.E. Seborg, T.F. Edgar and D.A. Mellichamp, John Wiley.
3. Chemical Process Control: An Introduction to Theory and Practice by G. Stephanopoulos, Pearson Education.

Course Outcome:

Students would be able to

1. Evaluate dynamic behaviour of first and second order system.
2. Determine the process stability in Laplace domain.
3. Analyze open-loop systems and linear closed loop systems.
4. Develop working knowledge of control system by frequency response.

CH306TPC13 Chemical Reaction Engineering - II [L:3, T:1, P:0]

Objectives

1. To give fundamental knowledge on principles of non-ideal flow pattern and age distribution of chemical reaction systems
2. To understand the fluid-particle reaction and fluid-fluid reaction behaviour
3. To understand basic principles of catalyst and various catalyst synthesis methods
4. To understand the adsorption characteristics of catalyst.

Contents:

Unit-I: Basics of Non-Ideal Flow: Age distribution of fluid, the RTD, Conversion in nonideal flow reactors, Models for non-ideal flow- dispersion model, Chemical reaction and dispersion, Tank in series model.

Unit-II: Mixing of Fluids: Self mixing of single fluid, degree of segregation, Early and late mixing, Mixing of two miscible fluids.

Unit-III: Fluid Particle Reactions: Un-reacted core model: Diffusion through gas film and ash layer control, Chemical reaction control, Rate of reaction for shrinking spherical particles, Determination of rate controlling step.

Unit-IV: Fluid-Fluid Reactions: Kinetic regimes for mass transfer and reaction, Rate equations for various regimes, Film conversion parameter, Application to design, Reactive and extractive reactions.

Unit-V: Catalysis: Heterogeneous catalysts, Adsorption on solid surface, Physical properties of catalysts, Preparation of catalyst, Steps in catalytic reactions synthesizing the rate law.

Suggested Text Books :

1. Chemical Engineering Kinetics by .M. Smith
2. Chemical Reaction Engineering by Octave Levenspiel
3. Chemical Reaction Engineering by H. Scott Fogler
4. Principles of Reaction Engineering by S.D. Dawande, Central Techno Publications
5. Chemical Engineering by J. M. Coulson and Richardson, Volume IV.

Course Outcome:

Students would be able to

1. Understand the principles of non-ideal flow pattern and RTD
2. Determine the behaviour of fluid-particle and fluid-fluid reaction system
3. Synthesis of catalyst with various methods
4. Basics of adsorption characteristics of catalyst.

CH306TPE31 Organic Chemical Technology [L:3, T:0, P:0]

Objectives

To study process technologies of various organic process industries such as oil, soap, polymer and cellulose.

Contents:

Unit-I: Oils & Fats : Status and scope, Major oils seeds production in India, Expression, Solvent extraction, Energy & solvent requirements, Mineral, seeds and other oil bearing materials, Hydrogenation of oils, Corrosion problems and materials of construction of equipments.

Unit-II: Soaps & Detergents: Raw materials, Manufacture of detergents, Active detergent matter, Biodegradability, Fat splitting, Purification of fatty acids, Soap manufacture, Total fatty matters (TFM), Glycerin manufacture, Materials of construction.

Unit-III: Cane Sugar: Cane production & varieties, Manufacturing equipment &technology, Cane sugar refining, Bagasses utilization, Energy requirements and conservation, Environmental considerations, Khandsari technology, Molasses based industries, Materials of construction.

Unit-IV: Polymers: Status and scope, Applications, Classification of polymers, Degree and modes of polymerization, Molecular weight and it distribution, Selected industrial polymerization including plastics, Synthetic rubber and polymeric foams, Synthetic fibres. Penicillin: Manufacturing process, Scope and applications.

Unit-V: Regenerated Cellulose: Growth of industry, Raw materials, Pretreatment, Pulping, Manufacture of paper, Recovery of chemicals, Environmental considerations, viscose rayon.
Varnishes and Paints: Scope and applications, Types of coatings, General manufacturing procedure, Environmental considerations.

Course Outcome:

Students would be able to

1. Impart the basic concepts of chemical technology
2. Develop understanding about unit process and unit operations in various industries.
3. Describe the processes involved in manufacturing of various organic chemicals and various chemical reactions involved in the process.
4. Draw the process flow diagrams and understand the major engineering problems encountered in the processes.
5. Explain important process parameters such as raw materials, environmental considerations, MOC etc.

CH306PPC07 **Mass Transfer Lab** **[L:0, T:0, P:3]**

Objectives

To provide the knowledge of working of mass transfer equipment's and the application of mass transfer operations.

Contents:

1. Determination of diffusion coefficient of organic vapour in air.
2. Determination of the vapour liquid equilibrium (VLE).
3. Study of the characteristics of steam distillation.
4. To Verify Rayleigh equation for distillation.
5. Determination of absorption of CO_2 in a packed column.
6. Study of the solid-liquid extraction method.
7. Study of the liquid-liquid extraction method.

Study of the operation of fluidized bed dryer.

Course Outcome:

Students would be able to

1. Handle the mass transfer equipment's.
2. Understand molecular diffusion and Apply mass transfer operations for separation of mixture.

CH306PPC08 Process Dynamics and Control Lab [L:0, T:0, P:3]

Objectives:

Students will learn about the fundamental concepts, difficulties, methodologies, and applications of process control in order to govern a variety of processes.

Contents:

Introduction: A historical point of view Process control incentives, control system synthesis Process variables are classified and defined.

Mathematical Modeling & Experiments: Mathematical modelling is required and used. Parameters that are lumped and distributed Analogies, chemical and electrical systems. Determine the transfer function of non-interacting tank control, find the transfer function of liquid level control system, determine the nature U-tube manometer and determine transfer function of mercury glass thermometer.

Realization of Control Modes: Realization of different control modes like P, I, D, In electric, pneumatic, hydraulic controllers.

Laboratory Work: Simulation of different control modes and Experiments around Basic Process RIG.

Course Outcome:

Students will be able to

1. Demonstrate a fundamental understanding of process control after completing the course.
2. Create a mathematical model of a variety of chemical reactions.
3. Describe the various control modes and how they are used to control various operations.
4. Describe how electric, hydraulic, and pneumatic controllers function.

B.Tech. VII Semester

CH07TPC14 **Process Equipment Design - II** **[L:3, T:1, P:0]**

Objectives

This course enables students to integrate all the subjects that they have learnt and design plant/processes from Chemical Engineering Principles. Graduates shall be able to: (a) Understand the Chemical Engineering Principles applicable to design Chemical Engineering equipment's; (b) apply standard codes for design of chemical plant equipment; (c) analyse the specifications for process equipment; (d) design process equipment's and its accessories.

Contents

Design of Heat Transfer Equipment's: Double Pipe Heat Exchanger, Shell and Tube Heat Exchanger, Vertical & Horizontal Condensers and Evaporators.

The candidates will be allowed to use the following reference book in the examination hall:

1. Hand book of Chemical Engineering J. H. Perry
2. Tubular Heat Exchange Manufacture Association Manual
3. Process Heat Transfer by D.Q. Kern
3. ISI Codes.

Candidates have to bring their own copies of the above books and they will be not supplied by the university or the examination centers.

Suggested Text Books

1. Process Heat Transfer by D. Q. Kern
2. Heat Transmission by McAdams
3. Unit Operations of Chemical Engineering by McCabe Warren, L Smith Julian and Harriot Peter, Fifth Edition, McGraw Hill Inc.
4. Chemical Engineering by J. M. Coulson and Richardson, Volume-1

Course Outcomes

Students should be able to design, calculate size/power/internals, etc required for all the process equipment in the PFD together with necessary instrumentation, safety aspects. Students should be able to calculate costs of equipment. Students should be able to perform a techno economic feasibility of the selected process.

CH07TPC15 **Chemical Reaction Engineering – II** **[L:3, T:1, P:0]**

Objectives

Graduates shall be able to (a) understand fundamental principles and experimental techniques of heterogeneous reaction systems; (b) apply principles of transfer operation in kinetics studies of heterogeneous reaction systems; (c) analyze the rate controlling step in heterogeneous reaction systems; (d) evaluate the catalytic activity and selectivity influenced by the physical and surface properties of the catalyst.

Contents

Unit-I : Basics of Non-Ideal Flow: Age distribution of fluid, the RTD, Conversion in nonideal flow reactors, Models for non-ideal flow- dispersion model, Chemical reaction and dispersion, Tank in series model.

Unit-II : Mixing of Fluids: Self mixing of single fluid, degree of segregation, Early and late mixing, Mixing of two miscible fluids.

Unit-III : Fluid Particle Reactions: Un-reacted core model: Diffusion through gas film and ash layer control, Chemical reaction control, Rate of reaction for shrinking spherical particles, Determination of rate controlling step.

Unit-IV : Fluid-Fluid Reactions: Kinetic regimes for mass transfer and reaction, Rate equations for various regimes, Film conversion parameter, Application to design, Reactive and extractive reactions.

Unit-V : Catalysis: Heterogeneous catalysts, General characteristics, Adsorption on solid surface, Physical properties of catalysts, Preparation of catalyst, Steps in catalytic reactions, synthesizing the rate law.

Suggested Text Books

1. Chemical Engineering Kinetics by J.M. Smith
2. Chemical Reaction Engineering by Octave Levenspiel
3. Chemical Reaction Engineering by H. Scott Fogler
4. Principles of Reaction Engineering by S.D. Dawande, Central Techno Publications
5. Chemical Engineering by J. M. Coulson and Richardson, Volume IV.

Course Outcomes

Students would be able to (a) explain the concepts of reactor design and reaction kinetics; (b) interpret reactor data; (c) identify ideal reactors and explain various aspects of design for single reactions; (d) explain various aspects of design for multiple reactions, (e) analyze effects of temperature and pressure on conversion.

w.e.f : Session 2021-22 **BoS held on 23.07.2021**

23/07/2021

CH07TPE43 **New Separation Processes** [L:3, T:0, P:0]

Objectives

This is a course further built up on and in continuation with Chemical Engineering operations. It forms the basis Chemical Engineering principles and hence it is required in almost all the courses and throughout the professional career of a Chemical Engineer.

Contents

Unit-I: Overview of Separation Processes: Basic concepts of separation processes; Physico-chemical properties and other factors controlling separation; Limitations of Conventional separation processes and new separation processes; Equilibrium and rate governed separation processes and their characteristics.

Unit-II: Membrane based Separation Processes: Principle of membrane separations process, advantages and disadvantages; classification, membrane materials, general methods of preparation and characterization of membranes; Membrane modules, Concentration polarization.

Unit-III: Porous Membrane Based Processes: Reverse osmosis, Ultrafiltration, Microfiltration, Nano-filtration, Dialysis, Ion-selective membranes and electro-dialysis; Industrial applications of porous membrane-based processes.

Unit-IV: Non-porous Membrane Based Processes: Gas separation, Pervaporation, Liquid Membranes and their Industrial Applications, Medical Applications of Membranes, Miscellaneous Membrane Processes, Membrane Distillation, Membrane Reactors.

Unit-V: Other Non-conventional Separation Processes: Foam and Bubble Fractionation, Pressure and Temperature Swing Adsorption, Cloud Point Extraction, Centrifugal Separation Processes, Super Critical Fluid Extraction.

Suggested Text Books

1. Separation Process Principles by J.D. Seader and E.J. Henley, John Wiley & Sons, Inc
2. Separation Processes by C. J. King, McGraw-Hill, Inc.
3. Membrane Separation Processes by K. Nath, PHI, New Delhi
4. Membrane Technology and Applications by R.W. Baker, John Wiley and Sons UK
5. Handbook of Industrial Membrane Technology by M.C. Porter, Crest Publishing House.

Course Outcomes

Explain membrane processes in terms of the membrane, feed, sweep, retentate, permeate, and solute membrane interactions. Distinguish among microfiltration, ultrafiltration, Nano filtration, virus filtration, sterile filtration, filter-aid filtration, and reverse osmosis in terms of average pore size. Explain common idealized flow patterns in membrane modules.

w.e.f : Session 2021-22 **BoS held on 23.07.2021**

CH07TOE31 Process Modeling & Simulation [L:3, T:0, P:0]

Objectives

Graduates shall be able to (a) understand chemical engineering system in term of modeling principle; (b) distinguish simulation from design of equipment; (c) apply software tools such as UNISIM to model chemical processes; (d) develop algorithm for modeling & solve the model.

Contents

Unit-I: Introduction: Uses of Mathematical Models, Scope of Coverage, Principles of Formulations. Mathematical Modeling in Chemical Reaction Engineering: CSTR, PFR, Batch Reactor, Semi batch Reactor, Series of Isothermal CSTR, Constant Hold-Up CSTR's, CSTR's with Variable Hold Ups, Gas Phase Pressurized CSTR, Non-Isothermal CSTR, Bioreactor, Trickle Bed Reactor.

Unit-II: Mathematical Modeling in Mass Transfer: Ideal Binary Distillation Column, Multi- Component Non-ideal Distillation Column, Batch Distillation with Hold Up, Steam Distillation, Multi-Solute Batch Liquid- Liquid Extraction, Continuous Extraction, Multistage Countercurrent Extraction, Plug Flow Type Liquid- Liquid Extraction, Reactor with Mass Transfer, Absorption, Adsorption.

Unit-III: Mathematical Modeling in Heat Transfer: Two Heated Tanks, Single Component Vaporizer, Double Pipe Heat Exchanger, Shell and Tube Heat Exchanger, Multicomponent Flash Drum, Cooling Towers.

Unit-IV: Mathematical Modeling of Other Chemical Processes: Interacting and Non-Interacting Systems with and without Heaters, Isothermal Hydraulic System, Forward and Backward Feed Triple Effect Evaporator.

Unit-V: Introduction of MATLAB and Use of Language, Simulation, Program Development and Numerical Solutions of Above Processes.

Suggested Text Books

1. Process Modeling, Simulation and Control for Chemical Engineers by W. L. Luyben, McGraw Hill, 1990.
2. Process Plant Simulation by B. V. Babu, Oxford University Press, 2004.
3. Optimisation Techniques for Chemical Engineers by A. Hussain and K. Gangaiah, Macmillan, 2001.
4. Process Control: Modeling, Design and Simulation by B. W. Bequette. Prentice-Hall India, 2006.
5. Elements of Chemical Reaction Engineering by Fogler, Prentice Hall of India.

Course Outcomes

Students would be able to (a) explain detail importance of ODE and PDE; (b) develop model equations for the given system; (c) solve structural, thermal, fluid flow problems; (d) demonstrate the model solving ability for various processes/unit operations; (e) demonstrate the ability to use a process simulation.

w.e.f : Session 2021-22 **BoS held on 23.07.2021**

Mandrakar 23/07/2021

B.Tech. VII Semester

CH07TOE32 Water Conservation & Management [L:3, T:0, P:0]

Objectives

To introduce the water management principles related to process plants.

Contents

Introduction: water cycle, water storage, water quality; water conservation in homes; water conservation in the work place; water management-water quality, controlling use and quality of water, water flow measurement, water quality control, testing water salinity, preserving water quality, minimising evaporation, water sanitation, water audits; water conservation in agriculture; water conservation in process industry; water conservation in construction industry; water conservation in service industry.

Suggested Text Books

1. Water Conservation, Management and Analysis by V. Madireddi and Subba Rao, Read worthy Publications (Pvt) Ltd
2. Protection and Conservation of, Water Resources by Hadrian F. Cook, John Wiley & Sons Inc.
3. Water Resources, Conservation and Management by S.N. Chatterjee, Atlantic Publishers & Dist.

Course Outcomes

Upon completion of this course, the students will be able to: (a) evaluate the performance of industrial boilers and furnaces; (b) identify the scope for recycle and reuse of water; (c) choose methods for waste minimization and water conservation.

B.Tech. VIII Semester

CH08TPC17 **Process Equipment Design- III** [L:3, T:1, P:0]

Objectives

Chemical Engineers should have knowledge about Design of mass transfer Equipments such as absorption, Distillation Columns, dryer etc. This will also be useful for using Design software which is widely used in chemical industries.

Contents

Mass Transfer Equipment design of: Absorption tower, Distillation tower, Tunnel and rotary dryers.

Suggested Text Books

1. Hand Book of Chemical Engineering J. H. Perry
2. Coulson & Richardson Vol.- VI
3. Mass Transfer by R. E. Treybal
4. ISI Codes

Candidates have to bring their own copies of ISI Code book and they will be not be supplied by the university or the examination centres.

Course Outcomes

Upon completion of this course, the students will be able to: (a) design mass transfer equipment's for chemical process.; (b) prepare drawing for chemical process equipment's.

B.Tech. VIII Semester

CH08TOE41 **Optimization Techniques** [L:3, T:0, P:0]

Objectives

To study and apply optimization techniques in the chemical process industry.

Contents

Unit-I: System Analysis and Modeling: Introduction to systems analysis and modeling with reference to chemical engineering problems, Differential method for solving one and two variable problems with and without constraints, Case studies, Application of langrangian multiplier method.

Unit-II: Linear Programming: Modeling, graphical method, single phase simplex method, two phase simplex method, duality, sensitivity analysis.

Unit-III: Geometric Programming: As applied to chemical engineering problems with degree of difficulty equal to zero and one, with and without constraints.

Unit-IV: Non-linear Programming: One dimensional search methods- Golden section method, dichotomous search method, Interval halving method, Fibonacci method, Newton method, Quasi-Newton method, Finite difference method, Polynomial approximation methods.

Unit-V: Dynamic Programming: Introduction to dynamic programming as applied to discrete multistage problems like cascade of CSTR, Train of heat exchanger etc., Computer programming techniques applied to optimization.

Suggested Text Books

1. Optimization Theory and Practice by Beveridge and Schecheter
2. Optimization Techniques for chemical Engineers by Asghar Hussain
3. Optimization by S.S. Rao
4. Linear Programming by Hadley

Course Outcomes

Upon completion of this course, the students will be able to: (a) formulate the objective functions for constrained and unconstrained optimization problems; (b) use different optimization strategies; (c) Solve problems using non-traditional optimization techniques; (d) use of different optimization techniques for problem solving.

w.e.f : Session 2021-22

BoS held on 23.07.2021

B.Tech. VIII Semester

CH08TPE53 Design and Development of Catalyst [L:3, T:0, P:0]

Objectives

To gain the knowledge of catalyst characteristics, mechanism of catalytic reactions, and design of catalytic reactors.

Contents

Structure of Solid Surfaces, Chemisorption and Physiosorption, Thermodynamics and Kinetics of Surface Processes, Principles of Heterogeneous Catalysis, Preparation, Characterization and Classification, Kinetics of Heterogeneous Reactions, Physical, Chemical and Mathematical Description of Catalyst Deactivation, Deactivation by Fouling, Poisoning and Sintering, Deactivation and Regeneration of Catalyst Pellets, Deactivation and Regeneration of Fixed Beds, Dynamics of Polyfunctional Catalysts, Electro catalysis and Photocatalysis, Mechanism and Kinetics of Some Typical Heterogeneous Catalytic Reactions, Applications in Fertilizer, Petroleum, Petrochemical Industries and Pollution Control.

Suggested Text Books

1. Preparation of Catalyst VI: Scientific bases for the preparation of Heterogeneous Catalysts by G. Poncelet,J. Martens, B. Delmon, Elsevier
2. Catalyst Preparation: Science and Engineering by John Regalbuto, CRC Press

Course Outcomes

Differentiate between chemisorption and physical adsorption, List steps involved in adsorption of a solute, and which steps may control the rate of adsorption, Explain the concept of breakthrough in fixed-bed adsorption. Upon completion of this course, the students will be able to: (a) develop various catalytic reaction mechanisms; (b) characterize a catalyst; (c) assess the effects of external heat and mass transfer effects in heterogeneous catalysis; (d) calculate the effectiveness of a porous catalyst; (e) design different types of reactors for catalytic reactions.

CH08TOE42 Project Engineering, Economics & Management [L:3, T:0, P:0]

Objectives

This course is required for the future professional career for engineering related industrial economics and management.

Contents

Unit I: Nature and Importance of Project and Project Engineering: Concept of Project and Project Management, Characteristics of Project, Introduction to Project Engineering, Role of a Project Leader, General Design Considerations, Plant Layout and Site Selection, Flow Diagram, Concept of Scale Up, Concepts of Techno-Economic Feasibility Report.

Unit II: Technical and Financial Analysis: Technical Analysis, Financial Analysis, Significance of Financial Analysis, Elementary knowledge of book of accounts- Journal, Ledger, Balance sheet, Profit and Loss Account. Cost Estimation, Cash Flow Investment, Production Cost, Capital Investment, Cost Indices, Production and Overhead Cost, Interest and Taxes.

Unit III: Project Financing and Value Engineering: Meaning and Importance of Project Finance, Means of Finance and Sources of Project in India, Financial Institution Structure and Financial Assistance, Norms of Finance and Term Loan Procedure, Value Engineering – Function, Aims and Procedure.

Unit IV: Capital Expenditure, Profitability & Alternative Investments: Importance and Kinds of Capital Expenditure Decision, Capital Budgeting Process, Criteria of Capital Budgeting, Depreciation and its Calculation Methods, Methods of calculating profitability, Alternative investments, Break Even Analysis.

Unit V: Network Techniques for Project Management: Introduction, Development of Project Network, Network Scheduling, Critical Path Method, Program Evaluation & Review Technique, Planning and Scheduling of Activity Networks, Time Analysis, Gantt Chart.

Suggested Text Books

1. Plant Design & Economics for chemical Engineers by M.S. Peters & K. D. Timmerhaus.
2. Projects: Planning, Analysis, Selection, Financing, Implementation and Review by Prasanna Chandra.
3. Project Engineering of Process Plants by H. F. Rase
4. Pilot Plants and Models and Scale up Methods in Chemical Engineering by R. E. Johnston.

Course Outcomes

Upon completion of this course, the students will be able to: (a) select a site for the project from given alternatives, (b) calculate working capital requirement for a given project, (c) calculate cost of equipment used in a plant total project cost, (d) calculate cash flow from a given project, (e) understand the break-even analysis; (f) calculate depreciation; (g) list out various milestones related to project concept to commissioning.

w.e.f : Session 2021-22 **BoS held on 23.07.2021**

DEPARTMENT OF CHEMICAL ENGINEERING
SCHOOL OF STUDIES OF ENGINEERING & TECHNOLOGY, GGV, BILASPUR, C.G.
(INDIA)

SCHEME OF EXAMINATION

M.TECH. CHEMICAL ENGINEERING

M.Tech. I-Semester

Sl.	Course Type/ Code	Subjects	Periods/Week			Evaluation			Credits
			L	T	P	IA	ESE	Total	
1.	CHPATT1	Advanced Heat Transfer	3	0	0	40	60	100	3
2.	CHPATT2	Advanced Separation Processes	3	0	0	40	60	100	3
3.	CHPATT3	Advanced Fluidization Engineering	3	0	0	40	60	100	3
4.		Elective – I	3	0	0	40	60	100	3
	CHPATP1	Advanced Reaction Engineering							
	CHPATP2	Advanced Wastewater Treatment Technology							
	CHPATP3	Advanced Chemical Process Modeling							
5.		Elective – II	3	0	0	40	60	100	3
	CHPATP4	Advanced Process Control							
	CHPATP5	Process Intensification							
	CHPATP6	Bioprocess Engineering							
6.	CHPALT1	Chemical Engineering Computational Lab	0	0	4	30	20	50	2
7.	CHPATC1	Research Methodology and IPR	2	0	0	-	50	50	2
		Total						600	19

M.Tech. II-Semester

Sl.	Course Type/ Code	Subjects	Periods/Week			Evaluation			Credits
			L	T	P	IA	ESE	Total	
1.	CHPBTT1	Advanced Transport Phenomena	3	0	0	40	60	100	3
2.	CHPBTT2	Chemical Reactor Design	3	0	0	40	60	100	3
3.		Elective – III	3	0	0	40	60	100	3
	CHPBTP1	Computational Fluid Dynamics							
	CHPBTP2	Fuel Cell Technology							
	CHPBTP3	Process Plant Design & Flow Sheeting							
4.		Elective – IV	3	0	0	40	60	100	3
	CHPBTP4	Design & Development of Catalyst							
	CHPBTP5	Industrial Pollution Control							
	CHPBTP6	Safety Hazards & Risk Analysis							
5		Open Elective	3	0	0	40	60	100	3
	MSPBTO1	1. Business Analytics							
	IPPBTO2	2. Industrial Safety							
	IPPBTO3	3. Operations Research							
	CEPBTO4	4. Cost Management of Engineering Projects							
	MEPBTO5	5. Composite Materials							
	CHPBTO6	6. Waste to Energy							
	ECPBTO7	7. Internet of Things							
	MCPBTO8	8. MOOCs							
6.	CHPBLT1	Advanced Chemical Engineering Lab	0	0	4	30	20	50	2
7.	CHPBPT1	Mini Project	0	0	4	30	20	50	2
8.		Audit Course/Value Added Course	2	0	0	0	0	0	0
	ELPBTX1	English for Research Paper Writing							
	PEPBTX2	Stress Management by Yoga							
	CEPBTX3	Disaster Management							
	LAPBTX4	Constitution of India							
		Total						600	19

Note: Under MOOCs the students have to opt any subject other than Chemical Engineering from NPTEL/UGC SWAYAM

Semester I

SUBJECT CODE	SUBJECT NAME	L:T:P	Credit
CHPATT1	ADVANCED HEAT TRANSFER	3:0:0	3

Course Objective:

- The course will deepen to understand of conduction, convection, radiation, phase change and dimensionless numbers.
- The course is design to learn the techniques for heat transfer enhancement and usage of numerical methods
- To understand for solving heat transfer problems such as heat exchangers and evaporators.

General equation of heat conduction, Transient heat Conduction numerical and analytical methods for the solution of transient heat conduction problems, Critical radius and optimum thickness of insulation. Free convective heat transfer under different situation and application of dimensional analysis to estimate the convective heat transfer coefficients. Heat transfer factor Reynolds No. Plot, Analogy equation for heat momentum transfer. Boiling heat transfer with particular reference to Nucleate and film boiling and estimation of boiling heat transfer coefficient. Heat transfer from condensing vapors. Nusselt equation for film type condensation of vapors over vertical surfaces and inclined tubes. View factors and emissivity factors for different situation. Radiation shield and radiation error in pyrometry. Combined conduction, convection and radiation heat transfer.

Course Outcome: After learning the course, the students will be able to:

- To design and analyze the performance of heat exchangers and evaporators
- To Analyze the various analytical and numerical heat transfer problem.
- Understand the basic concepts of phase change and their coefficient, impact on heat

Texts Books

- Hallman J. P., Heat Transfer Operation, McGRAW-Hill
- A Text Book on Heat Transfer, Universities Press; Fourth edition

Reference Books

- R.C.Sachdeva, Fundamentals of Engineering Heat & Mass Transfer.

Fluidized bed reactor modeling: Geldart Classification of powders, Fixed bed vs fluidized bed Why fluidized bed, important parameters pressure drop in fixed bed, Class I model Arbitrary Two Region Flow Models, Class II Chemical Reactor: Plug Flow or Mixed Flow Model. Class III Modeling the Bubbling Fluidized Bed Reactor, BFB, The Kunii-Levenspiel bubbling bed model, Gas Flow Around and Within a Rising Gas Bubble in a Fine particle BFB, Reactor performance of BFB.

Application of Population Balance Equations for reactor modeling: Particle size distribution, Distribution Functions in Particle Measuring Techniques, Particle distribution model in colloidal particle synthesis in batch reactor, Moments of Distribution, Nucleation rate based on volumetric holdup versus crystal growth rate.

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

- Evaluate heterogeneous reactor performance considering mass transfer limitations
- Perform the energy balance and obtain concentration profiles in multiphase reactors.
- Estimate the performance of multiphase reactors under non-isothermal conditions.
- Understand application of modern reactor technologies.

Texts Books

- J.M. Smith : Chemical Engineering Kinetics, Mcgraw Hill, Third Edition, 1981.
- Levenspiel O., Chemical Reaction Engineering, Wiley, 1998.
- Foggler,H.S., Elements of Chemical Reaction Engineering, Prentice Hall of India, 2008

Reference Books

- K.G. Denbigh : Chemical Reactor Theory, Cambridge University Press, Second Edition, 1971.
  Fromment G.F. and Bischoff K.B., Chemical Reactor Analysis and Design, John Wiley, 2010.

SUBJECT CODE	SUBJECT NAME	L:T:P	Credit
CHPATP2	ADVANCED PROCESS CONTROL	3:0:0	3

Course Objective:

- Expose students to the advanced control methods used in industries and research. This course prepares the student to take up such challenges in his profession.

Advanced Control Strategies: feed forward, cascade, dead time compensation, split range, selective and override control; automatic tuning and gain scheduling.

Review of Systems: Review of first and higher order systems, closed and open loop response. Response to step, impulse and sinusoidal disturbances. Transient response. Block diagrams.

Stability Analysis: Frequency response, design of control system, controller tuning and process identification. Zigler-Nichols and Cohen-Coon tuning methods, Bode and Nyquist stability criterion. Process identification. Special Control Techniques: Advanced control techniques, cascade, ratio, feed forward, adaptive control, Smith predictor, internal model control.

Multivariable Control Analysis: Introduction to state-space methods, Control degrees of freedom analysis and analysis, Interaction, Bristol arrays, Niederlinski index - design of controllers, Tuning of multivariable controllers.

Sample Data Controllers: Basic review of Z transforms, Response of discrete systems to various inputs. Open and closed loop response to step, impulse and sinusoidal inputs, closed loop response of discrete systems. Design of digital controllers. Introduction to PLC and DCS.

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

- Identify the control strategy.
- Type of controller to be used for a process
- Design of controllers for interacting multivariable systems
- Analyze the system response with and without control

Texts Books

- George Stephanopolous, Chemical Process Control An Introduction to Theory and Practice' Prentice Hall; 1st edition (1983).
- B.W. Bequette, 'Process Control: Modeling, Design and Simulation', PHI, 2006
- D.E. Seborg, T.F. Edger, and D.A. Millichamp, 'Process Dynamics and Control', John Wiley and Sons, 2nd Edition, 2004.

SUBJECT CODE	SUBJECT NAME	L:T:P	Credit
CHPBTT2	CHEMICAL REACTOR DESIGN	3:0:0	3

Course Objective:

- This course introduces students to the application of kinetics and reaction engineering in chemical engineering processes.
- Understand the concepts such as standard states, chemical reaction rates, reaction mechanism mass balances and design equations for ideal reactors as well as non-ideal reactors

Review of Design of ideal isothermal homogeneous reactor for single and multiple reactions, RTD of Ideal reactor, interpretation of RTD data, Flow models for non-ideal reactors, dispersion model, N tanks in series, multi parameter model, diagnosing the ills of reactor , influence of RTD and micro mixing on conversion. Adiabatic and non adiabatic operations in batch and flow reactors, optimal temperature in progression. Hot spot in tubular reactor auto thermal operation and steady state multiple steady state introduction to bifurcation theory Catalytic reactors, effectiveness factor, selectivity, catalyst deactivation, Design of heterogeneous catalytic reactors.

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

- Understand the Adiabatic and non-adiabatic operations in batch and flow reactors,
- Understand the reactor design involving Catalytic reactors, effectiveness factor, selectivity, catalyst deactivation,
- Understand the design of heterogeneous catalytic reactors.

Texts Books

- James J Carberry: Chemical and Catalytic Reaction Engineering McGraw Hill
- J M Smith " Chemical Engineering Kinetics", McHill

Reference Books

- O. Levenspiel, " Chemical Reaction Engineering", Wiley Eastern, 2nd ed. 1972
- Frinebt G. F. Bischoff K. B; " Chemical Reactor Analyzer and design" John Wiley & Sons.
- H. S. Foggler; Elements of Chemical Reaction Engineering

SUBJECT CODE	SUBJECT NAME	L:T:P	Credit
CHPBTP1	COMPUTATIONAL FLUID DYNAMICS	3:0:0	3

Course Objective:

- To solve the various physical problems of both laminar and turbulent flows to be solved by numerical methods. The equations of change shall be transformed in the light of assumptions and solved under the suitable boundary conditions to obtain the differential equation.
- To provide an introduction to the scientific principles and practical engineering applications of computational fluid dynamics.
- To give exposure to the commercial software ANSYS Fluent

Basic principles and equations of change in transport of momentum, heat and mass; Equations of continuity, motion, angular momentum, energy, and equation of continuity for multicomponent mixture, Flow of Newtonian and non-Newtonian fluids, use of equation of change for developing equations for laminar flow in internal and external flows, boundary layer flows, flow in stirred tanks, flow in pipe line and over flat plates and other physical situations for both Newtonian and Non-Newtonian fluids, Philosophy of computational fluid dynamics CFD, grid generation, structured and unstructured grids, choice of suitable grid, grid transformation of equations, some modern developments in grid generation for solving engineering problems, CFD essentials, Finite difference method (FDM), finite volume method (FVM) and finite element method (FEM): Discretization of ODE and PDE, , Explicit and Implicit scheme to solve heat and fluid flow problems, Application of 1st order and 2nd order Upwind Scheme, Application of SIMPLE, SIMPLER algorithm to solve fluid flow problems, Simulation of CFD problems using Fluent.

Course Outcome: After learning the course, the students will be able to:

- To discretize the momentum, mass and energy transport equations by finite volume technique.
- To simulate CFD problems by using in house developed computer code.
- To solve some problems with the help of the ANSYS Fluent software.

SUBJECT CODE	SUBJECT NAME	L:T:P	Credit
CHPATT3	ADVANCED REACTION ENGEENIRING	3:0:0	3

Course Objective: This Subject is essential for Design of Reactor especially heterogeneous reactors. Students will learn the energy balance, temperature and concentration profiles in different reactors, advance design aspects of multiple reactors, students will get insight of importance of population balance of particles.

Course Content:

Non-elementary Kinetics Importance: Approximations for formulations of Rate laws, Formulations of Kinetic model. Effect of flow on conversions in Reactors: Semi batch Reactors Importance and examples of applications , Material Balance on Semi batch Reactor, Multiple reaction in Semi batch Reactors, Conversion Vs Rate in Reactors, Use of POLYMATHS to solve the equations and understanding the profiles Non-Isothermal reaction modeling in CSTR & Semi-Batch reactor: Energy Balance equations for CSTR, PFR and Batch reactors, Adiabatic operations Temperature conversion profiles in PFR, CSTR, Steady state tubular reactor with heat exchange.

Need for Multi-staging CSTR with multiple stages: Exothermic and Endothermic Reaction with examples, CSTR with heat effects, Multiple reactions in CSTR and PFR with heat effects, Semi batch Reactors with heat exchange. Design of PFR and Packed Bed Tubular Reactors: Radial and Axial mixing in Tubular reactors, unsteady state in non-isothermal energy balance, CSTR, Energy balance in Batch Reactors, Volume of reactors calculations for non-isothermal reactors. Optimal Design of Reactors for Reversible exothermic reactions: Unsteady state non-isothermal reactor design, adiabatic operation in batch, Heat effects in semi batch unsteady state operation. Auto thermal Plug flow reactors and packed tubular reactors.PFR with inter stage cooling. Shift of Energy and material balance lines for reversible reactions in CSTR, Examples of optimal design of PFR and Semi batch and CSTR Exothermic Reactions.

Catalytic reactions: Theory and modeling: Global rate of reaction, Types of Heterogeneous reactions Catalysis, Different steps in catalytic reactions, Theories of heterogeneous catalysis. Steady State approximation, formulations of rate law, Rate laws derived from the PSSH, Rate controlling steps, Eiley-Rideal model, Reforming catalyst example :Finding mechanism consistent with experimental observations Evaluation of rate law parameters, packed beds : Transport and Reactions, Gradients in the reactors : temperature.

Porous media reactors: Mass transfer coefficients, Flow effects on spheres tube and cylinders, External Mass Transfer pore diffusion, structure and concentration gradients Internal Effectiveness Factor Catalytic wall reactor: limiting steps reactions and mass transfer limiting Porous catalyst on tube wall reactors Design of packed bed porous catalytic reactors: Mass transfer limited reactions in Packed bed.

SUBJECT CODE	SUBJECT NAME	L:T:P	Credit
CHPATT2	ADVANCED SEPARATION PROCESS	3:0:0	3

Course Objective:

- To familiarize students with various advanced aspects of separation processes and the selection of separation processes.
- To enable students to understand the principles and processes of adsorption, membrane separation and chromatography and to design an absorber or a membrane unit to achieve a specified separation.
- To introduce them to new trends used in the separation technologies.

Introduction: Conventional Separation Processes - Absorption, Adsorption, Conventional separation processes - Distillation, Drying, Extraction, Diffusion, Leaching, Crystallization. Advances in separation techniques based on size, surface properties, ionic properties. Cross flow filtration, Electro filtration, Dual functional filter, Surface based solid-liquid separations involving a second liquid, Sirofloc filter.

Bubble and Foam Fractionation: Nature of bubbles and foams, stability of foams, foam fractionation techniques, batch, continuous, single stage and multistage columns. Types and choice of membranes, Plate and frame, Spiral wound membranes, Tubular and hollow fibre membrane reactors, Membrane Permeates, Dialysis, Reverse osmosis, Nano-filtration, Ultrafiltration, Microfiltration, Dialysis, Ceramic membranes

Membrane Separation: Characteristics of organic and inorganic membranes, basis of membrane selection, osmotic pressure, partition coefficient and permeability, concentration polarization, electrolyte diffusion and facilitated transport, Industrial applications of Micro-filtration, Ultra-Filtration, Reverse Osmosis, Electro-Dialysis.

Special Processes: Liquid Membrane Separation, Super-Critical Extraction, Adsorptive Separation-Pressure, Vacuum and Thermal Swing, Pervaporation and Permeation, Nano-Separation.

Chromatographic Methods of Separation: Gel, Solvent, Ion and High Performance Liquid Chromatography.

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

- List situations where liquid–liquid extraction might be preferred to distillation, make a preliminary selection of a solvent using group-interaction rules, Size simple extraction equipment.
- Differentiate between chemisorption and physical adsorption, List steps involved in adsorption of a solute, and which steps may control the rate of adsorption, explain the concept of breakthrough in fixed-bed adsorption.
- Explain how crystals grow, Explain the importance of supersaturation in crystallization.
- Describe effects of mixing on supersaturation, mass transfer, growth, and scale-up of crystallization.
- Explain membrane processes in terms of the membrane, feed, sweep, retentate, permeate, and solute membrane interactions. Distinguish among microfiltration, ultrafiltration, Nano filtration, virus filtration, sterile filtration, filter-aid filtration, and reverse osmosis in terms of average pore size. Explain common idealized flow patterns in membrane modules.

Texts Books

- Seader J.D. and Henley E.J., "Separation Process Principles", 2nd Ed.,Wiley.2006
- Nakagawal, O. V., "Membrane Science and Technology", Marcel Dekker, 1992.

SUBJECT CODE	SUBJECT NAME	L:T:P	Audit
ELPBTX1	ENGLISH FOR RESEARCH PAPER WRITING	2:0:0	2

Course outcomes: At the end of the course, students will be able to

1 Understand that how to improve your writing skills and level of readability.

2 Learn about what to write in each section

3 Understand the skills needed when writing a Title

4 Ensure the good quality of paper at very first-time submission

Syllabus Contents:

- Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness
- Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticizing, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts. Introduction
- Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check
- Key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Ruseful phrases, how to ensure paper is as good as it could possibly be the first- time submissioneview of the Literature.
- skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions
- useful phrases, how to ensure paper is as good as it could possibly be the first- time submission

References:

- Goldbort R (2006) Writing for Science, Yale University Press (available on Google Books)
- Day R (2006) How to Write and Publish a Scientific Paper, Cambridge University Press
- Highman N (1998), Handbook of Writing for the Mathematical Sciences, SIAM. Highman'sbook .
- Adrian Wallwork , English for Writing Research Papers, Springer New York Dordrecht Heidelberg London. 2011

SUBJECT CODE	SUBJECT NAME	L:T:P	CREDIT
CHPATT3	ADVANCED FLUIDIZATION ENGINEERING	3:0:0	3

Course Objective :

- To study the phenomenon of fluidization with industrial processing objective
- To study the various regimes of fluidization and their mapping
- To study the design of equipments based on fluidization technique

Course Content:

Introduction to fluidization and applications: Phenomenon of fluidization, behavior of fluidized bed, contacting modes, advantages and disadvantages of fluidization, fluidization quality, selection of contacting mode, Fluidized Beds for Industrial Applications like coal gasification, synthesis reactions, physical operations, cracking of hydrocarbons. Mapping of fluidization regimes: Characterization of particles, mechanics of flow around single particles, minimum fluidization velocity, pressure drop versus velocity diagram, The Geldart classification of solids, fluidization with carryover of particles, terminal velocity of particles, distributor types, gas entry region of bed, pressure drop requirements, various distributor plates, design of distributor plate. Bubbling fluidized beds: Davidson model for gas flow at bubbles in a fluidized bed, the wake region and movement of solids at bubbles, coalescence and splitting of bubbles, bubble formation above a distributor, slug flow, Turbulent and fast fluidization - mechanics, flow regimes and design equations, Emulsion movement, estimation of bed properties, bubble rise velocity, scale up aspects, flow models, two phase model, K-L model. Solids movement and Gas dispersion: Vertical and horizontal movement of solids, Dispersion model, large solids in beds of smaller particles, staging of fluidized beds Gas dispersion in beds, gas interchange between bubble and emulsion, estimation of gas interchange coefficient, Heat and mass transfer in fluidized systems, Mixing in fluidized systems - measurements and models. Entrainment or Elutriation of Fluidized Beds , Reactors : Entrainment and elutriation, Freeboard behavior, gas outlet, entrainment from tall vessel, freeboard entrainment model, high velocity fluidization, pressure drop in turbulent and fast fluidization, Slugging, Spouted beds, Circulating Fluidized Beds. Mathematical model of a homogeneous fluidized bed, Design of catalytic reactors, pilot plant reactors, information for design, bench scale reactors, design decisions, deactivating catalysts, Design of no catalytic reactors, kinetic models for conversion of solids, models for shrinking particles, conversion of solids of unchanging size

Course Outcomes :

At the end of the course, the student will be able to:

- Performing and understanding the behavior fluidization in fluidized bed
- Evaluate the characterization of particles and power consumption in fluidization regimes
- Understanding the applicability of the fluidized beds in chemical industries

SUBJECT CODE	SUBJECT NAME	L:T:P	CREDIT
CHPBTP1	COMPUTATIONAL FLUID DYNAMICS	3:0:0	3

Course Objective :

- To provide an introduction to the scientific principles and practical engineering applications of computational fluid dynamics
- To give exposure to the commercial software ANSYS Fluent

Course Content :

Computational approach to Fluid Dynamics and its comparison with experimental and analytical methods, Basics of PDE: Elliptic, Parabolic and Hyperbolic Equations, Review of Navier-Stokes Equation and simplified forms, grid generation, structured and unstructured grids, choice of suitable grid, grid transformation of equations, some modern developments in grid generation for solving engineering problems, CFD essentials, Finite difference method (FDM), finite volume method (FVM) and finite element method (FEM): Discretization of ODE and PDE, , Explicit and Implicit scheme to solve heat and fluid flow problems, Application of 1st order and 2nd order Upwind Scheme, Application of SIMPLE, SIMPLER algorithm to solve fluid flow problems, Simulation of CFD problems using Fluent.

Course Outcome :

After learning the course, the students will be able to:

1. To discretize the momentum, mass and energy transport equations by finite volume technique.
2. To understand the subject of Computational Fluid Dynamics and know how to use it as tool to solve the Heat Transfer and Fluid Mechanics related Industrial Problems.
3. To solve some problems with the help of the ANSYS Fluent software.

Texts Books :

- Anderson J.D., Computational fluid dynamics, McGraw Hill
- Date A. W., Introduction to Computational Fluid Dynamics, Cambridge University Press

Reference Books :

- Versteeg H. K. and Malalasekera, An Introduction to Computational Fluid Dynamics: The Finite Volume Method, Longman Scientific & Technical
- Muralidhar K., and Sundararajan T., Computational Fluid Flow and Heat Transfer, Narosa Publishing House
- Patankar Suhas, Numerical Methods in Fluid Flow & Heat Transfer, CRC Press

SUBJECT CODE	SUBJECT NAME	L:T:P	CREDIT
CHPETP2	FUEL CELL TECHNOLOGY	3:0:0	3

Course Objective:

- Demonstrate a thorough understanding of the fuel cell power plant's and its components' performance characteristics
- Describe the performance and design characteristics of various fuel cells, as well as operational issues
- Discuss the design philosophy and challenges that must be overcome in order for this power plant to be economically viable
- Thermodynamics and electrochemistry will be the focus of the design and analysis

Course Content :

Low and high temperature fuel cells are discussed in this overview of hydrogen energy and fuel cells. Polymer electrolyte fuel cells, Alkaline fuel cells, Phosphoric fuel cells, Molten carbonate fuel cells, Solid oxide fuel cells, Microbial fuel cells, Fuel cell systems, and Sample calculations are all examples of fuel cell performance. Thermodynamics of fuel cells: heat, work potentials, reversible voltage prediction, and fuel cell efficiency. Electrocatalysts-design, activation kinetics, overvoltages, Tafel equation, charge transfer reaction, exchange currents, fuel cell reaction kinetics-electrode kinetics, overvoltages, Tafel equation, charge transfer reaction, exchange currents, electrocatalysts-design, activation kinetics Charge and mass transport in a fuel cell-flow field, transport in the electrode, and transport in the electrolyte Characterization of fuel cells:- characterization techniques in-situ and ex-situ, I-V curve, frequency response analyses Materials Science and Engineering, Process Safety and Process Design

Course Outcomes :

At the end of the course, the student will be able to:

1. Apply know-how of thermodynamics, electrochemistry, heat transfer, and fluid mechanics principles to design and analysis of this emerging technology
2. Have thorough understanding of performance behaviour, operational issues and challenges for all major types of fuel cells
3. Identify, formulate, and solve problems related to fuel cell technology keeping in mind economic viability
4. Use the techniques, skills, and modern engineering tools necessary for design and analysis of innovative fuel cell systems
5. Understand the impact of this technology in a global and societal context

Texts Books :

- Larminie J. and Dicks A., Fuel Cell Systems Explained. , John Wiley & Sons Inc.
- Barbir Frano, PEM Fuel Cells Theory and Practice, Elsevier Academic Press
- Hoogers G., Fuel Cell Technology Handbook, SAE International

SUBJECT CODE	SUBJECT NAME	L:T:P	CREDIT
CHPETP5	INDUSTRIAL POLLUTION CONTROL	3:0:0	3

Course Objective :

- To understand the importance of industrial pollution and its abatement
- To study the underlying principles of industrial pollution control
- To acquaint the students with case studies
- Student should be able to design complete treatment system

Course Content :

Air pollution Sources and Effects, Air pollution laws and standards; Air pollution sampling and measurement from point, non-point, line and area sources, analysis of air pollutants, Air pollution control methods and equipment, Design details of Particulate emission control equipments like Gravitational settling Chamber, Cyclone Separator, Fabric Filter, Electrostatic Precipitator, Wet scrubber; Case studies of a few industrial pollution control system. Sources, effects and laws of water pollution; BOD, COD; Waste water treatment, Design details of Primary Treatment methods like Pretreatment, Sedimentation, Floatation, Design aspects of Secondary Treatment methods like Activated Sludge Process, Trickling Filter. Design aspects of Advanced waste water treatment including Ion Exchanger, Reverse Osmosis, Electrodialysis, Advanced Biological Systems. Solid Waste Management, design calculation of disposal methods, Incineration, Hazardous Waste Management strategy and treatment methods, landfill closure and underground disposal.

Course Outcome :

After learning the course, the students will be able to:

1. Recognize the causes and effects of environmental pollution
2. Analyze the mechanism of proliferation of pollution
3. Develop methods for pollution abatement and waste minimization
4. Design treatment methods for gas, liquid and solid wastes

Texts Books :

- Schnelle K.B. and Brown C.A., Air Pollution Control Technology Handbook, CRC Press
- Peavy H.S., Rowe D.R. and Tchobanoglous G., Environment Engineering, McGraw-Hill

Reference Books :

- Trivedy R.K. and Goel P.K., An Introduction to Air Pollution, Technoscience Pub.
- Sengar D.S., Environmental Law, PHI
- B. Chawla, Jain A.K., Jain A.K., Waste Water Engineering