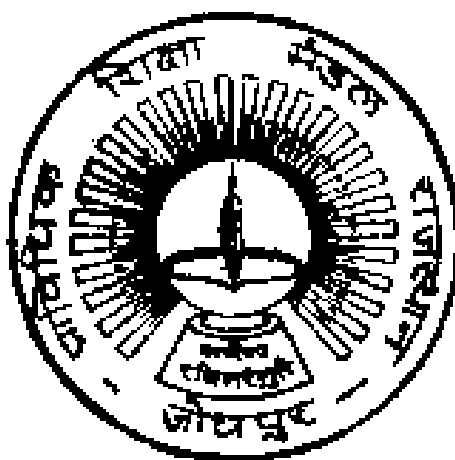


GOVERNMENT OF RAJASTHAN
BOARD OF TECHNICAL EDUCATION RAJASTHAN
JODHPUR

SEMESTER SCHEME-2020-21

(SESSION 2021-2022 & ONWARDS)



TEACHING AND EXAMINATION SCHEME
AND SYLLABUS

CHEMICAL ENGINEERING

(CH)

.....
Curriculum Development Cell
Board of Technical Education, Rajasthan
W-6 Residency Road,
Jodhpur

GOVERNMENT OF RAJASTHAN
BOARD OF TECHNICAL EDUCATION RAJASTHAN, JODHPUR
TEACHING AND EXAMINATION SCHEME
(SEMESTER SCHEME-2020-21)
FOR DIPLOMA III SEMESTER (CHEMICAL ENGINEERING) (CH)
SESSION 2021-2022 & ONWARDS

Subject Category	Subject Code	Subjects	Distribution of Time				Distribution of Max. Marks/ Duration						Total Marks	Credits	
			Hours per week				End Semester Exam			Internal Assessment					
			L	T	P	Tot	TH	Hrs.	PR	Hrs.	CT	TU /Assi.			PR(S)
PC	CH 3001	Introduction to Chemical Engineering	4	0	0	4	60	3	-	-	20	20	-	100	4
PC	CH 3002	Industrial Chemistry	3	0	0	3	60	3	-	-	20	20	-	100	3
PC	CH 3003	Chemical Process Calculations	2	1	0	3	60	3	-	-	20	20	-	100	3
PC	CH 3004	Momentum Transfer	2	1	0	3	60	3	-	-	20	20	-	100	3
PC	CH 3005	Mechanical Operations	2	1	0	3	60	3	-	-	20	20	-	100	3
PC	CH 3006	Engineering Thermodynamics	3	0	0	3	60	3	-	-	20	20	-	100	3
PC	CH 3007	Momentum Transfer Lab	0	0	2	2	-	-	40	3	-	-	60	100	1
PC	CH 3008	Mechanical Operations Lab	0	0	2	2	-	-	40	3	-	-	60	100	1
SI	CH 3009	Summer Internship-I(4 weeks after II Sem)	--	--	--	--	--	--	100	--	--	--	--	100	2
VS	+CH 3333	Anandam (Joy of Giving)	--	--	1	1	--	--	--	--	--	--	100	100	2
		Students Centered Activities	0	0	3	3	--	--	--	--	--	--	--	--	--
		Total Credits	16	3	8	27	360	--	180	--	120	120	220	1000	25
Grand Total :													1000	25	

- | | |
|--|---|
| 1. L : Lecture | 5. PR : Marks for End Semester Exam for Practical |
| 2. T : Tutorial | 6. CT : Marks for class tests (Internal Assessment) |
| 3. P : Practical | 7. TU/Assi : Marks for tutorials/Assignment (Internal Assessment) |
| 4. TH : Marks for End Semester Exam for Theory | 8. PR(S) : Marks for practical and viva (Internal Assessment) |

1. +CH 3333 is same in all branches of Engineering

Student Centered Activities will be graded as A, B, C & D on the basis of attendance and interest of the student in learning.

GOVERNMENT OF RAJASTHAN
BOARD OF TECHNICAL EDUCATION RAJASTHAN, JODHPUR
TEACHING AND EXAMINATION SCHEME
(SEMESTER SCHEME-2020-21)
FOR DIPLOMA IV SEMESTER (CHEMICAL ENGINEERING) (CH)
SESSION 2021-2022 & ONWARDS

Subject Category	Subject Code	Subjects	Distribution of Time				Distribution of Max. Marks/ Duration							Total Marks	Credits
			Hours per week				End Semester Exam			Internal Assessment					
			L	T	P	Tot	TH	Hrs.	PR	Hrs.	CT	TU/ Assi.	PR(S)		
PC	CH 4001	Process Heat Transfer	2	1	0	3	60	3		20	20	-	100	3	
PC	CH 4002	Mass Transfer – I	2	1	0	3	60	3		20	20	-	100	3	
PC	CH 4003	Chemical Engineering Thermodynamics	2	1	0	3	60	3		20	20	-	100	3	
PC	CH 4004	Chemical Technology	3	0	0	3	60	3	-	-	20	20	-	100	3
PE	CH 4005	Programme Elective - I CH 40051- Petroleum Refinery and Petrochemical Technology CH 40052- Petroleum Engineering	3	0	0	3	60	3	-	-	20	20	-	100	3
PC	CH 4006	Heat Transfer Lab	0	0	2	2	-	-	40	3	-	-	60	100	1
PC	CH 4007	Chemical Engineering Drawing Lab	0	0	4	4	-	-	40	3	-	-	60	100	2
PR	CH 4008	Minor Project	0	0	4	4	-	-	40	3	-	-	60	100	2
AU	+CH 4222	Essence of Indian Knowledge and Tradition	2	0	0	2	-	-	-	-	-	-	-	-	-
VS	+CH 4444	Anandam (Joy of Giving)	--	--	1	1	--	--	--	--	--	--	100	100	2
		Students Centered Activities	0	0	3	3	--	--	--	--	--	--	--	--	--
		Total Credits	14	3	14	31	300	--	120	--	100	100	280	900	22
		Grand Total :											900	22	

- | | |
|--|---|
| 1. L : Lecture | 5. PR : Marks for End Semester Exam for Practical |
| 2. T : Tutorial | 6. CT : Marks for class tests (Internal Assessment) |
| 3. P : Practical | 7. TU/Assi : Marks for tutorials/Assignment (Internal Assessment) |
| 4. TH : Marks for End Semester Exam for Theory | 8. PR(S) : Marks for practical and viva (Internal Assessment) |

1. +CH 4222 and +CH 4444 are same in all branches of Engineering

Student Centered Activities will be graded as A, B, C & D on the basis of attendance and interest of the student in learning.

Note: Students will go for 6 Weeks Summer Internship in the Summer Vacations after Fourth Semester. The assessment of the Summer Internship will be done in Fifth Semester

GOVERNMENT OF RAJASTHAN
BOARD OF TECHNICAL EDUCATION RAJASTHAN, JODHPUR
TEACHING AND EXAMINATION SCHEME
FOR DIPLOMA V SEMESTER (CHEMICAL ENGINEERING)(CH)
(SEMESTER SCHEME-2020-21)
SESSION 2022-2023 & ONWARDS

Subject Category	Subject Code	Subjects	Distribution of Time				Distribution of Max. Marks/ Duration							Total Marks	Credits
			Hours per week				End Semester Exam			Internal Assessment					
			L	T	P	Tot	TH	Hrs.	PR	Hrs	CT	TU/ Assi	PR(S)		
PC	CH 5001	Chemical Reaction Engineering	2	1	0	3	60	3	-	-	20	20	-	100	3
PC	CH 5002	Mass Transfer - II	2	1	0	3	60	3	-	-	20	20	-	100	3
OE	+CH 5100	Open Elective-I +CH 51001- Economic Policies in India +CH 51002- Engineering Economics & Accountancy	3	0	0	3	60	3	-	-	20	20	-	100	3
PC	CH 5003	Process Control & Instrumentation	2	1	0	3	60	3	-	-	20	20	-	100	3
PE	CH 5004	Programme Elective - II CH 50041- Material Science and Technology CH 50042- Energy Engineering	3	0	0	3	60	3	-	-	20	20	-	100	3
PE	CH 5005	Programme Elective - III CH 50051- Plant Utilities CH 50052- Safety in Chemical Process Industry	3	0	0	3	60	3	-	-	20	20	-	100	3
PC	CH 5006	Mass Transfer Lab	0	0	2	2	-	-	40	3	-	-	60	100	1
PC	CH 5007	Chemical Reaction Engineering Lab	0	0	2	2	-	-	40	3	-	-	60	100	1
SI	CH 5008	Summer Internship-II(6 weeks after IV Sem.)							100	--				100	3
PR	CH 5009	Major Project	0	0	2	2	-	-	-	-	-	-	-	-	--
VS	+CH 5555	Anandam (Joy of Giving)	--	--	1	1	--	--	--	--	--	--	100	100	2
		Students Centered Activities	0	0	3	3	--	--	--	--	--	--	--	--	--
		Total	15	3	10	28	360		180		120	120	220	1000	25
Grand Total :													1000	25	

- | | |
|--|---|
| 1. L : Lecture | 5. PR : Marks for End Semester Exam for Practical |
| 2. T : Tutorial | 6. CT : Marks for class tests (Internal Assessment) |
| 3. P : Practical | 7. TU/Assi : Marks for tutorials/Assignment (Internal Assessment) |
| 4. TH : Marks for End Semester Exam for Theory | 8. PR(S) : Marks for practical and viva (Internal Assessment) |

1. +CH 51001, +CH 51002 and +CH 5555 are same in all branches of Engineering

Student Centered Activities will be graded as A, B, C & D on the basis of attendance and interest of the student in learning.

Note:Major Project will be continued and Assesed in VI Semester

GOVERNMENT OF RAJASTHAN
BOARD OF TECHNICAL EDUCATION RAJASTHAN, JODHPUR
TEACHING AND EXAMINATION SCHEME
FOR DIPLOMA VI SEMESTER (CHEMICAL ENGINEERING) (CH)
(SEMESTER SCHEME-2020-21)
SESSION 2022-2023 & ONWARDS

Subject Category	Subject Code	Subjects	Distribution of Time				Distribution of Max. Marks/ Duration						Total Marks	Credits	
			Hours per week				End Semester Exam			Internal Assessment					
			L	T	P	Tot	TH	Hrs.	PR	Hrs.	CT	TU/ Assi.			PR(S)
HS	+CH 6111	Entrepreneurship and Startups	3	1	0	4	60	3	-	-	20	20	-	100	4
OE	+CH 6200	Open Elective-II +CH 62001- Project Management +CH 62002- Renewable Energy Technologies	3	0	0	3	60	3	-	-	20	20	-	100	3
OE	+CH 6300	Open Elective-III +CH 63001- Product Design +CH 63002- Disaster Management	3	0	0	3	60	3	-	-	20	20	-	100	3
AU	+CH 6333	Indian Constitution	2	0	0	2	-	-	-	-	-	-	-	-	0
PC	CH 6001	Project Engineering	2	0	0	2	60	3	-	-	20	20	-	100	2
PE	CH 6002	Programme Elective - IV CH 60021 -Process Equipment Design CH 60022- Waste Management	3	0	0	3	60	3	-	-	20	20	-	100	3
PR	CH 6003	Major Project	0	0	6	6	-	-	40	-	-	-	60	100	4
SE	CH 6004	Seminar	1	0	0	1	-	-	-	-	-	-	100	100	1
VS	+CH 6666	Anandam (Joy of Giving)	--	--	1	1	--	--	--	--	--	--	100	100	2
		Students Centered Activities	0	0	3	3	--	--	--	--	--	--	--	--	--
		Total Credits	17	1	10	28	300	--	40	--	100	100	260	800	22
Grand Total :													800	22	

- | | |
|--|---|
| 1. L : Lecture | 5. PR : Marks for End Semester Exam for Practical |
| 2. T : Tutorial | 6. CT : Marks for class tests (Internal Assessment) |
| 3. P : Practical | 7. TU/Assi : Marks for tutorials/Assignment (Internal Assessment) |
| 4. TH : Marks for End Semester Exam for Theory | 8. PR(S) : Marks for practical and viva (Internal Assessment) |

1. +CH 6111, +CH 62001, +CH 62002, +CH 63001, +CH 63002, +CH 6333 and +CH 6666 are same in all branches of Engineering

Student Centered Activities will be graded as A, B, C & D on the basis of attendance and interest of the student in learning.

GOVERNMENT OF RAJASTHAN
BOARD OF TECHNICAL EDUCATION RAJASTHAN JODHPUR
SEMESTER SCHEME-2020-21



III SEMESTER
(SESSION 2021-2022 & ONWARDS)

INTRODUCTION TO CHEMICAL ENGINEERING

Course Code	CH 3001
Course Title	Introduction To Chemical Engineering
Number of Credits	4 (L-4, T-0, P-0)
Prerequisites	NIL
Course Category	PC

COURSE LEARNING OBJECTIVES:

- To give a comprehensive knowledge on various aspects practiced in chemical engineering
- To give the sources of information on related topics.

COURSE OUTCOMES:

At the end of the course, the student can able to:

- Appreciate various unit operations and processes followed in transforming raw material into value added materials
- Understand the various representations of flow processes
- Significance of Chemical Engineering to the society in the areas of health, energy, environment

COURSE CONTENTS:**1. Introduction**

- 1.1 Basics of chemical Engineering
- 1.2 Chemical process industries
 - 1.2.1 History
 - 1.2.2 Role in Society
- 1.3 Role of Chemical Engineer
- 1.4 Greatest achievements of Chemical Engineering

2. Role of Science

- 2.1 Components of Chemical Engineering
 - 2.1.1 Role of Mathematics
 - 2.1.2 Role of Physics
 - 2.1.3 Role of Chemistry
- 2.2 Thermodynamic
 - 2.2.1 Transport Phenomena
 - 2.2.2 Chemical Kinetics
- 2.3 Process dynamics, design and control

3. Concept of Unit Operation and Unit Processes

- 3.1 Concept of Unit Processes and Unit Operations
- 3.2 Description of different Unit Processes and Unit Operations
- 3.3 Designing of equipments
 - 3.3.1 Symbols of equipments
 - 3.3.2 Basic representation of process flow sheet

4. Role of Computer technology

- 4.1 Role of Computer in Chemical Engineering
 - 4.1.1 Chemical Engineering Software: ANN, CAD
- 4.2 Relation between Chemical Engineering and other engineering disciplines
- 4.3 Traditional vs. modern Chemical Engineering
- 4.4 Versatility of Chemical Engineering
 - 4.4.1 Role of Chemical Engineers in the area of Food,
 - 4.4.2 Energy and Environmental

5. Future Scope

- 5.1 Paradigm shifts in Chemical Engineering

- 5.2 Range of scales in Chemical Engineering
- 5.3 Opportunities for Chemical Engineers
- 5.4 Future of Chemical Engineering.

REFERENCE BOOKS:

1. S. K. Ghosal, S. K., Sanyal and S. Datta, "Introduction to Chemical Engineering", Tata McGraw Hill Education Pvt. Ltd., New Delhi.
2. Pushpavanam.S., "Introduction to Chemical Engineering", PHI Learning Pvt. Ltd., New Delhi,
3. Badger W.L. and Banchero J.T., "Introduction to Chemical Engineering", 6thEdition, Tata McGraw Hill, 1997.
4. Dryden, C.E., "Outlines of Chemicals Technology", Edited and Revised by Gopala Rao, M. and M.Sittig, 2nd Edition, Affiliated East-West press, 1

SEMESTER SCHEME 2020-21

INDUSTRIAL CHEMISTRY

Course Code	CH 3002
Course Title	Industrial Chemistry
Number of Credits	3 (L-3, T-0, P-0)
Prerequisites	NIL
Course Category	PC

COURSE LEARNING OBJECTIVES:

- To develop the basic knowledge of organic compounds.
- To understand the concepts of polymerization
- To lay foundation for the understanding other chemical engineering subjects

COURSE OUTCOMES:

The student can be able to:

- Understand Basics of organic compounds
- Understand the nomenclature
- Identify the properties of various organic compounds

COURSE CONTENTS:**1. Introduction**

- 1.1 Basics of Industrial organic chemistry
- 1.2 Tetra valency of carbon
- 1.3 Bonding system

2. Introductory Study of Organic Compounds

- 2.1 Classification
- 2.2 Nomenclature
- 2.3 Homologous series
- 2.4 Functional groups
- 2.5 Isomerism – Structural and Stereo

3. Introduction of Polymerization:

- 3.1 Definitions and Types
- 3.2 Polymerization reactions
- 3.3 Polymer structure, functionality and degradation,
- 3.4 Characteristics of polymers.

4. Methods of Polymerization:

- 4.1 Mass polymerization processes,
- 4.2 Solution polymerization processes,
- 4.3 Emulsion polymerization processes
- 4.4 Suspension polymerization processes,

5. Colloids

- 5.1 Crystalloids and colloids
- 5.2 Classification
- 5.3 Preparation
- 5.4 Lyophilic and Lyophobic
- 5.5 Cataphoresis
- 5.6 Peptization
- 5.7 Applications

REFERENCE BOOKS:

1. R. T. Morrison, R. N. Boyd and S.K Bhattachrajee, 'Organic Chemistry' Pearson.
2. V Raghavan, "Material Science & Engineering" PHI Learning Pvt. Ltd.,
3. P.L. Soni and H.M.Chawla, "Text book of organic Chemistry", Sultan Chand & Sons – Tb
4. B.R.Puri, L.R.Sharma and M.S.Pathania, "Principles of physical chemistry"
Vikas Publishing House Pvt Ltd.,
5. K. S.Tewari, S. N Mehrotra, N. K. Vishnoi , "Textbook of organic chemistry"
Vikas Publishing House Pvt Ltd.,

SEMESTER SCHEME 2020-21

CHEMICAL PROCESS CALCULATIONS

Course Code	CH 3003
Course Title	CHEMICAL PROCESS CALCULATIONS
Number of Credits	3 (L-2, T-1, P-0)
Prerequisites	NIL
Course Category	PC

COURSE LEARNING OBJECTIVES

- To give students fundamental knowledge of Unit processes and Unit operation
- Understand the basic laws governing chemical operations
- To impart knowledge on material and energy balance with and without reactions.

COURSE OUTCOMES:

On completion of the course, the students would have,

- The capability to understand the need for study of unit operations and processes.
- Convert units and dimensions and also modify equations from one system to another.
- The capability to apply the laws of physics and chemistry in solving process industry related applications.
- The capability to use mathematical knowledge for solving mass and energy balance problems

COURSE CONTENTS:**1. Introduction**

- 1.1 Basics of unit operations and unit processes.
- 1.2 Units and dimensions.
- 1.3 Conversion of Units

2. Chemical and Physical Principles

- 2.1 Stoichiometric relations
- 2.2 Methods of expressing Composition
- 2.3 Ideal gas law and applications
- 2.4 Gaseous mixture
 - 2.4.1 Partial Pressure
 - 2.4.2 Vapour Pressure

3. Humidity

- 3.1 Vapour pressure , effect of Temperature on vapour pressure
- 3.2 Humidity and Solubility: Humidity - saturation -vaporization
- 3.3 Wet and dry bulb thermometry.

4. Material Balance:

- 4.1 Key components
- 4.2 Basis of calculations
- 4.3 Total and component balance
- 4.4 Steady state and unsteady state
- 4.5 By-pass and Recycle.
- 4.6 Simple numerical problems.

5. Energy Balance:

- 5.1 Energy Balance
- 5.2 Thermo chemistry - Hess's law of summation
- 5.3 Heat Effects
 - 5.3.1 Heat of formation
 - 5.3.2 Heat of reaction
 - 5.3.3 Heat of combustion
 - 5.3.4 Heat of mixing

5.4 Mean specific heat, Theoretical Flame Temperature.

REFERENCE BOOKS

1. K.V. Narayanan and B. Lekshmikutty, "Stoichiometry and Process Calculations", Prentice Hall of India Ltd, New Delhi..
2. V.Venkataramani, N.Anantharaman and K.M. Meera Sheriffa Begum, 'Process Calculations' Prentice Hall of India Ltd, New Delhi.
3. B. I. Bhatt, "Stoichiometry", Tata McGraw Hill Publishers Ltd., New Delhi.
4. C. M. Narayanan & B. C Bhattacharya, 'Unit operations and Processes' Vol-I, CBS Publishers & Distributors.

SEMESTER SCHEME 2020-21

MOMENTUM TRANSFER

Course Code	CH 3004
Course Title	MOMENTUM TRANSFER
Number of Credits	3 (L-2, T-1, P-0)
Prerequisites	NIL
Course Category	PC

COURSE LEARNING OBJECTIVES:

- To impart the fundamental concepts of fluid statics
- To nurture the students to solve fluid dynamics problems using Newton's laws of motion.
- To enable students to compute velocity profile, friction factor and head loss in pipes and fittings.
- To impart the knowledge of metering and transportation of fluids and fluid moving machinery performance.

COURSE OUTCOMES :

On completion of the course, the students would have,

- The knowledge of fundamental concepts in fluids statics and to use dimensional analysis for scaling experimental results
- The ability to solve hydrostatic and fluid flow problems using Newton's laws of motion
- The ability to analyze frictional flow in pipes and piping networks and to compute the head loss and power requirements for chemical process equipments.
- The ability to select the metering equipments and fluid moving machinery for appropriate chemical engineering operations.

COURSE CONTENTS:**1. Properties of fluids and concept of pressure**

- 1.1 Introduction
 - 1.1.1 Nature of fluids
 - 1.1.2 physical properties of fluids
- 1.2 Types of fluids.
- 1.3 Pressure measurement.
- 1.4 Dimensional analysis.
 - 1.4.1 Shear forces in flowing fluids
 - 1.4.2 Frictional losses in pipes

2. Momentum Balance and their Applications

- 2.1 Kinematics of fluid flow; Newtonian and non-Newtonian fluids
- 2.2 Reynolds number - experiment and significance
- 2.3 Momentum balance - Forces acting on stream tubes
- 2.4 Bernoulli's equation - Correction for fluid friction

3. Flow of incompressible fluids in pipes

- 3.1 Laminar and turbulent flow through closed conduits
- 3.2 Velocity profile & friction factor for smooth and rough pipes
- 3.3 Head loss due to friction in pipes, fitting etc.

4. Flow of Fluids through Solids

- 4.1 Form drag, skin drag , Drag coefficient.
- 4.2 Flow around solid and packed beds.
- 4.3 Friction factor for packed beds.
- 4.4 Fluidisation - Mechanism, types, general properties and applications

5. Transportation and Metering, Measurement of fluid flow

- 5.1 Orifice meter, Venturi meter and Rotameter.
- 5.2 Transportation of fluids: Fluid moving machinery performance.
 - 5.2.1 Selection and specification.
 - 5.2.2 Positive displacement pumps
 - 5.2.3 Rotary and Reciprocating pumps,
 - 5.2.4 Centrifugal pumps and characteristics,
- 5.3 Introduction to Fans, Blowers & Compressors

REFERENCE BOOKS

1. A. K. Mohanty, "Fluid Mechanics", Prentice Hall of India Ltd, New Delhi.
2. W. L. McCabe, J.C. Smith and P. Harriott, "Unit operations of Chemical Engineering", McGraw Hill, International Edn.,
3. J. M. Coulson and J. F. Richardson, "Chemical Engineering", Vol 1, Butterworth Heinemann.
4. C. M. Narayanan & B. C Bhattacharya, 'Unit operations and Processes' Vol-I, CBS Publishers & Distributors.

SEMESTER SCHEME 2020-21

MECHANICAL OPERATIONS

Course Code	CH 3005
Course Title	MECHANICAL OPERATIONS
Number of Credits	3 (L-2, T-1, P-0)
Prerequisites	NIL
Course Category	PC

COURSE LEARNING OBJECTIVES:

To impart knowledge on

- Understand basic principles of particle preparation and their characterization
- Understand the performance of different equipments for separation of solids and size reduction
- Basic principles in various operations such as Size Reduction, Filtration, etc.
- Study various methods for storage of solids and conveyors available for their transportation

COURSE OUTCOMES

On completion of the course, students are expected to

- Understand the basic principles of particles preparation and their characterization.
- Have knowledge about different size reducing equipment and power requirements during size reduction.
- Have an understanding of solid storage and their conveying in chemical process industries.

COURSE CONTENTS:**1. Characteristics of Particulate Material**

- 1.1 Properties and characterisation of particulate solids,
- 1.2 Flow properties of particulates.

2. Introduction to Comminution

- 2.1 Introduction
- 2.2 Determination of power in comminution energy by laws of comminution
- 2.3 Factors affecting comminution
- 2.4 Industrial comminution equipments
 - 2.4.1 Jaw crushers and Gyratory crushers
 - 2.4.2 Double roll crushers
 - 2.4.3 Ball mill
 - 2.4.3 Fluid energy mill

3. Screening

- 3.1 Screening, mesh number
- 3.2 Differential and cumulative analysis,
- 3.3 Screen capacity and effectiveness.
- 3.4 Screening equipments

4. Filtration

- 4.1 Filter medium,
- 4.2 Batch and continuous filtration,
- 4.3 Gravity and centrifugal filters.
- 4.4 Filtration equipments like sand filter, Rotary drum filter, bag filters, plate and frame filter press

5. Gas Cleaning and Transportation of Solids

- 5.1 Cyclones
- 5.2 Electrostatic precipitators,
- 5.3 Sonic agglomeration
- 5.4 Storage of solids
 - 5.4.1 Angle of repose

5.5 Conveyors like belt conveyor, screw conveyor, bucket elevators, pneumatic conveyors, and hydraulic transport.

REFERENCE BOOKS

1. Anup. K.Swain, Hemlata Patra, G.K.Roy., "Mechanical Operations", McGraw Hill Education.
2. McCabe and J.C.Smith," Unit Operation of Chemical Engineering", McGraw Hill., New York.
3. M. Coulson and J.F. Richardson, "Chemical Engineering", Vol. II, Butterworth- Heinemann.
4. Badger and Banchero, "Introduction to Chemical Engineering", McGraw Hill, New York.

SEMESTER SCHEME 2020-21

ENGINEERING THERMODYNAMICS

Course Code	CH 3006
Course Title	Engineering Thermodynamics
Number of Credits	3 (L-3, T-0, P-0)
Prerequisites	NIL
Course Category	PC

COURSE LEARNING OBJECTIVES:

To impart knowledge on

- To understand the basic knowledge of thermodynamic systems used in Chemical Engineering operations.
- To understand basic knowledge of refrigeration cycles and system.

COURSE OUTCOMES

On completion of the course, the students will be able to

- Understand the conceptual laws of thermodynamics
- Understand and analyze different thermodynamic cycles
- Understand the free energy functions.

COURSE CONTENTS:**1. Basic Concepts and Definitions**

- 1.1 Energy conversion and efficiencies
- 1.2 System property and state - Thermal equilibrium
- 1.3 Zeroth law of Thermodynamics.

2. First Law of Thermodynamics

- 2.1 The concept of work and adiabatic process - First law of thermodynamics -
- 2.2 Conservation of Energy principle for closed and open systems
- 2.3 Calculation of work for different processes of expansion of gases

3. Second Law of Thermodynamics

- 3.1 Equilibrium and the second law -
- 3.2 Heat engines - Kelvin-Planck statement
- 3.3 Reversible and irreversible processes -
- 3.4 Carnot principle - Clausius inequality-
- 3.5 Entropy –Third Law of Thermodynamics

4. Refrigeration Cycles and Systems

- 4.1 Reverse Carnot cycle - COP
- 4.2 Vapor compression refrigeration cycle and systems (only theory)
- 4.3 Liquification and solidification of gases

5. Free Energy Functions

- 5.1 Purpose of new Functions
- 5.2 properties of Gibbs free energy
- 5.3 properties of Helmholtz free energy
- 5.4 Temperature dependency of free energy

REFERENCE BOOKS

1. Nag, P. K., "Engineering Thermodynamics", Tata McGraw Hill Publishing Co. Ltd., New Delhi.
2. Arora, C.P., "Thermodynamics", Tata McGraw Hill Publishing Co. Ltd., New Delhi.

MOMENTUM TRANSFER LAB

Course Code	CH 3007
Course Title	Momentum Transfer Lab
Number of Credits	1 (L-0, T-0, P-2)
Prerequisites	NIL
Course Category	PC

COURSE LEARNING OBJECTIVES:

Understand and application of the principles & concepts of learned in momentum transfer theory course.

COURSE OUTCOME:

After completion of the course, student can able to

- Understand and application of the concept of manometers
- Understand and analyse the laminar and turbulent flow
- Understand the concepts of flow meters, pumps.

CONTENTS

To conduct experiment to study

1. Study of constructional features and working of different types of manometers and pressure gauges
2. Verification of Bernoulli's theorem
3. Measurement of flow by orifice and venturimeter
4. Study of pitot tube and rotameters
5. To determine friction loss in flow through pipes
6. To study constructional features of centrifugal pumps
7. To study constructional features of reciprocating pumps
8. To study constructional features of gear pumps
9. To study Reynolds's apparatus to determine laminar, transition and turbulent flow

REFERENCES:

1. Lab Manual
2. *W. L. McCabe, J.C. Smith and P. Harriott, "Unit operations of Chemical Engineering", McGraw Hill, International Edn.*
3. *G Chandrasekhar, Laboratory Experiments in Chemical and Allied Engineering, Penram International Publishing (India) Pvt. Ltd.*

MECHANICAL OPERATIONS LAB

Course Code	CH 3008
Course Title	Mechanical Operations Lab
Number of Credits	1 (L-0, T-0, P-2)
Prerequisites	NIL
Course Category	PC

COURSE LEARNING OBJECTIVES:

- To impart hands on experience on different unit operation equipments.
- Apply principles developed in Mechanical Operations

COURSE OUTCOME:

After completion of the course, student can able to:-

- Understand the fundamentals involved in the Mechanical operations.
- understand and application of the concept of Particulate properties

CONTENTS

1. To perform the Sieve analysis of a given sample
2. To study Rittingers's law of comminution
3. To study Kick's law of comminution
4. To study Bond's law of comminution
5. To study the rate of filtration with the help of filter press
6. To study screen effectiveness
7. To study the rate of conveying of material and motor power required for pneumatic conveyors
8. To study the power of drive motor for given load/ capacity for Bucket elevator.

REFERENCES:

1. Lab Manual
2. W. L. McCabe, J.C. Smith and P. Harriott, "Unit operations of Chemical Engineering", McGraw Hill, International Edn.,
3. G Chandrasekhar, Laboratory Experiments in Chemical and Allied Engineering, Penram International Publishing (India) Pvt. Ltd.,

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SEMESTER SCHEME-2020-21



IV SEMESTER
(SESSION 2021-2022 & ONWARDS)

PROCESS HEAT TRANSFER

Course Code	CH 4001
Course Title	PROCESS HEAT TRANSFER
Number of Credits	3 (L-2, T-1, P-0)
Prerequisites	NIL
Course Category	PC

COURSE LEARNING OBJECTIVES:

- To study the fundamental concepts of heat transfer viz., conduction, convection and radiation.
- To use these fundamentals in typical engineering applications (Heat exchanger and Evaporator).

COURSE OUTCOMES:

On completion of the course, the student can able

- to estimate steady state heat transfer rates.
- to use equations for different types of convection and solve for heat transfer rate by convection
- to estimate the rate of heat transfer by radiation
- to estimate steam economy, capacity of single and multiple effect evaporators.

COURSE CONTENTS:**1. CONDUCTION**

- 1.1 Basic modes of heat transfer
- 1.2 Fourier's law of heat conduction
 - 1.2.1 General heat conduction equations
 - 1.2.2 Unsteady state conduction
 - 1.2.3 Steady state conduction
- 1.3 Heat flow equation for composite wall
- 1.4 Concepts of thermal diffusivity
- 1.5 Heat flow equation for composite cylinder
- 1.6 Optimum insulation thickness

2. CONVECTION

- 2.1 Introduction to convection
- 2.2 Types of convection
- 2.3 Dimensional analysis
 - 2.3.1 Criteria of Similitude
 - 2.3.2 Advantages and limitations of dimensional analysis
- 2.4 Dimensionless number for heat transfer and their physical significance

3. RADIATION

- 3.1 Thermal Radiation laws
- 3.2 Radiant energy distribution curve
- 3.3 Black and Gray bodies
- 3.4 Boiling
 - 3.4.1 Boiling Phenomenon
 - 3.4.2 Hysteresis in boiling curve
- 3.5 Condensation
 - 3.5.1 Types
 - 3.5.2 Condensation of super heated vapors

4. HEAT EXCHANGER

- 4.1 Heat Exchangers
 - 4.1.1 Double Pipe heat exchanger

- 4.1.2 Shell and tube heat exchanger
- 4.1.3 Plate type heat exchanger
- 4.2 LMTD

5. EVAPORATION

- 5.1 Evaporation
- 5.2 Evaporators
 - 5.2.1 Single effect operation
 - 5.2.2 Multiple effect operation
- 5.3 Material and Energy balance in evaporators,
- 5.4 Boiling point elevation
- 5.5 Duhring's rule

REFERENCE BOOKS:

1. DC. Sikdar, "Process Heat Transfer and Chemical Equipment Design", Revised Ed., Khanna Publishing House
2. W. L. McCabe and J. C. Smith, "Unit Operations In Chemical Engineering", 7th Edn., McGraw Hill Publishing Co.
3. Binay K. Dutta, "Heat Transfer Principles and applications" Prentice Hall of India Pvt. Ltd.
4. C. M. Narayanan & B. C Bhattacharya, 'Unit operations and Processes' Vol-I, CBS Publishers & Distributors, 2006

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MASS TRANSFER - I

Course Code	CH 4002
Course Title	MASS TRANSFER - I
Number of Credits	3 (L-2,T-1, P-0)
Prerequisites	NIL
Course Category	PC

COURSE LEARNING OBJECTIVES:

- To learn the concept of diffusion in gas and liquid.
- To understand the basics of Absorption mass transfer process.
- To learn application of mass transfer operations like humidification, Drying & Crystallisation.

COURSE OUTCOMES:

On completion of the course, the student will be:

- familiar with the basic phenomenon of mass transfer involving phases.
- able to apply the concepts of mass transfer in gas-liquid systems like absorption, humidification, drying and crystallization
- Gaining good knowledge of required optimum condition for mass transfer operations .

COURSE CONTENTS:**1. Diffusion**

- 1.1 Definition- Fick's law
- 1.2 Molecular and eddy diffusion
- 1.3 Diffusion in
 - 1.3.1 Diffusion of A through non-diffusing B
 - 1.3.2 Equimolar counterdiffusion
- 1.4 Analogies between momentum, heat and mass transfer to predict mass transfer coefficients.

2. Absorption

- 2.1 Introduction to Absorption
- 2.2 Theory of gas absorption
 - 2.2.1 Two Film theory
 - 2.2.2 Penetration theory
- 2.3 Concept of Equilibrium and operating lines
- 2.4 Absorption Equipments
 - 2.4.1 Plate column
 - 2.4.2 Packed column

3. Humidification

- 3.1 Introduction to Humidification
- 3.2 Psychometric Chart
- 3.3 Construction and working of
 - 3.3.1 Humidifier
 - 3.3.2 Dehumidifier
- 3.4 Cooling towers

4. Drying

- 4.1 Drying Theory and Mechanism
- 4.2 Drying Characteristics
- 4.3 Estimation of Drying time and drying rate curve
- 4.4 Construction, working and application of dryers
 - 4.4.1 Tray Dryer
 - 4.4.2 Rotary Dryer
 - 4.4.3 Drum Dryer
 - 4.4.4 Spray Dryer

5. Crystallization

- 5.1 Growth and properties of crystals
- 5.2 Supersaturation
- 5.3 Crystallisation rate
- 5.4 Batch crystalliser – Tank
- 5.5 Continuous crystallisation

REFERENCE BOOKS:

1. Binay. K. Dutta “ Principles of Mass Transfer and Separation Processes”., PHI Learning
2. R.E. Treybal, “Mass Transfer Operations”, McGraw Hill Book Co., New York.
3. N. Anantharaman and K.M. Meera Sheriffa Begum, “Mass Transfer Theory and Practice”, Printice Hall of India Pvt. Ltd., New Delhi.
4. J. M. Coulson and J. F. Richardson, “Chemical Engineering”, Vol. II, Butterworth Heinemann, New York.
5. W.L. McCabe, J.C. Smith and P. Harriot, “Unit Operations of Chemical Engineering”, McGraw Hill Book Co., New York.

CHEMICAL ENGINEERING THERMODYNAMICS

Course Code	CH 4003
Course Title	CHEMICAL ENGINEERING THERMODYNAMICS
Number of Credits	3 (L-2, T-1, P-0)
Prerequisites	NIL
Course Category	PC

COURSE LEARNING OBJECTIVES:

This course will impart

- Knowledge on the concepts of thermodynamics.
- Use of thermodynamics concepts in chemical engineering applications.
- Appreciate the relationship between thermodynamics properties and reactions.

COURSE OUTCOMES:

On completion of the course, the students will be familiar with,

- Fundamentals of thermodynamics.
- Thermodynamics Properties as applied to ideal and real gases
- Determination of equilibrium states for mixture of gases.
- Relationship between thermodynamics properties.

COURSE CONTENTS:**1. Introduction**

- 1.1 Introduction to Basic laws and Terminologies in Thermodynamics
- 1.2 Statement of First law
- 1.3 Heat effects accompanying chemical Reactions
- 1.4 Statements of second law
- 1.5 Clausius Inequality
- 1.6 Mathematical Statement of Second law
- 1.7 Third Law of Thermodynamics

2. Applications

- 2.1 Applications to Laws of Thermodynamics
- 2.2 Flow processes: Flow in pipes
- 2.3 Compression- Refrigeration

3. Thermodynamic Properties of Fluids

- 3.1 Thermodynamic Properties of Pure Fluids
- 3.2 Classification of Thermodynamic properties
- 3.3 Work function and Gibb's Free energy
- 3.4 Fundamental Property relations
- 3.5 Maxwell's equations and Clapyeron equation
- 3.6 Differential equations of Entropy
- 3.7 Relationship between C_p and C_v
- 3.8 Gibb's Helmholtz Equation

4. Thermodynamic Properties of Solutions

- 4.1 Thermodynamic Properties of Solutions
- 4.2 Introduction to fugacity and activity,
- 4.3 Activity coefficients

- 4.4 Partial molar properties
- 4.5 Lewis Randall rule
- 5. **Equilibria**
 - 5.1 Phase Equilibria and Chemical Reaction Equilibria
 - 5.2 Criteria for phase equilibrium, Criterion of stability
 - 5.3 Phase equilibria in single and multiple component systems
 - 5.4 Duhem's theorem, VLE for Ideal solutions
 - 5.5 Reaction stoichiometry and Equilibrium constant
 - 5.6 Feasibility of reaction
 - 5.6.1 Effect of temperature, pressure, volume and other factors

REFERENCE BOOKS:

1. J.M. Smith, Hendrick Van Ness, Michael M. Abbott, Introduction to Engineering Thermodynamics, McGraw Hill, New York.
2. K.V.Narayanan, A Textbook of Chemical Engineering Thermodynamics, PHI Learning, New Delhi.
3. S. Sundaram, Chemical Engineering Thermodynamics, Ahuja Publishers, New Delhi.

SEMESTER SCHEME 2020-21

CHEMICAL TECHNOLOGY

Course Code	CH 4004
Course Title	CHEMICAL TECHNOLOGY
Number of Credits	3 (L-3, T-0, P-0)
Prerequisites	NIL
Course Category	PC

COURSE LEARNING OBJECTIVES:

- To impart the basic concepts of chemical technology.
- To develop understanding about unit process and unit operations.
- To learn manufacturing processes of organic and Inorganic Chemicals and its applications and major engineering problems encountered in the process.
- To learn the process flow sheet drawing for the manufacturing chemical processes.

COURSE OUTCOMES:

On completion of the course, the student can be able to

- Understand the various unit operations and unit processes.
- Understand the manufacturing process of processing and industrial microbial processes.
- Understand the various chemical reactions involved in the process
- Understand the manufacturing process of inorganic chemicals.
- Draw the process flow sheet and understand the major engineering problems encountered in the processes.

COURSE CONTENTS:**1. Natural Products Processing**

- 1.1 Production of pulp, paper
- 1.2 Manufacture of Sucrose
- 1.3 Manufacture of Starch

2. Industrial Microbial Processes and Edible Oils

- 2.1 Fermentation processes
- 2.2 Production of ethyl alcohol
- 2.3 Soaps and detergents

3. Chlor - alkali Industries

- 3.1 Manufacture of Soda ash
- 3.2 Manufacture of caustic soda and chlorine
- 3.3 Sulphur and Sulphuric acid:
 - 3.3.1 Manufacture of sulphur
 - 3.3.2 Manufacture of sulphuric acid

4. Cement

- 4.1 Types of cement
- 4.2 Setting and grades of cement
- 4.3 Manufacture of Portland cement
 - 4.3.1 Dry process
 - 4.3.2 Wet process

5. Fertilisers industry

- 5.1 Nitrogen Fertilisers: Synthetic ammonia, Urea
- 5.2 Phosphorous Fertilisers: Phosphoric acid,

Super phosphate and Triple Super phosphate

REFERENCE BOOKS:

1. R. Gopal and M. Sittig, "Dryden's Outlines of Chemical Technology: For The 21st Century" Third Edition, Affiliated East-West Publishers.
2. G.T. Austin, "Shreve's Chemical Process Industries", McGraw Hill, NewYork.
3. O.P. Gupta, "Chemical Process Technology", Khanna Publishing House
4. W.V.Mark, S.C. Bhatia "Chemical Process Industries volume I and II" CBS Publishers & Distributors
5. S. D. Shukla and G. N. Pandey, "Text book of Chemical Technology" Vol 2, Vikash Publishing Company.

SEMESTER SCHEME 2020-21

PETROLEUM REFINING & PETROCHEMICAL TECHNOLOGY

Course Code	CH 40051
Course Title	Petroleum Refining & Petrochemical Technology
Number of Credits	3 (L-3,T-0, P-0)
Prerequisites	NIL
Course Category	PE

COURSE LEARNING OBJECTIVES:

- To impart introductory knowledge of petroleum refining and corresponding processes.
- To provide an insight into petrochemical industry.

COURSE OUTCOMES

- On completion of the course, the students will be able to develop overview of petroleum industry and know about origin, formation composition and characterization of crude oil.
- Know about secondary conversion techniques and treatment processes in petroleum refinery to get products of desired yield and quality
- Understand manufacturing processes and applications of various petrochemical.

COURSE CONTENTS:**1. Introduction & primary processing**

- 1.1 Origin & formation of crude oil
- 1.2 Classification of crude,
- 1.3 Characterization of crude
- 1.4 Distillation practise
 - 1.4.1 Atmospheric distillation
 - 1.4.2 Vacuum distillation

2. Secondary Processing

- 2.1 Hydro cracking,
- 2.2 Reforming
- 2.3 Coking

3. Treatment Techniques

- 3.1 Clay contacting process
- 3.2 H₂SO₄ treatment process
- 3.3 Treatment of Kerosene by SO₂.

4. Petrochemical

- 4.1 Production of ethylene
- 4.2 Manufacture of polyethylene
 - 4.2.1 High pressure polyethylene
 - 4.2.2 Medium pressure
 - 4.2.3 Low pressure

5. Properties of Petroleum Product

- 5.1 Specific gravity
- 5.2 Viscosity
- 5.3 Flash & fire point
- 5.4 Cloud point, pour point, and freezing point
- 5.5 Smoke point
- 5.6 knocking and octane number

5.7 Cetane number

REFERENCE BOOKS

1. B.K. Bhaskarao, Bulk Chemicals from Petroleum, Khanna Publishing House
2. B. K. Bhaskara, "Modern Petroleum Refining Processes", Oxford and IBH Publishing Company, New Delhi.
3. W.L. Nelson, "Petroleum Refinery Engineering", McGraw Hill, New York.
4. O.P. Gupta, "Elements of Petroleum Refinery Engineering", Khanna Publishing House
5. Saikat Maitra & O.P. Gupta, "Elements of Petrochemical Engineering", Khanna Publishing House, New Delhi

SEMESTER SCHEME 2020-21

PETROLEUM ENGINEERING

Course Code	CH 40052
Course Title	Petroleum Engineering
Number of Credits	3 (L-3,T-0, P-0)
Prerequisites	NIL
Course Category	PE

COURSE LEARNING OBJECTIVES:

To provide

- An overview of petroleum industry.
- oil and gas reserve identification and evaluation.
- Drilling and production of oil and gas.

COURSE OUTCOMES

After completing the course, a student can able to understand the various processes involved in the upstream processes of petroleum Engineering.

COURSE CONTENTS:**1. Earth science**

- 1.1 Occurrence of petroleum Rocks and traps.
- 1.2 Reservoir rocks and properties.
- 1.3 Classification of oil and gas reserves

2. Drilling

- 2.1 Introduction to drilling of oil and gas wells.
- 2.2 Drilling rigs and equipments
- 2.3 Drilling fluids and cementing.

3. Logging techniques

- 3.1 Logging
- 3.2 Various types of logs
- 3.3 Formation parameters.
- 3.4 Log applications
- 3.5 Well completion.

4. Petroleum exploration

- 4.1 Well testing
- 4.2 Well performances.
- 4.3 Artificial lift

5. Petroleum Economics

- 5.1 Factors affecting petroleum economics
- 5.2 Transportation of oil and gas.

REFERENCE BOOKS:

1. Geology of Petroleum by Leveson A.L.- 2nd edition The AAPG foundation.
2. Principles of oil production by T.E.W Nind- 2nd edition Mc Graw-Hill.
3. Introduction to Petroleum Engineering by Geltin
4. Vikas Mahto, Objective Questions & Answers in Petroleum Engineering, Khanna Publishing House, New Delhi

5. Wellsite Geological Techniques for petroleum exploration, Oxford and IBH publishing Company.

SEMESTER SCHEME 2020-21

HEAT TRANSFER LAB

Course Code	CH 4006
Course Title	Heat Transfer Lab
Number of Credits	1 (L-0,T-0, P-2)
Prerequisites	NIL
Course Category	PC

COURSE LEARNING OBJECTIVES:

To provide exposure on heat transfer equipments of chemical industry.

COURSE OUTCOMES

The students will understand how heat transfer occurs for different equipments and worked out the parameters studied in theory.

CONTENTS

1. To study heat transfer through composite wall
2. To study heat transfer through lagged pipe.
3. To study heat transfer through forced convection apparatus
4. To study the double pipe heat exchanger.
5. To study shell and tube heat exchanger
6. To study plate type heat exchanger
7. To study Stefan-Boltzmann law
8. To study single effect evaporation
9. To study triple effect evaporation
10. To study condensation in vertical condenser

REFERENCE BOOKS

1. *Lab Manual*
2. *W. L. McCabe, J.C. Smith and P. Harriott, "Unit operations of Chemical Engineering", McGraw Hill, International Edn.,*
3. *G Chandrasekhar, Laboratory Experiments in Chemical and Allied Engineering:, Penram International Publishing (India) Pvt. Ltd.,*

CHEMICAL ENGINEERING DRAWING LAB

Course Code	CE 4007
Course Title	Chemical Engineering Drawing Lab
Number of Credits	2 (L-0,T-0, P-4)
Prerequisites	NIL
Course Category	PC

COURSE LEARNING OBJECTIVES:

- To draw the process equipments used widely in the chemical industry
- To understand the basic parts of equipments

COURSE OUTCOMES:

On completion of the course, the student can be able to

- Draw the Different types of valves and Pumps
- Draw the components of vessels
- Draw the P & I drawings of heat transfer and mass transfer equipments

COURSE CONTENT:

- Symbols**
 - 1.1 Instrument symbols
 - 1.2 Symbols of Unit Operations
 - 1.3 Colour code
- Pressure vessels and storage tanks**
 - 2.1 Drawing of Pressure vessels
 - 2.2 Drawing of Storage Tanks,
- Valves And Pumps**
 - 3.1 Valves: Gate,Glove, Plug, Check, Butterfly, Ball,Pressure safety valve, Pressure regulating valves
 - 3.2 Pumps: Centrifugal, Reciprocating, Gear
- P&I drawings of Mass Transfer Equipments**
 - 4.1 Distillation
 - 4.2 Dryer
- P&I drawings of Heat Transfer Equipments**
 - 5.1 Heat Exchangers
 - 5.2 Evaporators

REFERENCE BOOKS:

1. D.C. Sikdar, "Process Heat Transfer & Chemical Equipment Design", Revised Ed. Khanna *Publishing House*
2. V. V.Mahajani and S. B. Umarjii, "Joshi's Process Equipment Design", Mac Millan Publishers India Limited, New Delhi,
3. R. K. Sinnott, "Chemical Engineering Design", Coulson and Richardson's Chemical Engineering Series, Volume-6, Fourth Edition, Butterwoth-Heinemann, Elsevier, NewDelhi, 2005.
4. R. H. Perry, "Chemical Engineers' Handbook", 7th Edn., McGraw Hill , NewYork, 1998.
5. B.C. Bhattacharyya, "Introduction to Chemical Equipment Design Mechanical Aspects", CBS Publishers & Distributors, New Delhi.

ESSENCE OF INDIAN KNOWLEDGE AND TRADITION

Course Code	CH 4222(Same in All Branches of Engg.)
Course Title	Essence of Indian Knowledge and Tradition
Number of Credits	0(L-2,T-0, P-0)
Prerequisites	None
Course Category	AU

COURSE CONTENTS:

Basic Structure of Indian Knowledge System:

- (i) वेद,
- (ii) उन्नवेद (आयुर्वेद, धनुर्वेद, गन्धर्ववेद, स्थानतल्यआदद)
- (iii) वेदथांशंग (शिक्षथा, कलन, ननरुत, व्याकरण, ज्योनतषछथांद),
- (iv) उन्नथाइग (धर्मशथास्र, र्ीरथांशथा, नुरथाण, तकरशथास्र)
 - Modern Science and Indian Knowledge System
 - Yoga and Holistic Health care
 - Case Studies.

REFERENCES /SUGGESTED LEARNING RESOURCES:

1. V. Sivarama Krishna, “ Cultural Heritage of India- Course Material”, Bhartiya Vidya Bhavan, Mumbai, fifth Edition, 2014.
2. Swami Jitatmanand, “ Modern Physics and Vedant”, Bhartiya Vidya Bhavan.
3. Fritz of Capra, “ The wave of Life”.
4. Fritz of Capra, “ Tao of Physics”.
5. V N Jha, “ Tarka sangraha of Annam Bhatta, International” Cinmay Foundation, Velliarnad, Amakum.
6. R N Jha, “ Science of Consciousness Psychotherapy and Yoga Practices” Vidya nidhi Prakasham, Delhi, 2016.

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SEMESTER SCHEME-2020-21



V SEMESTER
(SESSION 2021-2022 & ONWARDS)

CHEMICAL REACTION ENGINEERING

Course Code	CH 5001
Course Title	CHEMICAL REACTION ENGINEERING
Number of Credits	3 (L-2, T-1, P-0)
Prerequisites	NIL
Course Category	PC

COURSE LEARNING OBJECTIVES:

- Introduce basic concepts of chemical kinetics
- This course will guide students to make use of key concepts and techniques of chemical kinetics for reactor designing

COURSE OUTCOMES:

On completion of the course, the students:

- Will understand the basic kinetics of chemical reactions
- will understand the reactor designing.
- will familiar with the Basic concepts of non ideal flow

COURSE CONTENTS:**1. Introduction :**

- 1.1 Rate of reaction
- 1.2 Variables affecting rate of reaction
- 1.3 Molecularity and order of reaction
- 1.4 Rate constant.

2. Types of Reaction :

- 2.1 Single - multiple reactions
- 2.2 Reversible - Irreversible reactions
- 2.3 Elementary - Non elementary reaction
- 2.4 Temperature dependency according to Arrhenius theory, collision theory and transition state theory,
- 2.5 Simple numerical problems

3. Constant Volume Batch Reactor :

- 3.1 Integral method of analysis of data
- 3.2 Differential method of analysis of data
- 3.3 Rate expressions for zero, first, second and third order reactions.
- 3.4 Simple numerical problems

4. Reactor Design :

- 4.1 Design equation for batch reactor
- 4.2 Semi batch reactor
- 4.3 Continuous reactor (C.S.T.R.)
- 4.4 Plug flow reactor
- 4.5 Adiabatic reactor
- 4.6 photochemical reactor
- 4.7 Space time
- 4.8 Holding time
- 4.9 Space velocity
- 4.10 Simple numerical problems

5. Comparison of Reactors :

- 5.1 Size Comparison For Single Reactors
- 5.2 Batch Reactor With Plug Flow Reactor
- 5.3 Study of Combined reactor:
 - 5.3.1 Mixed flow -plug flow
 - 5.3.2 Plug flow -mixed flow

6. Basic concepts of non ideal flow

- 6.1 Deviation From Ideal Flow
- 6.2 Residence Time Distribution (RTD) Function
- 6.3 Pulse Input
- 6.4 E Curve
- 6.5 F Curve

REFERENCE BOOKS:

1. K. A. Gavhane Chemical Reaction Engineering -I, NiraliPrakashanPublications,Pune
2. S C Roy and C Guha, 'A Text book of Chemical Reaction Engineering' Dhanpat Rai & Co. (P) Ltd.
3. O. Levenspiel, "Chemical Reaction Engineering", Wiley Easter Ltd., New York

SEMESTER SCHEME 2020-21

MASS TRANSFER – II

Course Code	CH 5002
Course Title	MASS TRANSFER – II
Number of Credits	3(L-2, T-1,P-0)
Prerequisites	NIL
Course Category	PC

COURSE LEARNING OBJECTIVES:

- To impart the basic concept of conventional mass transfer operations.
- To learn about mass transfer processes in distillation and it's design
- To understand the Liquid liquid Extraction, Leaching and adsorption.

COURSE OUTCOMES:

After completing the course, a student can able to

- Have an ability to apply the concepts of mass transfer in distillation.
- Understand Liquid liquid Extraction, Leaching and Adsorption.

COURSE CONTENTS:**1. Distillation**

- 1.1 Introduction
- 1.2 Importance of Distillation
- 1.3 Vapour Liquid Equilibrium diagram
- 1.4 Relative Volatility
- 1.5 Plate and packed column
- 1.6 Methods of distillations
 - 1.6.1 Differential Distillation
 - 1.6.2 Flash Distillation
 - 1.6.3 Continuous rectification
 - 1.6.4 Azeotropic distillation
 - 1.6.5 Extractive distillation

2. Design of Distillation

- 2.1 Reflux ratio and its significance
- 2.2 Equation of Q – line and its importance
- 2.3 Method of calculating number of plates by Mc-Cabe Thiele Method

3. Liquid liquid Extraction

- 3.1 Introduction
- 3.2 Purpose
- 3.3 Liquid liquid equilibrium (triangular method)
- 3.4 Choice of solvent

4. Leaching

- 4.1 Theory, Mechanism, Types of leaching
- 4.2 Solid - Liquid equilibria
- 4.3 Batch and continuous extractors
- 4.4 Equipments and industrial applications

5. Adsorption

- 5.1 Types of adsorption
- 5.2 Nature of adsorbents,
- 5.3 Adsorption isotherms,
- 5.4 Equipments and method

REFERENCE BOOKS:

1. R. E. Treybal, "Mass Transfer Operations", 3rd Edn., McGraw Hill Book Co., New York, 1981.
2. N. Anantharaman and K.M.MeeraSheriffa Begum, "Mass Transfer Theory and Practice", Printice Hall of India Pvt. Ltd., New Delhi, 2013.
3. M. Coulson and J. F. Richardson, "Chemical Engineering.", Vol - II, 5th Edn., Pergamon Press, New York, 2002.
4. W. L. McCabe, J. C. Smith and P. Harriot, "Unit Operations in Chemical Engg.",7th Edn., McGraw Hill Book Co., New York, 2004.

SEMESTER SCHEME 2020-21

ECONOMIC POLICIES IN INDIA

Course Code	CH 51001(Same in All Branches of Engg.)
Course Title	Economic Policies in India
Number of Credits	3 (L:3,T:0,P:0)
Prerequisites	NIL
CourseCategory	OE

COURSE LEARNING OBJECTIVES:

The objective of this course is to familiarize the students of different streams with the basic concepts, structure, problems and issues concerning Indian economy.

CO1	Understand Indian economics policy, planning strategies
CO2	It will enable to students to comprehend theoretical and empirical development across countries and region for policy purposes
CO3	Development Economics as a discipline encompasses different approach estotheproblems ofunemployment,poverty,incomegeneration,industrializationfromdifferentperspec-tives
CO4	Abletoidentifytheproblemsandcapabletodecidetheapplicationforfuturedevelopment
CO5	Analyzeeconomicissuesandfindsolutionstocomplexeconomicproblemsandtakecor-recteconomicjudgment

COURSE CONTENTS:**1. BASIC FEATURES AND PROBLEMS OF INDIAN ECONOMY:**

- 1.1. Economic History of India;
- 1.2. Nature of Indian Economy
- 1.3. Demographic features and Human Development Index,
- 1.4. Problems of Poverty, Unemploy-ment, Inflation, income inequality, Blackmoney in India.

2. SECTORAL COMPOSITION OF INDIAN ECONOMY:

- 2.1. Issues in Agriculture sector in India,
- 2.2. land reforms
- 2.3. Green Revolution
- 2.4. agriculture policies of India,
- 2.5.

3. INDUSTRIAL DEVELOPMENT,

- 3.1. Small scale and cottage industries,
- 3.2. Industrial Policy,
- 3.3. Public sector in India,
- 3.4. Service sector in India.

4. ECONOMIC POLICIES:

- 4.1. Economic Planning in India,
- 4.2. Planning commission v/s NITI Aayog,
- 4.3. Five Year Plans,
- 4.4. Monetary policy in India,
- 4.5. Fiscal Policy in India,
- 4.6. Centre state Finance Relations,
- 4.7. Finance commission in India
- 4.8. LPG policy in India

5. EXTERNAL SECTOR IN INDIA

- 5.1. India's foreign trade value composition and direction,
- 5.2. India Balance of payment since 1991,
- 5.3. FDI in India,
- 5.4. Impact of Globalization on Indian Economy,
- 5.5. WTO and India.

REFERENCE BOOKS:

1. Dutt Rudder and K.P.M Sunderam (2017). Indian Economy .S Chand & Co.Ltd. New Delhi.
2. Mishra S. K & V. K Puri (2017). Indian Economy and Its Development Experience. Himalaya Publishing House.
3. Singh, Ramesh, (2016): Indian Economy, Tata-McGraw Hill Publications, New Delhi.
4. Dhingra, I.C., (2017): March of the Indian Economy, Heed Publications Pvt. Ltd.
5. Karam Singh Gill, (1978): Evolution of the Indian Economy, NCERT, NewDelhi
6. Kaushik Basu (2007): The Oxford Companion to Economics of India ,Oxford University Press.

SEMESTER SCHEME 2020-21

ENGINEERING ECONOMICS & ACCOUNTANCY

Course Code	CH 51002 (Same in All Branches of Engg.)
Course Title	Engineering Economics & Accountancy
Number of Credits	3 (L:3,T:0,P:0)
Prerequisites	NIL
Course Category	OE

COURSE OBJECTIVES

- To acquire knowledge of basic economic of a facilitate the process of economic decision making.
- To acquire knowledge on basic financial management aspects.
- To develop the basic skills to analyze financial statements.

COURSE OUTCOMES:

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

CO1	Understand the macro-economic environment of the business and its impact on enterprise
CO2	Understand cost elements of the product and its effect on decision making
CO3	Prepare accounting records and summarize and interpret the accounting data for managerial decisions
CO4	Understand accounting systems and analyze financial statements using ratio analysis
CO5	Understand the concepts of financial management and investment

COURSE CONTENTS**1. INTRODUCTION:**

- 1.1. Managerial Economics;
- 1.2. Relationship with other disciplines;
- 1.3. Firms: Types, objectives and goals;
- 1.4. Managerial decisions;
- 1.5. Decision analysis.

2. DEMAND & SUPPLY ANALYSIS:

- 2.1. Demand;
 - 2.1.1. Types of demand;
 - 2.1.2. Determinants of demand;
 - 2.1.3. Demand function;
 - 2.1.4. Demand elasticity;
 - 2.1.5. Demand forecasting;
- 2.2. Supply;
 - 2.2.1. Determinants of supply;
 - 2.2.2. Supply function;
 - 2.2.3. Supply elasticity.

3. PRODUCTION AND COST ANALYSIS:

- 3.1. Production function;
- 3.2. Returns to scale;
- 3.3. Production optimization;
- 3.4. Least cost input; Iso quants;
- 3.5. Managerial uses of production function;
- 3.6. Cost Concepts;
 - 3.6.1. Cost function;
 - 3.6.2. Types of Cost;
 - 3.6.3. Determinants of cost;
 - 3.6.4. Short run and Long run cost curves;
 - 3.6.5. Cost Output Decision;
 - 3.6.6. Estimation of Cost.

4. PRICING:

- 4.1. Determinants of Price;
- 4.2. Pricing under different objectives and different market structures;
- 4.3. Price discrimination;
- 4.4. Pricing methods in practice;
- 4.5. Role of Government in pricing control.

5. FINANCIAL ACCOUNTING (ELEMENTARY TREATMENT):

- 5.1. Balance sheet and related concepts;
- 5.2. Profit & Loss Statement and related concepts;
- 5.3. Financial Ratio Analysis;
- 5.4. Cash flow analysis;
- 5.5. Funds flow analysis;
- 5.6. Comparative financial statements;
- 5.7. Analysis & Interpretation of financial statements;
- 5.8. Investments;
- 5.9. Risks and return evaluation of investment decision;
- 5.10. Average rate of return;
- 5.11. Payback Period;
- 5.12. Net Present Value;
- 5.13. Internal rate of return,

REFERENCE BOOKS:

1. Mc Guigan, Moyer and Harris, 'Managerial Economics; Applications, Strategy and Tactics', Thomson South Western, 10th Edition, 2005.
2. Prasanna Chandra. 'Fundamentals of Financial Management', Tata Mcgraw Hill Publishing Ltd., 4th edition, 2005.
3. Samuelson. Paul A and Nordhaus W. D., 'Economics', Tata Mcgraw Hill Publishing Company Limited, New Delhi, 2004.
4. Paresh Shah, 'Basic Financial Accounting for Management', Oxford University Press, New Delhi, 2007.
5. Salvatore Dominick, 'Managerial Economics in a global economy'. Thomson SouthWestern, 4th Edition, 2001.

PROCESS CONTROL & INSTRUMENTATION

Course Code	CH 5003
Course Title	PROCESS CONTROL & INSTRUMENTATION
Number of Credits	3(L-2, T-1, P-0)
Prerequisites	NIL
Course Category	PC

COURSE LEARNING OBJECTIVES:

- To introduce students to the terminology, concepts and practices of instrumentation and process control.
- To impart knowledge of control systems in chemical industries

COURSE OUTCOMES:

On completion of the course, the student will be able ::

- To understand the Instrumentations used in Chemical Process Industries.
- To understand the process control of chemical process industries

COURSE CONTENTS:**1. Introduction :**

- 1.1 Instrumentation and its importance to chemical industries
- 1.2 Important process parameters required to be measured in chemical Industry.
- 1.3 Importance of process control.

2. Temperature :

- 2.1 Different scales and conversions, brief construction and measurement of temperature by -
 - 2.1.1 Thermocouples
 - 2.1.2 Resistance thermometers
 - 2.1.3 Pyrometers
 - 2.1.4 Bimetallic thermometers
 - 2.1.5 Liquid in glass thermometer
- 2.2 Criteria of selection of thermometer for a particular measurement

3. Pressure :

- 3.1 Definition of absolute pressure, gauge pressure and differential pressure
- 3.2 Pressure measurement by –
 - 3.2.1 Manometers
 - 3.2.2 Elastic deformation element
 - 3.2.3 Strain gauge

4. Transmission:

- 4.1 Pneumatic transmission
- 4.2 Electrical transmission
- 4.3 Hydraulic transmission
- 4.4 Fields of applications of above transmission

5. Process Control:

- 5.1 Closed & Open loop system
- 5.2 Factors affecting control system
- 5.3 Different types of control actions - their merits and demerits
- 5.4 Process dynamic response of system
- 5.5 Function of an automatic controller

REFERENCE BOOKS:

- 1. D.R. Coughanowr and S. E. LeBlanc, 'Process Systems Analysis and Control', Mc.Graw Hill, III Edition.
- 2. G. Stephanopoulous, 'Chemical Process Control – Theory and Practice', Prentice Hall of India Ltd.

SEMESTER SCHEME 2020-21

MATERIAL SCIENCE AND TECHNOLOGY

Course Code	CH 50041
Course Title	MATERIAL SCIENCE AND TECHNOLOGY
Number of Credits	3(L-3, T-0, P-0)
Prerequisites	NIL
Course Category	PE

COURSE LEARNING OBJECTIVES:

- To impart the basic concept of material science.
- To understand the various properties, corrosion and Structure and Imperfections in Crystals.

COURSE OUTCOMES:

- After completion of the course, the students can understand the basics knowledge such as
- Atomic bonding, crystal geometry and engineering materials.
- Understand the various properties and corrosion behavior of the selected materials in chemical industries
- Experience in the metallic and nonmetallic material selection and handling.

COURSE CONTENTS:**1. Atomic Bonding:**

- 1.1 Classes of engineering materials
- 1.2 Selection of materials
- 1.3 Structure of atoms and molecules
- 1.4 Bonding in solids

2. Structure and Imperfections in Crystals:

- 2.1 Crystal structure
- 2.2 Structure of solids,
- 2.3 Methods of determining structures.

3. Properties and Corrosion of Material:

- 3.1 Mechanical, Electrical and magnetic properties of materials
- 3.2 Heat Treatment techniques
- 3.3 Corrosion and prevention of corrosion.

4. Metals: Engineering materials

- 4.1 Ferrous metals
- 4.2 Iron and their alloys
- 4.3 Non-ferrous metals and alloys
- 4.4 Aluminium, and it's alloys with reference to the application in chemical industries.

5. Non Metals:

- 5.1 Inorganic materials:
- 5.2 Ceramics and refractories
- 5.3 organic materials: wood, plastics, and rubber

REFERENCE BOOKS:

1. V. Raghavan, "Materials Science and Engineering- A First course", Prentice Hall of India Pvt. Ltd.
2. R. Balasubraman

ENERGY ENGINEERING

Course Code	CH 50042
Course Title	ENERGY ENGINEERING
Number of Credits	3(L-3, T-0, P-0)
Prerequisites	NIL
Course Category	PE

COURSE LEARNING OBJECTIVES:

- To identify different types of fuel sources for energy production.
- To appreciate the advantages of energy production from renewable energy resources.

COURSE OUTCOMES:

On completion of the course, the students will be able:

- To understand the energy production from conventional fuels and renewable energy resources,
- To familiar with information on renewable energy technologies.

COURSE CONTENTS:**1. Fuels**

- 1.1 Classification,
- 1.2 Properties, tests and analysis.
- 1.3 Solid Fuels
- 1.4 Coal, origin and classification
- 1.5 Carbonization and gasification

2. Liquid fuels

- 2.1 Petroleum based fuels,
- 2.2 Synthetic fuels,
- 2.3 Alcohol and blended fuels
- 2.4 Storage and handling.

3. Gaseous fuels

- 3.1 Water gas,
- 3.2 Producer gas,
- 3.3 Coal gas
- 3.4 Natural gas.

4. Combustion

- 4.1 Air requirement for solid, liquid and gaseous fuels,
- 4.2 Combustion equipment

5. Energy

- 5.1 Solar energy,
- 5.2 Wind energy
- 5.3 Nuclear energy.

REFERENCE BOOKS:

1. Gupta, "Energy Technology", Khanna Publishing House, New Delhi
2. G.D.Rai, "Non-conventional energy sources", Khanna Publishers, IV edition, New Delhi,

PLANT UTILITIES

Course Code	CH 50051
Course Title	PLANT UTILITIES
Number of Credits	3(L-3, T-0, P-0)
Prerequisites	NIL
Course Category	PE

COURSE LEARNING OBJECTIVES:

- To enable the students to understand the process plant utilities
- To enable the students to understand the waste disposal in chemical industries.

COURSE OUTCOMES:

At the end of this course, the students will be able to understand:

- The Steam, water, air used process industries and their importance
- Describe the different equipment used to run the process plants with different utilities.

COURSE CONTENTS:**1. IMPORTANT OF UTILITIES**

- 1.1 Hard and Soft water,
- 1.2 Requisites of Industrial Water and its uses.
- 1.3 Methods of water Treatment such as Chemical Softening and Demineralization,
- 1.4 Water Softening and Reverse Osmosis.

2. STEAM AND STEAM GENERATION

- 2.1 Properties of Steam.
- 2.2 Types of Steam Generator such as Solid Fuel Fired Boiler.
- 2.3 Scaling and Trouble Shooting.
- 2.4 Steam Traps and Accessories.

3. REFRIGERATION

- 3.1 Refrigeration Cycles
- 3.2 Methods of Refrigeration used in Industry
- 3.3 Refrigerating Effects and Liquefaction Processes.

4. COMPRESSED AIR

- 4.1 Classification of Compressor
- 4.2 Reciprocating Compressor
- 4.3 Single Stage and Two Stage Compressor
- 4.4 Use of Humidity Chart.
- 4.5 Equipments used for Humidification, Dehumidification and Cooling Towers.

5. AND WASTE DISPOSAL

- 5.1 Types of Fuel used in Chemical Process Industries for Power Generation such as Natural Gas, Liquid Petroleum Fuels, Coal and Coke. Internal Combustion Engine.
- 5.2 Waste Disposal.

REFERENCE BOOKS:

1. P. L. Ballaney, "Thermal Engineering", Khanna Publisher New Delhi.
2. Perry R. H. Green D. W. "Perry's chemical Engineer's Handbook", McGraw Hill, New York,.

3. D B DHONE, "Plant utilities" NiraliPrakashan.
4. P. N. Ananthanarayan, "Basic Refrigeration & Air-Conditioning", Tata McGraw Hill, New Delhi.
5. Sadhu Singh, Refrigeration & Air-Conditioning, Khanna Publishing House. New Delhi

SEMESTER SCHEME 2020-21

SAFETY IN CHEMICAL PROCESS INDUSTRIES

Course Code	CH 50052
Course Title	SAFETY IN CHEMICAL PROCESS INDUSTRIES
Number of Credits	3(L-3,T-0, P-0)
Prerequisites	NIL
Course Category	PE

COURSE LEARNING OBJECTIVES:

To enable the students learn about, hazard identification.

To enable the students for implementation of safety procedures, risk analysis and assessment

COURSE OUTCOMES:

On completion of the course the students will

- understand the importance of safety measures
- Know Different types of prevention techniques
- identify the risks in process management in different types of process industries.

COURSE CONTENTS:**1. Hazard identification**

- 1.1 Hazard identification methodologies.
- 1.2 Risk assessment methods - PHA, HAZOP and consequence analysis

2. Hazards in work places

- 2.1 Nature and type of work places,
- 2.2 Types of hazard.
- 2.3 Hazards due to improper house-keeping,
- 2.4 Guidelines and safe methods in the above situations.

3. Pollution in work places

- 3.1 Workers' exposures to hazardous chemicals,
- 3.2 Pollution in work places due to dangerous dusts, fumes and vapors.
- 3.4 Guidelines and safe methods in chemicals handling, storage and entry into confined spaces.

4. Hazards in various industries

- 4.1 Hazards peculiar to industries like fertilizer, petroleum, paints and dairy Industries.
- 4.2 Guidelines for safeguarding personnel and safeguarding against water, land and air pollution in the above industries.

5. Safety education and training

- 5.1 Safety management,
- 5.2 Fundamentals of safety tenets, measuring safety performance, motivating safety performance.
- 5.3 Legal aspects of industrial safety, safety audit.

REFERENCE BOOKS:

1. Dr B.K. Bhaskara Rao, Er. R.K. Jain, and Vineet Kumar, "Safety in Chemical Plants/Industry and Its Management" Khanna Publishers.
2. S.C. Sharma, "Industrial Safety and Maintenance Management", Khanna Book Publishing Co. Private Limited, New Delhi

SEMESTER SCHEME 2020-21

MASS TRANSFER LAB

Course Code	CH 5006
Course Title	MASS TRANSFER LAB
Number of Credits	1(L-0,T-0, P-2)
Prerequisites	NIL
Course Category	PC

COURSE LEARNING OBJECTIVES:

To provide exposure to mass transfer operations used in chemical industries

COURSE OUTCOMES:

After this Lab course, a student will be able to Understand the application of mass transfer principles applied to chemical industry equipments

COURSE CONTENTS:

1. Study of distillation in bubble cap column.
2. To study flash equilibrium distillation
3. Operation of cooling tower
4. To study adsorption column
5. To study working of dehumidifier
6. Study of absorption in packed column.
7. Study of rotary dryers.
8. Study of spray dryer
9. Batch drying of solid materials in tray dryer.
10. To crystallise a given hot saturated solution in a batch crystalliser

REFERENCE BOOKS:

1. *Lab manual*
2. *G Chandrasekhar, Laboratory Experiments in Chemical and Allied Engineering: Emphasis on Low Cost Experiments, Penram International Publishing (India) Pvt. Ltd..*

CHEMICAL REACTION ENGINEERING LAB

Course Code	CH 5007
Course Title	CHEMICAL REACTION ENGINEERING LAB
Number of Credits	1(L-0, T-0, P-2)
Prerequisites	NIL
Course Category	PC

COURSE LEARNING OBJECTIVES:

To provide exposure to chemical reactors used in chemical industries.

COURSE OUTCOMES:

After this Lab course, a student will be able to Understand the principles of chemical reactors applied to chemical industries.

COURSE CONTENTS:

1. Study of Batch reactor
2. Study of Plug flow reactor
3. Study of CSTR
4. Study of Combined reactor: Mixed flow -plug flow
5. Study of RTD plug flow tabular Reactor
6. Study of Adiabatic reactor
7. Study of photochemical reactor

REFERENCE BOOKS:

- 1.Lab manual

SEMESTER SCHEME 2020-21

GOVERNMENT OF RAJASTHAN
BOARD OF TECHNICAL EDUCATION RAJASTHAN JODHPUR
SEMESTER SCHEME-2020-21



VI SEMESTER
(SESSION 2021-2022 & ONWARDS)

ENTREPRENEURSHIP AND START-UPS

Course Code	CH 6111(Same in All Branches of Engg.)
Course Title	Entrepreneurship and Start-ups
Number of Credits	4 (L-3 ,T-1, P-0)
Prerequisites (Course code)	None
Course Category	HS

COURSE LEARNING OBJECTIVES:

1. Acquiring Entrepreneurial spirit and resourcefulness.
2. Familiarization with various uses of human resource for earning dignified means of living.
3. Understanding the concept and process of entrepreneurship-its contribution and role in the growth and development of individual and the nation.
4. Acquiring entrepreneurial quality, competency, and motivation.
5. Learning the process and skills of creation and management of entrepreneurial venture.

LEARNING OUTCOME:

Upon completion of the course, these student will be able to demonstrate knowledge of the following topics:

1. Understanding the dynamic role of entrepreneurship and small businesses
2. Organizing and Managing a Small Business
3. Financial Planning and Control
4. Forms of Ownership for Small Business
5. Strategic Marketing Planning
6. New Product or Service Development
7. Business Plan Creation

COURSE CONTENTS:**1. INTRODUCTION TO ENTREPRENEURSHIP AND START-UPS**

- 1.1. Definitions, Traits of an entrepreneur, Intrapreneurship, Motivation
- 1.2. Types of Business Structures,
- 1.3. Similarities / differences between entrepreneurs and managers.

2. BUSINESS IDEAS AND THEIR IMPLEMENTATION

- 2.1. Discovering ideas and visualizing the business
- 2.2. Activity map
- 2.3. Business Plan

3. IDEA TO START-UP

- 3.1. Market Analysis– Identifying the target market,
- 3.2. Competition evaluation and Strategy Development,
- 3.3. Marketing and accounting,
- 3.4. Risk analysis

4. MANAGEMENT

- 4.1. Company's Organization Structure,
- 4.2. Recruitment and management of talent.
- 4.3. Financial organization and management

5. FINANCING AND PROTECTION OF IDEAS

- 5.1. Financing methods available for start-ups in India
- 5.2. Communication of Ideas to potential investors– Investor Pitch
- 5.3. Patenting and Licenses

6. EXIT STRATEGIES FOR ENTREPRENEURS ,BANKRUPTCY, AND SUCCESSION AND HARVESTING STRATEGY

SUGGESTED LEARNING RESOURCES:

S.No.	Title of Book	Author	Publication
1.	The Startup Owner's Manual: The Step by-Step Guide for Building a Great Company	Steve Blank and Bob Dorf	K & S Ranch ISBN-978-0984999392
2.	The Lean Startup: How Today's Entrepreneurs Use Continuous Innovation to Create Radically Successful Businesses	Eric Ries	Penguin UK ISBN-978-0670921607
3.	Demand: Creating What People Love Before They Know They Want It	Adrian J. Slywotzky with Karl Weber	Headline Book Publishing ISBN-978-0755388974
4.	The Innovator's Dilemma: The Revolutionary Book That Will Change the Way You Do Business	Clayton M. Chris Tensen	Harvard business ISBN:978-142219602

SUGGESTED SOFTWARE/LEARNING WEBSITES:

- a. <https://www.fundable.com/learn/resources/guides/startup>
- b. <https://corporatefinanceinstitute.com/resources/knowledge/finance/corporatehstructure/>
- c. <https://www.finder.com/small-business-finance-tips>
- d. <https://www.profitbooks.net/funding-options-to-raise-startup-capital-for-your-business/>

PROJECT MANAGEMENT

CourseCode	CH 62001(Same in All Branches of Engg.)
CourseTitle	Project Management
NumberofCredits	3(L:3,T:0,P:0)
Prerequisites	NIL
CourseCategory	OE

COURSE LEARNING OBJECTIVES

- To develop the idea of project plan, from defining and confirming the project goals and objectives, identifying tasks and how goals will be achieved.
- To develop an understanding of key project management skills and strategies.

COURSE OUTCOMES

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

CO1	Understand the importance of projects and its phases.
CO2	Analyze projects from marketing, operational and financial perspectives.
CO3	Evaluate projects based on discount and non-discount methods.
CO4	Develop network diagrams for planning and execution of a given project.
CO5	Apply crashing procedures for time and cost optimization.

COURSE CONTENTS**1. CONCEPT OF A PROJECT:**

- 1.1. Classification of projects
- 1.2. Importance of project management
- 1.3. The project Life cycle
- 1.4. Establishing project priorities (scope-cost-time)
- 1.5. Project priority matrix
- 1.6. Work break down structure.

2. CAPITAL BUDGETING PROCESS:

- 2.1. Planning -Analysis-Selection-Financing-Implementation-Review.
- 2.2. Generation and screening of project ideas
- 2.3. Market and demand analysis
- 2.4. Demand forecasting techniques.
- 2.5. Market planning and marketing research process
- 2.6. Technical analysis

3. FINANCIAL ESTIMATES AND PROJECTIONS:

- 3.1. Cost of projects
- 3.2. Means of financing
- 3.3. Estimates of sales and production-cost of production
- 3.4. Working capital requirement and its financing
- 3.5. Profitability project , cash flow statement and balance sheet.
- 3.6. Breakeven analysis.

4. BASIC TECHNIQUES IN CAPITAL BUDGETING:

- 4.1. Non discounting and discounting methods
- 4.2. pay-back period
- 4.3. Accounting rate of return

- 4.4. Net present value
- 4.5. Benefit cost ratio
- 4.6. Internal rate of return.
- 4.7. Project risk.
- 4.8. Social cost benefit analysis and economic rate of return.
- 4.9. Non-financial justification of projects.

5. PROJECT ADMINISTRATION:

- 5.1. Progress payments,
- 5.2. Expenditure planning,
- 5.3. Project scheduling and network planning,
- 5.4. Use of Critical Path Method(CPM),
- 5.5. Schedule of payments and physical progress,
- 5.6. time-cost trade off.
- 5.7. Concepts and uses of PERT
- 5.8. Cost as a function of time,
- 5.9. Project Evaluation and Review Techniques
- 5.10. Cost mechanisms.
- 5.11. Determination of least cost duration.
- 5.12. Post project evaluation.
- 5.13. Introduction to various Project management softwares.

REFERENCE BOOKS

- 1. Project planning, analysis, selection, implementation and review –Prasannachandra–Tata McGraw Hill
- 2. Project Management – the Managerial Process– Clifford F. Gray & Erik W. Larson-McGrawHill
- 3. Project management- David I Cleland- Mcgraw Hill International Edition, 1999
- 4. Project Management– Gopala krishnan– Mcmillan India Ltd.
- 5. Project Management- Harry – Maylor – Peason Publication

RENEWABLE ENERGY TECHNOLOGIES

CourseCode	CH 62002(Same in All Branches of Engg.)
CourseTitle	Renewable Energy Technologies
NumberofCredits	3 (L:3,T:0,P:0)
Prerequisites	NIL
CourseCategory	OE

COURSE LEARNING OBJECTIVES

- To understand present and future scenario of world energy use.
- To understand fundamentals of solar energy systems.
- To understand basics of wind energy.
- To understand bio energy and its usage in different ways.
- To identify different available non-conventional energy sources.

COURSE OUTCOMES

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

CO1	Understand present and future energy scenario of the world.
CO2	Understand various methods of solar energy harvesting.
CO3	Identify various wind energy systems.
CO4	Evaluate appropriate methods for Bio energy generations from various Bio wastes.
CO5	Identify suitable energy sources for a location.

COURSE CONTENTS**1. INTRODUCTION:**

- 1.1. World Energy Use;
- 1.2. Reserves of Energy Resources;
- 1.3. Environmental Aspects OF Energy Utilisation;
- 1.4. Renewable Energy Scenario in India and around the World;
- 1.5. Potentials; Achievements/ Applications;
- 1.6. Economics of renewable energy systems.

2. SOLAR ENERGY:

- 2.1. Solar Radiation;
- 2.2. Measurements of Solar Radiation;
- 2.3. Flat Plate and Concentrating Collectors;
- 2.4. Solar direct Thermal Applications;
- 2.5. Solar thermal Power Generation
- 2.6. Fundamentals of Solar Photo Voltaic Conversion;
- 2.7. Solar Cells;
- 2.8. Solar PV Power Generation;
- 2.9. Solar PV Applications.

3. WIND ENERGY:

- 3.1. Wind Data and Energy Estimation;
- 3.2. Types of Wind Energy Systems;
- 3.3. Performance; Site Selection;
- 3.4. Details of Wind Turbine Generator;
- 3.5. Safety and Environmental Aspects.

4. BIO-ENERGY:

- 4.1. Bio mass direct combustion;
- 4.2. Bio mass gasifiers;
- 4.3. Bio gas plants;
- 4.4. Digesters;
- 4.5. Ethanol production;
- 4.6. Bio diesel;
- 4.7. Cogeneration;
- 4.8. Bio mass Applications.

5. OTHER RENEWABLE ENERGY SOURCES:

- 5.1. Tidal energy;
- 5.2. Wave Energy;
- 5.3. Open and Closed OTEC Cycles;
- 5.4. Small Hydro Geothermal Energy;
- 5.5. Hydrogen and Storage;
- 5.6. Fuel Cell Systems;
- 5.7. Hybrid Systems.

REFERENCE BOOKS

1. Non-Conventional Energy Sources, Rai. G. D., Khanna Publishers, New Delhi, 2011.
2. Renewable Energy Sources, Twidell, J.W. & Weir, A., EFN SponLtd.,UK,2 006.
3. Solar Energy, Sukhatme. S. P., Tata Mc Graw Hill Publishing CompanyLtd. ,New Delhi, 1997.
4. Renewable Energy, Power for a Sustainable Future, Godfrey Boyle, Oxford University Press, U.K., 1996.
5. Fundamental of Renewable Energy Sources, G N Tiwari and M K Ghoshal, Narosa, New Delhi, 2007.
6. Renewable Energy and Environment A Policy Analysis for India ,NH Ravindranath, U K Rao, B Natarajan, P Monga, Tata McGraw Hill.
7. Energy and The Environment, R A Ristinen and J J Kraushaar, second edition, John Willey & Sons, New York, 2006.
8. Renewable Energy Resources, J W T widell and A D Weir, ELBS, 2006.

PRODUCT DESIGN

CourseCode	CH 63001(Same in All Branches of Engg.)
CourseTitle	Product Design
NumberofCredits	3 (L:3,T:0,P:0)
Prerequisites	NIL
CourseCategory	OE

COURSE LEARNING OBJECTIVES

- To acquire the basic concepts of product design and development process
- To understand the engineering and scientific process in executing a design from concept to finished product
- To study the key reasons for design or redesign.

COURSE OUTCOMES

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

CO1	Understand the basic concepts of product design and development process.
CO2	Illustrate the methods to define the customer needs.
CO3	Describe an engineering design and development process.
CO4	Understand the intuitive and advanced methods used to develop and evaluate a concept.
CO5	Apply modelling and embodiment principles in product design and development process.

COURSE CONTENTS**1. DEFINITION OF A PRODUCT**

- 1.1. Types of product;
- 1.2. Levels of product;
- 1.3. Product-market mix;
- 1.4. New product development (NPD) process;
- 1.5. Idea generation methods;
- 1.6. Creativity;
 - 1.6.1. Creative attitude;
 - 1.6.2. Creative design process;
- 1.7. Morphological analysis;
- 1.8. Analysis of inter-connected decision areas;
- 1.9. Brain storming.

2. PRODUCT LIFECYCLE;

- 2.1. The challenges of Product development;
- 2.2. Product analysis;
- 2.3. Product characteristics;
- 2.4. Economic considerations;
- 2.5. Production and Marketing aspects;
- 2.6. Characteristics of successful Product development;
- 2.7. Phases of a generic product development process;
- 2.8. Customer need identification;
- 2.9. Product development practices and industry-product strategies.

3. PRODUCT DESIGN

- 3.1. Design by evolution;
- 3.2. Design by innovation;
- 3.3. Design by imitation;
- 3.4. Factors affecting product design;
- 3.5. Standards of performance and environmental factors;
- 3.6. Decision making and iteration;

- 3.7. Morphology of design (different phases);
- 3.8. Role of aesthetics in design.

4. INTRODUCTION TO OPTIMIZATION IN DESIGN

- 4.1. Economic factors in design;
- 4.2. Design for safety and reliability;
- 4.3. Role of computers in design;
- 4.4. Modeling and Simulation;
- 4.5. The role of models in engineering design;
- 4.6. Mathematical modeling;
- 4.7. Similitude and scale models;
- 4.8. Concurrent design;
- 4.9. Six sigma and design for six sigma;
- 4.10. Introduction to optimization in design;
- 4.11. Economic factors and financial feasibility in design;
- 4.12. Design for manufacturing;
- 4.13. Rapid Proto typing (RP);
- 4.14. Application of RP in product design;
- 4.15. Product Development versus Design.

5. DESIGN OF SIMPLE PRODUCTS DEALING WITH VARIOUS ASPECTS OF PRODUCT DEVELOPMENT;

- 5.1. Design Starting from need till the manufacture of the product

REFERENCE BOOKS

- 1.Product Design and Development, Karl T.Ulrichand Steven D.Eppinger, TataMc Graw–Hill edition.
- 2.Engineering Design– George E. Dieter.
- 3.An Introduction to Engineering Design methods Vijay Gupta.
- 4.Merie Crawford: New Product management, McGraw-Hill Irwin.
- 5.Chitale A K and Gupta R C,“ Product Design and Manufacturing”, Prentice Hall of India, 2005.
- 6.Kevin Otto and Kristin Wood, Product Design, Techniques in Reverse Engineering and New Product Development, Pears on education.

DISASTER MANAGEMENT

Course Code	CH 63002(Same in All Branches of Engg.)
Course Title	Disaster Management
Number of Credits	3 (L: 3, T: 0 ,P :0)
Prerequisites	NIL
Course Category	OE

COURSE LEARNING OBJECTIVES

Following are the objectives of this course:

- To learn about various types of natural and man-made disasters.
- To know pre and post-disaster management for some of the disasters.
- To know about various information and organizations in disaster management in India.
- To get exposed to technological tools and their role in disaster management.

COURSE OUTCOMES:

- 1.1. After completing this course, student will be:
- 1.2. Acquainted with basic information on various types of disasters
- 1.3. Knowing the precautions and awareness regarding various disasters
- 1.4. Decide first action to be taken under various disasters
- 1.5. Familiarised with organization in India which are dealing with disasters
- 1.6. Able to select IT tools to help in disaster management

COURSE CONTENTS**1. UNDERSTANDING DISASTER**

- 1.1. Understanding the Concepts and definitions of Disaster,
- 1.2. Hazard,
- 1.3. Vulnerability,
- 1.4. Risk,
- 1.5. Capacity–Disaster and Development,
- 1.6. Disaster management.

2. TYPES, TRENDS, CAUSES, CONSEQUENCES AND CONTROL OF DISASTERS

- 2.1. Geological Disasters (earth quakes, land slides,tsunami, mining);
- 2.2. Hydro-Meteorological Di-sasters (floods, cyclones, lightning, thunder-storms, hailstorms, avalanches, droughts, cold and heat waves)
- 2.3. Biological Disasters (epidemics, pestattacks, forestfire);
- 2.4. Technological Disasters (chemical, industrial, radiological, nuclear)
- 2.5. Manmade Disasters (building collapse, rural and urban fire, road and rail accidents, nuclear, radiological, chemicals and biological disasters)
- 2.6. Global Disaster Trends
- 2.7. Emerging Risks of Disasters
- 2.8. Climate Change and Urban Disasters.

3. DISASTER MANAGEMENT CYCLE AND FRAME WORK

- 3.1. Disaster Management Cycle
- 3.2. Paradigm Shift in Disaster Management.
- 3.3. Pre-Disaster
- 3.4. Risk Assessment and Analysis,
- 3.5. Risk Mapping,
- 3.6. Zonation and Microzonation,
- 3.7. Prevention and Mitigation of Disasters,
- 3.8. Early Warning System
 - 3.8.1. Preparedness,
 - 3.8.2. Capacity Development;
 - 3.8.3. Awareness.

- 3.9. During Disaster
 - 3.9.1. Evacuation
 - 3.9.2. Disaster Communication
 - 3.9.3. Search and Rescue
 - 3.9.4. Emergency Operation Centre
 - 3.9.5. Incident Comm and System
 - 3.9.6. Relief and Rehabilitation
- 3.10. Post-disaster
 - 3.10.1. Damage and Needs Assessment,
 - 3.10.2. Restoration of Critical Infra structure
 - 3.10.3. Early Recovery Reconstruction and Redevelopment;
 - 3.10.4. IDNDR, Yokohama Strategy, Hyogo Framework of Action.

4. DISASTER MANAGEMENT IN INDIA

- 4.1. Disaster Profile of India
- 4.2. Mega Disasters of India and Lessons Learnt.
- 4.3. Disaster Management Act 2005
- 4.4. Institutional and Financial Mechanism,
- 4.5. National Policy on Disaster Management,
- 4.6. National Guidelines and Plans on Disaster Management;
- 4.7. Role of Government (local, state and national),
- 4.8. Non-Government and Inter Governmental Agencies

5. APPLICATIONS OF SCIENCE AND TECHNOLOGY FOR DISASTER MANAGEMENT

- 5.1. Geo informatics in Disaster Management (RS, GIS, GPS and RS).
- 5.2. Disaster Communication System (Early Warning and Its Dissemination).
- 5.3. Land Use Planning and Development Regulations,
- 5.4. Disaster Safe Designs and Constructions,
- 5.5. Structural and Non Structural Mitigation of Disasters
- 5.6. S & T Institutions for Disaster Management in India

REFERENCES

1. Publications of National Disaster Management Authority (NDMA) on Various Templates and Guide lines for Disaster Management
2. Bhandani, R. K., An over view on natural & man-made disasters and their reduction, CSIR, New Delhi
3. Srivastava, H. N., and Gupta G. D. , Management of Natural Disasters in developing countries, Daya Publishers, Delhi
4. Alexander, David, Natural Disasters, Kluwer Academic London
5. Ghosh, G .K. ,Disaster Management, APH Publishing Corporation
6. Murthy, D. B. N., Disaster Management: Text & Case Studies, Deep & Deep Pvt. Ltd.

INDIAN CONSTITUTION

CourseCode	CH 6333(Same in All Branches of Engg.)
CourseTitle	Indian Constitution
NumberofCredits	0 (L:2,T:0;P:0)
Prerequisites(Coursecode)	None
CourseCategory	AU

COURSE CONTENT**1. THE CONSTITUTION –**

- 1.1. Introduction
- 1.2. The History of the Making of the Indian Constitution
- 1.3. Preamble and the Basic Structure, and its interpretation
- 1.4. Fundamental Rights and Duties and their interpretation
- 1.5. State Policy Principles

2. UNION GOVERNMENT

- 2.1. Structure of the Indian Union
- 2.2. President– Role and Power
- 2.3. Prime Minister and Council of Ministers
- 2.4. Lok Sabha and Rajya Sabha

3. STATE GOVERNMENT

- 3.1. Governor– Role and Power
- 3.2. Chief Minister and Council of Ministers
- 3.3. State Secretariat

4. LOCAL ADMINISTRATION

- 4.1. District Administration
- 4.2. Municipal Corporation
- 4.3. Zila Panchayat

5. ELECTION COMMISSION

- 5.1. Role and Functioning
- 5.2. Chief Election Commissioner
- 5.3. State Election Commission

SUGGESTED LEARNING RESOURCES:

S.No.	Title of Book	Author	Publication
1.	Ethics and Politics of the Indian Constitution	Rajeev Bhargava	Oxford University Press, New Delhi, 2000
2.	The Constitution of India	B.L.Fadia	Sahitya Bhawan; New edition(2017)
3.	Introduction to the Constitution of India	D D Basu	Lexis Nexis; Twenty-Third 2018 edition

SUGGESTED SOFTWARE / LEARNING WEBSITES:

1. <https://www.constitution.org/cons/india/const.html>
2. <http://www.legislative.gov.in/constitution-of-india>
3. <https://www.sci.gov.in/constitution>
4. <https://www.toppr.com/guides/civics/the-indian-constitution/the-constitution-of-india/>

PROJECT ENGINEERING

Course Code	CH 6001
Course Title	Project Engineering
Number of Credits	2 (L-2, T-0, P-0)
Prerequisites	NIL
Course Category	PC

Course Learning Objectives:

The learning objective of this subject is to enable the students:

- to gain experience in organization and implementation of a small project, their pre-requirements, flow chart preparation, cost analysis ,
- design and optimization of instruments based on both technical and commercial point of view.

COURSE OUTCOMES

On completion of this course the students will be able to:

- Understand project characteristics and various stages of a project.
- Understand the conceptual clarity about project organization and feasibility analyses – Market, Technical, Financial and Economic.
- Analyze the learning and understand techniques for Project planning, scheduling and Execution Control

COURSE CONTENTS:**1. Process Design and Development**

- 1.1 Plant location and site selection
- 1.2 CCOE Clearance & MoEF Clearance
- 1.3 Factors affecting plant location
- 1.4 Steam distribution including appropriate mechanical valves and instrumentation
- 1.5 Process pumps
 - 1.5.1 Positive displacement pump
 - 1.5.2 Centrifugal pumps
- 1.6 Compressors
 - 1.6.1 Positive displacement compressor
 - 1.6.2 Dynamic compressor

2. Plant Design

- 2.1 Piping design
- 2.2 Connecting pipes to process equipment
- 2.3 Layout
- 2.4 Support for piping insulation

3. Process Economics

- 3.1 Value of money
 - 3.1.1 Straight line method
 - 3.1.2 Declining balance method
 - 3.1.3 Double declining balance method
 - 3.1.4 Sum of year digit method
- 3.2 Depreciation

4. Cash Flow

- 4.1 Balance sheet
- 4.2 Variable cost & Fixed cost
- 4.3 Economic production charts- Break Even analysis chart

5. Profitability Analysis

- 5.1 Rate of return and Pay out time
- 5.2 Overall Cost Analysis
- 5.3 Economic tradeoffs

REFERENCE BOOKS:

1. J.M. Coulson, JF Richardson, RK Sinnott Butterworth Heinman, Chemical Engineering Volume 6, Revised Second Edition, Butterworth-Heinemann.
2. M. S. Peters & K. D. Timmerhaus, 'Plant design & Economics for Chemical Engg.' McGraw-Hill Science/Engineering/Math 5th Ed.
3. Industrial Boilers, and Heat recovery Steam Generators Design, Applications and calculations by V.Ganapathy, Marcel Dekker, Inc.,
4. Sivasubramanian V, "Process Economics and Industrial Management", Galgotia Publications Pvt Ltd..

PROCESS EQUIPMENT DESIGN

Course Code	CH 60021
Course Title	Process Equipment Design
Number of Credits	3(L-3,T-0, P-0)
Prerequisites	NIL
Course Category	PE

Course Learning Objectives:

This course is useful for chemical engineering students as

- it develops the skill to select and design the appropriate process equipment for the required process operation
- evaluate the performance of existing equipment.

COURSE OUTCOMES

On completion of this course the students will be able to:

- Design pressure vessel equipment
- Design of heads and supports
- Design of agitated vessels, storage tanks and reaction vessels
- 4.Design of mass transfer equipments
- Design of heat transfer equipments .

COURSE CONTENTS:**1. Design of Pressure Vessels**

- 1.1 Cylindrical vessel
- 1.2 Spherical vessel
- 1.3 Conical vessel

2. Heads & Supports

- 2.1 Design of heads/closures
 - 2.1.1 Flat Heads
 - 2.1.2 Flanged Heads
- 2.2 Design of supports
 - 2.2.1 Vertical supports (Skirt support, Ring support)
 - 2.2.2 Horizontal supports (Saddle support)

3. Agitated Vessels, Storage Vessels, Reaction Vessels

- 3.1 Design of Storage tanks
- 3.2 Design of Agitated vessels and Reaction vessels.

4. Phase Separation Equipment

- 4.1 Design of physical separation equipments
 - 4.1.1 Gas phase continuous system
 - 4.1.2 Liquid phase continuous system

5. Heat Exchangers, Gas –Liquid Contact System

- 5.1 Design of Heat Transfer Equipments
- 5.2 Design of Mass Transfer Equipments
 - 5.2.1 Distillation columns
 - 5.2.2 Absorption columns
 - 5.2.3 Extraction columns

REFERENCE BOOKS:

1. R. H. Perry, "Chemical Engineers' Handbook", 7th Edn., McGraw Hill , New York.

2. R. K. Sinnott, "Chemical Engineering Design", Coulson and Richardson's Chemical Engineering Series, Volume-6, Fourth Edition, Butterworth-Heinemann, Elsevier, New Delhi.
3. L. E. Brownell and E.H. Young, "Process Equipment Design - Vessel Design", Wiley Eastern Edn. New York.
4. B.C. Bhattacharyya, "Introduction to Chemical Equipment Design Mechanical Aspects", CBS Publishers & Distributors, New Delhi.
5. D.Q. Kern "Process Heat Transfer", Tata McGraw Hill Edn..
6. V. V. Mahajani and S. B. Umarjii, "Joshi's Process Equipment Design", 4th Edn., Mac Millan Publishers India Limited, New Delhi.

WASTE MANAGEMENT

Course Code	CH 60022
Course Title	Waste Management
Number of Credits	3(L-3,T-0, P-0)
Prerequisites	NIL
Course Category	PE

Course Learning Objectives:

This course will help to recognize and learn about

- Pollution, pollutants, waste disposal processes, waste management, waste treatment and recycling
- To understand the impacts on our environment.

COURSE OUTCOMES

On completion of this course the students will be able to:

- Understand the types and characteristics of solid and hazardous waste
- Apply steps in solid waste management-waste reduction at source, collection and reduction techniques .
- Understand optimization of solid waste transport, treatment and disposal techniques.
- Design of landfill bioreactors and environment monitoring of landfills.
- Understand the legislations on management and handling of solid and hazardous waste

COURSE CONTENTS:**1. Solid and Hazardous Waste**

- 1.1 Types and Sources of Solid and Hazardous Wastes
- 1.2 Need for solid and Hazardous Waste Management
- 1.3 Waste Generation Rates - Composition – Hazardous Characteristics

2. Storage, Collection, Reduction, Handling

- 2.1 Waste Sampling - Source Reduction of Wastes - Recycling and Reuse - Handling and Segregation of wastes at Source
- 2.2 Storage and Collection of Municipal Solid Wastes - Analysis of Collection Systems
- 2.3 Labeling and Handling of Hazardous wastes

3. Waste Processing Technologies

- 3.1 Waste Processing
- 3.2 Processing Technologies - Biological and Chemical Conversion Technologies
- 3.3 Thermal Conversion Technologies - Energy Recovery - Incineration
- 3.4 Treatment of Biomedical Wastes

4. Landfill

- 4.1 Disposal in Landfills - Site Selection - Design and Operation of Sanitary Landfills
- 4.2 Secure Landfills and Landfill Bioreactors - Leachate and Landfill Gas Management
- 4.3 Environmental Monitoring - Closure of Landfills - Landfill Remediation

5. Legislations

- 5.1 Legislations on Management and Handling of Municipal Solid Wastes
- 5.2 Legislations on Management and Handling of Hazardous Wastes

5.3 Legislations on Management and Biomedical Wastes

REFERENCE BOOKS:

1. O.P. Gupta, "Elements of Solid Waste Hazardous Management", Khanna Publishing House, New Delhi, 2018
2. George Tchobanoglous, Hilary Theisen and Samuel A, Vigil, Integrated Solid Waste Management, McGraw-Hill, New York, 19932.
3. CPHEEO, Manual on Municipal Solid waste management, Central Public Health and Environmental Engineering Organization, Government of India, New Delhi.
